Carolina da Graça Cúrdia Lourenço Coelho

LIFE WITHIN ARCHITECTURE FROM DESIGN PROCESS TO SPACE USE

ADAPTABILITY IN SCHOOL BUILDINGS TODAY – A METHODOLOGICAL APPROACH

PhD Thesis in Architecture, supervised by Professor Mário Júlio Teixeira Krüger and co-supervised by Professor Teresa Frederica Tojal de Valsassina Heitor and presented to the Department of Architecture, Faculty of Sciences and Technology of the University of Coimbra

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Universidade de Coimbra

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Cover Image

Quinta das Flores School, Coimbra, Portugal, 2017 © Carolina Coelho

The research for this dissertation benefited from the financial support of a Doctoral grant given by FCT - Fundação para a Ciência e a Tecnologia under the program QREN-POPH-Tipologia 4.1-Formação Avançada, co-financed by the European Social Fund and by the national funds of the Portuguese Ministry of Education and Science.

TITLE

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KEYWORDS

. Adaptability

. Methodology

. School building

. Design process

. Space use

ABSTRACT

Acknowledging school space as an enabler of the teaching and learning process, this research proposes to problematise the relevance of space use in the learning environments as a variable to be introduced in the design and spatial adaptability as a possibility of enhancing that use.

Adaptability copes with the changes brought by the rapid developments from the pedagogical practices, the curricular options and the information technology, enabling a more lived educational space, which allocates more diverse activities and users, within a longer lifecycle.

Despite having been previously studied, namely in the 1970s, adaptability in school buildings today translates itself onto the current spatial and technical requirements guided by the contemporary pedagogical practices and a more independent and creative student profile. Therefore, this research intends to identify how the concept of adaptability in the 21st century secondary schools is understood and configured and to define a methodology able to observe and describe the condition of adaptability within this context.

The original methodological approach presented aims to assess the schools' ability to cope with the pedagogical and social evolving needs and to conclude on the design attributes that potentially enhance adaptability, for a more lasting and effective building performance. It systematically introduces procedures from different epistemological provinces, providing a more extensive analysis on the building's description for a more supported retrieval of its adaptability potential, sequentially as: description of the spatial sample, functional and morphological, informing on how it supports activity allocation; description of all possible activity allocations, informing on the pedagogical potential of each educational environment; description of effective events, informing on actual behaviour and spatial appropriation on the school; and description of the potential correlations amongst each stage and transversally on all these variables. This last milestone enables the retrieval of the school's adaptability.

As a case study this research assesses space use in a Portuguese contemporary artistic school, as a hub for a broader school community and a wider range of uses, amongst which the defined methodology will be tested and calibrated.

Finally, the milestones of the proposed methodology are assessed and their results correlated, in order to understand potential similarities and variances that might be specific of its application onto the case study, or that might imply more general correlations between spatial morphology, entropy and effective spatial fruition. Conclusions also lie on their respective implications towards adaptability, acknowledging them both in the design and during the school's fruition and recognising potential pedagogical, social and cultural changes that might convey life and learning within a school environment.

TÍTULO

A vivência na arquitectura do projecto ao uso

Adaptabilidade no programa escolar de hoje – Uma abordagem metodológica

PALAVRAS-CHAVE

. Adaptabilidade

. Metodologia

. Edifício escolar

. Processo de projecto

. Uso do espaço

RESUMO

Ao entender o espaço da escola como potenciador do processo de ensino-aprendizagem, propomo-nos problematizar a importância da utilização do espaço em ambiente escolar como variável para o processo de projecto e a adaptabilidade espacial como forma de promover esse uso.

A adaptabilidade visa a acomodação da mudança provocada pelos rápidos desenvolvimentos das práticas pedagógicas, das opções curriculares e da tecnologia de informação, permitindo assim um espaço educativo mais vivido, que alberga actividades e utilizadores mais diversos, num ciclo de vida mais extenso.

Apesar de anteriormente estudada, particularmente nos anos de 1970, a adaptabilidade nos edifícios escolares de hoje traduz as actuais exigências espaciais e técnicas, balizadas por práticas pedagógicas contemporâneas e por um perfil de aluno mais independente e criativo. Pretende-se, assim, identificar como se considera e configura este conceito nas escolas secundárias do século XXI e definir uma metodologia capaz de observar e descrever a condição de adaptabilidade adequada a este contexto.

A abordagem metodológica original apresentada tem como objectivo aferir a capacidade da escola em responder às contínuas mudanças pedagógicas e sociais e concluir sobre os atributos espaciais que potencialmente promovem a adaptabilidade, para um desempenho mais longo e efectivo do edifício. A metodologia introduz sistematicamente procedimentos de diferentes campos epistemológicos, permitindo uma análise mais completa da descrição do edifício, visando uma conclusão mais suportada quanto à sua adaptabilidade, sequencialmente da seguinte forma: descrição da amostra espacial, funcional e morfológica, informando sobre como esta suporta a alocação espacial; descrição de todas as possíveis alocações de actividades, informando sobre o potencial pedagógico de cada ambiente educativo; descrição da fruição efectiva, informando sobre a experiência e a apropriação do espaço no edifício escolar; e descrição das potenciais correlações em cada etapa e transversalmente entre todas estas variáveis. Esta última etapa permite concluir sobre a adaptabilidade do espaço da escola.

Enquanto caso de estudo, avaliar-se-á o uso do espaço numa escola portuguesa artística de hoje, como agregadora de uma comunidade escolar mais ampla e de um leque de usos mais alargado, na qual se irá testar e calibrar a metodologia definida.

Por fim, as etapas da metodologia proposta são aferidas e os seus resultados correlacionados, no sentido de perceber semelhanças e variantes que possam ser específicas da sua aplicação no caso de estudo, ou que possam implicar correlações mais gerais entre morfologia do espaço, entropia e fruição espacial efectiva. As conclusões residem também nas suas respectivas implicações para com a adaptabilidade, compreendendo-as tanto em projecto como durante a real fruição da escola e reconhecendo as eventuais mudanças pedagógicas, sociais e culturais que possam pautar a vida e a aprendizagem dentro do edifício escolar.

ACKNOWLEDGEMENTS

This Doctoral Thesis results from a research path, which has come across several people, often set in different geographic locations and different time limes on this research, whose thoughts and actions, either more specifically or more frequently, from an academic or more informal manner, have contributed to this final document.

To whom I have more to thank for are my Thesis Supervisors: Professor Mário Krüger and Professor Teresa Heitor. I would like to express my deepest gratitude towards Professor Mário Krüger, my mentor, whose widespread knowledge and critical thinking have always been an extraordinary example of how several research cultures and authors could be thought, critically and holistically, always aiming to knowledge advancement within architecture. I have to thank Professor Mário Krüger's critical remarks on my work and all the challenges set and, foremost, for showing me with such certainty where my path lies. No words could ever be enough to express the honour that has been to have had the opportunity to be supervised by Professor Mário Krüger, to be able to exchange thoughts and ideas on the subjects under study and the testimonies on the Anglo-Saxon context and respective research culture, and to have had the opportunity to lecture and to learn during the Theory of Architecture classes on the Department of Architecture, who we all acknowledge. It has been my biggest challenge to be taught by Professor Mário Krüger, and surely by biggest honour.

To Professor Teresa Heitor also lies my deepest thank you, for making me advance further and further, for presenting me with all the possibilities, for her wisest conjectures on this research question and for sharing with me her approach to it. I thank Professor Teresa Heitor for believing in the contemporaneity of this proposal, its originality and its making, under a shared research interest and common academic beliefs. It has been with the deepest admiration and humility that I have had Professor Teresa Heitor's extensive support and knowledgeable feedback for this study.

The contribution of Dr. William Fawcett since our initial contacts via email in April 2011 until more recent developments, have been paramount for the development of this Doctoral Thesis whose state of the art lies very significantly in Fawcett's 1978 Doctoral Thesis *A Mathematical Approach to Adaptability in Buildings* from the University of Cambridge. Having been able to access his work on adaptability, as well as the acknowledgement of his later developments on that behalf, have been true opportunities that I deeply have to thank for. Moreover, Dr. William Fawcett's attentive reading of some of my papers and his critical remarks have been most significant for the further development of this research and its contemporary and original assessment.

I also thank the architect José Paulo dos Santos for his availability in receiving me, explaining me his work and the context of Quinta das Flores School rehabilitation and for the interview that was kindly possible to be held in his office. I also thank him very much for attentively reviewing the interview's transcription and for authorising its insertion in this Thesis as a support and as an original primary source for the thoughts exposed throughout.

From Quinta das Flores School and the Music Conservatory of Coimbra, this Thesis case study, the understanding and cooperative role of both theirs Directors at the time of the research, Professor Ana Margarida Marques and Professor Manuel Rocha, respectively, have been crucial for the undertaking of the methodology here proposed, from our multiple reunions from early 2011, to the preparations of all the procedures and the gathering of all the authorisations needed for entering the School's premises, recording the uses and the users' feedback and actually experiencing space has been truly fundamental. Along with their support, I also express a word of gratitude towards all the school community. The students, for their openness in portraying their lives within the School, the Student Association of Quinta das Flores School and the Student Association of the Music Conservatory for their eager in participating on the focus groups, their openness and availability and for providing their photographic records of the Conservatory events, namely by António Godinho and Mariana Veiga. Besides, the remaining Direction board of both the School and the Conservatory, namely the then Vice-Director Catarina Peixinho, who have all collaborated with this study. Also, the teachers and staff, particularly the ones who were available to show the school's spaces and to elaborate on them and on the people's routines in space, that have also been significant. Specifically, I thank Inês Pedruco, a dance teacher and their students, who have accepted that I attended their dance class and record it for the purpose of this Thesis. Furthermore, testimonies such as the one by Cláudia Fernandes, former artistic student and teacher, enabled a more comprehensive understanding of individual fruition in the building.

Naturally that a deeper word of acknowledgement goes to the contributors on the focus groups and the parents of all the children involved that have understood its relevance and have also authorised their participation. I thank the teachers from the Conservatory: Helena Ruas, Fausto Moreira, Jaime Barbosa and Samuel Couto and also the teachers from the School: José Olímpio, Luís Ala, Rosário Agra and Maria da Luz Santos. I also thank the students from the regular teaching curriculum that have contributed for the surveys: Joana Catré, Catarina Beirão, Beatriz Leite, Francisco Rocha and their respective parents that have authorised their participation, namely Célia Filipe (Francisco Rocha's mother) for their motivation and understating. Finally, I thank the artistic students for their contribution and for their very particular motivation in regard to depicting their lives within the building, their critical thinking and interest in expressing their regards: António

Godinho, Mariana Veiga, Beatriz Ramos, Margarida Lopes, Guilherme Gouveia, Ricardo Falcão and Luisa Falcão. The high involvement of their parents also implies a word of acknowledgement, particularly for Paula Sá (António Godinho's mother), Cláudia Azevedo (Guilherme Gouveia's mother) and Cristina Fonseca (Ricardo and Luisa Falcão's mother).

For the description of effective spatial fruition the team gathered to observe and record all the procedures undertaken has played a crucial role: Micael Soares, Stephanie Torres, Daniela Aires, Jéssica Barreto, Maria Catré and Juliana Ferreira. I thank you all for your enthusiasm, availability and for your extreme rigour on each task you were given. I could not have chosen a better and more devoted team.

From the beginning of this research, the gathering of all the materials related to this project were paramount as a basis to work on, from an architectural perspective on the implementation of this methodology. The supported provided by Parque Escolar has, therefore, been of extreme relevance, namely by the architects Hugo Carvalho and Sofia Reis and also by Dr. Catarina Frazão for the publication of photographs of the schools. Besides, the support of Dr. Filipa de Jesus also implies her acknowledgement for contributing to this Thesis references.

Throughout all this process, there have been many milestones to achieve and relevant moments of input. The first would have to be the presentation of the Thesis Project after a year and a half of frequent classes on the first Course on Architectural and Urban Culture on the Department of Architecture in the University of Coimbra. This has been presented in February 2012, and has had the critical assessment of Professor Alexandra Alegre, whose attentive reading and remarks enabled a more robust research question and a more supported state of the art. Since our initial contacts regarding Professor Alexandra Alegre's Doctoral Thesis, to the encounters on Instituto Superior Técnico, or on several conferences, whose themes we share, these have been relevant inputs to this Thesis and to the belief of a shared interest.

Also from Instituto Superior Técnico, I thank Professor Ana Tomé and Maria Bacharel for promptly receiving me and providing me with more detail on the In_ Learning Project and the establishment of potential research synergies.

More recently, all the support from Instituto Superior Técnico concerning the *11th Space Syntax Symposium*, namely by Maria Bacharel and Luísa Cannas, has demonstrated common study fields and has contributed to input my personal research. Also from the this symposium the relevant feedback by Professor Luiz Amorim on the paper I presented (Coelho and Heitor, 2017) as a systematic outlook of my Thesis has proven relevant in deepening the space and society's relation in regard to Basil Bernstein, also through the work of Claúdia Loureiro (Loureiro, 2000) that Professor Luiz Amorim has provided me with.

Besides, from this symposium, another most significant contact was received on behalf of Adrian Leaman related to another paper presented there on the early beginnings of space syntax (Gil and Coelho, 2017), that demonstrates its relevance and originality, foremost by one of its most prominent intervenients, forty years after his seminal paper with Bill Hillier (Hillier, Leaman, Stansall and Bedford; 1976). It is also acknowledged Adrian Leaman's interest and his recognition towards our work, promoting the pursuit of this theme even further, and his availability for accomplishing it, as future developments of our research to be continued beyond this Doctoral Thesis here presented.

Also from the previous *10th Space Syntax Symposium* in London in 2015, I thank the input from professor Bill Hillier, who has attended the session in which the paper that also underlies my study on the approach of space syntax to entropy was first presented (Coelho and Krüger, 2015) and who advanced the interest of studying entropy, then stating that "entropy is a fundamental measure to man". Prior to this personal contact with Professor Bill Hillier, an initial one by email has also been successful in regard to the space syntax within the Bartlett School of Graduate Studies, and the authorisation for publishing an image on that behalf, for the paper (Coelho, 2013c) and for the presentation on the Teaching through Design: International Colloquium on Design Studio Education in 2012. Under this context I also thank Paulo Providência and Gonçalo Canto Moniz for the organisation of that colloquium.

Also from the Bartlett School of Architecture, I thank Kerstin Sailer for the prompt reply, in 2013, in regard to their work on the Project Effective Workplaces (Sailer, Budgen, Lonsdale and Penn, 2007a), specifically for the authorisation for publishing a diagram from that study, provided in high resolution, also within the scope of the Teaching through Design: International Colloquium on Design Studio Education in 2012 (Coelho, 2013c). Within the same paper, authorisation has also been given for publication of images regarding the Larc 503 Design Activism by Ben Spencer and by Professor Paul Jenkins for two of his diagrams (Jenkins, 2010)

Dillier Scofidio + Renfro have been most helpful in enabling the publication of images of their projects for this mentioned colloquium but also for the publishing of other images for the *11th Conference of the European Architectural Envisioning Association* in Milan in 2013 (Coelho, 2013e). Furthermore, I also thank Atelier Joana Vasconcelos for the cooperation in publishing an image from their work for the same conference in Milan.

For the contacts exchanged during the *International Conference and Workshop on Architectural Education - Educating the Future: Architectural Education in International Perspective 2013* in Istanbul, and all the publications provided also for the Department of Architecture's library, I thank Susanne Komossa and Sien Van Dam, from Delft University of Technology. Also from Delft University of Technology, I thank Jorge Mejía for his invitation for submitting a paper that has been published within *Writingplace - Laboratory for Architecture and Literature* (Coelho and Gil, 2013f).

For the information exchanged from the *Arquitectonics Conference* in 2013 in Barcelona (Coelho, 2013b), until the most recently conversations on research cultures, I thank Professor Josep Muntañola's very insightful outlook and feedback from both papers presented at the *11th Space Syntax Symposium*, and also the acceptance in publishing my paper (Coelho, 2017) on the relation between school and learning in the *Architecture and social space. Arquitectonics* edited by him. During the same Barcelona conference, other contributions have been exchanged namely with Professor Michael Holquist over the work of Mikhail Bakhtin and also with Ramon Carvalho for his suggestions.

From the feedback gathered during the *Nexus Conference* in Milan in 2012 (Coelho, 2012b), I thank Dr. Maria Zack, and the contact established through her to Jimmy Hite who has shared some input on his work from the American context of adaptability. Besides, I also thank the feedback from Professor Cornelie Leopold and Professor Michael Ostwald within the same conference's context and further contacts by email regarding very relevant suggestions.

More recently, I thank David Viana, Frankim Morais and Jorge Vaz for their welcome and enthusiastic interest for my presentation on the 3rd International Symposium Formal Methods in Architecture (Coelho, 2016) and future publication of the full paper.

For the invitation for contributing to the Coimbra Biennial of Contemporary Art *700+25 Architecture at the UniverCity. Anozero'15*, I thank Désirée Pedro, José António Bandeirinha and Nuno Grande in (Coelho, 2015a and 2015b).

For the invitation for submitting a paper for the *Ambiances Review, International Journal of Sensory Environment* (Coelho, 2015c), I also thank Eugenio Morello and Barbara Piga, whose interest on my research started from the presentation in the *11th Conference of the European Architectural Envisioning Association* in Milan in 2013 (Coelho, 2013e).

During his stay in Coimbra in November 2015, Anthony Vidler has shown the interest on my personal research and has provided me with some feedback on it, particularly with regard to his previous work, which I thank.

As the materials and references were not immediately accessible from Coimbra regarding the case study and the references on adaptability, both contemporary and from the state of the art. So, there are some contributors that have provided me with papers and documents that could be retrieved elsewhere, to whom I thank. I thank Odete Coelho from the National Laboratory for Civil Engineering for providing me with a relevant reference for my research and I also thank Françoise Le Cunff for the help on the search of two documents for the state of the art on the subject. Besides, Mariana Carvalho has also provided me with the documents that she has gathered from her study of the National Laboratory for Civil Engineering. I also thank Ana Moreira for conveying me a very relevant paper on space syntax

from the Calouste Gulbenkian Foundation library, as well as Raquel Margarido and Filipe Silva for proving me with a paper from the Organisation for Economic Co-operation and Development from Paris, otherwise inaccessible from Portugal. I also thank Susana Faria, a very present friend, for retrieving some essential papers from the Bartlett School of Architecture and for the references exchanged whenever our themes crossed each other. Also for the all the synergies found between our works, I also thank Andrea Vieira as a colleague and a friend.

A word of thank you is also left to all my friends and colleagues whose informal conversations have often inputted my work and my thoughts. I thank Luís Miguel Correia, Susana Constantino, Nelson Mota, Miguel Oliva, Dalila Gomes, David Neto. I also thank the caring friendship and support of Filipa Madeira and her family. The frequent reunions organised by Professor Mário Krüger amongst all his PhD students have been relevant sessions for knowledge acquisition and exchange amongst all the different themes dealt by each PhD candidate, but that often approached our own interests under common themes and authors. I thank Cristina Castelo Branco, Susana Faria, Diogo Morato, Joana Maia, Cátia Ramos, Rui Aristides, Rodrigo Holzer de Brito, Miguel Eufrásia, Andreia Margarido, Ana Tavares, Mariana Couto, Ana Tavares, Alexandre Oliveira, Ana Aragão and Joana Capela.

Besides, I also thank all the PhD candidates that have enrolled in the Course on Architectural and Urban Culture on the Department of Architecture, who have been my peers and also all the teachers of that Course for their invaluable lectures, that have created significant moments of critical thinking and have also been the start of very relevant professional and personal relations and friendships.

I would also wish to thank Professor José António Bandeirinha for teaching me so much since my Graduation Thesis, as my supervisor, but also for standing by my side on most of the Master Thesis that I have co-supervised, for teaching the students and also for teaching me so much on the contents of approach but also on their pedagogical conveyance, for the critical thinking on the possible research questions and how to best respond to them. Foremost, I thank Professor José António Bandeirinha for teaching me to follow my path, also socially engaged to architecture, to the city and to the organisation of space towards people.

A word of particular acknowledgement to Gonçalo Canto Moniz, for all the friendly and trustworthy moments of reflection provided by our conversations on these topics, for his support with some references and for the contacts towards a relevant community of researchers on this field and for his invitation, along with António Rochette, for joining him in research project applications such as Learning Spaces: Construction and Transformation of the Secondary School (2015) and Breaking Walls (2017).

I also thank all my colleagues of the Department of Architecture, with whom my daily professional life is spent in the Department of Architecture and whose

interest and companionship have always been so significant. I thank José António Bandeirinha, Jorge Figueira, Gonçalo Canto Moniz, Nuno Grande, Rui Lobo, Carlos Martins, Armando Rabaça, Paulo Providência, Pedro Pousada, Susana Lobo, Adelino Gonçalves, Vítor Murtinho, António Bettencourt, Teresa Pais, Joaquim de Almeida, António Olaio, António Lousa, João Paulo Cardielos, José Fernando Gonçalves, Pedro Maurício Borges, João Mendes Ribeiro, Walter Rossa, Margarida Relvão, Carlos Antunes and Desirée Pedro. Furthermore, I thank my dear friend Graça Simões for her constant availability and support.

Still, in the Department of Architecture, I also thank Sílvia Damas, Vanessa França, Lurdes Figueiredo, Lurdes Eufrásio and António Cardoso that have been so supportive for so many years.

My recognition also goes ineluctably to Nuno Nina, always available and very rigorous, but foremost someone I consider a very special friend, with whom I could always count on.

I also thank all of my students of the Department of Architecture, that has been my home for so many years, I thank them for their interest and support, for also teaching me everyday where my life lies and the joy I so honestly take from researching, learning and lecturing. I thank them for enhancing even further my motivation for simultaneously complying with lecturing different subjects of Theory and History of Architecture and accomplishing a Doctoral research. I thank them all, the ones still studying on the Department of Architecture and who I meet every day and all the remaining ones, whom I hope to have assisted on their formation as current architects, in the many ways of professional engagement possible.

I thank the Foundation for Science and Technology for providing me a PhD scholarship (SFRH/BD/69433/2010) and the Centre for Social Studies and all its team, for receiving me as the research unity associated with my Doctoral Research.

Finally, my thank you to those who were always a part of this personal and professional project, that have travelled it alongside with me and have always believe in it and contributed the most to its achievement and to my accomplishment. I thank my family, my parents Carlos Coelho and my mother Conceição Coelho, for acknowledging this as my path and my life, and my grandparents António and Idalina Coelho for their unconditional support. Also I thank Vasco and Luísa Gil.

To Bruno Gil, my husband, my colleague and my partner in life, I thank you for sharing with me our past, our present and our future projects, for believing in all of them. Thank you for being in my life, in each of its multiple layers, for climbing each step with me and for always wishing for the next one. Thank you.

To those whom I love.

To those who love me.

To our future…

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1. INITIAL CONSIDERATIONS

1.1. Introduction

> "You cannot talk about a corridor being narrow without making assumptions about how buildings are used." (Fawcett, 1995, p.8)

The Thesis presented is a result of a specific research that took place since 2010, but that has been previously supported by a strong motivation and a comprehensive background on studies related to spatial experience and appropriation, space-use reciprocity, participatory design processes and user research studies, throughout the all Course for the Degree of Architecture. These studies culminated in the Graduate Thesis *The matter of the architect: the Portuguese society and the architect, today,* presented in the University of Coimbra in 2008, supervised by Professor José António Bandeirinha and argued, on its final presentation, by Professor Mário Krüger, which already discussed the role of the architect and its interconnection to society and the bond between space and life within.

Following Popper's (1975[1]) line of thought on the third world of the logical relations between space and society, the Graduate Thesis aimed to answer some of the questions that a *yet to be* architect would place, namely what are the needs and wants expected to be answered by the architect and what are the answers the architect expects to pursue towards answering society's requirements.

Still, that Thesis already implied future developments and the investigation of a specific hypothesis, under a Doctoral Research in a near future. At this stage, this Doctoral Thesis aims to deepen the knowledge on this embedded bond under a specific approach on a particular research question to be presented on chapter 1.3. The research question.

The main title aims to resume all these motivations, focusing on the deep relation between *life* and *architecture*, considered to be of significant relevance throughout all the lifecycle extent of space, from the *design process* by the architect, to *space use* by the inhabitants.

Besides, the sub-title aims to present the specificity of this particular agenda from

[1] First edition in English from 1972.

the more general interest of the main title, the case study and the time frame of the Thesis, by referring to *Adaptability in school buildings today*.

In what concerns the Keywords, the chosen ones relate to the main issues in which this Thesis centres around: *Adaptability* is the variable to be analysed; *Methodology* implies the sequential means and stages by which adaptability will be analysed and consists of a significant part of this Thesis, as it presents an original set of procedures to undertake in order to determine adaptability within today's pedagogical model and educational spaces; *School building* is the brief and the building typology in which the methodology will be applied in; and it is considered that adaptability is a variable that concerns all the lifecycle extent of the building that, when considered during the *Design process,* provides a longer and broader *Space use* from its future inhabitants.

This research is also supported by the contents provided during the first three semesters of the Course on Architectural and Urban Culture from the Department of Architecture of the Faculty of Sciences and Technology of the University of Coimbra, in which several subjects have been lectured and the Thesis Project more clearly defined, from the classes and all the papers undertaken, from September 2010 to February 2012.

In fact, all the subjects lectured during this Course allowed to better inform this issue already identified as the research problematics, to broaden the data on the state of the art, to widen the knowledge on the study area and respective authors of reference, to realise other adjacent issues and study fields and to understand their affinities and complementary contents for the current matter. It also provided a development of the arguing skills, and foremost the abilities for researching and reflecting upon the contents, fundamental for the pursuit of the Third Cycle Studies.

The frequency of these three semesters entitled the Candidate with a Diploma of Advanced Studies on Architecture. This process culminated in its final presentation in February 2012, with the presence of Professor Teresa Valsassina Heitor as Thesis Co-Supervisor, Professor Maria Alexandra Alegre as Examiner and Professor Nuno Grande as President of the Jury.

Throughout this research, academic papers have also been produced under the scope of international conferences and publications such as: *Nexus Conference* (Milan 2012), *International Colloquium Teaching through Design* (Coimbra, 2013), *Arquitectonics Network* (Barcelona, 2013), *Conference of the European Architectural Envisioning Association* (Milan, 2013), *International Journal of Sensory Environment* (2015), *International Symposium Formal Methods in Architecture* (Porto, 2015) and *International Space Syntax Symposium* (London, 2015; Lisbon, 2017)[2]. This attests the academic interest on the research question and peer acceptance and validation on the work produced during this process.

[2] All the personal publications are listed in the final chapter of the Bibliography.

Finally, this Thesis is presented with the Centre for Social Studies as the associated Research Laboratory and has had a grant from the Foundation for Science and Technology (SFRH/BD/69433/2010).

The following chapter aims to present and justify the choices made throughout the remaining document of this Thesis, considering that a whole introductory text comprising all the considerations here presented would need to be structured into less extensive and specific texts. That explains the need to section the Initial Considerations chapter into eight topics for clarification of each individual situation that leads to the final result on this Thesis' following chapters, holding the main contents' relevance clarified in the first.

This current Thesis is written in UK English and the references presented in the text and in the Bibliography are cited in APA style (American Psychological Association). The quotes have been presented in English, mostly through the reading of the versions translated to English. When Portuguese, French or any foreign language quotes are needed, they have been translated by the author of this Thesis to English for better understanding by non-speakers of those languages. In these cases the original version is added in a footnote on that page.

1.2. Motivation and background: Architecture and Life - conceiving forms of engagement

> "Architecture has its own realm. It has a special physical relationship with life. I do not think of it primarily as either a message or a symbol, but as an envelope and background for life which goes on in and around it, a sensitive container for the rhythm of footsteps on the floor, for the concentration of work, for the silence of sleep." (Zumthor, 1988, p.1)

This initial text aims at providing a background understanding and critical reflection upon the possibilities of engagement between Architecture and Life, so the subsequent ones may specifically present the concept of adaptability as a form of that engagement, considered in the design of space and experienced throughout its fruition.

Overall, the living experience is deeply embedded in architecture, as a feature but foremost as a significant part of its being, to be thought while conceiving the initial drafts until its effective occupancy. The interconnection between space and the body is profoundly embedded in architecture and is understated when describing, conceiving and assessing its spatial outcome. This condition can consider space as a *stage* for action to happen, but also and upmost as an *enhancer* of the interaction between space and body, the self and the contextual surroundings, and ultimately, architecture and people[3].

Straightaway, it becomes quite significant to highlight the different terms and their respective meanings, used from this point on and throughout the all Thesis. The initial concept used for this research has been the Portuguese word ***vivência***, whose

[3] This approach on the connection between Architecture and Life has been presented in the *11th conference of the European Architectural Envisioning Association*, in 25-28 September 2013, Milan, for testing and academic validation. It has also been published in the Conference's proceedings as: Coelho, C. (2013). Designing and assessing the living experience from brief to use. In E. Morello; B. Piga (Eds.). *Envisioning Architecture: Design, Evaluation, Communication- Proceedings of the 11th conference of the European Architectural Envisioning Association.* Milano, 25-28 September 2013. (pp.183-191). Politecnico di Milano. Milano: Edizioni Nuova Cultura.
Besides, and by furthering the study on this dichotomy, another publication has been produced and published in a peer review journal as: Coelho, C. (2015). The Living Experience as a design content: from concept to appropriation. *Ambiances Review, International Journal of Sensory Environment, Architecture and Urban Space [En ligne]. Experiential simulation.*

translation to English may be disputable. Even if some concepts can be considered, such as: *experience*, *fruition*, *appropriation*, *use*, *usage* or *occupancy*, they all report to different contexts and connotations, with subtle, yet actual, distinctions from the original Portuguese word *vivência*.

From this point, *life* has been considered to be the widest concept in scope, which had similar connotations under this subject area. Because *life* embraces human activities, whatever they may be. By proposing an engagement between Architecture and Life, it is understated an embedded connection between space and any form of spatial experience: mental of physical; under any building task; or any individual or collective, formal or informal manifestation of spatial appropriation. This explains the main title of this Thesis.

Nevertheless, when considered suitable, this notion will also be described as *experience* when regarding spatial fruition overall, or when a more analytical connotation is implied, the term *use* will also be introduced.

Therefore, at this stage, it becomes relevant to clarify not only the divergences in approach between the two concepts, but additionally that there are also dissimilarities in each one's meaning, when regarding particular authors or study fields.

The concept of *experience* has been interpreted in different ways according to the authors of reference. Commonly connected with the practical action and to the way how to capture the exterior, epistemologically it relates to feeling, spatial fruition and, hence, the sensorial stimulus projected by space onto its occupants, and simultaneously the occupants' reactions that this stimulus arouses in them, strengthening people's engagement to space.

Commonly, it is regarded as an inner feeling that is perceived by each individual according to his personal filters of interpretation, cultural and social dimension; but it can also be acknowledged as a shared feeling by a community, with a common social denominator.

Philosophically, it could also be regarded as an intellectual conception of space by means of our structures of understanding and perceiving space, or it could be understood as a sensitive experience of space made through the way space arouses our senses. According to the authors of reference, it can be both intellectual - according to Plato or Descartes; or sensitive - according to Locke or Hume. In his work *Critique of Pure Reason,* Kant (2001[4]) acknowledges perception as a gathering of these two approaches - intellectual and sensory, implying that a certain object triggers a sensitive experience in the self, that is later processed by our structures of understating, producing an intellectual interpretation.

[4] Consulted edition in Portuguese from 2001, original edition from 1781.

As a matter of fact, the relation between the spatial features and the inhabitant's experience of space has been interpreted by different and most diverse approaches, from the study fields of literature, art or philosophy, to several studies within architecture itself: from the well-known quote by Churchill "We shape our buildings, and afterwards our buildings shape us." (Churchill, 1943[5]); to Hillier and Hanson's work *on The Social Logic of Space* (1984) where it is stated "Society must be described in terms of its intrinsic spatiality; space must be described in terms of its intrinsic sociality" (p.26). Also in Markus's *Buildings and Power* (1993), the author supports that different buildings and respective features can induce asymmetries in the power holding and thus in society. Accordingly, and despite the differences in outlooks, all these approaches centre around the bond between space and behaviour.

Thus, while conceiving experience as the first step in the uptake of the exterior stimuli, it becomes relevant to understand how the individual perceives and understands it.

Within another context, Jauss (1986[6]) develops for literature the *reception theory*, from the opening lecture given in 1967 at the University of Konstanz entitled *What is and Toward What End Does One Study Literary History?*. According to this theory there are three poles dynamically related: production, reception and communication. The reading is always considered to be production and the reader a creator of sense. Thus, the literary work has both a meaning implied by the work itself and another defined by a given subject. Also from the School of Konstanz, Gadamer (1976, 2004[7]) formulates the concept of *hermeneutics*[8], which he brings into the aesthetic of the artwork, assuming that it also enables an interaction between production, reception and communication.

Previously to this literary context, some authors stand out as precursors of the relevance given to the reader, of which Hohendahl, Lanson, Schucking, Benjamin,

[5] Quote from Winston Churchill's speech in the House of Commons in 28th October 1943 about the reconstruction of the Parliament after the bombing from World War II, according to The Churchill Center in http://www.winstonchurchill.org/resources/quotations/499-famous-quotations-and-stories (consulted in 6 January 2016). According to the same source, the broader quote would be:
"On the night of May 10, 1941, with one of the last bombs of the last serious raid, our House of Commons was destroyed by the violence of the enemy, and we have now to consider whether we should build it up again, and how, and when.
We shape our buildings, and afterwards our buildings shape us. Having dwelt and served for more than forty years in the late Chamber, and having derived very great pleasure and advantage therefrom, I, naturally, should like to see it restored in all essentials to its old form, convenience and dignity."
Brand states that Churchill had already used this quote in 1924 before the Architectural Association like so: "There is no doubt whatever about the influence of architecture and structure upon human character and action. We make our buildings and afterwards they make us. They regulate the course of our lives." (Brand, 1994, p.3).

[6] Consulted version in Spanish from 1986, original version from 1977.

[7] Consulted edition of *Philosophical Hermeneutics* from 1976 and original edition from 1967. Consulted edition of *Truth and Method* from 2004, original edition from 1960.

[8] "According to its original definition, hermeneutics is the art of clarifying and mediating by our own effort of interpretation what is said by persons we encounter in tradition." (Gadamer, 1976, p.98)

Brecht, Escarpit and Sartre. Both Barthes with his *The Death of the Author* (1977[9]) and Benjamin's *The Author as Producer* (1982[10]) had already assumed the role of the reader as a conceiver of an individual and situated narrative, questioning the concept of authorship by implying that the spectator's fruition was also a way of authorship:

> "For the reader is at all times ready to become a writer, that is, a describer, but also a prescriber. As an expert - even if not on a subject but only on the post he occupies - he gains access to authorship." (Benjamin, 1982, p.259)

Later, Lefebvre (1974) develops a mechanism for analysing the relationship between concrete and abstract space, which can be transposed to understanding the relationship between experts and nonexperts. Thus, Lefebvre, by establishing the binomial conceptual/lived space, induces a dialogic relationship between the space *envisioned* by architect and *lived in* by the user.

In a different approach, Bakhtin's concept of "chronotope" (1981), a space-time connection that Holquist (2002[11]) transposes to architecture with the possibility of a building being read as a book "in a ongoing multi-level exchange" (Holquist, 2013[12]), also stresses experience as being situated in and calibrated by the individuals' space and time.

Even in the artistic field**,** the artwork is only completed when perceived by the spectators, that can be actively engaged with the piece, fulfilling its definition with each individual's emotional fruition. Once more, this bond can either be intellectual and enable mental experiences based on semantic changes and conceptual interpretations of the individual, but it can also be more sensitive and actively trigger the spectators' physical condition.

This is clear in the work produced by Duchamp with his ready-mades, whose conceptual meaning is not only carried on by the objects themselves but in what they convey to each user (Fig. 1). Considering that each user has a particular cultural background and a social and cultural dimension, the fruition becomes also individual. Similarly, in Joseph Beuy's *Olivestone* (1984) - a stone vat filled with oil that slowly becomes embedded in the stone, disseminates its scent into the air, actively triggering people's senses. And in doing so, the artwork's fruition passes from perception to being embedded on the individual(s).

[9] Original edition from 1968.

[10] Original edition from 1937.

[11] Original edition from 1990.

[12] From Holquist's lecture "Numbers, words and dialogues", in Barcelona, 29th May 2013, for Arquitectonics Network.

Fig. 1. Before Duchamp's piece on MoMA : *To Be Looked at (from the Other Side of the Glass) with One Eye, Close to, for Almost an Hour* (1918)
(Photo by Carolina Coelho)

Paralleling this to architecture, both the fruition and appropriation of space made by the inhabitants provide it with features that complete its semantic and physical definition. And although architecture and art carry specific values and are perceived at different functional, aesthetical and environmental dimensions, they share the concept of *living experience*, embedded in real time and actual use. Particularly, for architecture, the feedback of spatial fruition is implicit in the way people move, act and enjoy space. This assumption was already pointed out by Barragán in 1955:

> "The sense of all the beautiful things created, resides both in the soul of the beholder as in the soul of those who produced it.Yes, it is also the viewer who pays to the beautiful thing its myriad meanings, and makes it wonderful for us, putting it into a new relationship with the time […]"[13] (Barragán, 1955, p.379)

Yet, architectural experience carries significant specificities, given that the inhabitant, as a contextualised subject, will interpret the values raised by space within his cultural coordinates, in real time and space. Also, because spatial experience takes places at different levels, such as aesthetic, social, environmental or functional, whether of a

[13] Free translation to English from the Spanish quote: "El sentido de todas las cosas bellas creadas reside tanto, por lo menos, en el alma del que la contempla como en el alma del que la produjo. Sí, más bien es el espectador quien presta a la cosa bella sus mil sentidos, y la hace maravillosa para nosotros, colocándola en una nueva relación con la época […]" (Barragán, 1955, p.379).

more intentional or unconscious way, that bear meaning to this analysis.

Hill (2003) relates his approach of architecture to Barthes' literature outlook on *The death of the author* (1977[14]), due to their common outlook on the relevance of a triangular connection between author, work and user/reader, introducing in this relation the work as a enabler of meaning constructed by the reader or the user:

> "The building is not directly comparable to the text. Instead, I suggest that writer–text–reader relations as a whole are analogous to architect–building–user relations. Barthes' reformulation of the author and the reader suggests a model for architecture in which there is not a clear linear route from the architect to the user. To use a building is also to make it, either by physical transformation, such as moving walls or furniture, using it in ways not previously imagined, or by conceiving it in a new way. Just as the reader makes a new book through reading, the user makes a new building through using." (Hill, 2003, p.70)

Hill continues by stating that, although Barthes does not imply the artistic work, this could also be applied to it by the "artist–viewer relations" (p.70), that can also be considered in architecture.

When addressing the individuals or communities that proceed with the occupancy of the space after its design and construction, the concept in question can also be discussed. Generally, *users* are naturally the subjects who *use* space, and *inhabitants* the ones who inhabit the space. To inhabit here can also bear different approaches, from the common dwelling someone's residence and ultimately, someone's home, but it can also be considered to live in, spend time, occupy a particular space, whose connotation can now imply spatial *fruition* or *occupancy* from a set of individuals or a collectivity amongst a conceived space. Appropriation bears also relevance as a concept at this stage, because, if a space bears a certain sense of belonging to people, then *appropriation* (rather than *property*[15]), can be acknowledged, by making that space their own. According to Lefebvre:

> "It may be said of a natural space modified in order to serve the needs and possibilities of a group that it has been appropriated by that group. Property in the sense of possession is at best a necessary precondition, and most often merely an epiphenomenon, of 'appropriative' activity, the highest expression of which is the work or art." (Lefebvre, 1991[16], p.165)

[14] Original edition from 1968.

[15] Property is a concept that can imply the possibility of someone's possessions to be sold/purchased, whereas appropriation is the possibility of someone to consider a sense of belonging to a space, often public or from a collectivity, but that is aimed at providing a more personal way of living in that space, occupying it.

[16] Original edition from 1974.

Thus, appropriating space is a stage of a building's lifecycle that can also, and cyclically, redefine/reinterpret the conceived space by the architect. In fact, by living in space, dwellers shape space, shape it to their needs and wants, to their cultural and social background, acknowledging them as producers and creators of meaning, rather than mere spectators of an "empty vessel" (Hill, 1998, p.2).

When referring to the different ways by which people occupy space, Hill refers to: "passive, reactive and creative"[17] (2003, p.27). As for user creativity, the author also considers it in five different dimensions: "mental", "bodily", "physical", "constructional" or "conceptual"[18] (p.86).

Ultimately, if the experience provided does not emanate directly from the space, but it is constructed by the inhabitant, through his active and creative appropriation, that changes it, defines and completes it, this may acknowledge him as a producer and a creator of meaning, rather than a spectator or a passive user. Then, he is also an author, an "illegal architect":

> "The illegal architect questions and subverts the established codes and conventions of architectural practice, and acknowledges that architecture is made by use and by design." (Hill, 2003, p.131)

In this sense, a spatial conception that conditions a fixed and specific use of space will confine its appropriation to a pre-determined spatial experience. From the paradigm of the house as a *machine à habiter* to Grete Schütte-Lihotzky 1927's Frankfurt Kitchen, particular spatial uses were suggested, narrowing the actions and dwellers to a modernist standard. Thus, *function* is understood as a single part of the potential of the building's usage. If Modern architecture always wanted to improve the living conditions of the people, it also imposed lifestyles, enticing the dwellers to use it in a pre-determined way, as passive receivers of the spatial experience.

The individuality expressed in this appropriation was a relativised variable by modernist principles, when in 1928 the declaration of La Sarraz, the final act of the first CIAM, would express the desire to find solutions for the modern man defined as a stereotype, where the variants of each one did not enter in the equation of space:

[17] "I suggest three types of use: passive, reactive and creative. The passive user is predictable and unable to transform use, space and meaning. The reactive user modifies the physical characteristics of a space as needs change but must select from a narrow and predictable range of configurations largely defined by the architect. The creative user either creates a new space or gives an existing one new meanings and uses. Creative use can either be a reaction to habit, result from the knowledge learned through habit, or be based on habit, as a conscious, evolving deviation from established behaviour." (p.27)

[18] "I identify five types of user creativity, which can be accidental or intentional, and occur singly or in combination: mental, a change in understanding, such as renaming a space or associating it with a particular memory; bodily, a movement or series of movements, independent of or in juxtaposition to a space, such as a picnic in a bathroom; physical, a rearrangement of a space or the objects within it, such as locking a door; constructional, a fabrication of a new space or a physical modification of an existing form, space or object, such as removing the lock from a door; conceptual, a use, form, space or object intended to be constructed, such as a door." (p.86)

> "[...] they expect from the consumer (that is to say the customer who orders the house in which he will live) a revision of his demands in the direction of a readjustment to the new conditions of social life. Such a revision will be manifested in the reduction of certain individual needs henceforth devoid of real justification; the benefits of this reduction will foster the maximum satisfaction of the needs of the greatest number, which are at present restricted." (CIAM, 1928)

This statement would be later criticised and reviewed, assuming that *use* does not have to be fixed, pre-determined or only connected with functionality. It is also a broad term, not only constricted to a functional use, but to the diverse "building tasks" (Norberg-Schulz, 1996[19], p.109) possible to happen in that space. According to this author, they can have different implications and be studied according to four dimensions: "physical control" (p.112), "functional frame" (p.114), "social milieu" (p.118) and "cultural symbolization" (p.122). But all in all, a space may enclose all of these dimensions, implying that the building task can be considered "as a whole" (p.127), sheltering life and all the ways in which life is held:

> "The preceding sections have suggested that most building tasks comprise all the four dimensions we have introduced. The physical control is interconnected with particular functions, and the functions on their hand are determined by social conditions which presuppose the existence of cultural objects. The four dimensions not only allow us to render an account of the functions, interactions and values which make up the building task, but they also make a comparison and classification of the building tasks possible." (Norberg-Schulz, 1996, p.127)

Conversely, the term *living experience* comprises the various ways in which to inhabit a building, involving individual or collective spatial fruition, commonly in a more phenomenological approach. The intangibles, measurable only by forms of appropriation of space, are not amenable of analysis when only analysing the functions of space, considering the space as a flexible vessel for ownership and, thus, a *facilitator* of experiences.

The sensorial stimulus, as a vehicle for a deeper and closer interaction between space and inhabitant(s) in architecture, has already been recognised and dealt by diverse approaches and respective authors. Rogers (1958) refers to "esperienza dell'architettura" and Rasmussen (1962) as "experiencing architecture". Pallasmaa more recently encapsulates it as "understanding architecture" (McCarter & Pallasmaa, 2012). By and large, and despite the choice in verb, architecture bears life within and possibly influences the actions that it shelters. So, the living experience, contextual and cultural as it is, is placed in space and time, and architecture is its vehicle.

[19] Consulted edition from 1996, original edition from 1963.

Furthermore, Tschumi argues that the unpredictability and the events are central for architecture, which can then be defined by actions rather than by shapes that merely create the boundaries of that experience: "Architecture is defined by the actions it witnesses as much as by the enclosure of its walls." (1994b, p.100).

Experience is, in fact, deeply discussed in Pallasmaa's extensive work on phenomenology, recognising space as an emotional vehicle for individual appropriation and a sensorial catalyst, beyond measurability:

> "A building is encountered; it is approached, confronted, related to one's body, moved through, utilised as a condition for other things. Architecture initiates, directs and organises behaviour and movement. A building is not an end in itself; it frames, articulates, structures, gives significance, relates, separates and unites, facilitates and prohibits." (Pallasmaa, 2005, pp.63-64)

For Pallasmaa, "significant architecture"[20] (Pallasmaa, 2005, p.11) or "life-enhancing" architecture (Goethe *apud* Pallasmaa, 2005, p.44) engages the inhabitant(s) by means of all the senses and is not limited to the "ocular bias" (p.30): the primacy of sight over the other senses. This adds to the fact that, instead of an ocular centrism, space is *lived in* and not only *looked at* [21]. Pallasmaa much rather refer to the "epistemology of the senses" (2005, p.17) or what Bachelard identifies as "the polyphony of the senses" (1960, p.6) that is perceived by the body, thought by the mind, and internalized by our consciousness in a whole, articulated process.

According to Holl, Pallasmaa "[...] practices the unanalysable architecture of the senses whose phenomenal properties concretise his writings towards a philosophy of architecture." (Holl, 2005, p.7). This assertion is most insightful since the space is considered to individually arouse the senses, but foremost this "phenomena" is considered "unanalysable" and that "transcends geometry and measurability" (Pallasmaa, 2005, p.64).

Kahn corroborates this statement with his famous saying: "A great building must begin with the unmeasurable, must go through measurable means when it is being designed and in the end must be *unmeasurable*." (Kahn, 1961, p.149)

On the other hand, Hacking in his essay *The creation of phenomena* (1983) claims for another perspective of the term phenomenon, which he shares with the realm of science:

> "My use of the word "phenomenon" is like that of the physicists. It must be kept as separate as possible from the philosophers'

[20] "Significant architecture makes us experience ourselves as complete embodied and spiritual beings." (p.11)

[21] "We behold, touch, listen and measure the world with our entire bodily existence, and the experiential world becomes organized and articulated around the centre of the body." (p.64)

> phenomenalism, phenomenology and private, fleeting, sense-data. A phenomenon, for me, is something public, regular, possibly law-like, but perhaps exceptional." (Hacking, 1983, p.222)

Whereas phenomenon is considered by Pallasmaa's outlook to be based on an implicit and non-generalisable relation between architecture and the individual, or specifically, between the space and the body, acknowledging the body as the vehicle for sensation, and "the locus of perception" (Pallasmaa, 2005, p.10). Ian Hacking describes "phenomenon" guided by a more analytical approach within the field of science, considering it to be as a regular, collective and definite happening. So, while the first assertion acknowledges architecture as perceived by each person's relation to space, the latter may be translated into the recursive and collective features of use, and hence the actions a certain space is likely to project, assuming a common denominator for all.

Conversely, according to Tadao Ando, architecture gathers a mental and a sensory dimension to be regarded as a whole, both while conceiving the design and also throughout its occupancy:

> "Architecture consists of two elements. An intellectual element in that we have to create a space that is logical and clear, that has a logical or intellectual order. At the same time, you have to use your senses to imbue the space with life. These are the two main aspects of creating architectural space. One is practical and theoretical; the other is sensory and intuitive..." (Ando, 2002[22])

Thus, thinking about the condition of architecture as a vehicle for life within, is thinking about the contextual layers of architecture, not at the expense of functional or aesthetical values, or even by breaking the architect's professional boundaries, but by recognising architecture's feature of conceiving a space that will contain life within, on the diverse dimension it comprises, despite the diversity of approaches undertaken by each author of reference.

The acknowledgement of the lived space complements the design process, simultaneously approaching and validating concept and experience, creator and user. Whether using the more traditional tools of architecture to the most recent ones, even the most prominent architects anticipate life as part of their design, often opening the space to multiple interpretations and living experiences.

Thinking about the living experience implies acknowledging what is immediately outside of ourselves and how we, as individuals, perceive and are engaged by it. Assuming that the definition of experience is addressed by different study fields but equally valued, for architecture it holds particular relevance.

[22] Tadao Ando interviewed by Michael Auping (Auping, 2002).

As seen throughout this initial reflection, within the discipline of architecture, and despite this shared concern, the diverse approaches to identify and conceive the living experience in the space envisioned are very broad, hence the diversity of their respective methods of assessment.

Despite the choice in concept regarding both the action and the subject, and all the possible different considerations of the tasks and activities held in space, the acknowledgement that they are, in fact, of different nature, will sustain this Thesis and will also support the methodology constructed to analyse the broad scope of usages, experiences and people in space[23].

This introductory approach intended to provide a background reflection on Architecture and Life as an initial motivation, almost as a foreword for the following research outputs. It has also pondered experience and life, acknowledging them throughout all the stages of the building's lifecycle, from the brief and the design process in which it becomes a motivation and an expectation, until the space's occupancy, when it is actually accomplished, in order to produce a more insightful and comprehensive outlook on this issue.

This has been the general motivation that guided all the process of research even before if became a Doctoral Thesis. In fact, the reciprocity between space and experience, architecture and life, represents a bond that has been embedded in our previous reflections and academic publications since a very early stage in the Course of Architecture. In this Thesis, this issue aims to be deepened, by a specific approach on this general problematics, to be raised and explained in the following chapter, but which has an understated motivation on the paramount bond between Architecture and Life.

[23] As it will be detailed in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

1.3. The research question: Adaptability as a form of engagement between Architecture and Life

> "Only by means of a full understanding of the tasks may we find the means relevant to their solution. It is more important for the result to put correct questions than to give correct answers to wrong questions." (Norberg-Schulz, 1996[24], p.130)

In recognising architecture's embedded relevance for society and simultaneously the incidence of the context where architecture is made as its source and product, it is also acknowledgeable the deep relation between the professionals and the inhabitants[25], and the place with the actions it shelters and promotes[26].

The previous chapter recognised space as a social and cultural set that deeply influences users' experiences, and also that users change space by experiencing it[27]. Therefore, it becomes crucial to conceive space use as an input to the design process[28]. Space use, in its multiple dimensions and all the activities it comprises, is therefore the validation of the design process and the ultimate test to realize if it fulfils the users' needs.

Understanding that space is both designed by the architect as a *cosa mentale* and experienced by the inhabitants as a contextualized object (Lefebvre, 1974), and acknowledging use as part of architecture's intrinsic being, is therefore ineluctable. After the design process and its construction, the building becomes part of reality, where the needs for which it was created start to be answered by its actual inhabitants

[24] Consulted edition from 1996, original edition from 1963.

[25] Respectively the architects and society at large.

[26] The relation between space and people, particularly applied to school buildings, has been discussed in the communication presented in the International Workshop *Architecture, Education and Society. Creative chronotopes, cultural landscapes and dialogical imagination, Jornadas Cientificas COAC* Barcelona 2013. It has been published in the Conference's proceedings as: Coelho, C. (2013). Place and action: The school building as an enhacer of the learning process. In *Jornadas Cientificas COAC Barcelona 2013*. Rede Arquitectonics. Barcelona, Espanha: Universitat Politècnica da Catalunya_Departement de Projectes Arquitetonics. ISBN 978-84-695-9424-7.

[27] For a detailed explanation of the bond between design and use, please see the previous chapter: 1.2. Motivation and background: Architecture and Life – conceiving forms of engagement.

[28] The research question of this Thesis has been the focus of the first paper to be published and the first communication undertaken, within the process of investigation for this Doctoral Research. It has been presented in the *Nexus 2012 Relationships Between Architecture and Mathematics*, in 11-14 June 2012, Milan, for testing and academic validation. It has also been published in the Conference's proceedings as: Coelho, C. (2012). From design process to space use: Adaptability in school buildings today. In M. Rossi (Ed.), *Proceedings of the Nexus 2012 Relationships Between Architecture and Mathematics*. (pp.23-28). Politecnico di Milano. Milano: McGraw-Hill.

in real time. This "real time" assertion implies the recognition of a broad range of users and actions that will take place in that space, along with the changeable circumstances that occur throughout the whole space's lifecycle.

Adaptability is here considered a form of engagement between Architecture and Life[29]. Truly, it is a building's feature that has to be planned during the design process, which maximises future uses, linking design and appropriation, conceived and lived space. Hence, it enables a more diverse range of activities and a broader variety of uses and users in an expanded lifecycle, aiming at more fully suiting the designed space to forthcoming tasks.

This has particular relevance for school buildings, because they have the potential to answer and foremost to enhance the learning process. Monahan (2002) considers schools as "built pedagogies", Heitor (2005) as an "educational tool", and more recently, Lippman (2010) construes the concept of "transactional settings".

Bernstein (1971) points out that schools mimic the social construction of society and Fawcett (2011[30]) also supports the school programme as an appropriate case study for academic research of the space-use relation, due to the variety of general behaviour patterns, combined with the variability of small daily happenings that can be generated. Furthermore, both Lippman (2010) and Hertzberger (2008) underline the relevance of working on the school programme.

Thus, it is up to the architect, in his social and professional responsibility, to understand this correspondence and rethink the design process and goals, not just technical or aesthetic, but also semantic, as creators of meaning and social and human development:

> "Just as we see learning as second nature and an enlargement of one's space, it should be second nature to architects to prime space to those ends." (Hertzberger, 2008, p.9)

So, there is a wide range of recent literature on today's school buildings and on how to translate the current learning processes to spatial features, namely by OECD (Organisation for Economic Co-operation and Development) - attesting that it is a current and emerging theme. This situation is mostly due to the pedagogical paradigm shift brought by the contemporary teaching practices, the prominence of informal and non-academic spaces, the wide use of information technology, and the social and economic changes, which result in the creation of the present-day way of understanding the formation of the student and the educator, as well as the teaching and learning profile. School space should thus respond, be adapted to, and strengthen this change, to the current and up-coming social, pedagogical and functional needs, as a vital part of the whole process:

[29] See chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[30] Communication by e-mail from 26 April 2011.

> "Educational facilities need to accommodate both the known and identifiable needs of today, and the uncertain demands of the future." (OECD, 2001, p.vii)

Therefore, schools are a paradigmatic case study on space's influence on life within it, since they are also an active enhancer of the learning process, an "educational tool" (Heitor, 2005). By aggregating a wide range of activities and users, both internal users (students, teachers and staff) and external (users of schools' public spaces), schools can become an intensively lived space for a broad community.

Due to current pedagogical developments, educational spaces have undergone alterations in their organisation and materialisation, recognising the school as a "catalyst for change" (Worthington, 2007, p.15) that acts as both a facilitator and also an enhancer of the learning process (Coelho, 2013b), much recalling Markus's (1993) assumption, already referred to, that the diversity in spatial solutions can motivate differences in the actions allocated to spaces and ultimately in the power holding.

Today schools are guided by new pedagogical practices, a creative and pro-active student profile and demanding spatial and technical needs. The teacher acts not only as a "content provider", but mostly as a "facilitator" of knowledge (Lippman, 2010) that can be conveyed on active learning environments, not necessarily formal or academic. The decentralization from the classroom to a variety of informal spaces is explained by a broader concept of learning. New technologies partly explain this change to a *non-face-to-face* paradigm[31].

In Portugal, as the existing school buildings were becoming obsolete, the school rehabilitation process that has been undertaken since 2007, aimed at endowing schools with the ability to perform pedagogically, technologically and socially with the current educational needs. These renewed school buildings have undergone an "adaptive reuse" process that enabled them to become adaptable and to answer more thoroughly to the current and future demands. Thus, this research will be particularly applied to the Portuguese current reality, assuming general invariables, but also cultural specificities.

So, adaptability enables a more lived school space, able to cope with changeable learning processes, curricula and students' profile, within a lasting and more sustainable built object.

In fact, an adaptable school building, by coping with the current requirements and the future unpredictable changes, will enhance its performance and answer the community's needs, as a more endurable and sustainable building, considering adaptability as an attribute for exemplary educational facilities today (OECD, 2011).

[31] This will be further developed in the chapter 2.3. Adaptability for contemporary learning practices and environments.

Therefore, this Thesis recognises the relevance of adaptable educational architecture towards evolving pedagogical, technical and social needs, for a more complete spatial answer and a better building performance over time. The research question resides in "how" and "by what means" can a contemporary school be considered on its degree of adaptability, recognising formal classrooms as content providing places, as well as informal spaces where peer communication bears an acknowledged relevance towards educational experience and student achievement.

All things considered, this research aims at gathering design and appropriation, through the assessment of objective variables of space use that will inform future design processes. This is, hence, a theme directly engaged with the current reality that aims at providing valuable and operative input to architectural design process.

This Thesis considers the hypothesis that adaptability in school buildings today can be a feature that enables a wider variety of uses and users, when conceived as a variable to be thought during the design process and validated by space use. In fact, the choices in spatial attributes like: dimension, configuration, coating, networks, environmental conditions, accessibility and spatial morphology; can condition the adaptability of the building and, consequently, its ability to cope with the current and future needs overall.

Besides, after recognising school space as relevant to the actions and outcomes that it provides, conversely it becomes crucial to study use in order to inform on the frequency, range and actors of the actions that happen in that building. But foremost, these serve as tools to test expected and effective use along space's lifecycle, realising first if its social and functional purposes are being fulfilled, and secondly accompanying the natural and inescapable changes on activities and people's wants and needs, since its completion and throughout its use.

So, it is proposed that adaptability, applied to contemporary school buildings, actively potentiates high performance building and today's learning process. Thus, it is potentially considered to be a "responsive approach" (Lippman, 2010, p.30[32]) to the design process, based on space use studies, because it allows that today's unpredictable needs can be answered by effective spatial responses later on.

The central problematics of this research is to identify the concept of adaptability when applied to school space, the features of an adaptable space defined during the design process, and the ways to analyse an adaptable space by means of space use research, using a Portuguese secondary schools as a case study.

[32] "A responsive approach is an alternative to current practice whereby the creation of a place not only involves aesthetics, but is also grounded in research on the social environment, learning, and the physical environment. The responsive approach, which is the ideal, views each learning environment as unique and as raising a variety of issues that include, but are not limited to, the following: understanding the diverse ways in which people learn, how the learner and the social environment influence and shape learning, how pedagogy is used, how the physical environment may be designed to promote people's engagement in goal-oriented activities, the use of technology, and sustainability." (Lippman, 2010, p.30)

All in all, the research question can be placed like so:

> **By acknowledging that, from the current pedagogical practices derive the current spatial requirements of the schools, which influence the learning process, how is the concept of *adaptability* defined in the secondary schools of the 21st century, and how can it be considered throughout the building's lifecycle – translated into the design process and enhancer of the spatial usage?**

Besides proposing an original methodology to assess adaptability in school buildings today and to prove its validation, this Doctoral Research aims to confirm or refute the validation of the following hypotheses:

1.
The definition of adaptability as "the ability of the built form to maintain compatibility between activities and spaces, as those vary"[33] (Krüger, 1981a, p.1169) remains appropriate today and particularly suitable for the school brief.

2.
Adaptability can be thought in the design process, by introducing specific attributes that enable a more diverse range of activities and users further on, during the building's occupancy.

3.
The methodology proposed by this Thesis is proven to be robust and to provide a comprehensive conclusion on the condition of adaptability in school buildings today, and is specifically appropriate for the schools of the context under this study.

4.
The methodology provides a valid outlook on the adaptability of that school building and is able to be applied to other schools. It can be understood as operative data, transposable to future designs as knowledge advancement and also to future interventions on the buildings already assessed.

Furthermore, the conclusions on the hypotheses above, will also potentially represent valid contributions for both the academia and the practice in architecture.

[33] Free translation of the original quote in Portuguese: "A adaptabilidade será caracterizada pela capacidade que a forma construída apresenta para manter a compatibilidade entre atividades e espaços, à medida que aquelas variam." (Krüger, 1981a, p.1169)

1.4. Research objectives

> "The interplay of architectural design and user creativity needs to be a constantly expanding field of discourse, experience and practice." (Hill, 2003, p.3)

As previously addressed, this research has been guided by an embedded motivation concerning the dichotomies between design process and spatial experience, architect and user, conceived and lived space.

Therefore, general motivations continued to be pursued under this research from its initial stages, which already derived from a previous background on this subject area. Namely the following:

1.
To formalise design strategies *with* the future users of the lived space, rather than *for* the users in the conceived space.

2.
To clarify the users and the architects' interactions and contributions to the design and to space, in which adaptability plays a relevant role for approaching design process and space use.

3.

To problematize the importance of spatial experience as a variable to the design process, recognising adaptability as an enhancer of that experience provided for in the design.

These questions underline general research interests that centre around spatial experience and appropriation, space-use reciprocity, participatory design processes and user research studies[34].

[34] A more general approach on this topic introduces this Doctoral Thesis in chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

Nevertheless, this Doctoral Thesis aims at deepening the body of knowledge in this subject area, by specifying the research on adaptability, as previously explained[35].

In fact, by addressing adaptability - considering it to be a design feature introduced during the design process that will potentially enable a wider, more diverse and longer spatial experience - it is believed to draw professionals and inhabitants closer together, and to consider design and fruition as part of a whole spatial lifecycle.

But foremost, thinking about adaptability implies thinking about designing and adaptable space and also how, by whom and to what extent, can space be experienced throughout its lifecycle. Consequently, adaptability will potentially imply designing space considering "life within architecture"[36] further on during its occupation and fruition, so it copes with the effective needs and experiences in space.

1.4.1. General objectives

Consequently, after explaining the general motivations, this Doctoral research aims at addressing and resolving the research question clearly pointed out in the previous chapter:

> **By acknowledging that, from the current pedagogical practices derive the current spatial requirements of the schools, which influence the learning process, how is the concept of *adaptability* defined in the secondary schools of the 21st century, and how can it be considered throughout the building's lifecycle – translated into the design process and enhancer of the spatial usage?**

This can be translated into the following general goals of this Doctoral research:

> **1.**
> To identify the concept of adaptability applied to contemporary school buildings and to analyse whether definitions such as the ones provide by the OECD[37] (1976) and Krüger[38] (1981a) are still suitable today and particularly appropriate when concerning educational facilities.

[35] See chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[36] For a more thorough explanation of both the similarities and differences between spatial experience and use, please see chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[37] OECD defined adaptability as: "the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition in respect of either the constructional elements, services or the finishes of the building - essentially large magnitude/low frequency change" (1976, p.10).

[38] Krüger defined adaptability as "the ability of the built form to maintain compatibility between activities and spaces, as those vary" (1981a, p.1169) (Free translation from the original Portuguese paper), which implies the building's potential to allocate a range of activities without any physical transformation.

2.
To identify the spatial attributes for an adaptable contemporary school building, conceived in the design, which promote a wider usage, throughout the whole building's lifecycle.

3.
To construct a methodology to identify and assess adaptability in school buildings today and to prove that it provides a comprehensive outlook on the adaptability condition of the buildings in which it is applied, and that it is adequate to its particular context, with its respective spaces, users and activities.

4.
To apply the methodology proposed to a particular case study, retrieving the results on its adaptability, and also to validate and calibrate the methodology, if needs be.

5.
To consider the methodology as a robust contribution for the practice, informing on variables that potentiate adaptability, and also for the academia, as an original methodological approach to adaptability in the context of contemporary schools, that could be applied to future research projects.

1.4.2. Specific objectives

The pursuit of these responses shall have an effective foundation based on the following specific objectives, concerning the significance and operability of spatial experience for the design process of school buildings today:

1.
To identify areas of research and methodologies of analysis whose study field regards spatial experience, and to investigate how the contribution of these areas can be introduced as a design-oriented tool.

2.
According to Brand: "Age plus *adaptivity* is what makes a building come to be loved. The buildings learn from its occupants, and they learn from it." (Brand, 1994, p.23).

It is intended to analyse whether adaptability in school buildings today potentiates spatial experience and appropriation.

3.
Following Duffy et al.: "Designing for adaptability forces everyone to join in predicting the future. And because it encourages shared responsibility in the decision-making process, it tend to lead to affordable solutions." (Duffy et al., 1998, p.76).

Therefore, it is proposed to examine whether adaptability can be an operative tool that engages design and fruition, the architect and the inhabitant.

4.
To analyse forms of horizontal and vertical discourse acquisition and circulation (Bernstein, 1999) and its correspondence with the structure of relations between the agents involved, namely professionals and inhabitants.

5.
To relate spatial morphology with activities and movements of users in space and to compare them with the current forms of education and their relevance to the learning process.

1.4.3. Specific objectives regarding the approach on the case study

By transposing the concept of adaptability and establishing the methodology to identify and assess this condition in a particular case study, generalities are to be maintained, but specificities have also to be accounted for, according to: the social and cultural profile of the school community, the school management that can condition the range of activities in space, and its urban condition that can contribute to a more or less openness of the school to activities and communities.

So, the following specific objectives are placed, particularly addressing the case study under analysis:

1.
To identify the definition of adaptability on its specificities, when applied to this particular case study and its social and urban context.

2.
To describe the school space and how it supports activity allocation, by the definition of a spatial sample, by a functional and morphological analysis[39].

[39] This is proposed in this Thesis in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

3.
To describe all possible activity allocations to educational environments.

4.
To describe effective events and experience in that school.

5.
To describe the potential correlations from school space, potential activity allocation and effective experience in the school, and to retrieve the results on the school's adaptability.

6.
To validate and calibrate this methodology in this specific school.

7.
To analyse whether expected spatial use from the design coincides with effective uses and to identify the conditions that promote or hinder a wider range of activities and a more diverse community to experience school space.

1.5. The case study

1.5.1. The Portuguese case study

> "Research has a lot to do with the context, it is not a sum of events, it has to create complicities, it has to show that it is useful." [40] (Portas, 2011).

The choice of a Portuguese case study on the school space is justifiable by diverse causes. First and foremost, because Portugal is involved in a basic and secondary school rehabilitation process since 2007, whose aim is to endow schools with more current spatial solutions that respond and potentiate today's learning context, guided by a more creative and critical student profile, as well as by the relevance of informal and non-pedagogical spaces, and also with active learning environments in which communication and socialisation are vehicles for learning, along with today's pedagogical practices endorsed by information technologies. Consequently, if the learning experience in school space today is conceived differently, then the design of the school space has possibly to be rethought.

Hence, the Portuguese context brings forth the concepts of *memory* and *transformation*, *past* and *change*, acknowledging the memory of the original school buildings, their continuity into the present and their continuation onwards to the future, as able and valid spaces for learning[41].

The memory of the school space, both individually or collectively, often comes associated with the gathering of students in the classroom directed by a teacher that provides knowledge and contents. Yet, the current pedagogical practices reflect

[40] Quote from a communication by Nuno Portas at the Department of Architecture of the University of Coimbra, for the Doctoral Course, in October 2011.
Free translation of the original quote in Portuguese: "A investigação tem muito a ver com o contexto, não é uma soma de acontecimentos, tem de criar cumplicidades, tem de mostrar que é útil." (Portas, 2011).

[41] The connection between memory and changing experiences has been dealt in the communication with the following reference: Coelho, C. (2013). A memória do espaço e a transformação das suas vivências: dinâmicas da arquitectura escolar recente**.** Communication in the *IV International Colloquium of PhD students of Centre for Social Studies - Coimbra C: Dialoguing with the Times and Places (s) World* (s). 6 e 7 December 2013 in the University of Coimbra.

an evolutionary development from these memories in the long run, leading to new dynamics in the construction and communication of knowledge and also to different interpersonal relationships in the educational context[42].

From these pedagogical practices come new functional, constructive and environmental needs and new relations with the places, which architecture has been studying, through conceptual and technical responses, respectively contextualised in each Portuguese intervention under the Secondary School Modernisation Programme[43].

Actually, in the specific case of Portugal, this issue had relevant impact since the existing buildings presented different spatial solutions dating from different time periods. This fact reflected a disparity in the quality of the construction, in the capacity to answer the pedagogical, functional, environmental, technical and technological needs of today, and foremost to support the current learning experience in school space. The Secondary School Modernisation Programme has been developed under this need to rehabilitate the existing school buildings, in order to provide them with pedagogical and social spatial solutions consistent with this current framework.

Additionally, the school's lifecycle is being reconsidered, under a perspective of rehabilitation and potentiation of the exiting spaces, according to the current needs and aspirations of the contemporary life and learning in school buildings.

The option for rehabilitation, which enables the buildings to extend their lifecycle, as opposed to the assumption of their obsolescence and the pursuit of a construction *ex nuovo*, illustrates the value of spatial memory and also brings environmental and sustainable gains:

> "Moreover, the reuse of school buildings - as opposed to the decision to demolish and build new ones - will contribute to support healthy living and promote environmental awareness and social responsibility, as part of a comprehensive and lifelong approach." (Heitor, 2011, p.35)

Furthermore, the Portuguese experience of the Secondary School Modernisation Programme can be considered a recent project of great investment at different levels. But much remembering Bernstein's work on sociology of education in the 1970s, under the London context of the Institute of Education, this Portuguese programme naturally introduces a disciplinary reflection on the way the current student performance and achievement have been impacted by the renovation of the existing school spaces under this current spatial and pedagogical requirements, guided also by the contemporary social and pedagogical context.

[42] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[43] In Portuguese: Programa de Modernização do Parque Escolar destinado ao Ensino Secundário (http://www.parque-escolar.pt).

Hence, the recent interventions in the Portuguese secondary schools reveal a dialogue between the memory of a space and of a collectivity and the current need for spatial rehabilitation after the assumption of change.

This process also expresses the relation between the beginning and the present, possibly the future circumstances of the buildings and the people within it, with respect to the context in which it happens, recalling Kahn's text "I love beginnings" (1972[44]).

From this choice, this study aims at concluding on the adaptability level of the Portuguese schools analysed, but also their contextual constraints and assets, and to point out their specificities, namely cultural, social and pedagogical.

So, according to the upper quote by Nuno Portas (2011), at a Conference at the Department of Architecture of the University of Coimbra, for the Doctoral Course, research has to "understand change" and to face the context in which change is occurring. Therefore, it is up to research to understand the current boundaries of the actual context of Portuguese school buildings and to contribute, in an operative and disciplinary manner, for the knowledge advancement in architecture, for both the past but also for future happenings[45].

Besides, the closeness to the case study allows a more in-depth knowledge and more frequent visits to the school, which enable a deeper awareness of the living and learning process within, and a further acquaintance of all the school community and its activities.

1.5.2. Artistic schools as a specific case study

> "Music has an important part to play in helping schools to deliver against a range of targets, from the emotional health and well-being of young people to the development of family learning and wider community engagement. For example, spaces can be reconfigured so that parents and community groups can access them safely and independently when they are not timetabled for curriculum use." (Department for Education[46], 2010, p.11)

Assuming that each school enables different spatial experiences and in order to accurately define this methodology, the current research is developed within

[44] "I love beginnings. I marvel at beginnings. I think it is beginning that confirms continuation." (Kahn, 1986, p.150). From the communication *The Invisible City, International Design Conference*, Aspen, Colorado, 19 June 1972, afterwards mentioned as "I love beginnings".

[45] Quoting once more Portas: "perceber melhor o que se fez para trás e encontrar pistas para o que vem a seguir." (Portas, 2011), which means in a free translation to English: "providing a better understating of what has been done before and finding leads for what is to come" (Portas, 2011).

[46] This quote is taken from a publication by the English Department for Education London.

a particular case study of a school that holds both artistic and regular teaching, assuming its specificities and acknowledging their relevance for the application of the proposed methodology.

The specific choice of these artistic schools for this research is justified by the fact that these particular schools combine both the regular - with basic and secondary levels - and also the artistic teaching of music and dancing. This implies that the space and the institution itself are impelled to aggregate a broader school community to occupy the same space for numerous activities.

In this specific case, the coexistence of different student profiles, such as the artistic and the regular ones, in the same school environment, has fostered the conception of even more lived and aggregated spaces. Furthermore, as in the case of artistic schools this covers a wide range of activities, with a broad internal and external community, there is an urgent need for spatial diversity for specific and multi-purpose uses, individual and collective, as well as informal and adaptable spaces.

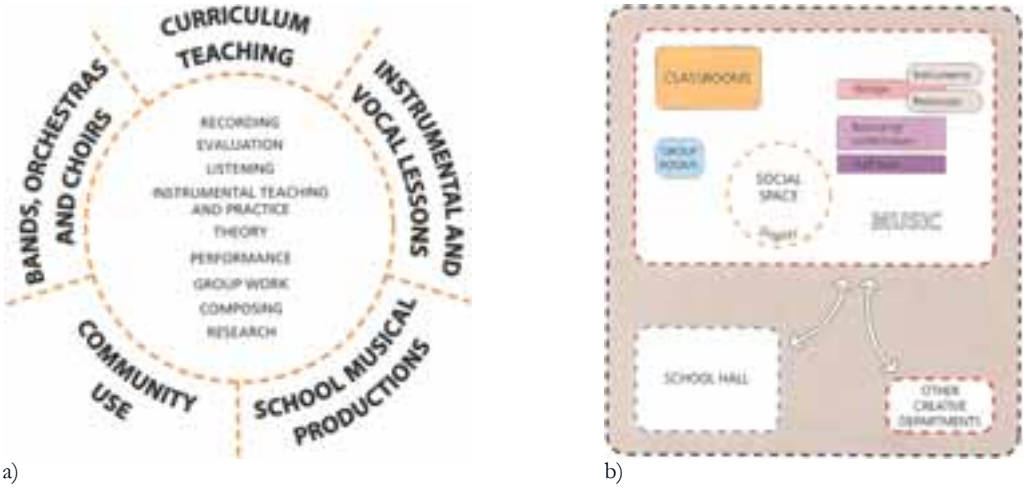
In fact, these schools have a more demanding need for reconfigurable spaces - flexible and/or adaptable[47], both formal and informal ones, for the variety of performances with different spatial needs, with varying number of performers and of diverse nature. Since shows can be for the students alone, for the students' parents or for a wider community, spatial requirements vary and space should, potentially, meet them.

Consequently, the adaptability requirement is more pressing in these schools. The concept of adaptability is also justified by the fact that these schools have been adapted from pre-existing spaces amongst the intervention for their modernisation. Thus, schools have maintained their pedagogical function, but have physically altered their space in a large magnitude initiative. According to the definition adopted of adaptability[48] this corresponds to a process of adaptation, rather than a need for flexibility (OECD, 1976, p.10).

Indeed, the schools with regular and artistic teaching have to comprise with spatial cohesion under this multiple options teaching regime. Besides the spatial features needed for each teaching regime, the features necessary for the external uses of a music and dance school with an auditorium brings additional demanding and technical requirements, as well the observation of the environmental quality, comfort and acoustics needed for each space and for the school overall.

[47] These concepts and definitions will be further developed in chapter 2.1. Adaptability: definition and adjacent concepts.

[48] See chapter 2.1. Adaptability: definition and adjacent concepts.



a) b)

Fig. 2. a) Diagram of the component of a music department and the potential relations it can have with other parts of the school; b) Diagram of the possibilities of expansion of the department of music with other activities, as proposed by the English Department for Education

(Department for Education, 2010, pp.9, 13)

As a relevant and current study, the publication by the Royal Institute of British Architects (RIBA) (Department for Education, 2010) focuses specifically on the spatial needs of music activities in secondary schools today, particularly with regard to: the design of space, the specific needs of "individual spaces" for activities related to the artistic use, "furniture and equipment", "services and environmental design" (*ibid.*).

Besides, the artistic learning process also provides the school with a particular ambiance, often with a particular emphasis on spontaneous performances for practising or even for leisure purposes, both in collective gatherings or solo happenings. Even formal learning and performances, according to the nature of the events and the expected audience, can occur in different spaces of the schools, besides the formal studios, the orchestra room or the auditorium.

So, the artistic practice does not have to be confined to the individual studios and can be played in formal and informal school spaces. The artistic formation also carries a theoretical and practical character, which demands both personalised and collective encounters and formation. It can even be considered a social activity of bounding and knowledge spread, as a way of social participation in a community and, cyclically, of social aggregation of the community with the educational practice (Fig. 2a).

When the music department works as "social hub" (Department for Education, 2010, p.13), it has the possibility of connecting with other subjects and to extrapolate the music outside the department, particularly to the school and the community

(Fig. 2b). Under this perspective, there are numerous forms that music has to be related to the school, to all students (and not only the ones with artistic education) and also to the community.

Besides, when the artistic teaching shares its spaces with other subjects, and reflexively when common use spaces are the stage for artistic performances to happen, either internally or externally, they come closer to the rest of the school community and to the external community overall. This has consequences in the design of space, in the requirements of each space individually and also on the spatial morphology of the entire school and the location of each compartment.

Fautley and Savages's approach (2011) to the "cross-curricular" teaching in secondary schools, accentuates the need to face each student's curriculum as a whole and "co-equal" (p.31) process, not isolated by specific subjects and where the artistic teaching plays a relevant and equivalent role in the students' formation:

> "In the co-equal cognitive integration style, learning in and through the arts is placed on a similar footing to other curriculum areas. To work in this way will require significant input both at the planning and enactment stages from arts teachers. In many ways this style is the most appropriate to cross-curricular arts learning in terms of the ways in which knowing in and through the arts is treated." (Fautley and Savage, 2011, p.31)

A "cross-curricular" school provides interdisciplinary links between the subjects each student attends, but also between the competences needed to attend each one as a cohesive pedagogical path, and it also introduces a transdisciplinary formation. This formation has also "cross-curricular" dimensions on: "themes" (p.4) lectured transversally on several subjects; and "skills" like: "communication, numeracy, problem solving, information technology and study skills" (*ibid.*).

Furthermore, in the publication *Arts and Cultural Education at School in Europe* (Education, Audiovisual and Culture Executive Agency, 2009) that provides an "overview of the state of artistic and cultural education in Europe" (p.3), it is also specified the "cross-curricular links between the arts and other areas of the curriculum" (p.15). In addition, also the "learning aims/outcomes" that arts and cultural education[49] intend to develop, can be both specific and transversal such as: "artistic skills, knowledge and understanding"; "critical appreciation"; "understanding of cultural heritage"; and "of cultural diversity"; "the development of individual expression and the development of creativity".

[49] This publication's scope gathers the areas of "visual arts, music, drama, dance, media arts and crafts" (Education, Audiovisual and Culture Executive Agency, 2009, p.12).

Besides other specific goals, these are also complemented by more general ones like: "the development of social skills", "the development of 'pleasure/ satisfaction' and 'communication skills'", "'raising pupils' awareness of their environment" and "development of 'self-confidence or self-esteem'" (pp.20-21), which are enriching to all students overall.

Furthermore, the Qualifications and Curriculum Authority (2009) also mentions the need for "cross-curricular dimensions" (p.1[50]), whose cohesiveness, associated with the cross-curriculum teaching, aim at fostering a whole individual, both in school and in society:

> "The cross-curriculum dimensions reflect some of the major ideas and challenges that face individuals and society, and help make learning real and relevant.
> The dimensions are unifying areas of learning that span the curriculum and help young people make sense of the world. They are not curriculum subjects, but are crucial aspects of learning that should permeate the curriculum and the life of a school." (Qualifications and Curriculum Authority, 2009, p.1)

Thus, in these schools the relation between the contents and information provided, and the ways of proceeding, thinking and doing, are fostered in a "multi-layered and simbiotic" way (Fautley and Savage, 2011, p. 30[51]; Russel and Zemblylas, 2007, p.288[52]). According to Russel and Zemblylas:

> "[…] if we stop thinking in dualisms and move beyond the *either* (disciplines) / *or* (handmaidens) dichotomy, we may begin to examine arts integration on a totally different level of thinking – that is, as multilayered and symbiotic with other learning." (Russel and Zemblylas, 2007, p.288).

They are envisioned as a whole that works as a unified curriculum. In fact, the narrowing of interdisciplinary relationships in the formation of a student profile enables a more holistic training and education founded on creativity, collaboration and individual customisation.

Thus, these students' profiles have a quite specific condition, since the students

[50] In this publication the "cross-curriculum dimensions" are: "identity and cultural diversity", "healthy lifestyles", "community participation", "enterprise", "global dimension and sustainable development ", "technology and the media" ,"creativity and critical thinking" (*ibid.*).

[51] In the full quote: "The notion of being "multi-layered and simbiotic" is a key one in terms of thinking, planning and enacting cross-curricular learning [...]" (p.30).

[52] The terms "multi-layered and symbiotic" have already been used by Russel and Zemblylas in 2007 and are cited by Fautley and Savage (2011, p.30).

have to understand and develop the artistic ability, through the development of skills on production, perception, reflection upon contents and techniques, and also have to reveal interpretative skills and the ability to make aesthetic judgments. Actually, the arts students' profile reports a sensitivity and creativity, and results in a totality of contents and skills from different subject areas, quite enriching and wide. So, the school's spatial usage, bounded to the activities that are played by students in space, can potentially be a reflection of this active and creative profile.

Specifically, there is also an appraisal on the artistic education from the Portuguese Ministry of Education undertaken by a team of researchers (Fernandes et al., 2007) and intended, among other purposes, to focus on the practices and outcomes of the specialised teaching of Music, Dance and the Visual Arts towards a possible development (p.5), particularly on the public schools (p.8).

The relevance of the artistic education is left clear for being associated with "cognitive abilities" for other subjects and activities (p.28) and for holding themselves an "increasingly more significant set of activities" associated with future employment:

> "[…] all national and international indicators show that a great variety of artistic manifestations are assuming an increasing and decisive importance in the generation of a diversified, and increasingly more significant set of economic activities generating young employment."[53] (Fernandes et al., 2007, p.24)

The overall legislation for the Basic Courses of Dance, Music and Gregorian Chant are established in specific legislation[54] and the different possibilities of attendance of the teaching regimes of the secondary courses of Dance, Music and Singing are clearly put by the legislation[55], establishing three possibilities for attending them in the following regimes: "integrated, "articulated" and "supplementary"[56]. The integrated teaching occurs in only one institution that lectures both the general formation and the vocational component, whereas the articulated teaching is held in two teaching facilities where one lectures the regular teaching components with

[53] Free translation of the original quote in Portuguese: "[…] todos os indicadores nacionais e internacionais revelam que uma grande variedade de manifestações artísticas estão a assumir uma importância crescente e decisiva na geração de um conjunto diversificado, e cada vez mais significativo, de actividades económicas geradoras de emprego jovem." (Fernandes et al., 2007, p.24)

[54] This process and legal framework is expressed in detailed in Portaria nº 267/2011, DR 178, Série I, from 15th September, which is the first alteration to Portaria n.º 691/2009, from 25th June, which creates the Basic Courses of Dance, Music and Gregorian Chant and that approves their syllabus.

[55] This is explained in the legislation: Portaria 225/2012, from 30th July; Portaria nº 243-B/2012 from 13th August.

[56] From the Portuguese "integrado", "articulado" and "supletivo". As these concepts refer to a specific Portuguese lexicon related to artistic teaching regimes of attendance ("regime de frequência"), it was chosen to use a literal translation to English.

the general subjects and the others lectures the specialised artistic components. In the supplementary regime both components are lectured in separate institutions and have independent curricula (p.135).

This report also suggests the integrated teaching (Fernandes et al., 2007, p.51), by enabling the institutions[57] to be schools "in the true meaning of the word" with "consistent and feasible educational projects" and that "reduce the absenteeism, retention and abandonment by the students" (p.27). It is also stated that "articulations and/or associations with regular teaching schools" are suggested by some and are even endorsed by regulations (p.70).

Contrarily, it discourages the supplementary regime when compared to the remaining two options. Because, despite being considered the most frequent of the three because of the difficulties often found in the gathering of the two institutions' schedules for enabling the articulated teaching (p.136), it does not imply a concentration of efforts from the institutions, aiming at a whole cohesive curriculum (p.71). Furthermore, it is argued that:

> "A conservatory fully integrated in the educational system will certainly be more supported, more contextualised, more suitable to become a school of reference and excellence in the field of Dance or Music."[58] (Fernandes et al., 2007, p.26)

Hence, when compared to analogous situations on other countries, the report concludes that these are diverse but converging towards a tendency to a "more integrated and pedagogically more flexible experiences, in the sense that the system allows training to start at various times in the student's life" and for "providing conditions for a higher qualification within regular education"[59] (p.222). It is determined that, despite each country's different curricular offer, articulated and integrated artistic education are the future options to be developed, not only in Portugal but internationally (p.223).

[57] The report identifies the Music Academy of Santa Cecilia in Lisbon and the Calouste Gulbenkian Music Conservatory of Braga to have integrated teaching of music and also the Dance and Music Schools of the National Conservatory. Besides, after the rehabilitation of Rodrigues de Freitas School, the Conservatory of Porto has been relocated and began holding the integrated teaching of music in 2008/2009 (Inspecção-Geral da Educação e Ciência, 2014a, p.1; Nogueira, 2015, pp.61,79; Conservatório de Música do Porto, 2008, p.9).

[58] Free translation of the original quote in Portuguese: "Um conservatório integrado plenamente no sistema educativo estará, com certeza, mais apoiado, mais enquadrado, mais apto a transformar-se numa escola de referência e de excelência no domínio da Dança ou da Música." (p.26)

[59] Free translation of the original quote in Portuguese: "Este modelo parece ceder o lugar a experiências mais integradas e pedagogicamente mais flexíveis, no sentido em que o sistema permite que a formação se possa iniciar em vários momentos da vida do aluno. A aposta parece ir mais no sentido de proporcionar condições para uma qualificação de maior excelência adentro do ensino regular." (p.222)

Fig. 3. Quinta das Flores School, Coimbra
(http://www.josepaulodossantos.com)

1.5.3. The case study under this research

> "The project assumes the generous and fruitful cohabitation between secondary education and the teaching of music, regarding that neither the existing, nor the new proposal, have predominance over the other, enabling a careful interaction between the parties."[60] (Santos, 2008)

The case study of this research is the current Quinta das Flores School in Coimbra, Portugal, which is a Basic and Secondary School with the Artistic School of the Music Conservatory[61] (Fig. 3).

This school was built in 1968 as a Basic and Secondary school, and has undergone a process of rehabilitation in 2008-2009 by the architect José Paulo dos Santos (Traço Banal), which joined the music and dance teaching of the conservatory with the regular teaching of Quinta das Flores School that already took place there.

Within the context of the Portuguese School Building Modernisation Programme this school has undergone a process of "adaptive re-use", which implies the space

[60] Free translation to English from the original quote from the architect in Portuguese: "O projecto pressupõe a generosa e frutuosa coabitação entre o ensino secundário e o ensino da música, havendo o cuidado de quer no existente quer no proposto novo não haver predominância de um programa sobre o outro, havendo uma cuidada interacção entre as partes." (Santos, 2008)

[61] In Portuguese "Escola Artística do Conservatório de Música de Coimbra".

has been changed to be adapted for the current activities and to comply with contemporary pedagogical, functional and social requirements, rather than changing a particular space or its functions within. So, adaptability plays a relevant role because the school is now adapted to current demands and to today's curriculum. This validates this school as a relevant case study for adaptability in Portuguese school buildings today.

Consequently, Quinta das Flores School has been adjoined to the Artistic School, working within the "articulated" music teaching regime, which means that both the Basic, Secondary and Artistic Schools share the common areas and services, such as: the main hall, the cafeteria and the outdoor spaces. In these spaces the students get openly together and these are often the stage of spontaneous artistic performances amongst an artistic ambiance shared generically by all and individually internalised by each one. This follows the understanding of the cross-curricular teaching quoted earlier (Fautley and Savage, 2011), as a whole, interdisciplinary curriculum for each student.

It also favours group dynamics, social cohesion between students and a trandisciplinarity of competences and abilities that are trained in each teaching regime and passed out to students and amongst each other in this shared moments and spaces.

Thus, the spatial cohabitation also implies a sharing of the living experiences between all the school community. In this school all students benefit from the artistic and cultural milieu of the music and dance school and the common and generic spaces aggregate all students, teachers and staff from both teaching regimes, having to comply with their needs and daily activities and routines. This is an example of an equilibrium between the needed autonomy of each regime and the specificity of some spaces, but also a shared co-existence between them all, implying knowledge and environmental exchanges and a pedagogical and spatial tie.

In Coimbra, the Artistic School of the Music Conservatory has both articulated and supplementary teaching, because it has students that have lessons within the conservatory independently of their curricular options elsewhere after the school hours in the supplementary teaching regime. It also has students that are enrolled in the articulated teaching regime attending Quinta das Flores School. Ultimately, even if the official teaching regime is articulated, the spatial fruition can be argued to be integrated, because effectively the space is the same for all students of Quinta das Flores School and the Music Conservatory, sharing the same building's facilities and common spaces and living with each other as a whole community. So, despite the co-existence of both institutions - the School and the Conservatory -, indeed the spatial experience of the subjects taught by both are held in the same building and even spread throughout the school's overall facilities, from the entry of the new building built under the modernisation process, to the existing and rehabilitated pavilions and external courtyards used by students on their breaks.

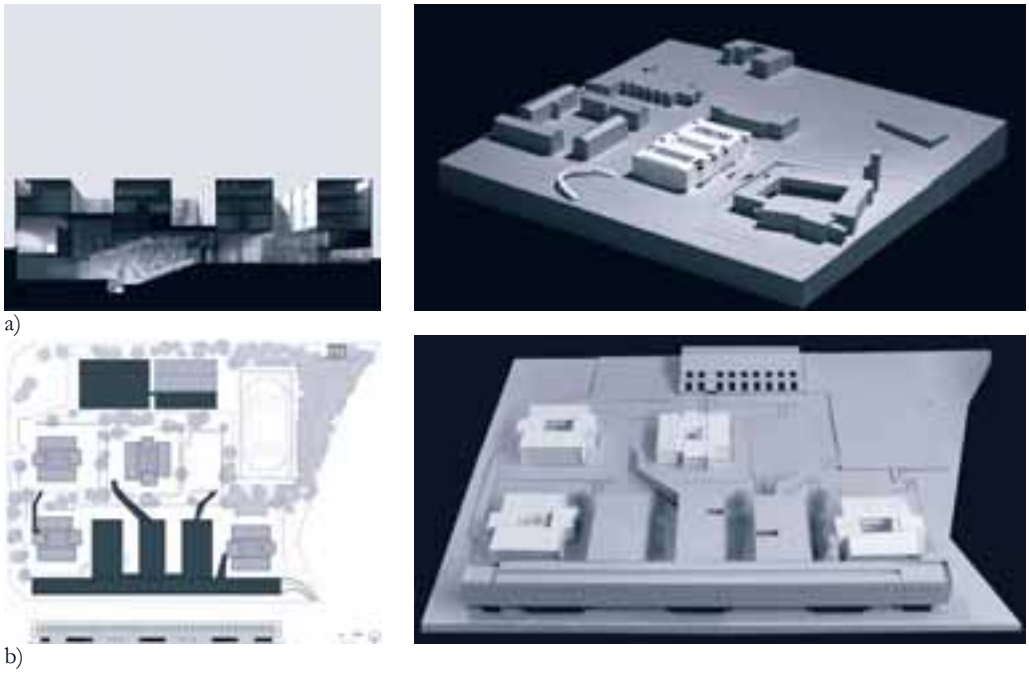


Fig. 4. a) Project of the initial Artistic School, by José Paulo dos Santos
b) Project of the final Artistic School in Quinta das Flores School, by José Paulo dos Santos
(http://www.josepaulodossantos.com)

In fact, all the school community uses the same entrance and the common spaces are shared, even if there are separate offices for both administrations. So, all the staff, students and teachers use the same spaces built or modernised within the rehabilitation process and that provided the space with a more enlarged and enriched curricular options and community, that have become broader by both the conservatory and the school's students, parents and an external audience for attending the performances of them both.

Hence, this gathers more activities from different nature, frequent and occasional users, and by and large, an enriched and broader community from the school and the conservatory, and even others for using the facilities for extra-curricular activities or specially spaces such as the auditorium, which have enlarged the possible uses and activities as a community and urban aggregator.

As this Thesis's scope is within space and architecture, it is considered that the spatial blend between the users and the activities that occur within this building are *integrated* in a whole built space, despite the institution to which they belong, which, at a large scale, could surpass the institutional specificity of the conservatory or the school, and act as a cultural and urban cohesive core.

Previously to this, the architect José Paulo dos Santos had already conceived the project of Santa Cecília Music Academy[62] in Lisbon, which is a school with the

[62] From the Portuguese: "Academia de Música de Santa Cecília".

integrated teaching of music:

> "Long before the conservatory I did a project for the integrated teaching of music, the Music Academy of Santa Cecilia in Lisbon. [...] the project is organised in complementarity: one hallway for pre-primary, primary, secondary, and gymnasium; the recovery of the garden, where a small palace is located, north of Lisbon, and north of Lumiar, with a hallway only for music, which has more or less the same programme as the Coimbra conservatory."[63] (Santos, 2017)

In the first project by José Paulo dos Santos the conservatory was located in a near-by site to the school in Vale das Flores, as an isolated building, which only accommodated the conservatory (Fig. 4a). This had double-loaded corridors for instrument rooms and single-loaded corridors for rooms for groups (Santos, 2017).

But after the consideration of a possible access between that project and the existing school, it was considered to place the new conservatory in the existing Quinta das Flores School site, after an initial possibility of placing it in José Falcão School. In the final project it was not possible to use single-loaded corridors and so it was decided to place the largest spaces in the extremities of the linearly developed building (Santos, 2017).

The final project results from the possibility of joining both institutions: the conservatory and the school, by the rehabilitation of the existing pavilions of the school and with a new building that comprises the new spaces (Fig. 4b). It thus, aggregates both the regular teaching of the school and the music teaching of the conservatory independently, and also the teaching attendance that is possible by the articulated teaching where the regular formation is joined with the artistic formation in a whole curricular option. The project provided spatial, technical, social and environmental features that enable and potentiate this current pedagogical status and the spatial diversity and specific requirements on acoustics, soundproofing, lighting, furnishing and information technology of each one.

Specifically, the intervention on this school designs a new building (Fig. 5a) that consolidates the street façade that was once a defragmented set of smaller buildings facing the posterior façade of a commercial building. Now, this new volume is a part of the city, it presents the school as a community equipment with its respective representativeness.

[63] Free translation of the original quote in Portuguese from the interview with the architect: "Muito antes do conservatório fiz um projecto para o ensino integrado de música, a Academia de Música de Santa Cecília em Lisboa. [...] o projecto organiza-se em complementaridade: uma ala para a pré-primária, primária, secundária, e ginásio; a recuperação do jardim, onde está instalado um palacete, a norte de Lisboa, e a norte do Lumiar, com uma ala só para a música, que tem mais ou menos o mesmo programa que o conservatório de Coimbra." (Santos, 2017)

a) b) c)

Fig. 5. a) Quinta das Flores School - The preexisting school (top) and new façade (bottom)
b) Quinta das Flores School - Pavilions before (top) and after the intervention (bottom)
(Top, Parque Escolar in http://www.parque-escolar.pt/pt/escola/067; Bottom, Carolina Coelho)
c) Quinta das Flores School - New rear façade connected to the existing spaces (Carolina Coelho)

Besides, it also, and metaphorically, aggregates all the community that uses this space, by gathering and welcoming them all on this new building, which contrasts with the previous spatial layout of a set of scattered pavilions from 1968[64]. Yet, and contrarily to Rodrigues de Freitas School whose patrimonial heritage is demarcated[65], Quinta das Flores School's urban form is not so referential.

The spatial connection between the new and the existing spaces is assumed by interior paths, shaped as arms, that link both the posterior façade of the new building and the existing pavilions (Figs. 5b, c). This could be interpreted as a reflection of the willingness to join both teaching regimes and spatial solutions, which has been one of the goals of the intervention, supported by the upper quote by the architect, that introduced this chapter.

The school spaces are appropriated by the students, which enable a sense of belonging to them by the activities that occur there. Interestingly enough, the main hall (Fig. 6a), for example, is a clearly appropriated space for students and a place of informal learning, in which there is a piano that is actively used by students for

[64] The pavilion layout used for the schools is taken on since 1968 as a response to the massive growth in school population and the increase in the compulsory school (Veloso, Sebastão, Marques and Duarte, 2015, pp.60-63). For further development on the stages undertaken by the building school construction in Portugal. See: Heitor, T. (2014) 40 Anos de Construção Escolar: Cartografia de um Percurso. In M. Rodrigues L. (Org.) (2014). *40 Anos de Políticas de Educação em Portugal. Volume II - Conhecimento, Atores e Recursos*. (pp.495-529) Coimbra: Almedina.

[65] According to the architect Fernandes de Sá: "In addition, the building is under heritage easement, encompassed in the whole of Marques da Silva's work classified by the IGESPAR […]" (Fernandes de Sá, 2008, p.14).
Free translation of the original quote in Portuguese: "Acresce que o edifício está sob servidão patrimonial, englobado no conjunto da obra de Marques da Silva classificado pelo IGESPAR[...]" (Fernandes de Sá, 2008, p.14)

a)

b)

Fig. 6. a) Quinta das Flores School, Coimbra - The school's main hall (http://www.josepaulodossantos.com)
b) Quinta das Flores School, Coimbra - Artistic performances in informal spaces (Student Association of the Music Conservatory of Coimbra)

spontaneous creations, training or collective informal performances, enhancing the referred artistic ambiance. It also awakens the artistic interest of the remaining students and the school community overall. The same is true in other areas of common use, such as the cafeteria, where the two teaching regimes are congregated by the space, by the environment and by the activities they share in common.

Interestingly, in Quinta das Flores School the design solution was to insulate the individual music studios from each other, but not into the hall, which spreads the music throughout the school, beyond the specificity of its spaces.

The music thus takes many forms (because of the variety of different instruments and genres that are played here) and also takes place in different spaces (Fig. 6b), not just confined to the studio and to the individual teaching, but also as a creative and social activity elsewhere.

In fact, this artistic school has the specificity to bestow on the entire school environment a particular sensory experience, because music is not restricted by the boundaries of the formal classroom spaces, but is also played in the corridors, outside spaces and in all informal spaces, truly acknowledgeable as active and creative environments. It is also enjoyed transversally, not only by the music students but by all the community, promoting emotional and sensory experience as a vehicle for peer interaction and knowledge transfers amongst the students. The living experience here bears a particular sensory and bodily dimension, by means of informal performances from the students who take ownership of the space with artistic casual displays of all types.

Fig. 7. Quinta das Flores School, Coimbra. Dance lesson
(Carolina Coelho)

Therefore, the study of the spatial experience in this particular school, with its cross-curricular educational model, represents a more complex case study, that stretches the boundaries of the living experience from an ordinary school into a multi-layered sensory dimension, which influences the social, pedagogical and cognitive aspects of the students' lives.

Moreover, along with this curricular and spatial change, the school's activities and inhabitants were visibly enlarged and diversified. The school community (internal users) now comprises students of the artistic teaching, of the regular teaching and students of both regimes, besides all the teachers and staff. The school now has also the ability to engage a broader range of external users, who attend it for occasional public performances in the auditorium, or that recurrently use the school spaces like general classrooms, the library, the gymnasium or the cafeteria for after work activities arranged by associations that have protocols with the school board.

In addition to the artistic education, Quinta das Flores School has a very wide educational offer within the regular education, which involves not only the general courses, as well as options on different vocational courses, in sports, information technology and arts, which implies other specific spaces for lecturing these subjects, besides providing spaces of common use for a broader range of student profiles. This is proven by the external evaluation report from the school that confirms that: "The school shows a good ability to attract students and families, for which contributes, among other things, the pedagogical offer and the existing

environment."[66] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.4)

Its integrating character for aggregating a vaster community, with different paths and formations, is still reinforced by the fact that students, whose artistic formation have been started elsewhere, mainly in local music schools, bands or philharmonic groups, can pursue their formation here. This places the school, pedagogically, in a very significant position, despite its rather peripheral placement in the city of Coimbra.

Overall, this school could be considered a "social hub" (Department for Education, 2010, p.13) in the sense that the artistic school is not confined to its specific spaces, but rather establishes a proximity with other areas of the regular teaching, which enables a deeper interrelation of activities and people altogether.

Furthermore, in Coimbra, the option of opening the school to the city and the community is enabled by the space, but also by the management that provides protocols with diverse associations, broadening the spatial usage of the school outside the regular and artistic teaching, to extra-curricular, after-work or other diverse activities for an enlarged external community[67]. This acknowledges the school with the ability to be perceived as a communitarian centre and aggregator of a wider and more diverse set of individuals and a higher mix of social and pedagogical profiles. Thus, music and dancing act as an urban, spatial and social qualifier (Fig. 7).

[66] Free translation of the original quote in Portuguese: "A Escola mostra uma boa capacidade de atracção junto dos alunos e famílias, para o que contribui, entre outros aspectos, a oferta formativa e o ambiente existente." (2011, p.4)

[67] The list of protocols from 2011 is cited in the evaluation report: "Encontram-se celebrados alguns protocolos e parcerias que contribuem para a operacionalização dos objectivos inscritos no Projecto Educativo. Destacam-se os existentes com diferentes Faculdades e Departamentos da Universidade de Coimbra, Instituto Bissaya Barreto e Instituto Miguel Torga (para a realização de estágios dos docentes e formação), Centro de Saúde Norton de Matos (no campo da saúde), Centro de Neurociências de Coimbra e com empresas que colaboram na realização de estágios dos cursos tecnológicos e profissionais.
Para além dos projectos anteriormente referidos merecem destaque o Ciência Viva, Optimização do Ensino das Ciências Experimentais e o Projecto de Educação Sexual em Meio Escolar." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.11)
Free translation to English: "There are some signed protocols and partnerships that contribute to the implementation of the objectives of the Educational Project. Noteworthy are the existing ones with different Faculties and Departments of the University of Coimbra, the Bissaya Barreto Institute and the Miguel Torga Institute (for teachers training and formation), the Health Centre Norton de Matos (in the health department), the Center for Neuroscience of Coimbra and with the companies that cooperate in the internships of technological and professional courses.
In addition to the above-mentioned projects there are also noteworthy the Live Science, the Experimental Sciences Teaching Optimization Project and the Project for Sexual Education in School Environment." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.11)

Even if other schools could be mentioned by their pedagogical curriculum or their openness, this school's particular urban and communitarian engagement is very representative of a wider set of activities that are held in its space, a broader range of people that use it, and a deeper and more diverse range of spatial requirements to be answered.

All things considered, the choice of Quinta das Flores School as the case study is validated by the fact that it is a very particular and enriching learning environment. It is also due to its pedagogical perspective based on the curricula it lectures that is truly aggregator of the artistic and regular teaching and that gathers diverse educational options, lectured in spaces with assorted spatial features, namely: space for public and private use, for individual or collective classes, of specific or general occupancy, according to the array of spatial needs that this school's curricula implies.

1.6. Methodological approach

> "The idea is to help people report to architecture, to help architecture report to people, and to help people to report themselves." (Sejima, 2010)

As explained earlier[68], this research aims to define an original operative methodology to identify and assess adaptability, specifically intended to the case study of the recently rehabilitated Portuguese school buildings that gather regular and music teaching in a cross-curricular pedagogical model.

All in all, the structure of this Doctoral Thesis is based on three stages, in which each stage will inform the subsequent[69]:

- First, it is crucial to clarify the concept of adaptability directly applied to contemporary school buildings, in terms of activities, users, spatial features and design.

- Secondly, the research aims at defining an operative methodology capable of identifying and assessing adaptable school space. Presumably, space use methodologies applied to formal learning environments in the 1970s (such as Fawcett's (1978) mathematical approach), may differ from the analysis of today's flows of users in a more informal space or one with a non conventional shape (like the current use of video recording (Heitor and Tomé, 2009)).
  Hence, it resorts to the contributions from related areas in the scope of space use assessment methodologies (e.g. evidence-based design, post-occupancy evaluation, space syntax, facilities performance evaluation,

[68] See chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[69] The general methodological approach of this Thesis has been the first paper to be published and the first communication undertaken within the process of investigation for this Doctoral Research. It has been presented in the *Nexus 2012 Relationships Between Architecture and Mathematics*, in 11-14 June 2012, Milan, for testing and academic validation. It has also been published in the Conference's proceedings as: Coelho, C. (2012). From design process to space use: Adaptability in school buildings today. In M. Rossi (Ed.), *Proceedings of the Nexus 2012 Relationships Between Architecture and Mathematics.* (pp.23-28). Politecnico di Milano. Milano: McGraw-Hill.

usability studies[70]), assuming that the use of different methods brings quantitative and qualitative data and specific advantages, resulting on a more thorough conclusion. The crossing of data on school spaces and users' patterns of movement for each schedule, informs on the actual or potential activities for each space and its specific adaptability features.

- Thirdly, the methodology is tested in a school with a variety of spaces to validate its adequacy and effectiveness.

As it will justified in chapter 3[71], the methodology for this research that more fully answers the problematics[72] is considered to be a combination of distinct methods that provide specific results and comprise different levels of the living experience, considering the specificity of the artistic school. Hence, in order to develop a more comprehensive analysis, it is intended to use a triangulation of methods, by crossing different approaches for a more thorough output, on both individual and group fruition, emotional and physical experience in space. This can be achieved by crossing distinct frameworks under space use assessment methodologies, as detailed in the following description of the methodology here proposed:

I. Description of the spatial sample by a functional and a morphological analysis.

Space syntax studies analyse the building's morphology, assuming that "the degree to which spaces are used for movement is a function of their configurational position" (Hillier, 2007[73], p.392). By formulating axial and convex maps and determining the values of the parameters such as integration, depth or connectivity, these studies provide data on the degree of centrality of a space or a pathway within the whole system, the features of proximity and sinuosity of a particular pathway, and ultimately its intelligibility and easiness of perceiving the space. The conclusions provided by these studies, when subject to cultural and social interpretation, can suggest whether the variables related to spatial morphology affect spatial fruition.

[70] Those particular study fields and respective authors and bibliographic references will be cited in the chapter 3.1. Space use assessment methodologies, where these will be further detailed.

[71] See chapter 3. Construction of the methodology.

[72] The problematics has been explained in chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[73] Consulted edition from 2007, original edition from 1996.

II. Analytical feasibility matrices quantitatively display the relation between spaces and activities, by matching spatial attributes to the activities they have the potential to support. These outcomes are collected in charts subject to interpretation, concluding on the attributes that enable the highest entropy levels[74], and consequently which spaces are the most probable to shelter the widest range of activities. A set of matrices displays what are the actual activities that can take place in every space. This describes the formal activities thought for each space and that can be experienced by a collective ensemble, previously determined by the management of the school. The compared results between matrices provide information on how and under what conditions each space is occupied and its "loose-fit" (Becker, 1990) potential to shelter other activities and occupants.

This information when crossed with the data collected by Space Syntax studies indicates whether the location of a particular space can influence its occupancy, both on the frequency of use and on the range of activities held.

III. Observations of effective spatial fruition and self-reports for personal testimonies and deliver individual qualitative descriptions on spatial fruition and complement the previous, more general conclusions, with a more detailed assessment of the living experience. This is particularly relevant in contemporary school buildings that value informal spaces and activities as a crucial part of the learning process, such as casual events that take place in public spaces like the cafeteria or the school's common hall. In addition, since it is aimed at an artistic school, the nature of the activities and inhabitants involved has to be considered. Hence, feedback by means of self-reports describes more thoroughly individual experience in space and informal appropriation. The information in these reports illustrates, in another context, how Jauss's (1986[75]) reception theory can be transposed to the school's inhabitants, as active *readers* of the space, creators of sense, or authors of their own narratives, as Benjamin (1982[76]) described it.

[74] Further explanation on this subject will be provide in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[75] The book version consulted is in Spanish and dates from 1986, but the original version is from 1977.

[76] Consulted edition from 1982, original edition from 1937.

IV. The final stage of this research corresponds to the interpretation of the results gathered, translating them into operative knowledge for a broad depiction of the space and the spatial features that enable the identified experiences, either individual and collective, formal and informal, in Quinta das Flores School.

The expected outcomes are a comprehensive outlook on how, when and by what means does space enable or constrain the spatial experience envisioned by the architect, or whether effective spatial fruition overlaps the expected one. Overall, this gathering of methods and respective results describes more fully the spatial experience, quantitatively and qualitatively.

For the purposes of overcoming the expected outcomes of this research, it is crucial to progressively introduce information from a theoretical research on literature on the state of the art of adaptability in school buildings, as well as adaptability overall, the evolution of spatial solution in schools, and also related to space use assessment methodologies.

Then it will proceed by explaining in detail the construction of the methodology, specifically constructed for the purposes of this research, amongst the diverse methods of assessing space use.

Subsequently, the practical fieldwork will be depicted, and the methodology will be applied to the case study under examination.

Afterwards, the conclusions achieved will be described, to subsequently inform both the theory and the practice of architectural research, and also to raise the possibility of applying this methodology to other schools as future potential developments.

Therefore, the Thesis will be organised in the following chapters:

1. Initial considerations

2. State of the art and critical revision of the concept of adaptability

3. Construction of the methodology

4. Application of the methodology in the case study

5. Conclusion

Bibliography

Chapter 1: Initial considerations aims to introduce the research question and to contextualise it under a deeper and more extensive personal and academic motivation. It is also where the research objectives are promptly clarified, so that the approaches to reach them become clear and gradually answered throughout the all document. Also under this chapter lies the justification for the choice of the case study and the specific presentation of the school where the methodology will be applied in, with its respective specifies that lead to the choice on the approaches to assess its adaptability. Additionally, this chapter will also justify the scope of the Thesis under architectural research, considered to be significant for knowledge advancement on this subject and also to perceive it as an original and state of the art approach on the matter.

Chapter 2: State of the art and critical revision of the concept of adaptability intends to address the concept of adaptability and adjacent terminologies according to the authors of reference and then, more specifically, to point it out to the educational brief and, particularly, to the scope of the contemporary learning environments for today's varied curricular options.

As previously explained in this chapter, this research is structured by four stages, in which the previous will inform the subsequent. So, after the initial considerations placed in chapter 1, chapter 2 will focus on the concept of adaptability and its state of the art and authors of reference, analysing whether its previous definitions can continue to be understood contemporarily and whether the approach to the school buildings can constrain the specificity of the definition.

Chapter 3: Construction of the methodology presents various space use assessment methodologies from different study fields within architectural research, which will be presented and analysed for identification of the ones considered more significant for the assessment of the use(s) and experience(s) the space enables, according to its potential level of adaptability.

This chapter introduces the methodology defined for this research, which aims at identifying and assessing adaptability in learning environments, after the comprehensive study of the different approaches, study fields and respective outcomes that each one provides. Therefore, it acts as a very significant part of this Thesis that explains in detail this original methodology, the options that support it and the expected results from its application.

Chapter 4: Application of the methodology in the case study introduces the case study in detail and aims at validating the methodology that has been previously defined in abstract, within a case study, introducing it in a real life scenario.

This chapter corresponds to stage three of the research, which is the testing of the methodology in a variety of spaces in the case study, to analyse its adequacy and to test its robustness.

Chapter 5: Conclusion draws the final outcomes, according to the results provided by the application of the methodology in the case study. Each stage of the proposed methodology is analysed and critically assessed, the results are studied and the potential correlations between the results from each approach from the overall methodology is identified towards a more general framework of application.

Bibliography corresponds to the final part of this document and lists all the direct and passive references used for the purposes of informing the research, in its diverse subject areas from which this Thesis has sought for information and contents, based on different sources such as books, book chapters, articles in periodic publications, websites of institutional and academic value… Finally, it also specifies all the personal publications developed throughout this research process that have already been subject of peer review and have been presented and/or published as academic and original developments.

Overall, it is considered that this Thesis's organisational structure can lead to the achievement of the objectives defined in chapter 1.4[77] and the conclusion on the hypotheses suggested in chapter 1.3[78]. It is also considered that throughout all these stages and respective chapters, the research question will also be addressed and thoroughly answered. The identification of the concept of adaptability for contemporary school buildings will be clarified in chapter 2[79], the methodology to identify and assess it will be extensively explained in chapter 3[80], and its application in the case study will be described and examined in chapter 4[81], for reaching the final conclusions presented in chapter 5[82].

[77] Chapter 1.4. Research objectives.

[78] Chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[79] Chapter 2. State of the art and critical revision of the concept of adaptability.

[80] Chapter 3. Construction of the methodology.

[81] Chapter 4. Application of the methodology in the case study.

[82] Chapter 5. Conclusion.

By identifying adaptability in school buildings, it is possible to assess it during its spatial usage and understand how and by what means can an adaptable space be projected and how can it enhance a wider range of experiences and users in space throughout a longer period of time. Moreover, it also provides information on the features of design that enhance the adaptability level of each space that can be pre-perceived in the design, as a way to broaden its usage, in time and activities.

Hence, according to the Thesis's organisational structure explained, and assuming the sequence of information each chapter will bring, it is considered that the research question identified in chapter 1.3.[83], under the context selected for this research and accurately justified in chapter 1.5[84], will be answered throughout the all document and explicitly in the conclusion chapter.

All in all, the aim of this methodology is to take into account all procedures that could bring further information to the final result, in which nothing could be added or taken off. In this same manner, this methodological structure also aims at providing a thorough approach to this subject matter in an overall cohesive approach. Hence, Alberti's quote could then better explain this goal:

> "For many components are required to finish the work, and as the absence of any of them can impede or result in the ruin of the entire structure, it is your duty not to miss anything that will add to the overall scheme if present, but detract from it if absent." (Alberti, 1988, p.37[85])

[83] Chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[84] Chapter 1.5. The case study.

[85] Quote from the English version translated in 1988 by Joseph Rykwert, Neil Leach and Robert Tavernor. Alberti's original work dates from 1485.
The original quote from the Latin as follows: "Cum uero tota ædificii ratio ex singulis modulorum partibus ita erit apud te spectata et cognita: ut nihil non animaduersum: nihil non adnotatum uspiam relinquatur: & interea ita omnino decre ueris ædificare: et apud te constabit unde sumptibus oportune satisfiat / parabis reliqua ad opus ipsum exequendum necessaria: ne quid inter ædificandum desit: quod a perficiundi operis celerita te auocet. Nam cum sint plura quibus ad opus absoluendum indi geas : cumque illorum quid uis ni adsit omnem structuram possit aut impedire aut uitiare / officii erit nihil neglexisse / quod confe rat si adsit: aut noceat / si desit." (Alberti, 1485, Book 2, p.43)
Note also that the first Portuguese translation was published in 2011 translated by A. M. E. Santo and the Introduction, notes and disciplinary revision done by M.J.T. Krüger. In the Portuguese version this quotes has been published as follows:
"Na verdade, sendo muitas as coisas de que necessitas para concluir a obra, e como qualquer delas, se faltar, pode impedir ou prejudicar toda a construção, é teu dever nada descurar naquilo que é importante, se houver, e prejudicial, se faltar." (Alberti, 2011, p.195).

1.7. Architectural disciplinary scope, relevance and originality of the research

> "Change has become the greatest challenge, aesthetic as well as programmatic, of contemporary architecture." (Duffy and DEGW, 1998, p.11)

After recognising the advantages provided by adaptability when applied to school buildings[86] and, subsequently, determining the objectives of this research in order to address this subject matter[87], the relevance of adaptability for the discipline of architecture can be considered to be established.

Adaptability, when planned in the design, goes hand in hand with sustainability, in terms of a better environmental performance and the reduction of maintenance or rehabilitation costs, which could be perceived as a better economic investment, in the way it intends to avoid or postpone its obsolescence, assisting it to continue to cope with the changing needs. Additionally, because it enables the achievement of an appropriate response of a building not only for the present moment but also in the long run, it also allows a better functional and material performance for longer.

Moreover, when applied to school buildings, adaptability is also recognised as an architectural quality factor[88] and a pedagogical quality promoter, as educational spaces can act as community aggregators and potential enhancers of the learning process and student achievement (Schneider, 2002b; Moore and Lackney, 1994).

According to the contemporary social, educational and constructive requirements for schools, this is a topic which is being rethought. Indeed, due to the current curricular and technological changes, along with today's significance of the learning

[86] As seen in chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[87] See chapter 1.4. Research objectives.

[88] As noted by the OECD in its publications (1976, 1996, 2001, 2006), but also by other literature references on this subject area like the Commission for Architecture and the Built Environment (2007), National Clearinghouse for Educational Facilities (Bingler, Quinn, Sullivan, 2003; Nair, Fielding, 2005), Commission of the European Communities (2007) and Educause (Oblinger, 2006; Oblinger, Oblinger 2005). And for both the American and the English secondary school programmes, both flexibility and adaptability are essential in the design for exemplary schools as "Important issues to consider early on" (CABE, 2007, p.7).

experience in space, within its wide possibilities and specificities, contemporary educational spaces' requirements have also evolved and the concept of adaptable schools has evolved along with them.

In fact, given the role of informal spaces, the prominence of knowledge creation through individual and group work, the *non-face-to-face* model for lecturing and work production, conceivable due to the information technology, and coexisting with the traditional *face-to-face* model, where the physical co-presence plays a fundamental role, besides the profusion of teaching methods by means of the new information technologies and the curricula changes; hence, spatial responses will necessarily be different from previous design solutions.

In the case of a subject openly debated in the 1970s (OECD, 1976; Ader, 1975a, 1975b; Oddie, 1975), it becomes relevant to study it according to the present educational paradigm, and specifically into the current Portuguese reality. Undeniably, the Secondary School Modernisation Programme implemented in Portugal, suggests a deeper understating of the need for an adaptable school, while planning the renovation designs for fulfilling the pedagogical and social requirements, within a more fully and informed spatial answer.

So, this is a research that is committed to the current Portuguese reality[89], intending to achieve operative results, within an area that is being discussed nationally and internationally, which adds to its relevance for both the country's research development, and the knowledge advancement for the discipline of architecture.

Thus, the methodology will be supported by the most representative references on the state of the art of adaptability and particularly of adaptability in school buildings, but will also be critical towards them, introducing the approaches considered to be more informative and projecting them into the current Portuguese context of educational spaces. So, in chapter 3.3.[90] when the methodology will be extensively described and justified, its originality will again be referred, as the methodology constructed under the scope of this Doctoral Thesis will be justified, and the approaches to authors of reference for its validation will be critically analysed. At that point, its originality will become even clearer in a more explicit manner, while comparing existing approaches to the one presented, in the number of procedures, in the sequence suggested, in the approaches undertaken and, foremost, in the features considered and assessed and the process to do it so, such as: possible activities, effective events, spaces, users and allocations.

All in all, for both the theory and the practice of architecture, the study of

[89] The relevance and originality of the choice in the case study have already been subject of reflection in the chapter 1.5. The case study, from the Portuguese schools, then to the artistic schools and finally to the identification of the specific case study, where the methodology will be applied on and for which it will be constructed.

[90] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

adaptability in school buildings can represent a knowledge advancement when designing educational spaces, aiming at lasting longer, being potentially more sustainable and coping with the inevitability of social, pedagogical and technical changing requirements.

Also for the theory of architecture, this research plays a significant role, since it approaches both the concept of adaptability today, but also the wide scope of user research studies that can potentially report and inform spatial fruition. It also analyses their potentialities and scope, and concludes on the methodological approach to identity and assess the concept under the context of the case study.

Then, intending to test the methodology in a case study for which it has been specifically constructed, this methodology aims at being translated to the practice of a real life scenario. This testing and validation will ultimately make it more robust and able to be further applied to other schools, for assessing their adaptability and the ability of their educational spaces to cope with the current and future requirements, but also to inform future designs on the needs to be answered if a rehabilitation process is in order.

So, likewise, and recognising that the school programme has been the subject of an extensive architectural, building and financial investment, this research will seek to advance on the disciplinary knowledge for both the intervention in the building here analysed as case study, as in others later on.

Overall, this acknowledges this research as an architectural study that aims at deepening the subject matter of adaptability in school buildings, whose relevance is supported by literature and organisations' work throughout, and which becomes even more significant under the present pedagogical context and directives.

But, specifically, its application under the Portuguese context, supports it as even more relevant for the study of the current reality for both the theory and the practice of architecture in Portugal, making it more significant to understand the process undertaken, the current spatial potential of the renovated schools and possibly their ability to cope with future developments.

Hence, the relevance of this research lies within the need to study and assess the current spatial fruition in today's active learning environments, as a very significant contemporary challenge for the discipline of architecture, as seen in the quote that introduced this chapter by Duffy and DEGW (1998)[91].

It is also pointed out to a specific school that could be considered a more complex case study, since it holds a more plural set of inhabitants and actions, and whose

[91] "Change has become the greatest challenge, aesthetic as well as programmatic, of contemporary architecture." (Duffy and DEGW, 1998, p.11)

activities act as a relevant cultural, social and educational centre for a broader community.

This reference to the case study of a particular school that gathers artistic and regular curricula is an example of a space rehabilitated to potentiate a broader range of activities by a wider community that ultimately can be best assessed by an extensive range of methods in order to fully identify its multi-layered experience in space. It is also an example where the change in space has potentially an implication in the learning process, ultimately bonding architecture and experience and including the human condition in the design.

All in all, the originality of this research lies in the methodological approach to adaptability, under the contemporary context and within the choice of the artistic contemporary school building as case study, assessing its specific ambiance experienced at several levels. The fact that it is originally targeted, specifically, to the Portuguese artistic schools, also designates that the definition and the methodology to be adopted should originally match its characteristics and contextual specificities. Furthermore, it aims to be informed by several research cultures, focused on the adaptability's methodological approaches studied on the state of the art, but proposing an original and contemporary specific methodology applied to current school buildings that potential demonstrate its possible gathering.

Overall, it aims at providing original and state of the art knowledge to the subject of architecture, displacing the advancement from the achievements of the relevant, yet previous authors, but also their possible interconnection(s). It also intends to contribute with a thorough and refreshed outlook regarding adaptability in school buildings today, as an input to the theory of architecture, the definition of the concept and its respective methodological approach, but similarly to the practice, considering adaptability already in the design process and as an asset throughout the buildings' occupancy.

1.8. Viability and feasibility

> "The question is not whether we have to adjust with difficulty to what has been produced with even more difficulty, but whether we make something which from the beginning is totally part of ourselves, for better or worse." (Habraken, 1972, p.13[92])

Having explained the methodological approach[93] and its suitability to the research question and to the objectives sought[94], the research development and foremost the achievement of the defined the goals could be concluded as feasible.

Furthermore, the option for a case study from the Portuguese context also justifies the adequacy of the study object to the purposes of the research and the adequacy of the means to the goals.

Besides, the established contacts allow us to conclude on the availability of the entities to provide data and relevant interviews for this research. Namely the availability of Parque Escolar[95], as the entity in charge for the School Modernisation Programme and the upholder of the technical drawings, plans, sections and elevations from the case study, as well as the descriptive text written by the architect, which has provided crucial material for the research, enabling the application of the methodology in the case study.

Specifically, the study of Quinta das Flores School can also be considered viable and feasible, due to the availability of the data needed for this investigation, as well as the cooperation of the stakeholders.

In fact, the Direction of Quinta das Flores Basic and Secondary School, by its Director - Professor Ana Margarida Marques, and the Artistic School of the Music Conservatory of Coimbra, also by its Director at the moment of the research - Professor Manuel Rocha[96], have been available for interviews of particular

[92] Translated from the Dutch by B. Valkenburg. First edition in Dutch from 1961.

[93] See chapter 1.6. Methodological approach.

[94] See chapter 1.4. Research objectives.

[95] We deeply acknowledge Parque Escolar for its availability, as indicated in the Acknowledgements section.

[96] In chapter 4.1. Presentation and justification of the chosen case study, these titles will be explained in detail

significance and have allowed several visits to the space. Besides, also the architect José Paulo dos Santos has been accessible for interviewing under the scope of this research.

Furthermore, the established contacts that took place throughout all the research process, both by email or in person, on peer meetings and international conferences, have considered this issue to be suitable and viable for presentation in its sequential stages of development.

Likewise, publications, conferences and contacts, have also provided input for consideration and critical assessments that enable a more supported answer and sequential reflections on the progresses of this research.

Nevertheless, the research question on adaptability that underlies this Doctoral Thesis implies additional efforts to fully and more comprehensively address it, which have been noted from past researches, as well as by the practice. In fact, the pursuit of adaptability and the methodological approach to assess it, have been considered by literature to hold some constraints that need to be acknowledged, to be tackled in this research process, because of the potential they could bear for hindering adaptability's feasibility in space.

In fact, the relation between the changing needs of the people and the lasting character of the built form, can be difficult to answer in the design (Duffy and DEGW, 1998, p.53[97]). Adaptability addresses this dichotomy because it implies the buildings' ability to relentlessly respond to changing needs, whether functional, technical, aesthetical, environmental,... despite the reductive constancy of its physicality.

Therefore, an adaptable building will supply the current demands of all its users, throughout its lifecycle, acknowledging potential changes in the future and the need for spatial adequacy. This fact can introduce a difficulty in providing and "designing for the future" (Duffy and DEGW, 1998), which is at the time of the design still uncertain[98]. According to DEGW:

> "Designing for adaptability forces everyone to join in predicting the future. And because it encourages shared responsibility in the decision -making process, it tend to lead to affordable solutions. How much adaptability is something that can be calculated after thinking through scenarios of change. To what extent and in what areas adaptability is needed are questions that help to inform realistic and sustainable solutions." (Duffy and DEGW, 1998, p.76)

and the institutional differences explained.

[97] The work of DEGW will be assessed in detail. See chapter 2.1. Adaptability: definition and adjacent concepts.

[98] Becker and Sims (2000) called this "the uncertainty dilemma" (pp.5-7).

Indeed, this implies an equilibrium between supply and demand, now and in the future. One of the possible approaches is the "strategic briefing"[99] for identifying those requirements and making them possible to be answered later on, ensuring the buildings performance over time. Rather than providing a deterministic space for people and activities, this considers an openness of the space for other endeavours and people that might occupy the building in the unknown future[100].

But, in fact, the transference of adaptability from brief to use has not always been carried out in the most appropriate or effective manner, namely by unfitting designs and solutions, or even by a mismatch between the emergent demands and the available supply and, ultimately, the lack in communication between professionals and future inhabitants.

The divergence between expected and effective spatial fruition may be due to "under-provision" (Fawcett, 2010b), when spatial constraints hamper the building's ability to cope with the upcoming demand, like an increase on the number of people that occupy the space and more demanding spatial requirements from activities that have not been perceived at the time of the design.

Therefore, a certain degree of spatial indetermination can be considered in order to cope with future options on activities and, specifically for schools, curriculum variations. This can be considered an "elastic fit" (Becker, 1990)[101] that copes with this lack of certainty. Already in 1975 this was a spatial concern by the OECD:

> "The rigour which is implicit in the briefing and design process does not preclude a certain degree of indetermination in all multi-option school projects, the practice of an education of options leads to a random factor in forecasting requirements, the allocation of the different spaces within the school must be capable of variation and it must also be possible to change teaching practices as time goes by." (Ader, 1975a, p.7)

On the other hand, the problem of "over-provision" (Fawcett, 2010b) of the design can be due to excessive solutions set out in the project-phase, involving unnecessary costs, availability of space and exaggerated technical resources or a range of systems, that future users will not take advantage of. As an example of "over-provision", Fawcett (2010b) points out the Free University of Berlin[102].

[99] "According to Colin Cave, former chief executive and now consultant at DEGW, strategic briefing is about "Envisaging how buildings are going to be used. It is a matter of identifying strategic requirements, describing possible solutions and setting the critical success factor for a project, together with the means of measuring or calibrating success."" (Duffy and DEGW, 1998, p.54)

[100] "Strategic briefing could be seen – wrongly – as an infallible method of determining the ideal size, layout, furnishing, servicing and overall look of a building, which magically materialises at the end of the process. DEGW's objectives in the strategic briefing process are not, however, to encourage architectural determinism: the idea that there is only one "correct" solution. Rather the aim is to lay down a strategic and overarching framework within each client, architect and other professionals may work to achieve optimum results." (p.67)

[101] From Becker's (1990) "elastic organization" "loose-fit" and "tight-fit" concepts.

[102] "A classic example of over-provision for flexibility is the Free University of Berlin by Candilis Josic Woods.

In fact, oversupply and unnecessary solutions, do not often guarantee a more durable and effective investment in the long term, but rather a needed balance between what adds value to space but is also cost-effective in the design. This is identified by the work of the Research Project Adaptable Futures at Loughborough University:

> "For many people, it [adaptability] has been branded as costly, an 'extra', rarely used, and involves state-of-the-art gadgetry which only works half the time. This is all in an effort to safe-guard the end user against unpredictable changes in organizational structure, functional use, spatial arrangements, technological advances, and so on. This perceived view has been driven by technical attempts at future proofing buildings through the application of specific solutions." (Schmidt III et al., 2010b, p.4)

Instead, DEGW identifies three conditions to match more accurately spatial supply with the user demand, which are: proficient management, user engagement in both the design and management, and innovative design options, for enabling adaptability overall (Duffy and DEGW, 1998, p.77)[103]. Hence, besides facilities management and actual knowledge on how to use them, adaptability conceived in the design by the professionals plays a significant role for the overlapping of the effective requirements and the spatial potential to cope with them, and is a contribution specifically made possible by the discipline of architecture.

Having already addressed the design solutions that provide for adaptability and the urge to balance its provision with the effective use value they convey, at this point we will now focus on the two remaining conditions: management and user involvement, referred above by DEGW.

The school management policy can, in fact, condition its occupancy. So, its openness may be a reflection of "the style of management in the school" (Fawcett, 1976a, p.10), but also of its pedagogical options, more than just the individual and spontaneous space use *per se*. In this sense, Quinta das Flores School, by promoting agreements with other several institutions, gets closer to the community and opens itself to the city.

Won in competition in 1963 and built in 1967-74, it is an indeterminate two-storey network […] By the 1990s a major refurbishment was required. Comparison of the plans in 1974 and postrefurbishment show that the building envelope did not move, and the main internal alteration was the division of larger spaces into small offices – which could be done in studwork without the totally flexible construction system. It seems that the architects drastically over-valued the excessive (as it turned out) provision of physical interchangeability." (Fawcett, 2010b, p.14)

[103] "Matching demand and supply so that user needs are continually reconciled with building capacity is the basis of a successful real estate, property of facilities strategy. To achieve this in a time of change, DEGW has recognized that three requirements must be met: facilities management must achieve far higher levels of service and professionalism; users must be involved in space design and management to stimulate solutions that are far more innovative and cost-effective; and finally new design and managerial techniques are needed to make the working environment far more adaptable." (p.77)

Actually, the current needs from the local collectivities and the places and buildings available to accommodate them, has led to rethink the diversity of pedagogical and community uses that may occur in the school buildings, both during and outside school hours, which has been subject of reflection on the *Séminaire L'élargissement des Fonctions des Bâtiments Scolaires* (1996)[104]. Issues like co-usage or shared spaces have been discussed, as well as "full service schools" as a place where it is provided an integrated and broader pedagogical, social, family, health and working care (p.23).

Overall, the possibility of opening the schools for external uses, during weekends, after work hours and vacations' breaks, as a way to capitalise the investment on the school building and on its maintenance, has been subject of consideration. Besides, this is also a way to answer the growing social needs for spaces for: leisure activities of children and adolescents outside school hours; to accommodate cultural, sporting or communitarian activities for adults; for activities concerning the use of new technologies and information resources; and the creation of community centres with social and cultural assets, which can potentially be fulfilled in school buildings (p.9).

Furthermore, DEGW also mentions user engagement for overlapping supply and demand, which suggests that users take part in the design decisions and actively appropriate space.

A weak role of the user in the decision process often results from the unawareness of the benefits it brings, the lack of a design methodology that incorporates this input and also the lack of investment in the interrelationship between the user(s) and the architect(s), or even the media attentiveness to the aesthetic dimension of the built form[105], rather than the use value of the inhabited building (Coelho, 2008).

Habraken (1972), reflecting on an alternative system to "mass housing", also refers to the importance of user involvement, because, otherwise, the end result may not be as suitable and people may not feel a sense of belonging there.

Moreover, often the lack of ownership can be related to an intricate cultural factor and a resistance in changing habits and routines. If there is no community involvement, people may not fully enjoy the new possibilities of space, enabled by the school modernisation, and so, potentially, unpairing projected with effective space use.

Consequently, the translation of the concept of adaptability to the design and to its effective spatial fruition is conditioned by a balance between supply and demand,

[104] This seminar took place in Lyon in 1995, as a OECD PEB initiative.

[105] Quoting Gehl: "Usually there are no people on photographs in architectural magazines, but in actual life there are almost always people to be seen in and around buildings, due to the very simple fact that buildings are made to accommodate various human activities." (1970, p.62).

cost and value, intended and effective use. An adaptable building will then respond to the effective use and actual requirements in due time, because of its early provision in the design for a solution that can meet changing spatial demands.

Yet, and despite the difficulties of approaching this issue mentioned above, its relevance urges to address it and the sequential stages identified in the methodology consider it viable to be achieved.

But foremost, and retrieving once more DEGW, it is an inspiring subject for the discipline of architecture and a motivation for the creation and the advancement of the architectural knowledge:

> "Designing for change over time should be stimulating rather than constraining for designers. Architects ought to enjoy the constant, demand-led renegotiations that are inevitable when many diverse constituencies involve themselves not just in the design process but equally in the reinvention of the use of space over time. […] Such challenges are not bad. They stimulate invention." (Duffy and DEGW, 1998, p.53)

2. STATE OF THE ART AND CRITICAL REVISION OF THE CONCEPT OF ADAPTABILITY

2.1. Adaptability: definition and adjacent concepts

> "A building operates on many levels, aesthetic and practical, public and private, but, increasingly, buildings need to be seen not just in space, as physical objects, but also in time, as organisms which have a lifespan during which they will inevitably change and adapt." (Duffy and DEGW, 1998, p.54)

This quote by Duffy and the DEGW is central to acknowledge the building and its *lifespan* during which it is subject to change. Adaptability will then provide the building for coping with those possible changes during its lifespan.

This chapter intends to focus on the concept of adaptability and to provide an informative outlook on the authors that have tackled it, their research contexts and their definitions. This will be followed by its specification to schools on the following chapter and how it has been perceived in the design of past adaptable school buildings[106]. The final part of chapter 2 will focus on contemporary learning environments, how can these be perceived in relation to the current learning paradigm and the role of adaptability to correlate them both[107]. Only after the study of the concept of adaptability, how it has been observed and studied and, particularly, how it has been translated onto schools and how it has been transposed for contemporary learning spaces, can the methodology to be proposed by our current Thesis be perceived in the following chapter 3.

Specifically, this initial part aims at providing a far-reaching outlook on the concept *per se* for understanding the possible approaches to it, their outsets and early intentions and their developments onwards, so that an adequate definition can be achieved. Only after understanding the adequacy of the definition of adaptability towards the chosen brief and the current case study application, can the methods to assess it be proposed.

Before examining the concept of adaptability in detail, it is relevant to identify that the building holds, in fact, a lifecycle in which changes occur, which are still unforeseeable in the brief and in the design process, regarding the "many levels" in which the building acts, referred in the upper quote by Duffy.

[106] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

[107] See chapter 2.3 Adaptability for contemporary learning practices and environments.

. An approach to the building's lifecycle

The time coordinate is essential to analyse buildings along their pathway, relating the architect(s) and the user(s), design and use, assessing the buildings' costs and validating the design choices. Byrne (2012) on a communication at the Department of Architecture for the Doctoral Course referred to the fact that buildings had a lifecycle that is prolonged from the brief, stating that:

> "From the moment that buildings are ready they have a life of their own. The buildings' own life results from the fact that that structure, thought and built, is prepared to resist in time, with the life that occur within it."[108] (Byrne, 2012)

Under closer examination, the building is, in fact, a living organism that is developed within a persistent structure that is the physical space. This coincides with Byrne's assumption of the building as a "life container"[109]. Living buildings continue to respond to what is asked of them along the time, reacting functionally, aesthetically and socially, urbanely,… to those requests. This ability to respond is related to the building's "change readiness", which makes them available to gather people within, strengthens their relation to people, and which ultimately makes them alive. The concept of "change readiness" is very directly approached to an ability to answer the current and also the future, still unknown needs, as explained by Finch (2012a, 2012b):

> "[…] the ability to configure systems and assets such that they can meet the requirements of various possible futures. Again, not only do we have the 'presenting problem' of current day concerns, we also need to identify concerns of tomorrow." (Finch, 2012a, p.14)

In Lynch's (1958) paper *Environmental adaptability*[110], flexibility, plasticity and adaptability are tackled, in which the first relates to "active participation", the second to "personal repair or modelling" and the latter to "the generalized adjustability of an environment or artifact, with minimum effort, to future changes of use" (Lynch, 1958, p.16). As opposed to a "strait jacket" (p.16) adaptability "*allows* growth or development"[111], being "permissive" to it (p.23). Lynch presents the duality between a "narrow adaptation to the immediate situation" and the "looseness of fit", as the "conflict of basic objectives" that implies a balance solution and a contextual

[108] Free translation of the original quote in Portuguese: "A partir do momento em que os edifícios estão prontos têm vida própria. A vida própria de um edifício resulta do facto da relação dessa estrutura, pensada e construída, estar preparada para resistir no tempo, com a vida que se processa dentro dela." (Byrne, 2012)

[109] Expression often used by architect Gonçalo Byrne of "contentor de vida" (Byrne, 2007, pp.23 -24).

[110] This paper will be analysed in further detail in the chapter 3.2., as a significant contribution for the state of the art on a methodological approach to adaptability assessment. See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[111] Italics from the original quote.

decision-making (pp.23-24).

Two years later, Weeks argues for *Planning for growth and change*, focusing on a design that can cope with changing requirements. Weeks focuses in hospitals because of their needs for possible far-reaching transformations, like expansion or compression in size, but also to more frequent changes that do not involve such alterations or larger scale (Weeks, 1960, p.20). Flexibility is approached using the metaphor of the "duffle coat" that can shelter different situations, as the "common denominator of space required for various routines", rather than a specific "tailor-made garment", which could be paralleled to Lynch's recognition of the "conflict of basic objectives" (Lynch, 1958, p.24):

> "In order to get maximum flexibility within a department it is necessary to provide rooms which fit around the activities which are to be carried on in them like a duffle coat. The duffle coat, provided by the Navy for its officers, was not a tailor-made garment. A few sizes were made and these were related to the known range of sizes of sailors so that it was usually possible to find one that would fit very reasonably, and keep the sailor quite snug." (Weeks, 1960, p.20)

Weeks assumes the difficulty between planning the whole building and simultaneously meeting the specificities of the brief and the clients' meticulous demands that hold great significance for the patient's well-being, which he compares to a dwelling, and that cannot be bounded only by aesthetical decisions:

> "The architect must produce a system of space development relevent [sic] to the planning needs and correct in the scale of building; devise a method for ordered small scale decision-making within an overall design system, and refrain from the arrogant denial of function through private delight in form." (Weeks, 1960, p.22)

Cowan (1963) also approaches this subject on his paper from *Studies in the growth, change and ageing of buildings*[112], establishing that: "The rate of change in human affairs is accelerating very quickly." (Cowan, 1963, p.56). Being subject to change, growth and ageing, the buildings' equilibrium - as their "homeostasis" - is achieved by a balanced outlook with their contextual systems, which simultaneously impact them and that the buildings cyclically influence[113].

[112] This paper will be analysed in further detail in the chapter 3.2., as a significant contribution for the state of the art on a methodological approach to adaptability assessment. See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[113] "I have shown them as part of the general system of human affairs which is constantly changing, and have tried to indicate the way in which buildings affect and are affected by the larger systems of human development. The key lies in recognising the changing balance of such systems. Homeostasis, which describes the shifting balance between an organism and its environment, is a condition which we should seek to achieve in our buildings." (Cowan, 1963, p.82)

In regard to the unforeseeable grown and change in organisations[114], in the following year Weeks's paper *Indeterminate Architecture* assumes this subject to be already disclosed, even if it had not been before:

> "Almost unnoticeably a new class of architectural problem has isolated itself during recent years. I use the word "unnoticeably" since although the elements of the problem are now relatively easy to identify and it has been with us for some time architects have behaved either as though it could be contained within existing architectural manners or that it is in some way anti-architecture, and must be fought against. It has not been given, therefore, characteristic form. Its emergence therefore is 'unnoticeable'." (Weeks, 1964, p.85)

Still, according to Weeks, the buildings are conceived for a more tight approach to a specific function, which hinders them to accommodate changing uses[115]. Using as example the hospital at Renkioi on the Dardanelles by I. K. Brunei and the Crystal Palace, Weeks ascertains that these have been conceived with "determinate" and "indeterminate" elements that responded to "an incomplete brief" and accounted for change. Weeks discusses solutions for coping with that unpredictability and concludes that a design that regards growth and change holds the control of the building's development more so than not comprising them:

> "I have tried to show that the aim of achieving an indeterminate architecture can be a positive factor in design and that control exercised over the way a building will grow is not achieved through indecision, but by decisions taken at every point in design." (Weeks, 1964, p.104)

Prior to Weeks's focus on hospitals for their possible changes in this paper, Llewelyn-Davies' pioneer work during the 1950s is also to be mentioned, when he ran the Nuffield Foundation Division for Architectural Studies. This is a research centre were Weeks was also a contributor. Studies on movement (Fig. 8) or space use were plotted against specific layouts for assessing their performance. Llewelyn-Davies stated the relevance of these studies by the operative information they could infer, assuming *Deeper knowledge, better design* (1957):

> "It is in some ways the only substitute we have for tradition. Tradition was built up after a long period of trial and error. They tried all sorts of rooms, windows, etc., over many years, research of a slow and very

[114] "The problem is that of sheltering an organisation which has a rate of growth and change which is so great that it makes its buildings obsolescent before they decay naturally." (Weeks, 1964, p.85)

[115] "Buildings today are built to lesser space standards and to higher standards of service provision than in the past. Rooms today are tailored more and more accurately to the work to be done in them and refined tools are now available to increase this accuracy. They are not, therefore, easily able to absorb larger populations except with a loss of amenity through the greater density of use. Their service provision is often both elaborate and accurately provided and so inhibits the easy change of use of space." (Weeks, 1964, p.86)

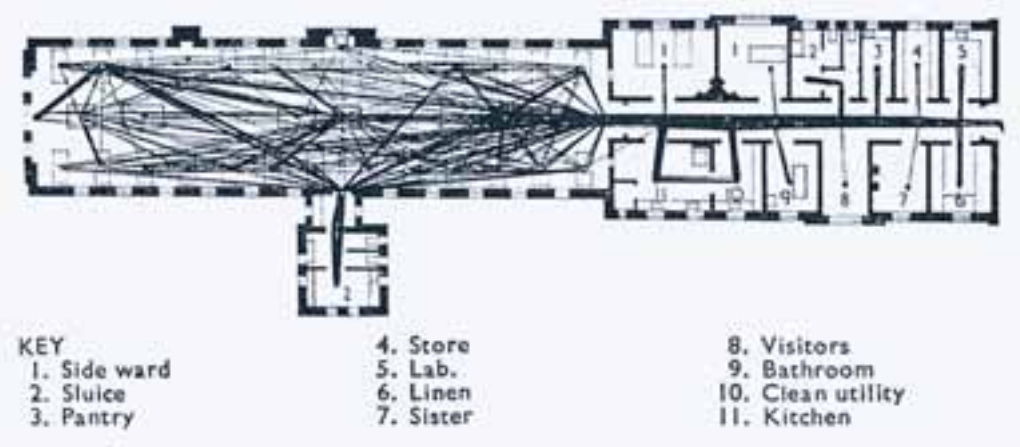


Fig. 8. "The movement record of a first year nurse's typical day of work. […] The nurse's movements were recorded by threading string around corresponding points on a plan "

(Llewelyn-Davies, 1952, p.105)

> expensive kind. Now we can't afford to do that; we must use more intensive methods, to get the old quality into architectural design." (Llewelyn-Davies, 1952, p.105)

The emphasis on these studies between space and activities would be later transferred to the context of the schools of architecture, namely the Unit for Architectural Studies, at the Bartlett School of Architecture, University College London (Unit for Architectural Studies, 1968). Then, a specific study on research laboratories, also pursued within the scope of the Nuffield Foundation, would be taken on by the Unit for Architectural Studies, coordinated by Musgrove in 1967. Specifically, this study focused on the "use of space and facilities in universities" regarding the rooms' "characteristics" that enabled a wide range of functions within, instead of a specific function paired to each room: "Thus it is not the permanent characteristics of the room but its loosely fitting function which is used to classify it in every day parlance" (Musgrove and Doidge, 1970, p.31).

For this study "port-a-punch cards" (Fig. 9) were used for assembling room information regarding: their "room code number" from previous drawings (A), their "location" (B), "size and shape", "current primary room use" and "environmental factors" (E). This allowed to gather information on "the nature of the activity; the number of people involved; and the location of the activity in relation to others" (Musgrove and Doidge, 1970, p.32) according to the data from each room[116]. These are informative data for our current research for matching activities to spaces according to their spatial features.

[116] See the feasibility matrix on chapter 4.2.2. Description of all possible activity allocations to educational environments.

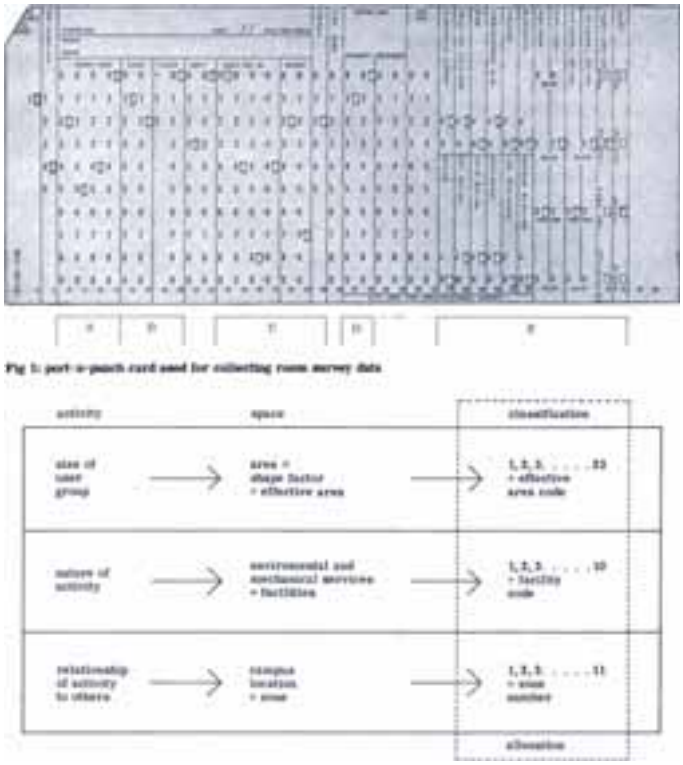


Fig. 9. "Port-a-punch card used for collecting room survey data" and "main classification categories"

(Musgrove and Doidge, 1970, p.32)

Similarly, at Cambridge, the University Study[117] was being developed at the Centre for Land Use and Built Form Studies since 1967[118], where one of the goals was to understand "growth and change in pure science buildings"[119], as well as "evaluation of performance, structure and flexibility" by the use of models (Bullock, Dickens and Steadman, 1969[120]):

> "Only in exceptional circumstances are buildings constructed for a specific purpose and then demolished when no longer needed for this use. A building which provides a range of room sizes can quite often serve a number of purposes so long as the new activities do not have very specialised requirements." (Bullock, Dickens and Steadman, 1969 p.93)

[117] This study will be analysed in further detail in the chapter 3.2., as a significant contribution for the state of the art on a methodological approach to adaptability assessment in educational facilities. See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[118] This study started in 1965 with a grant from Calouste Gulbenkian Foundation.

[119] "Growth and change in the structure of buildings are largely brought about in response to changes in their use – for example population growth, changes in activity, or alterations in space standards. For these reasons it is essential to see growth and change in buildings as the product of such factors, and not just to study building changes in their own right." (Bullock, Dickens and Steadman, 1969, p.93)

[120] Consulted edition from 1969, first edition from 1968.

. Other concepts related to adaptability

Other concepts related to change over time could also be mentioned, according to other authors, holding adjacent meanings to adaptability. Hertzberger's (2001) theoretical and practical work applied directly to the school brief rejects flexibility, in the sense that it is not committed to uses, and refers to "polyvalence", related with: "providing conditions for different things" (Hertzberger, 2010[121]).

"Polyvalence", which Ader (1975b, p.45) defines, in a publication by the OECD regarding multiple option schools, is considered as "the ability that a set of facilities has for being simultaneously used for different activities" and also "the possibility of holding successively different activities in the same space"[122].

The concept of "plasticity", which Lynch also approached on his 1958 paper is, in fact, an important reference that is here transposed from the neurosciences, and that approximates adaptability, as the system's ability to react to environmental changes. Likewise an adaptable building, facing environmental alterations, reacts according to the changes of uses that occur in it, and through its ability to cope with change and be enriched by it. Adaptability is thus, assumed as the relationship between the object/the building and the external environment (Fig. 10).

Simon's[123] (1996[124]) approach to "the sciences of the artificial" argues that their field of action resides in the interstitial space between the "inner environment" and the "outer environment" - the "interface", because adaptability is their problematics. Architecture, precisely as a science of the artificial, deals with problems of adaptation between environments. It products - the "artifacts", must adapt their "internal structure" to the context ("external environment"), aiming for a "purpose". And so, this could be transposed to a building that has to be adapted to the changes from the "external environment" and for continuing to act as an "interface" for people and activities.

Furthermore, Iselin and Lemer (1993) on their book *The Fourth Dimension in Buildings: Strategies for Minimizing* state that obsolescence is not necessarily regarded to a "dysfunctional" building, but when these "do not measure up to current needs or expectations" and may be a consequence from "change in the requirements or expectations regarding the use of a particular object or idea" (Iselin and Lemer, 1993, p.11). The authors also focus on the concept of "service life" of a building

[121] This seminar had the presence of Herman Hertzberger and Manuel Tainha, was organised by Parque Escolar and took place in the National Laboratory of Civil Engineering, in 20th May 2010.

[122] From the quote in French: "a) La polyvalence est la possibilité qu'offre un ensemble d'installations d'être utilisé simultanément pour des activités différentes. […]
b) La polyvalence est la possibilité offerte de pratiquer successivement des activités différents dans un même ensemble. […]" (Ader, 1975b, p.45)

[123] Herbert Simon was Nobel Prize Laureate in Economics in 1978.

[124] Consulted edition from 1996, original edition from 1969.

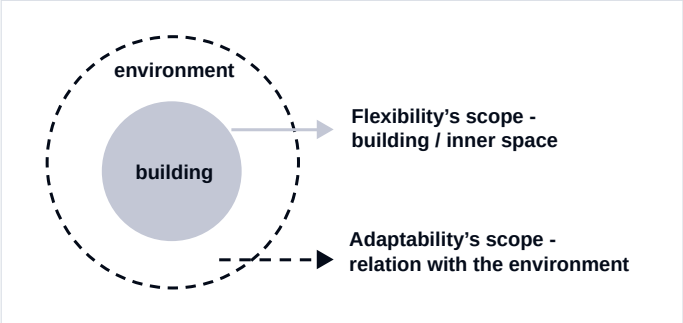


Fig. 10. Spheres of influence of the concept of adaptability and flexibility (edited to English)
Free translation from the Portuguese: "Âmbitos de influência do conceito de adaptabilidade e flexibilidade."
(Heitor and Tomé, 2007, p.4)

as: "the period of time over which a *building*, *component*, or *subsystem* actually provides adequate performance" before engaging in obsolescence (p.68)[125].

The concept of "lifespan" or "lifecycle", as it is currently referred to, is understood by König et al. (2010) encompassing "the actual life of a building" and is divided into four stages: "new building" ranges from the design to its building, "use" refers to occupancy and maintenance from the end of the building's construction to its rehabilitation, "refurbishment" implies an intervention: partial or full renovation, "deconstruction" regards demotion with the intention of ending its use (Fig. 11).

The acknowledgement of all these phases intends to make "strategic designs" for the present and the future in a whole "life cycle-oriented design" (König et al., 2010, p.19). This can be perceived as a more complete perspective of the design, that involves not only its intervention but also the following stages after it is handed over for occupancy. According to König et al. this perspective on the design comprises options that will cater for use afterwards and recognise their impact:

> "In the case of life cycle considerations, it is a multidimensional solution corridor. The final choice of possible solutions in the solution space depends on social, formal or other criteria considered and adapted on a case by case basis. New design tools integrate this view by establishing life cycle-oriented solution spaces in the briefing/programming phase." (König et al., 2010, p.18).

But it is also highlighted that as some information is not available from the beginning of this cycle, it is through time that its starts to be known. If this is not regarded from the start "the project can undergo continuous refinements". These may be costly, environmentally hazardous or socially inconvenient, and users may also be themselves responsible for following interventions in the building that are

[125] Italics from the original quote.

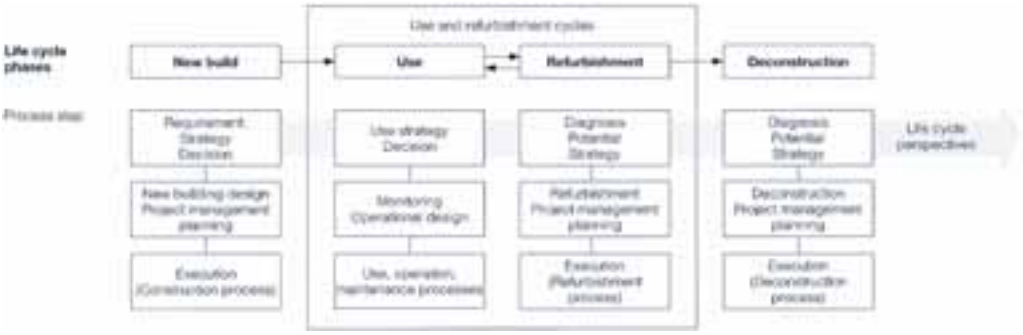


Fig. 11. "Life cycle phases"
(König, et al., 2010, p.19)

not informed or, in unity, with the original concept and design options. Overall, this could lead to: "inconsistencies and multilateral dependencies of, for example, environmental burdens and costs, durability and flexibility etc. […] Significant potential synergies are therefore lost." (*ibid.*).

Planning tools may contribute to assume the use during the initial design, preventing premature design interventions and refurbishments and, potentially, postpone obsolescence. This implies a process of "future-proofing" as "the number of options they hold for the future" (*ibid.*). Adaptability is here enclosed as a building's provision that caters for future change on the initial information and overall resilience for upcoming demands, as a "strategic decision" that comprises the building's overall stages and ultimate intends to delay the last.

All in all, König et al. refer to "life cycle design", which embraces different solutions that commonly regard the four stages they mention by resorting to "scenarios to determine and quantify the development of the requirements, the aging process and the loss of value over the life of the building" (p.19). This refers to the relations and impacts of the initial options on the building's following stages, for the whole or for parts of it, according to the specificities of its context and use, that are paramount to be reflected upon during the design process.

When a building ceases to fully perform, losing its "use value" (Duffy and DEGW, 1998, p.49), it is deployed of the life that originates the process. The process of "obsolescence" (Mansfield and Pinder, 2008) is triggered based on the discrepancy between today's needs and the needs that the building was able to meet at the time of its construction. Obsolescence implies a loss of value, in relation to its function ("functional obsolescence"), aging or need for maintenance of the materials ("physical obsolescence"), technical standards ("technical obsolescence"), current regulations ("legal obsolescence"), revenue of the building ("economic obsolescence"), or aesthetic value according to present-day standards ("style

obsolescence") (König et al., 2010, p.32). So, the study on adaptability also focuses on the way in which the permanence of life within the building can be extended, assuring its performance capacity and delaying its obsolescence.

By and large, adaptability allows the building to contain life more fully and for longer. It is thus, a factor of spatial quality, ensuring a dynamic and economically sustainable, functional, constructive and environmental performance of a space that reacts to people and with people. It is a way of introducing time into the equation, in a shared way by users and architects, within this "strategic briefing". It is also a feature of space to be considered in the design and to validated by use:

> "Adapting the working environment to respond both to rising user expectations and to diminishing time horizons for decision-making is as much a design issue as it is critical for management. (Duffy and DEGW, 1998, p.76)

. The concept(s) of adaptability

By analysing the concept of adaptability, we find, on the one hand, the profusion of bibliography dating considerably from the 1970s and, on the other hand, the lack of uniformity in its definition and on the proximity of adjacent concepts, with rather indefinite limits and varying according to the authors.

During the post-war period, adaptability went hand in hand with rapid and cost-effective school building construction. Today, adaptability is a spatial qualifier that goes along with spatial customisation, to accommodate different educational activities with evolving spatial needs. Current literature gathers adaptability with users' engagement and a sense of belonging in space, along with building management and an adaptable building design process, as relevant conditions to match expected and effective use.

In the *Design Participation Conference* (Design Research Society) in Manchester, Eastman (1971) presents an approach to design entitled *Adaptive-Conditional Architecture*. Eastman starts by making reference to a long process of adaptation provided by architecture as it adapts "the surroundings to desired human behaviour" (Eastman, 1971, p.51). In the spirit of the early 1970s, and also of the conference, his conception of "modern design" criticised the functionalist era, arguing for the "ethic" of architecture by freeing the man-environment relation of any "constraints":

> "[…] the ethic of modern design is to take human activities as given, without constraints, and to create an environment which maximally supports them. Instead of constantly adjusting his own actions to meet the structure of the environment, a person in a well designed

> environment is free to act with the environment fully supporting him. Freeing man from the constraints imposed by the environment has been one influence allowing the surge of creative power evidenced in western material technology." (Eastman, 1971, p.51)

For this purpose, the author refers to three aspects related to fit: "measuring fit for anonymous users", "predicting fit in new environments", and "controlling fit for activities which change over time". The latter refers to the evolution of activities and a hypothesis of how to approach its predictability, by designing a space with fewer constraints:

> "In removing the constraints of an existing environment, the designer may significantly improve the fit between the activities in the old environment and the new space. […] Production procedures, organisational structures, treatment in health care, teaching methods in a school, life patterns of the family are but a few examples of the changes imposed by wider social influences which affect the fit between activities and space." (Eastman, 1971, p.52)

Actually, the relation between the environment and people, spaces and activities, was transversal in the several studies presented in the above conference. Most of them reflected upon how life patterns change and building should cope with them (Wellesley-Miller, 1971) [126], surpassing what Friedman (1971, pp.45-46) considered as a "fallacious" attempt by the architects and planners of designing for "the average future user"[127].

Similarly, Wellesley-Miller made reference to the basic and specific needs in the developing countries and their demand for solutions in low cost housing, even if "not only in developing countries but also in the West the future environment is becoming increasingly complex and probabilistic" (Wellesley-Miller, 1971, p.60). Hence, the author maintained that the "problem of designing a dwelling for a family whose future membership, social status, pattern of living and economic level is unknown but open to change" (p.60).

Nevertheless, when designing for a large number of people, the difficult problem persisted of simultaneously considering the effective requirements and, at the same time, the evolving family patterns, to which housing should be planned in advance,

[126] In his communication *Self organising environments*, Wellesley-Miller distinguished between "hard" design and "soft" design by arguing that: "A definitive solution embodied in a 'hard' design that will remain valid for the complete life span of the building is impossible. What we have to search for is a 'soft', adaptable design that can be made to respond over a short period of time to the changing needs of its occupants." (Wellesley-Miller, 1971, p.60)

[127] "I don't think that I need to explain in detail what were the results: there is massive discontent manifested by all individual users of architects' products. The reason for this discontent is obvious: *the average user is a non-existent one!* If there are satisfied but the average client's needs, it is logically implied that *no specific needs of any individual user can be sufficiently satisfied.* Thus, we satisfy the non-existent client instead of satisfying the existent one." (Friedman, 1971, p.45) (Italics from the original quote)

within an open global strategy, making it adaptable to change. This question was frequent in many meetings of the International Union of Architects (UIA) at the end of the 1960s on the 'habitat', namely the one in Agadir in 1968, where Habraken's research team presented their work on the "supports to mass housing"[128].

Also the Lima PREVI (Proyecto Experimental de Vivienda) – experimental housing project – after John Turner efforts, underlined strategies for open design and customised building. All these experiences were translated onto many projects, where adaptation and flexibility were part of the same solution: a house that could evolve in time.

Indeed, the "personal element in housing" was aimed by Rapoport's (1968) research on open-ended design, where he quotes examples of studies that contradict the idea of dwellings designed for generalised categories of people[129].

Amongst these examples are the studies by Portas at LNEC (National Laboratory for Civil Engineering[130]), the public research institute in Portugal. The study *Habitação Evolutiva*, written in 1971 as a report and published in 1972 by Silva Dias and Portas (1972), would regard precisely an evolutionary approach to dwellings[131], while aiming at the equilibrium of a global strategy for the large number of people and the evolution of specific patterns[132]:

> "Thus, the aim is therefore to devise a possible strategy to reach the largest number recognising a structural situation characterised by scarce resources aggravated by the trend towards growing needs. This is the first of these referred levels: considering housing not only as a physical system in which needs and possibilities to satisfy them will evolve in time, it seems that also the physical structures of urbanisation and resistance will have to be adaptive, that is, designed in such a way that can, with a minimum of institutional friction and cost, improve, expand or renew, along with the evolution of the users and, or, by the resources allocated to the social sectors."[133] (Silva Dias and Portas, 1972, p.101)

[128] Habraken's approach to adaptability will be further developed in this chapter.

[129] Considering housing in Britain as a case study, Rapoport argued that "adaptability and open-endedness do not seem to be a consideration in development or acceptance of system building" (Rapoport, 1968, p.302). Rapoport also refers to Chombart de Lauwe, and the "basic discord between designers and inhabitants [that] can take different forms: unconscious or conscious, passive or active. Man adapts to the dwelling in analogous ways – consciously or unconsciously, actively or passively. The preferred pattern of resolving the conflict and adapting is through the participation of the inhabitants (conscious, active – *creative*)." (p.301). See also Lauwe, *Des Hommes et des villes.* Consulted edition 1970, original edition 1963.

[130] From the Portuguese: Laboratório Nacional de Engenharia Civil.

[131] This would also be pursued in a more recent study by Coelho and Cabrita (2003) *Habitação evolutiva e adaptável.*

[132] Likewise, Silva Dias and Portas (1972, p.104) mention Rapoport and his distinction between "qualitative visual" and "quantitative physical" densities, where the first results from the enclosure and intricacy degrees. Finally, besides mentioning PREVI, Silva Dias and Portas recall other similar examples, as in Morroco by Azaguy, or at the Edimburgh University by Byron.

[133] Free translation of the original quote in Portuguese: "Assim, procura definir-se uma estratégia possível

Departing from the theory "low rise high density" as developed by the Centre for Land Use and Built Form Studies in Cambridge from the second half of the 1960s that argued for low rise solutions, the study by Silva Dias and Portas designed three low rise typological solutions ("narrow plot", "medium plot", and "square plot"[134]) that could evolve, where infrastructure was completed from the beginning to "discipline the future construction"[135] (Silva Dias and Portas, 1972, pp.109-110). Additionally, the dwelling envelope would follow one of two strategies: it should be either built immediately in its final completion and consequently subdivided, with interior partitions; or it should be expanded from the initial construction (estimated on 1/3 of the final dwelling). The overall provision would be accomplished as long as the three stages were progressively fulfilled: "1st, initial construction"; "2nd, fitting adjustment" and "3rd, stabilised habitat"[136] (p.108).

On other contexts, other studies would consider the paradoxes behind the research of the "man-environment paradigm", as Hillier and Leaman (1973) argued. Besides the consideration of an ever-changing environment, some researchers would rely on structuralism for reaching the deep structures of the paradigm, cultural and anthropologically perceived. Someone who launched an analytical approach to this paradigm was Alexander (1964), who evolved through that paradox, after an early study on form through a synthesis systematically obtained in *Notes on the synthesis of form*. Adaptation was seen as a "homeostasis" between form and context over time, which would work better in an "unselfconscious" process rather than in a "selfconscious" [137] one:

> "The basic principle of adaptation depends on the simple fact that the process toward equilibrium is irreversible. Misfit provides an incentive to change; good fit provides none. In theory the process is eventually bound to reach the equilibrium of wellfitting forms. However, for the fit to occur in practice, one vital condition must be satisfied. It must have time to happen.
> The process must be able to achieve its equilibrium before the next culture change upsets it again." (Alexander, 1964, pp.50-51)

para atingir significativamente o maior número tendo em conta uma situação estrutural caracterizada pela escassez dos recursos agravada pela tendência para o crescimento das necessidades. Este o primeiro dos níveis referidos: considerando a habitação como um sistema não apenas físico em que necessidades e possibilidades de as satisfazer evoluirão no tempo, parece que também as estruturas físicas de urbanização e resistência terão de ser adaptativas, ou seja, concebidas por forma tal que possam, com um mínimo de atrito institucional e de custos, melhorar, ampliar ou renovar, a par e passo com a evolução dos utentes e, ou, por recursos atribuídos aos sectores sociais." (Silva Dias and Portas, 1972, p.101)

[134] Free translation of the original quote in Portuguese: "lote estreito, lote médio e lote quadrado".

[135] Free translation of the original quote in Portuguese: "disciplinar a construção futura".

[136] Free translation of the original quote in Portuguese: "1ª fase, núcleo inicial; 2ª fase intermédia, de ajustamento; 3ª fase, 'habitat estabilizado'."

[137] According to Alexander, a "selfconscious" process acknowledged planning, whereas "unselfconscious" resulted from an adaptation through experience over time. (Alexander, 1964, p.33)

After an auto-critique of this initial work, Alexander started to consider the *timeless* patterns as a way to conceive the future through the invariants of past experience. In his books *Timeless Way of Building* (Alexander, 1979) and *A Pattern Language* (Alexander, 1977), both written at the Center for Environmental Structure, University of Berkeley, Alexander and his research team reached a large number of axioms. In "208. Gradual Stiffening" it is stated:

> "The fundamental philosophy behind the use of pattern languages is that buildings should be uniquely adapted to individual needs and sites; and that the plans of buildings should be rather loose and fluid, in order to accommodate these subtleties." (Alexander, 1977, p.963)

Other references to adaptable spaces, presented in *A Pattern Language* – "146 Flexible work space"; "148 Small work groups" – consisted on the idea of an adaptable workspace, where used a mixture of configurations was used, rather than flexible partitions within an open space (Fig. 12).

Moreover, according to Alexander's assumption in *The timeless way of building*, each part of the building had to be autonomous and simultaneously adapted to the whole:

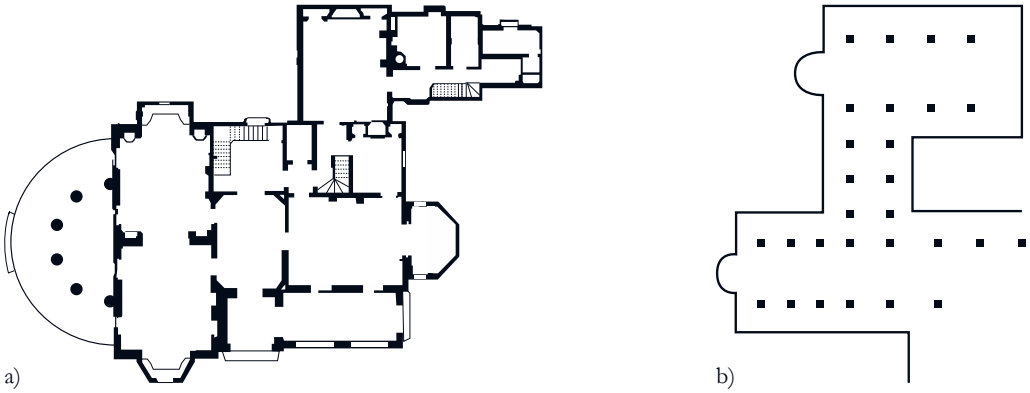
> "The quality without a name, like all forms of organic wholeness, depends essentially on the degree of adaptation of the parts within the whole.
> In a system which approaches the character of nature, the parts must be adapted with an almost infinite degree of subtlety: and this requires that the process of adaptation be going on through the system, constantly.
> It requires that each part at every level, no matter how small, has the power to adapt itself to its own processes.
> This cannot happen unless each part is autonomous.
> *A building which is natural requires the same.*"[138] (Alexander, 1979, p.163)

Returning to the disbelief in the self-conscious process, already stated in *The Notes on the synthesis of form,* Alexander concludes that "*Adaptation of buildings to people becomes impossible."*[139]:

> "Even when experts make buildings which are "adaptable," to solve this problem, the result is still trivial, because the unique particulars are still subservient to the common generalities. Huge machine-like buildings which allow people to move the walls around, so that they can express themselves, still make them subject to the "system."" (Alexander, 1979, p.239)

[138] Italics from the original quote.

[139] Italics from the original quote.



a) b)

Fig. 12. a) "Mixture of room sizes."; b) "Possibility of many different sized rooms" (Alexander, 1977, p.692, 694) (edited)

Despite Alexander's disbelief, theoretical studies specifically regarding adaptability have also been developed, from the end of the 1960s, considering spaces and activities' reciprocity. Within this subject matter, Markus's initial studies at the Building Performance Research Unit in the School of Architecture at the University of Strathclyde associated building and people[140]:

> "It is obvious that buildings are for people. People pay for them; people use them; people design them. The design of a building consists of people making decisions on behalf of other people which affect another set of people." (Markus and Building Performance Research Unit, 1972, p.1)

Thus, this approach resorts to "complex interactive processes" modelled by a system (p.2) (Fig. 13). "Adaptive systems" held biunivocal stimuli and modifications between the individual and the environment: "the individual modifies the environment in order to achieve his goals and he modifies himself and his goals in order to fit into the environment" (*ibid.*). In a detailed approach, this system entailed diverse variables, namely "building", "environment", "activity", "objectives" and "resources"[141], considered to be intertwined. Adaptability was considered within the "objectives system"[142], along with "production", "morale" and "stability". Adaptability is here considered as the reaction from environmental changes, which could be both the introduction of a new elements or the replacement of existing ones[143]:

[140] This research will be analysed in further detail in the chapter 3.1., as a significant contribution for the state of the art on a methodological approach to space use assessment. See chapter 3.1. Space use assessment methodologies.

[141] "Resources system" is added in 1972 (Markus and Building Performance Research Unit) to the initial study from 1967 (Markus, 1967).

[142] "Objectives system" is the concept used in the book from 1972 (Markus and Building Performance Research Unit), while in 1967 these are entitled "organisational objectives" (Markus, 1967).

[143] Markus and the Building Performance Research Unit studies in schools will be further developed in the following chapter 2.2. Adaptability in school buildings: approaches for growth and change.

a)

b)

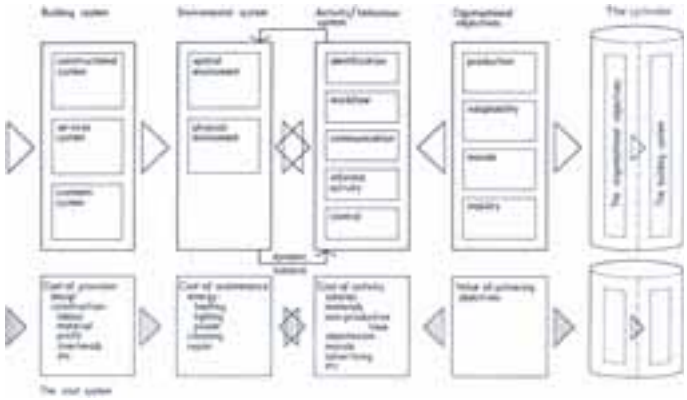
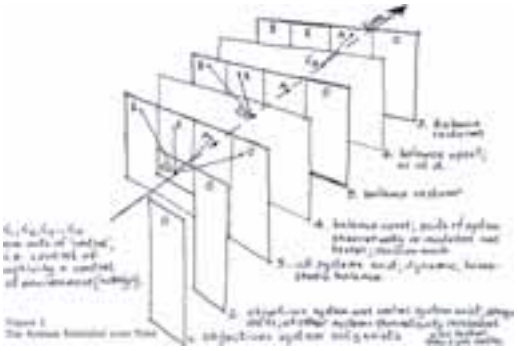


Fig. 13. a) "The building / environment / activity / objectives / cost / system";
b) "The building-environment-activity-objectives system: a conceptual model"
(Markus, 1967, p.1570); (Markus, 1970, p.90)

> "A slightly less obvious organisational objective is that being able to adapt. As we noted earlier survival is based upon a two way process of this simulation adaptation and for an organisation the ability to change itself in response to changes in the environment is a crucial one. As with other organisms it is likely that also with organisations some of the most crucial limitations on adaptation are set by physical structure." (Markus and Building Performance Research Unit, 1972, p.6)

The approach to this system is also comprehended in time (Fig. 14), reaching the "homeostatic balance" between environment and activity that the model of the "building-environment-activity-objectives system" already observed in the two-way arrows between both systems that determined them to be "mutually interactive". As it had also been previously addressed by Cowan regarding the "shifting balance between an organism and its environment" (Cowan, 1963, p.82), this interaction is also identified here as: "an organisation moving into a somewhat unsuitable environment alters its activities to make the best use of it, and in turn moulds the environment" (Markus, 1967, p.1571).

a)



b)

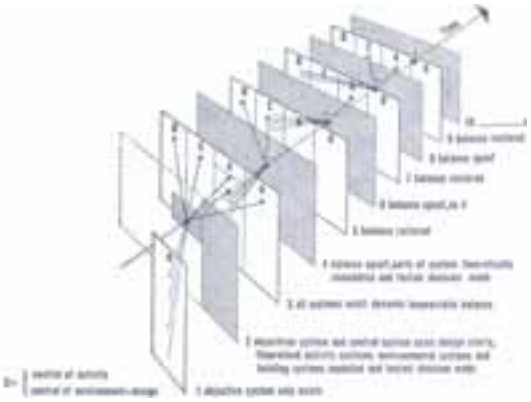


Fig. 14. a) "The System Extended over Time"; b) "The system model extended in time" (Markus, 1972, p.29-6-9); (Markus and Building Performance Research Unit, 1972, p.16) (edited)

Leaman[144] in the 1990s would retrieve the building performance research field launched by Markus in the Building Performance Research Unit. After the initial studies with Hillier (Hillier and Leaman, 1973, 1974, 1975; Hillier, Leaman, Stansall and Bedford, 1976) at RIBA, Leaman along with Bordass focused on performance evaluation, which resulted in a "series of twenty published building performance evaluations between 1995 and 2002"[145] (Bordass and Leaman, 2013). Within this context, Leaman and Bordass consider adaptability as one of the key-points for future proofing, surpassing flexibility:

> "[…] long-term adaptability may be a better and most cost-effective way of meeting unforeseeable future changes than quick-fix flexibility" (Leaman and Bordass, 2004, p.147)

This approach on both flexibility and adaptability revealed a more recent development of the concepts and their specific assets, but during the post-war era flexibility was already sought for coping with the needs of public and private buildings:

[144] See Leaman, 2016, 2002, 2000; Leaman and Bordass, 2015, 2005, 2004, 2001; Bordass, Cohen, Standeven and Leaman, 2001a, 2001b; Cohen, Standeven, Bordass and Leaman, 2001; Bordass, Leaman and Ruyssevelt, 2001.

[145] In the context of PROBE (Post-occupancy Review of Buildings and their Engineering).

> "The talent of housing architects since World War II has been almost solely devoted to solving the two problems of 'architecture' defined by Durand around 1800: the problem of private building, which is to provide the optimum accommodation for the smallest sum of money; and the problem of public building, which is how to provide the maximum accommodation for a given sum." (Rabeneck, Sheppard and Town, 1973, p.698)

In 1973 Rabeneck, Sheppard and Town in an article published in *Architectural Design*, introduce several options for flexible houses in different countries, because these authors considered that "there is now a sufficient number of realized flexible housing projects to allow us to learn from the results and to develop new direction in housing design, and a new concept of housing process." (*ibid.*) (Fig. 15a).

Flexibility or "multi-use of restricted space" introduced a design solution for "providing opportunities for choice or personalization". So, Rabeneck, Sheppard and Town consider that, despite the projects published in this issue, "many important questions remain unanswered" (*ibid.*).

In the following year, Rabeneck depicts an "adaptable row housing in Norway" proposed by Erik Hultberg in collaboration with Professor Nils-Ole Lund, in an article in *Architectural Design* (Rabeneck, 1974, p.655). This project proposed a variability of two-story row-houses for Skjetten, according to "the interpretation of these possibilities in terms of the life-style of the inhabitants" (p.656) (Fig. 15b). The aim for adaptable houses is explained by the difference between the architect's information and the inhabitant's expectations:

> "There are many reasons for the inhabitants to have differing expectations of the place where they are going to live. No architect can know what these expectations are or what the occupants' performance requirements would be if they were consulted. This is the fundamental reason for building adaptable houses." (Rabeneck, 1974, p.657).

Recently, Rabeneck has contributed to Fawcett's 2016 book (2016a, 2016b[146]) regarding the subject of "Flexibility for activity change". In this book Fawcett defines adaptability within a correlation between activities and spaces. Moreover, Fawcett overlaps adaptability to flexibility under the same definition, even if authors can distinguish the two in regard to implication of physical change:

> "In this chapter the words 'flexibility' and 'adaptability' are taken to be synonyms, describing the ability to cope with change.
> It is possible to use the words to identify distinct concepts. This was

[146] Fawcett 2016a refers to the e-book available online entitled *Built Space in the Digital World: the Activity-Space Research initiative* and 2016b refers to the published book called *Activity-Space Research: built Space in the Digital World.*

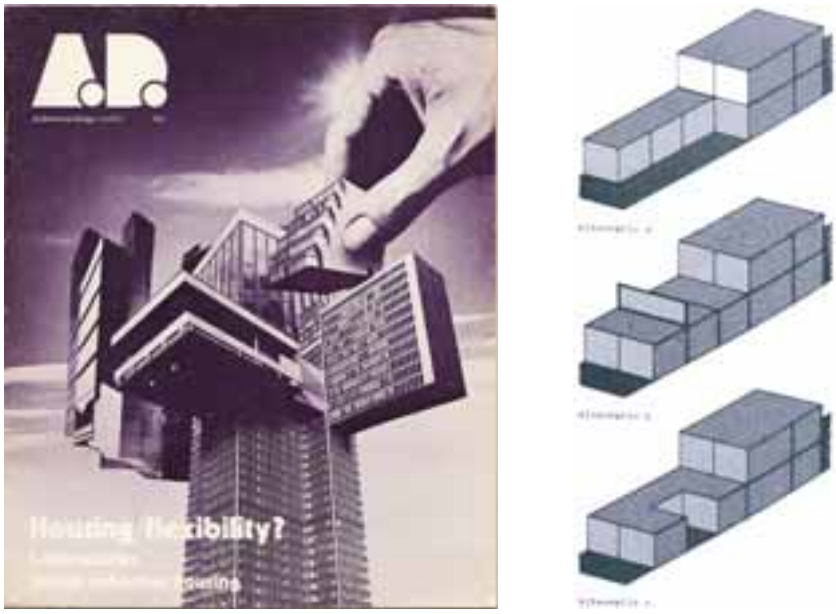


Fig. 15. a) Architectural Design 11/ 1973 (Rabeneck, Sheppard and Town, 1973, cover)
b) "Alternative forms of expansion" (Rabeneck, 1974, p.659)

> done by Andrew Rabeneck in the 1970s, when he proposed that flexibility meant the ability to change the physical configuration of a building, and adaptability meant the ability of a building to absorb a variety of use patterns without physical change (Rabeneck et al. , 1973 & 1974). […]
> Using the two words to refer to different aspects of flexibility/ adaptability risks confusion, so here only one word 'flexibility' is used. When particular aspects of flexibility or adaptability are discussed they have to be defined explicitly." (Fawcett, 2016a, p.48)

The assumption that adaptability and flexibility may be used for analogous approaches, has also been done in the paper *Investing in flexibility: the lifecycle options approach*:

> "In this context the words flexibility and adaptability overlap in meaning. Sometimes a distinction is drawn between the precise meanings of the two words but, confusingly, this is not done in a consistent way. In this paper flexibility is used exclusively, but the words are regarded as synonyms and the choice is arbitrary." (Fawcett, 2011b, p.13)

In Fawcett' s previous extensive work on adaptability from his Doctoral Thesis[147] *A Mathematical Approach to Adaptability in Buildings* (Fawcett, 1978) presented in

[147] Fawcett's (1978) Doctoral Thesis *A Mathematical Approach to Adaptability in Buildings* will be subject of detailed analysis in chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

Cambridge and supervised by Lionel March, adaptability was already perceived under the scope of the "relationship between activities and spaces" (Fawcett, 1978, p.i)[148]. Analogously to the simultaneous research elaborations being undertaken in this decade and that have also informed Fawcett's state of the art, adaptability is comprehended within an analytical approach, regarding adaptability as a "quantified measurement" (p.54) achieved by "mathematical elaboration" (p.i).

This approach is also perceived from the papers from this time period within Fawcett's research, such as *School Management and School Design* (Fawcett, 1976a), *Measuring Adaptability* (Fawcett, 1976b), *Activity-space systems: four isomorphisms* (Fawcett, 1977) and following Fawcett's Thesis completion the papers published in *Environment and Planning B*: *All possible and most probable schedules in organizations* (Fawcett, 1979a) and *Catalogue of activity schedules for small organisations* (Fawcett, 1979b).

Specifically in the paper *School Management and School Design* (Fawcett, 1976a) Fawcett points out the schools, to be a particularly relevant case study for this research, for having a complex building that accommodates diverse activities in several schedules. The design has to comply with these affordances, associating people, activities, and spaces (Fig. 16), in a whole arrangement thought by allocation, managerial constrains and time schedules:

> "School is first and foremost an activity, and secondly a place. School activity generates the need for built space, and school design begins by considering activities. A design procedure typically counts up all the expected activities in a school, defined with respect to subject, functional activity, size and frequency of occurrence, and generates a schedule of spaces from this, again defined by type, size, and number." (Fawcett, 1976a, p.10)

Fawcett introduces "style of management in the school" that may change both the activities and the space where those activities are held and that may be unforeseeable during the brief (*ibid.*)[149]. Thus, adaptability holds a central role for schools, because broader "potential arrangements" enable a more open allocation of activities to spaces:

> "A school building that not only accommodates a set of school activities but also accommodates them in many different ways and includes a variety of different sets of school activities, is an adaptable school building." (Fawcett, 1976a, p.11)

[148] "We argue that adaptability is a fruitful subject for research, and offer this thesis as a contribution to architectural research into the relationship between activities and spaces." (Fawcett, 1978, p.2)

[149] Management has also been addressed by Broadbent (1973), arguing for its centrality for space use: "All users of buildings are constrained by administration, using that word in the broadest possible sense to describe any person or group of people who decide what may or may not be done within a building or to the building fabric. […] Administration in the form of the headmaster lays down rules about how pupils and teachers shall behave in school, which entrances the pupils may use and so on […]" (Broadbent, 1973, p.172)

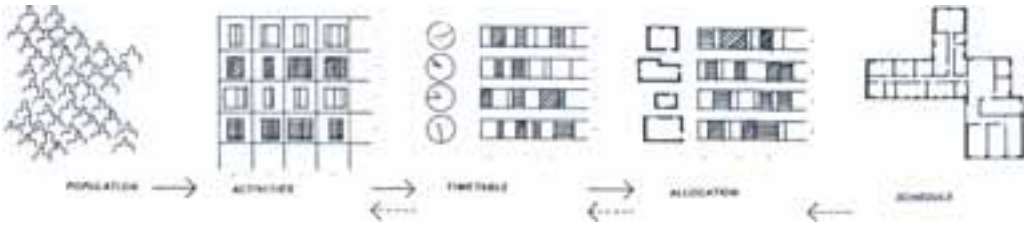


Fig. 16. "Organizational structures in a comprehensive school"
(Fawcett, 1976a, p.12)

Fawcett introduces the concept of adaptability related to the "looseness" for accommodating activities to spaces. In this sense, the broader the range of possible spaces, the broader their adaptability. This is associated to the "uncertainty of the probability distribution", related to the information theory's concept of entropy [150]:

> "In this method adaptability is defined as a measure of the variety of ways that a set of activities can be allocated to a set of spaces. Considering individual activities, some might take place feasibly in many different spaces whilst others might be feasible in just one. […] The greater the number of choices that an activity has, the more loosely, we can say, it is accommodated. If there is one overwhelmingly appropriate choice but others that would in addition be possible, then this is looser than if there were only the one; but if the same number of choices were more evenly distributed then it would be looser still. […] The looseness of the activity then corresponds to the uncertainty of the probability distribution. The looseness, and uncertainty, is zero if one possibility has a probability of one, and is high if many possibilities are equally likely. Information theory provides a unique, unambiguous criterion for the amount of uncertainty in a probability distribution, and this is called the entropy of the uncertainty distribution $S_i = -\Sigma_j$ pijlnpij.
> Thus adaptability is seen as the looseness of fit of an activity schedule into a physical schedule, and the concept of entropy seems likely to be a helpful tool in measuring it." (Fawcett, 1976a, p.17)

The paper *Measuring Adaptability* from the same year (Fawcett, 1976b) displays a very comprehensive outlook on Fawcett's approach to adaptability, from a combinatorial perspective that tackled two approaches: "loose-fit" by means of feasibility matrices and microstates, and engaged entropy for assessing adaptability. Here a definition of adaptability is recognised which will be central to our current research:

[150] This will be paramount for studying adaptability in our proposed methodology and will be addressed in further detail in chapters 3.2. regarding Fawcett's Thesis and chapter 3.3. when our methodology is explained in detail. See chapters 3.2 Adaptability assessment methodologies: reviewing previous approaches, and chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

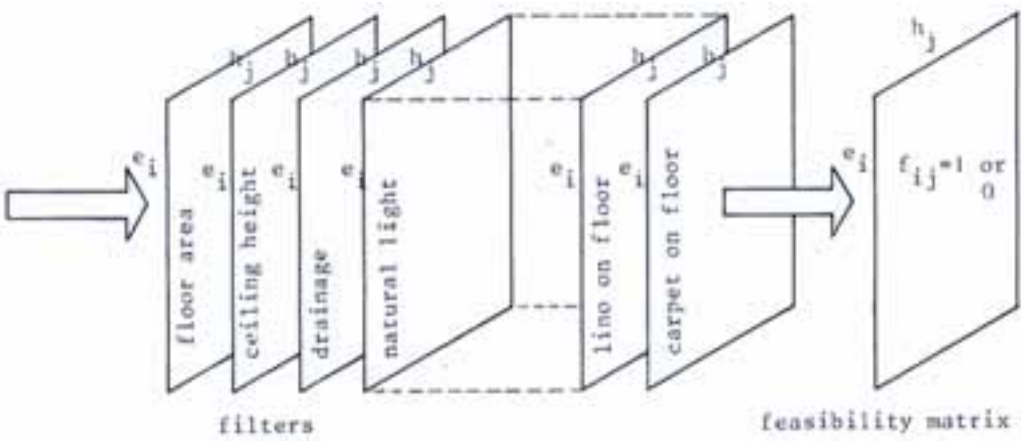


Fig. 17. "Diagram showing that the entries in an activity-space feasibility matrix can be based on many attributes, not just floor area (from Fawcett, 1978, p.205). Each attribute acts as a filter, and the activity (e_i) must be compatible with the space (h_j) with respect to all the filters in order to arrive at an overall entry of 1 in the feasibility matrix. If the activity and space are incompatible with respect to one or more filters, the entry in the feasibility matrix is 0."

(Fawcett, 2011c, p.207)

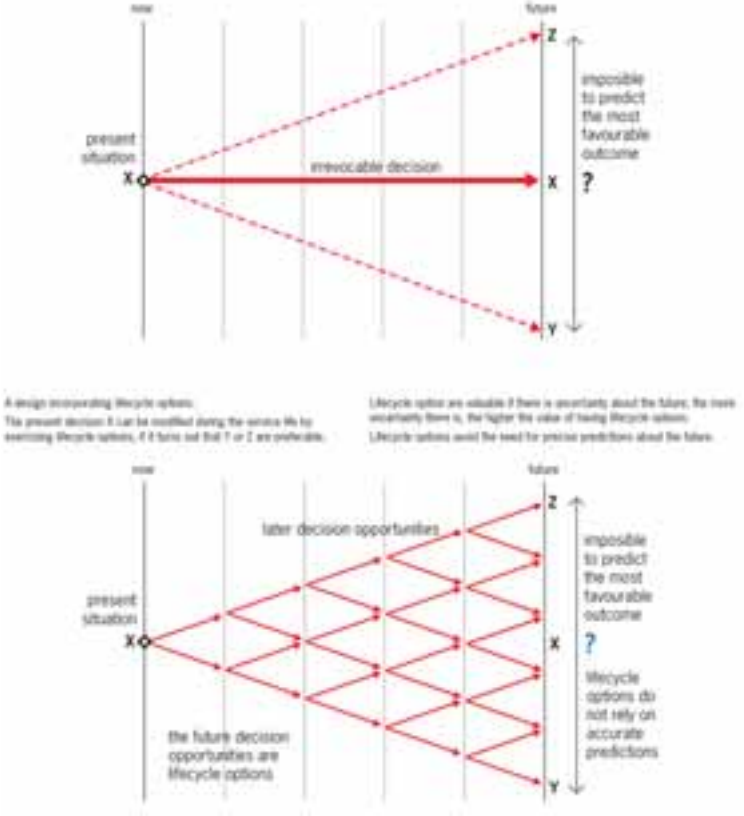


Fig. 18. The traditional model for decision-making (upper diagram) vs Fawcett's "lifecycle options" (bottom diagram)

(Fawcett, 2016b, p.57)

> "Adaptability is the ability to maintain compatibility as the activities change – as they will." (Fawcett, 1976b, p.5)

Fawcett's approach to adaptability has evolved into more recent developments over lifecycle assessment, also related to sustainable strategies, associating both adaptability and flexibility. The paper *The Sustainable Schedule of Hospital Spaces: investigating the 'duffle coat' theory of flexibility* (Fawcett, 2011c; 2010a) centres around the hospital programme, rather than the previous study on schools, still acknowledging change, considering: "large and complex buildings presenting many challenges for design and management, amongst them problems of growth and change"[151] (Fawcett, 2011c, p.193). Fawcett approaches flexibility to the metaphor of the "duffle coat" tackled by Weeks in 1960, suggesting that higher flexibility would be subject to "greater interchangeability between activities and spaces" and "designs with a smaller number of distinct room sizes provide more interchangeability and so increase flexibility", as Fawcett systematises (Fawcett, 2011c, pp.194-195).

Despite recognising that Weeks' approach had been largely acknowledged, Fawcett does not validate it by a "mathematical model". Fawcett assumes that other strategies would be needed for understanding flexibility and the built-in features of the design that would maximise the feasibility matrix for the activities-space allocation, besides the room size studied by Weeks, including other features that would determine the spaces' capacity constraints, as he had already presented in his Doctoral Thesis from 1978 (Fig. 17):

> "Flexibility is quite rightly seen as a high priority for the long-term value and sustainability of hospital buildings, but it is poorly understood. Weeks's duffle coat theory was an intuitive response to a complex problem, but it should now be set aside in favour of better-researched strategies for flexible hospital design." (Fawcett, 2011c, p.208)

In recent publications Fawcett (2010b, 2011a, 2011b, 2016) also sustains the approach to "lifecycle options" that "transfer decision-making from people in the present to people in the future who will know more about the changing state of the world." (Fawcett, 2011b, pp.2-3). Thus, it does not imply a decision in the present moment, but allows future decisions to be made, with a lower degree of indeterminacy from the initial moment and when more information is available (Fig. 18). In this model, the risk of "over" or "under-provision" is lower, as well as the cost of undertaking those decisions, thus avoiding options that might prove unnecessary: "In this approach, a lifecycle option is a feature of a design or plan that makes it possible for new decisions to be made in the future." (p.2).

[151] "Loose-fit design, providing flexible hospitals that work for the initial activities and can also cope with activity change over time, would increase the long-term usefulness of the financial, social and resource investment in hospital buildings, and would be highly sustainable. Therefore it is important to investigate whether the flexible design strategies that have been put forward are likely to contribute to this desirable objective." (Fawcett, 2011c, p.194)

These options vary according to each situation and the decision-making should be well-adjusted between the cost / time / benefit of introducing each one, as well as the "amount of uncertainty" on future change, as well as being informed by user research (Fawcett, 1995)[152]. This can be corresponded to Rabeneck's recent thoughts on *Flexibility in practice*, published in Fawcett's book *Built Space in the Digital World* (2016a). According to Rabeneck's:

> "Note that a design's flexibility depends on the set of activity states used for the test. The same design will perform differently with different sets of activity states; and if the flexibility of alternative designs is being compared, the ranking may change according to the set of activity states used for evaluation" (Rabeneck, 2016, p.48)

Even more recently, the book *Adaptive Architecture: Changing Parameters and Practice* (Preiser, Hardy and Wilhelm, 2017) centres around "the challenge of adaptive design" (Fawcett, 2017a, p.65), namely in Fawcett's chapter, where it also states the relevance of assessing adaptability: "The arguments in favour of adaptive architecture will be stronger if its adaptive performance can be measured." (Fawcett, 2017b, p.67)

Also in Cambridge, Krüger's work from his Doctoral Thesis comprises an analytical approach, in this case applied to built forms' connectivity within an urban modelling strategy. This has been published in *Environment and Planning B* as a series of papers regarding *An approach to built-form connectivity at an urban scale* (1979a, 1979b, 1980, 1981b, 1981c):

> "An attempt is made to model the distribution of partitions (party walls) and built-form arrays within the entropy maximization and information minimizing formalism for the ninety-five kilometre-square cells used to record the town of Reading, England." (Krüger, 1981b, p.41)

The paper *Maximização da adaptabilidade*[153] holds particular significance for our current Thesis because it presents a straightforward definition for adaptability as "the ability of the built form to maintain compatibility between activities and spaces, as those vary"[154] Krüger's (1981a, p.1169), which implies the building's potential to allocate a range of activities without any physical transformation.

This is similar to Fawcett's (1976b, p.5) definition from an early paper: "Adaptability is the ability to maintain compatibility as the activities change – as they will.",

[152] "A good user model is in fact a precondition for setting many different design criteria." (Fawcett, 1995, p.9)

[153] Original Portuguese title that is translated to English as "Maximising Adaptability".

[154] Free translation of the original quote in Portuguese: "A adaptabilidade será caracterizada pela capacidade que a forma construída apresenta para manter a compatibilidade entre atividades e espaços, à medida que aquelas variam." (Krüger, 1981a, p.1169)

considering that both Krüger and Fawcett have a common research background at Cambridge, relatively simultaneous and embedded into an analytical approach. The common consideration of adaptability related to activities, the assumption that activities might change in the future and that adaptability is associated to pursuing "compatibility", in the sense of an adequate fit for coping with the changing activities, are central issues in both definitions.

The context of Fawcett's quote[155] already specifies a direct correlation between space and activities in "feasible" and "non-feasible" and displayed in a feasibility matrix. Besides, Fawcett also considers adaptability to be a feature to be assessed in the building from its initial construction. These already imply the acknowledgement that adaptability is identified by an analytical approach on this correlation and that it is built-in, which could compel the introduction of other approaches on the methodology to be proposed on our current Thesis.

This definition is also considered to be comprehensive and forthright for the purposes of our current Thesis, because it immediately acknowledges spaces and activities. It also recognises the possibility of growth and change in the future between what may impact both the activities and its correlation to space. Besides, the definition is open enough to be adequate for the current context and applied generally to complex buildings, but is also leaves its assessment open to further specificities that our current research might comprise for regarding contemporary school buildings.

The paper *Maximização da adaptabilidade* (Krüger, 1981a), as well as *Modelos Probabilísticos em Estudos de Arquitectura*[156] (Krüger, 1984) are central for Kruger's study of adaptability, that also discusses Fawcett's work. From Krüger's definition of adaptability, it is established that adaptability concerns the building's design process, conceived with the information gathered at the time, regarding both future management and users' behaviour (Krüger, 1981a, p.1169). This could be matched to Fawcett's approach considering adaptability a feature of the building conceived with the information provided in the present instead of the future unforeseeable data[157].

[155] "We can consider an institution as a function consisting of a number of activities, and some accommodation consisting of a number of spaces. It will be either feasible or non-feasible for the activities to take place in the spaces - and it is preferred to maintain the former state. If, after time, the accommodation can no longer house the function, it is obsolete. Adaptability is the ability to maintain compatibility as the activities change - as they will. If adaptability can be measured at first-build, then it must be with the data available at the time of building." (Fawcett,1976b, p.5)

[156] Original Portuguese title that is translated to English as "Probabilistic models in architectural studies".

[157] "But how, when our knowledge of future activities is uncertain, can our subjectively held estimate of a building's adaptability be established? We cannot test whether a building will become obsolete by reference to what actually happens to it in the future since we do not know: a workable measure must rely wholly on information available in the present." (Fawcett, 1978, pp.54-55)

Krüger also distinguishes flexibility and adaptability. On the one hand, flexibility is achieved by means of "technological solutions that aim to alter the interior partitioning of the built forms over time"[158] that aims to hinder obsolescence, brought by an incongruity between activities and spaces (Krüger, 1981a, pp.1169-1170). On the other hand, adaptability is achieved by means of building programming rather than technological strategies concerning the "spatial characterization of each room in order to allow a diversified use of the spaces by its occupants." [159](p.1170). Despite their differences, "both adaptability and flexibility maximising intend to minimise the pre-determination of the users' needs by enabling a spatial occupancy that is not univocally defined in the design" [160](p.1170). This is central because it provides the straightforward differences between flexibility and adaptability, in which the first implies physical alterations over time and the latter its initial consideration in the design. Besides, adaptability also anticipates a diversity of activities in spaces, instead of a specific provision of spaces to activities that can change onwards. Finally, it also states that flexibility and adaptability accommodate changing activities in time, as opposed to a single fixed functionality for each room[161].

For maximising adaptability Krüger (1981a, 1984) proposes different possibilities within a probabilistic outlook on the pairing of activities to spaces namely the focus on the feasibility matrix approach, which leads to the "number of biunivocal corresponding matches between the sets of activities $\{a_i\}$ and spaces$\{e_j\}$"[162] (Krüger, 1981a, p.1171). A high adaptability design will be the one that is provided to accommodate a higher number of activities within spaces, increasing the corresponding matches on the feasibility matrix (p.1180).

[158] Free translation of the full original quote in Portuguese: "A flexibilidade em projeto de arquitetura baseia-se, em geral, em soluções tecnológicas que visam a alteração da compartimentação interior das formas construídas ao longo do tempo, o que pressupõe, geralmente, o uso de divisórias interiores ligeiras, estruturas porticadas de grandes vãos, envolventes construtivas pré-fabricadas em peças monolíticas e ainda a pré-localização e dimensionamento das áreas de serviços e equipamentos." (Krüger, 1981a, pp.1169-1170)

[159] Free translation of the full original quote in Portuguese: "A segunda abordagem, a da adaptabilidade, aponta, não para uma solução que se baseie em processos tecnológicos relativamente sofisticados, mas para um estudo programado, ainda em fase de projeto, da caracterização espacial de cada compartimento de forma a possibilitar aos seus ocupantes uma diversificada utilização dos espaços que habitam." (Krüger, 1981a, p.1170)

[160] Free translation of the full original quote in Portuguese: "Tanto a maximização da adaptabilidade bem como da flexibilidade visam minimizar a pré-determinação das exigências dos usuários ao permitir uma ocupação espacial que não é definida univocamente em fase de projeto." (Krüger, 1981a, p.1170)

[161] Nevertheless, this approach is not always consensual and may vary according to the authors. Dluhosch in 1974, suggests the twofold approach between *variability* and *flexibility* under the context of mass housing. According to this author, flexibility does not involve physical changes and variability does:
"- FLEXIBILITY may be defined as the ability to achieve a change of conditions, without changing the basic system as such;
-VARIABILITY may be defined as the ability to achieve a change of conditions by changing the system.
Thus, FLEXIBILITY refers primarily to adaptations to change, while VARIABILITY refers more to change as such." (Dluhosch, 1974, p.40)
Dluhosch also assumes that adaptability gathers both flexibility and variability: "Strictly speaking, adaptability assumes both flexibility and variability, either as programmatic elements or as regular features of design" (*ibid.*)

[162] Free translation of the original quote in Portuguese: "[...] o número de correspondências biunívocas entre os conjuntos $\{a_i\}$ e $\{e_j\}$" (Krüger, 1981a, p.1171).

Additionally, Krüger centres around the correlation between activities' size and frequency that takes a gamma distribution, consistently with Fawcett's (1978) approach to schools and to Bullock, Dickens and Steadman (1969[163]) in university *campi*. Krüger then proposes to maximise adaptability by means of maximising the entropy, on the uncertainty about the information on a situation, according to Shannon's information theory outlook.

The paper on *Modelos Probabilísticos em Estudos de Arquitectura* (Krüger, 1984) develops this subject matter even further, pointing out different possibilities to address probabilistic models, based on the Krasil'nikov's[164] (1928) early mathematical work. The relevance of probabilistic models lies in the possibility of reaching the most probable states based on the uncertainty of the distribution, even if it is acknowledged that these might also be constrained by behavioural variables that cannot be modelled and that are embedded in real situations (Krüger, 1984, p.1694)[165]. Nevertheless, probabilistic models can infer data towards "improving or correcting solutions for a good adjustment between the systems of activities and that of spaces"[166] (*ibid.*).

For adaptability this holds significance because it deals with the uncertainty of future activities states and their requirements for being adequately accommodated in space. Krüger therefore, explains the combinatorial approach to micro, macro and hyperstates and these imply the uncertainty of a situation: "the most probable macrostate is the one with the highest entropy"[167] (Krüger, 1984, p.1700).

Krüger concludes that the paper intends to "present a systematisation of an approach to architectural studies, developed, instrumentally, as probabilistic models of activities/spaces at the scale of the building"[168] (p.1718). By introducing capacity constraints the model can be closer to a real situation (p.1719). However, it is concluded that these studies do not aim at an "optimisation measure" and are

[163] Consulted edition from 1969, first edition from 1968.

[164] Translated to English by Catherine Cooke in 1975 and published in *Environment and Planning B: Planning and Design*.

[165] "Evidently, probabilistic models always make hypotheses about the relationship between variables that are ultimately behavioural in nature, that is, how people use certain spaces, lacking, overall, a methodology that indicates the real utility of the most probable solutions." (Krüger, 1984, p.1694)
Free translation of the original quote in Portuguese: "Evidentemente que os modelos probabilísticos fazem sempre hipóteses sobre o relacionamento de variáveis que, em última instância, são de natureza comportamental, isto é, de como as pessoas utilizam determinados espaços, faltando, em regra geral, uma metodologia que nos indique a utilidade real das soluções mais prováveis." (Krüger, 1984, p.1694)

[166] Free translation of the original quote in Portuguese: "[...] a melhorar e a corrigir estas soluções de forma a se obter um bom ajustamento entre o sistema de atividades e o de espaços." (*ibid.*)

[167] Free translation of the original quote in Portuguese: "[...] o mais provável macrostado é o que apresenta entropia máxima." (Krüger, 1984, p.1700)

[168] Free translation of the original quote in Portuguese: "Este estudo teve por objectivo apresentar uma sistematização de uma abordagem aos estudos de arquitetura, desenvolvida, instrumentalmente, como modelos probabilísticos de atividades/espaços à escala da edificação [...]" (p.1718)

considered as "piecemeal" to the studies that comprise diverse layers of analysis[169]. Still, these studies enable to critically confront expected and perceived results for the advancement on "a body of knowledge" in the area of the "spatial organisation of the human habitat"[170](p.1721).

Both Fawcett's and Krüger's approach will be central for our proposed methodology for assessing adaptability in contemporary school buildings for the entropy approach to adaptability[171].

Kruger's definition may also be complemented by the OECD's (1976) study on *Adaptability and Flexibility in School Buildings*, which established a clear definition of adaptability applied to the design of buildings and that is followed by a specific approach to schools[172]:

> "[…] adaptability, the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition in respect of either the constructional elements, services or the finishes of the building - essentially large magnitude/low frequency change" (OECD, 1976, p.10)

In this definition another correlation is present: magnitude/frequency, in which adaptability is of great magnitude, justified by the building's material changes and low frequency because they are only performed a few times, while flexibility is the concept of contrary correlation. A year earlier, in another publication, also on behalf of the OECD, the relationship between spaces and activities was explained by Oddie:

> "Adaptability is the ability to physically change, by moving, replacing and removing components, or by subsequent addition of other components. Flexibility is the quality of the building as it exists at

[169] Full quote in English: "It remains to draw attention to the probabilistic nature of the three models analysed, which are intended solely to describe the more probable states of behaviour and not to submit the whole design or study of architecture to an optimisation measure that, however good it may be, will not fail to be piecemeal and non-comprehensible of all possible dimensions present within architectural studies. " (p.1721)
Free translation of the original quote in Portuguese: "Resta ainda fazer uma chamada de atenção para a natureza probabilística dos três modelos analisados, que pretendem unicamente descrever estados mais prováveis de comportamento e não submeter todo o projeto ou estudo de arquitetura a uma medida de optimização que, por melhor que seja, não deixará de ser parcelar e não compreensiva de todas as dimensões possíveis presentes nos estudos de arquitetura." (p.1721)

[170] Full quote in English: "This allows public criticism of this knowledge, its process of formation and gestation until we are able to objectively construct the theory of architecture, that is, until we are able to formulate the set of principles that describe and explain a body of academic, professional and disciplinary knowledge that has as its object the spatial organisation of the human habitat." (p.1721).
Free translation of the original quote in Portuguese: "Isto permite a crítica pública deste conhecimento, do seu processo de formação e gestação até sermos capazes de construir objetivamente a teoria da arquitetura, isto é, até sermos capazes de formular o conjunto de princípios que descrevem e explicam um corpo de conhecimento professional, acadêmico e disciplinar que tem por objeto a organização espacial do habitat humano." (p.1721).

[171] See chapter 3.3 A methodology for identifying and assessing adaptability in learning environments.

[172] Recall from the previous reference to Fawcett, that he also states that adaptability is often associated with no physical change for authors of reference such as Rabeneck.

> any time, which makes it possible to modify the type of activities that it can accommodate, without the need to perform a material adjustment. As a result, the greater the flexibility, the later the need for adaptation."[173](Oddie, 1975, p.37)

Blyth and Worthington (2001) assume adaptability as the most pressing characteristic to predict in design:

> "Flexibility defines change that can be made quickly and with relatively little effort or cost (short-term and tactical) whilst adaptability is concerned with larger scale changes over longer periods of time (long-term and strategic). Adaptability implies the ability to change, whilst still leaving options open and not being unnecessarily costly or complicated. [….] Lack of adaptability is more serious, resulting in premature obsolescence." (Blyth and Worthington, 2001, p.45)

Likewise, DEGW also shares this view and advocates adaptability as a more promising solution, as opposed to flexibility, because it implies that the building has been designed with this capability, not in a redundant but open way to change:

> "Adaptability is a much better - and much cheaper - term to use because it means including within the design the capacity to add features later: planning for change, rather than catering for anything that might happen." (Duffy and DEGW, 1998, p.76)

Habraken (1972[174], 1998) also plays a relevant role for the state of the art of adaptability, first for the relevance bestowed upon user engagement, for approaching design to user participation in a holistic process and for recognising several stages for the space's completion[175]. Secondly, for conceiving a framework that comprises two separate levels: "support" and "infill", so that the built space, here particularly focused on dwellings, can be thought and materialised according to the user's intentions and expectations[176]:

> "It is therefore necessary that we consider housing as a totality of

[173] Free translation to English from the quote in French: "L'adaptabilité est la capacité de changement matériel, par déplacement, remplacement et suppression des composants, ou par addition ultérieure d'autres composants. La flexibilité est la qualité du bâtiment tel qu'il existe à n'importe quel moment, qui permet de modifier le type d'activités qu'il peut accueillir, sans qu'il faille procéder à une adaptation matérielle. En conséquence, plus la flexibilité est grande, plus loin dans le temps peut être repoussé le moment où l'adaptation sera nécessaire." (Oddie, 1975, p.37)

[174] Consulted edition from 1972, original Dutch edition from 1961.

[175] "It cannot be denied that in thinking of the user we are dealing with an actual force in the total process, for if this were not so there would be no reason to fear his involvement as a disturbing and intractable influence." (Habraken, 1972, p.7)

[176] "If we investigate the nature of the influence which the inhabitant can exercise it will soon appear that it is not negligible, for because it arises from the everyday actions of people it is closely connected with essential human activities." (Habraken, 1972, p.9)

> events which cannot be looked at meaningfully in isolation from each other. We are dealing with mutually related forces arising from all sides of society and which, if all goes well, act in equilibrium." (Habraken, 1972, p.5)

From the title of his book *Supports: an Alternative to Mass Housing*, "mass housing" is no longer an amount of similar spaces for all, implying the consideration of the user, as an *alternative* to it that encompasses "personal considerations and decisions", enabling the achievement of a "personal environment where one can do as one likes" (Habraken, 1972, p.12). According to Habraken, space cannot gain sense with appropriation, it has to provide meaning from the start and additionally, buildings are not considered secluded structures from the context of the users or "ready-made dwellings" (p.94), and so they are developed as part of life.

This is especially central for the design of dwellings because, as Habraken states, a home is only a home when it is a home to someone. It is not a mere practical or technical answer to a well-defined functionality, but rather a space to accommodate life within[177]. Therefore, this concurs with the idea that mass housing can be conceived as such, with similar spaces for all, because activities and peoples are not themselves uniform from the start[178]. Habraken, therefore, presents his "support structure", and defines it as such:

> "*A support structure is a construction which allows the provision of dwellings which can be built, altered and taken down, independently of the others.*"[179] (Habraken, 1972, pp.59-60)

Habraken argues for a "support structure" to the unknown future developments, enabling a diversity of housing[180] (Habraken, 1972, p.61). Building on the recognition of users' participation on the decision-making, the relevance attached to appropriation and the idea of separate levels of the building leads also to the 'open building'[181] approach (Kendall, 2004; Kendall and Teicher, 2000).

[177] "A dwelling is only a dwelling, *not* when it has a certain form, *not* when it fulfils certain conditions which have been written down after long study, *not* when certain dimensions and provisions have been made to comply with municipal by-laws, but only and exclusively when people come to live in it. […] *The notion of 'dwelling' is entirely subjective and is certainly not related to any particular form."* (Habraken, 1972, pp.15-16) (Italics from the original quote)

[178] "The form of housing we supply for ourselves conforms to an invented, restricted world, and has thus indeed become barrack living, and in comparison with the inexhaustible variety of real existence can therefore be called unnatural to a high degree." (Habraken, 1972, p.23)

[179] Italics from the original quote.

[180] "A support structure, on the other hand, is built in the knowledge that we cannot predict what is going to happen to it. The more variety housing can assume in the support structure, the better. (Habraken, 1972, p.61)

[181] "Residential Open Building is a new multi-disciplinary approach to the design, financing, construction, fit-out and long-term management processes of residential buildings, including mixed-use structures. Its goals include creating varied, fine-grained and sustainable environment, and increasing individual choice and responsibility within it. In Open Building, responsibility for decision-making is distributed on various levels." (Kendall and Teicher, 200, p.x)

This is followed by more recently studies on the built environment that are also envisaged in *The structure of the ordinary: form and control in the built environment* (Habraken, 1998). Under a closer regard, change is specially focused in this book, assuming that it occurs through time, and for the environment to continue as a lived "organism" it has to change and to adapt:

> "Moreover, built environments have lives of their own: they grow, renew themselves, and endure for millennia. Conservation may serve to freeze works of art in time, resisting time's effects. But the living environment can persist only through change and adaptation" (Habraken, 1998, p.6)

This thought on the environment's transformation in time so it continues to be lived in, relates to the need to accommodate and react to change and also to the human interaction of the people / the "builder", as an "agent of change" (Habraken, 1998, p.7). Inherently, it could be argued that this may be intrinsic to adaptability, for accommodating and responding to change and changing uses. On this regard, Habraken states that: "We must learn to look afresh at the intricate ongoing symbiosis between people and built matter." (p.8).

Habraken's approach to "supports" and "infill" (1972) may be paralleled with Duffy (1990) and Brand's (1994) "shearing layers of change", which lead to diverse adaptable solutions. Duffy (1990) identified four layers: "shell", "services", "scenery" and "set", all relating to different elements of the buildings, respective lifecycles and frequency in the need for change in order to accommodate upcoming spatial needs foreseen after the brief (Fig. 19). Brand's (1994) enlarges Duffy's 4S model to six "shearing layers of change": "site", "structure", "skin", "services", "space plan" and "stuff"[182](Fig. 20).

These developments can be analysed and overlapped, according to the literature interpretation of both references and authors. Consequently, conclusions on eventual new developments, concepts or definitions from 1990 to 1994 can be produced and structured in the form of a chart (Fig. 21).

[182] "SITE - This is the geographical setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings. 'Site is eternal' [...]

STRUCTURE - The foundation and load-bearing elements are perilous and expensive to change, so people don't. These *are* the building. Structural life ranges from 30 to 300 years (but few buildings make it past 60, for other reasons).

SKIN - Exterior surfaces now change every 20 years or so, to keep up with fashion or technology, or for wholesale repair. Recent focus on energy costs has led to re-engineered Skins that are air-tight and better-insulated.

SERVICES - These are the working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (heating, ventilation, and air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many buildings are demolished early if their outdated systems are too deeply embedded to replace easily.

SPACE PLAN - The interior layout - where walls, ceilings, floors, and doors go. Turbulent commercial space can change every 3 years or so; exceptionally quiet homes might wait 30 years.

STUFF - Chairs, desks, phones, pictures; kitchen appliances, lamps, hair brushes; all the things that twitch around daily to monthly." (Brand, 1994, p.13) (Italics from the original quote)

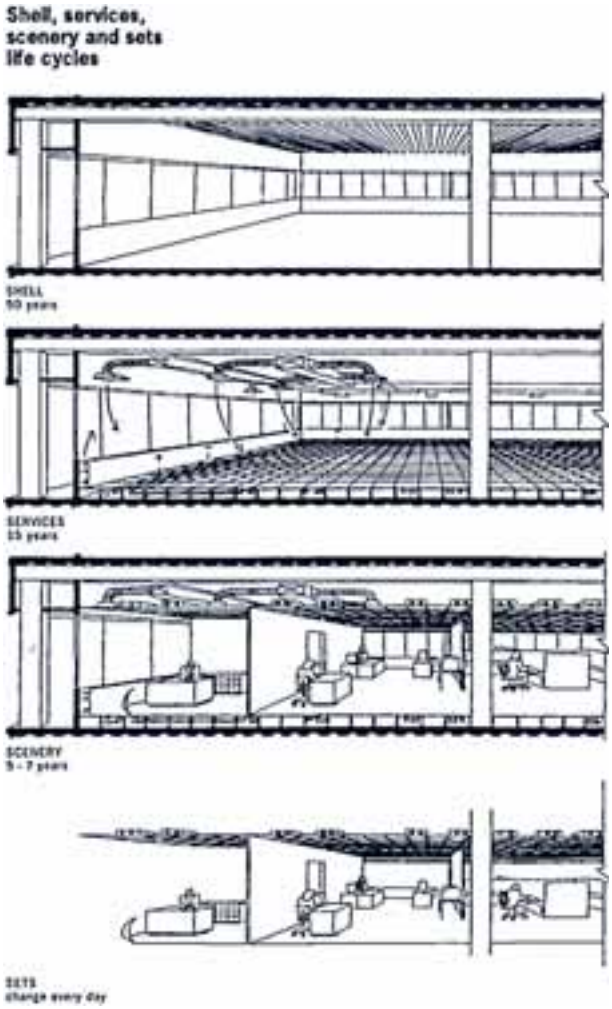


Fig. 19. Duffy's layers of change.
(Duffy, 1990, p.17)

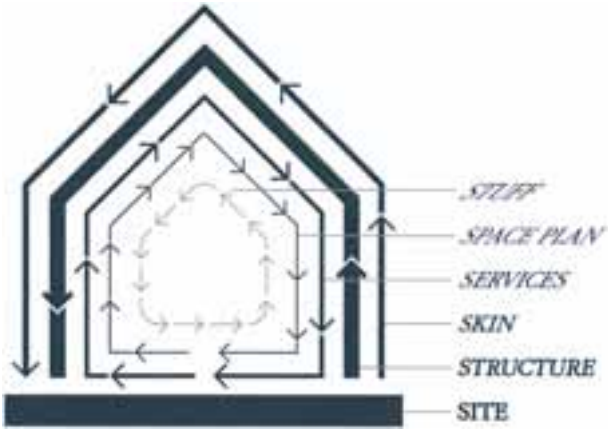


Fig. 20. Brand's shearing layers of change.
(Brand, 1994, p.13)

DUFFY (1990)			BRAND (1994)			
NAME	**DEFINITION**	**TIME**	**NAME**	**DEFINITION**	**TIME**	**Alterations from one author to the other**
			SITE	"Geographical setting, the urban location"	Ethernal	New concept
SHELL	"Structure"	50 years [183]	**STRUCTURE**	"Foundation and load-bearing elements"	30-300 years	Lifetime corresponds now to 30-300 years
			SKIN	"Exterior surfaces"	20 years	New concept
SERVICES	"Cabling, plumbing, air conditioning, elevators"	15 years	**SERVICES**	"Working guts of a building"	7-15 years	From 15 years to 7-15 years
SCENERY	"Layout of partitions"	5-7 years	**SPACE PLAN**	"The interior layout"	3 years	From 5-7 years to 3 years
SET	"Shifting of furniture by occupants"	Months to weeks	**STUFF**	"Chairs, desks, phones, pictures; kitchen appliances, clamps, hair brushes; all the things that twitch" [184]	Months to days	From months to weeks, or to days

Fig. 21. Interpretative comparison of both Duffy's and Brand's models (Carolina Coelho)

From the chart's interpretation, there are similarities but also differences in the concepts themselves, respective definitions and also on the duration of each layer. Brand introduces "site" as a new concept that embraces a larger / territorial scale and which he considers to be timeless, implying it to be everlasting, according to this author, and the sole to withstand amongst the remaining layers. Duffy's "shell" and "Brand's "structure" can possibly be overlapped, because both refer to the "foundation elements" of the building, considered by Duffy as lasting 50 years and for Brand between 30 to 300 years. Brand also introduces the concept of "skin" that he indicates as the "exterior surfaces" and presumes to last for 20 years. Curiously, both authors use the same concept of "services", even though Duffy relates it to 15 years, whereas Brand points out that it could go from 7 up to 15 years. The interior layout is named by Duffy as "scenery" and by Brand as "space plan", going from 5 to 7 years according to the first and only 3 according to the latter. Finally, and to mention a smaller scale layer, Duffy refers to "set" that can be moved and changed between months to weeks, while Brand considers a possible more frequent change from months to days.

[183] According to Duffy: "Rather than describe and measure buildings in material terms - amounts of concrete, glass and steel - it is necessary to describe them in terms of time: shells that last up to 50 years, services that last 15 years before they must be replaced, scenery which, these days, has a duration of five years or even less." (1990, p.17)

[184] The definitions in quotes are from Brand's (1994). *How buildings learn: What happens after they're built.*

These features, organised here from the most general to a more detailed scale, as presented by these authors, bear relevance for the space's individual characterisation and for the system's internal dynamics. But foremost, the choice in each of these levels will lead to different spatial responses in relation to activity allocation, the ability to cope with change, and lastly, adaptability. More recently and based on Brand's previous approach for composing layers of a building, Leupen's approach to flexibility (2006, 2005) uses five ones: "structure", "skin", "scenery", "access" and "services" and proposes two components: the lasting "frame"[185] and "the generic space" (Leupen, 2006, p.10).

The gathering of all these layers composes to the building that has a lifecycle over time:

> "My approach is to examine buildings as a whole - not just whole in space, but whole in time. Some buildings are designed and managed as a spatial whole, none as a temporal whole. In the absence of theory or standard practice in the matter, we can begin by investigating: What happens anyway in buildings over time?" (Brand, 1994, p.2)

To illustrate "what happens when they [the buildings] are built[186]" Brand shows two similar houses in New Orleans from 1857 and how they have changed and differ in 1993 (Fig. 22). Brand states: "Both buildings grew. They diverged. Their skins changed markedly." (Brand, 1994, p.1). These images illustrate these buildings' persistence through time, but also their ability to change from their early construction. The perceived changes regard physical expansion, coating materials, ground floor's space's functionality, and small other attachments (*ibid.*). These changes could be thought regarding Brand's shearing layers of change, for acknowledging that the most superficial and removal layers, like skin, have been transformed, but that others, more permanent ones, like site and structure, have endured since 1857. These alterations, additions and renewals of different scale and frequency, recall Brand's quote on the "shearing layers of change": "Because of the different rates of change of its components, a building is always tearing itself apart." (Brand, 1994, p.13). These changes are conveyed by and from its occupants along its lifespan:

> "Age plus *adaptivity* is what makes a building come to be loved. The buildings learn from its occupants, and they learn from it."[187](Brand, 1994, p.23)

Brand concludes that buildings change and adapt through time, for being suitable for their users, but along with their changes, their age and history are also embedded within them (p.209). From Brand's concluding remarks: "an adapted state is not an end state" (*ibid.*), it can be argued that if change is not an end in itself, it is the possibility of continuing in time and along this path, continuing to change. So, providing for change is enduring in time.

[185] "This present study takes not the changeable but the permanent as its departure-point. This, I hope, will open up new perspectives. The permanent, meaning the more durable component of the house, constitutes the *frame* within which change can take place." (p.9) (Italics from the original quote)

[186] From the book's title: *How buildings learn: What Happens After They're Built.*

[187] Italics from the original quote.

a) b)

Fig. 22. a) "4 May 1857. New Orleands *[sic]* Notarial Archives, Plan Book 43, Folio 46"
b) "November, 1993. Robert S. Brantley, New Orleans"
(Brand, 1994, pp.viii-1)

Rusell and Moffatt (2001) understand that adaptability encloses not only flexibility, but two other concepts: "flexibility" for smaller changes (potentially regarding the previously addressed low magnitude changes), "convertibility" as a possibility to alter the uses of space and "expandability" for future spatial increases[188] (Rusell and Moffatt, 2011, p.2). These authors also state the benefits of adaptability related to: "more efficient use of space", "increased longevity" and "improved operating performance" (p.4). The central proposal the authors make is for evaluating the building's "elements" in order to conclude on their adaptability, matching Brand's approach to the "shearing layers of change". These are considered as such: "foundation" that copes with possible growth, "superstructure" desirably of reinforced concrete to allowing internal and external changes, "envelope" that should be detached from the structure, "services" that enable modifications in the system, and "interior spaces" that accommodate different uses (p.12).

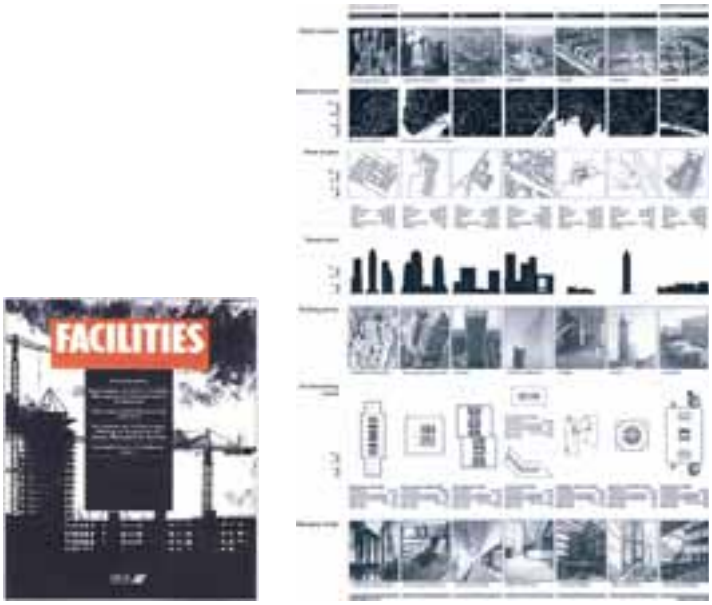
Having already recalled Duffy's works in previous quotes, an after a review on potential approaches to Brand's "shearing layers of change", the DEGW's work will be focused regarding their approach to *design for change*[189] (Duffy and DEGW, 1998). This has been founded as JFN in 1971 in London, and established as DEGW in 1974 by Francis Duffy, Peter Eley, Luigi Giffone and John Worthington (pp.11-12). Duffy[190] and DEGW's work are paramount for the state of the art on this subject matter directed towards building's uses throughout and the "social phenomena of change" (p.11).

Similarly to Brand's approach, time is a central variable on their research because it is over time that building's needs and users change, acting as a "critical dimension of

[188] "The concept of adaptability can be broken down into a number of simple strategies that are familiar to most designers:
• Flexibility, or enabling minor shifts in space planning;
• Convertibility, or allowing for changes in use within the building; and
• Expandability, (alternatively shrinkability) or facilitating additions to the quantity of space in a building." (Rusell and Moffatt, 2011, p.2)

[189] From the title of: Duffy, F.; DEGW (1998). *Design for Change: The Architecture of DEGW*. Basel: Watermark/ Birkhauser.

[190] "Francis Duffy is an apostle of change – but change with a human face." (Duffy and DEGW, 1998, p.24)



a) b)

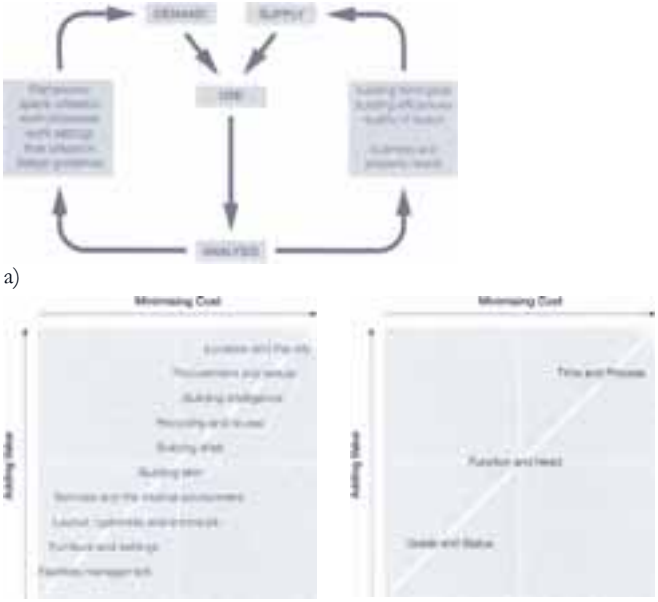
Fig. 23. a) *Facilities* has been launched by DEGW in 1983
b) "Building appraisal techniques played a key role in defining the brief for the Broadgate project and set the benchmark for all future development. Prepared for Rosehaugh Stanhope this diagram sets Broadgate in a world context. Accommodating and managing change are key factors."
(Duffy and DEGW, 1998, pp.46,48)

architectural design" (Duffy and DEGW, 1998, p.40). Time can be considered through the building's occupancy, as Brand interprets it, but it could also be perceived towards the practice, in the design of the building itself. This will converge time with functional, financial and effective requirements onto: "the need to create an architectural aesthetic that combines permanence and transience and gives to each its due meaning and importance. Such an aesthetic will shape the twenty-first century." (p.41).

From the 1980s that DEGW's work has displaced information on building managements and design and on the interactions between "cities and people and buildings and organizations" (p.47), which also coincided with their launching of the journal *Facilities* in 1983 (Fig. 23a).

The initial 'ORBIT' Studies[191] also date from 1981/82 focused on "the impact of information technology (IT) on office buildings" and these are a central example of DEGW's work, concerning "the physical and the organisational" (Duffy and DEGW, 1998, p.47). 'ORBIT 1' studies have been undertaken to assess the building's "capacity to accommodate change", and have been followed by the 'Building

[191] "The three main practical consequences of the ORBIT studies are, first, the development of systematic methods to measure the capacity of buildings to accommodate change; second, an increasing reliance on sectoral studies of the development of client requirements to both validate and calibrate such measurements of building capacity; and third, the development of time-based models which are intended to explain, in as elegant a way as possible, the likely consequences of change." (Duffy and DEGW, 1998, p.47) (Use of capital letters from the original quote)



a) b) c)

Fig. 24. a) "Matching patterns of user demand with building supply is essential to any successful commercial property strategy"; b) "A diagram from *The Responsible Workplace*, showing the tension between an organisation's need to minimise costs while simultaneously adding value at different levels of decision-making"; c) "Another diagram from *The Responsible Workplace*, showing how a time-based redesign of the work process is the most effective way to minimise cost and add value" (Duffy and DEGW, 1998, pp.50-51,76)

Appraisal techniques'[192] (Fig. 23b) informing on "future proofing"[193] (pp.47-49) and by the 'Responsible Workplace' model, whose diagrams may be comparable to our current research in the cost/value of different criteria (Figs. 24b, c)[194].

By focusing on change, considering time in both the design and the buildings' use and also having recognised strategies for assessing building's "future proofing", adaptability is inherently emphasised by DEGW. Thus, adaptability relates to the accomplishment of user requirements and consequently, attaining building performance (p.76) through a changing situation.

From a managerial perspective, building quality concerns its "suitability" towards a variety of uses. In this sense, it correlates users' "demand" and the building's ability to cope with them - the "supply" (Fig. 24a). As these can fluctuate over time, its accomplishment is bounded by facilities management, user engagement and design solutions, all contributing to an adaptable working space (Duffy and DEGW, 1998, p.77).

[192] "[…] Building Appraisal techniques […] analyse and compare the configuration of the whole building, floorplates and servicing systems with regard to specific user requirements and different commercial sectors […] The typical result of a building appraisal exercise on an existing or a proposed building is a relative rating against other buildings […] If a building has the capacity to accommodate several predefined profiles, it has, by extrapolation, the ability to accommodate a lot of change." (Duffy and DEGW, 1998, p.49)

[193] "'Future proofing' is a shorthand way of describing what building appraisal does for an investor's portfolio, for a developer's project or for a user-client's outline project. Building appraisal has the advantage of both modeling and testing the impact of change on office buildings." (Duffy and DEGW, 1998, p.49)

[194] These studies have been informed by Duffy's PhD Thesis in 1969, presented in Princeton.

Several works could be mentioned within DEGW's research, but two specific papers are cited for its representativeness in an earlier construction of these withstands: Duffy and Worthington (1972) *Designing for changing needs* and Duffy and Worthington (1976) *Organisational design and space*[195]. The first assumes that: "Organisations grow and change very rapidly." (Duffy and Worthington, 1972, p.463). On their approach to office buildings' "predictive planning" rather than "definitive", the authors acknowledge the building's "*over* time"[196] exceeding the present time of the brief. A "paradox" is thus pointed out, on the strict accomplishment of current needs that can be overly rigid for future demands, and which could be perceived in other building types such as the school (*ibid.*):

> "The paradox is that concentration on design for short term needs leads very quickly to an understanding of the long term limitations built into office building shells.
> The lesson is that in office design it makes sense to distinguish between different levels of design activity purely on the basis of how long the things designed can usefully last." (Duffy and Worthington, 1972, p.463)

The latter paper also recognises the discrepancy between "short term" and "long time" design decisions, respectively as the ones that accommodate current needs and the ones that are general and enduring towards "the capacity of various kinds of building shell to accommodate activities over time" (Duffy and Worthington, 1976, p.605). It is also stated to be a significant research one that would not only be focused in future change, but that would observe how buildings have adapted to change in the past, which might reveal the interactions, uses and users throughout.

Worthington, also a member of the DEGW, has also several publications on this subject, particularly applied to office buildings. In *Reinventing the workplace* (Worthington and DEGW, 2006[197]), Worthington associates change in the workplace to: technology, which impacts the working process, with more diverse and flexible possibilities; the working equipment, that needs to be economical, sustainable; and possible locations, both virtual and physical. All in all, architecture should continue to pursue design solutions to cope with these demands, rather than the most traditional ones used for another working models and processes[198] (pp.6-7).

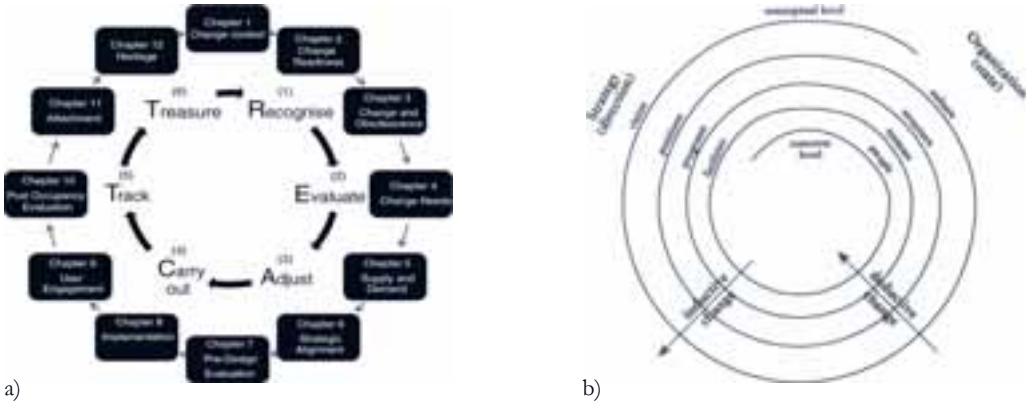
Duffy's contribution in the book *Building Evaluation Techniques* (Baird et al.,1996) regarding change, as well as the book *Managing the brief for better design* by Blyth and Worthington (2001) demonstrate that building assessment is currently a widespread

[195] This paper will be referred on the sate of the art for a methodological approach. See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[196] Italics from the original quote.

[197] Consulted edition from 2006, original edition from 1997.

[198] "For providers and their architects, the challenge is to avoid conventional solutions. Working simultaneously both physically and virtually is certain to result in workplaces that are very different from the norm." (Worthington and DEGW, 2006, p.7)



a) b)

Fig. 25. a) "REACT model – the framework for 'facilities change management'";
b) "Levels of organizational change"
(Finch, 2012b, p.13); (Mintzberg and Westley 1992, p.42)

study field both in approaches, as in researchers and respective affiliation centres[199]. Also within Voordt and Wegen's (2005) *Architecture in Use: An Introduction to the Programming, Design and Evaluation of Buildings,* flexibility an multifunctionality are suggested, enabling individual appropriation, much recalling Weeks' metaphor of a coat *vs* a tailor made jacket:

> "Just as a tailor-made suit only fits one wearer, so a space designed to suit only one function is often rather badly suited to other functions. However, both use and users change with time. This is why many architects try to produce structures that are suitable for multiple use, allowing individual interpretations and interventions." (Voordt and Wegen, 2005, p.32)

Finch (2012a) addresses *Facilities Change Management,* reflecting upon "the challenge of making the physical environments we inhabit fit for a future that will be significantly different" (Finch, 2012a, p.xi). This book has several contributors from different countries and representing different institutions, revealing that it is a transversal and contemporary research matter, essential to be studied.

Finch presents the 'REACT model' (Fig. 25a) that acknowledges change in different situations of the building and involves distinctive actions, because if change is "recognised" from the start, assessed in each stage, and if it is monitored towards the future, then its "carry out" phase is more informed and supported for the demands in time. This is relevant because this framework enlarges the change process beyond the building's lifecycle in itself, being subjective to other variables, such as "new technologies, new working practices, reorganisations, new service solutions" that are also transformed throughout, in a more comprehensive outlook (p.12). This is supported by the previous approach on *Cycles of organizational change* by Mintzberg and Westley (1992), which model change in a centric framework (Fig. 25b).

[199] This subject will be studied in detail in chapter 3.1. Space use assessment methodologies.

Another significant conclusion from Finch's approach to change is the recognition that the 'punctuation' (meaning the stage for radical transformation) is responded by the building and its management, but that these are also embedded themselves in that change. So much so that: "buildings and facilities themselves have the potential to shape and change the organisation. They are not simply an instrument of change - they *are* the change."[200] (Finch, 2012a, p.8).

On this approach to change, Finch tackles the concept of "change readiness*"* (Finch, 2012b), as previously mentioned, that can be twofold: regarding the "willingness" provided by facilities management and flexibility, as its physical provision, or its "the state of being" able to cope with change, as opposed to preventing it. The equilibrium resides on a balance between being "over-specified for improbable futures" and "under-specified for futures which could have been anticipated", that can be surpassed by recognising the wide array of forthcoming possibilities on both design and management (Finch, 2012b, p.17). The scope of possible specifications resembles Becker's (1990) concepts of "elastic fit" and "elastic organization*"*[201]. When translating this concept onto space, the "elastic" fit can be considered as the possibility of a built spatial framework to manage the upcoming changes, differently from what the author calls "tight-fit" or "loose-fit" (Becker, 1990, pp.18-22).

Despite approaching change and "change readiness*"* to flexibility, Finch's definition is closer to the building's ability to adapt, and his approach holds significance for this current Thesis, as a holistic consideration upon building's change that is impacted by several variables, to which the building has to respond, "adapt" and "react" (Finch, 2012b, p.21)[202].

Thus, if flexibility copes with change and if change tackles many variables of the building, then flexibility can also be perceived according to each situation. Finch even relates this idea to Duffy's (1990) layers, assuming that flexibility can be thought on each one's regard[203]. This resembles Pinder et al.'s (2012) approach on a variety of possible "adaptable design strategies"[204] and also on the building's ability to either "support and facilitate change" (Pinder et al., 2012, p.26). Nevertheless, it is first required to understand how does change weigh on the buildings and by what means can these cope with it, in order to, then, comprehend how can the buildings weigh on change (p.27).

[200] Italics from the original quote.

[201] "The elastic organization encourages diversity within well-defined frameworks, and it provides clear guidelines within which decentralized groups can quickly make decisions to respond to changing conditions." (Becker, 1990, p.21).

[202] "A good building design can adapt in response to changing circumstances. This in-built capacity, which we describe as flexibility, refers to a facility's capacity to support change readiness." (Finch, 2012b, p.21)

[203] This has been advanced by Sethi and Sethi (1990), who have identified the following flexibilities: "machine flexibility", "material handling flexibility", "operation flexibility" (these three related to "component flexibilities"), "process flexibility", "product flexibility", "routing flexibility", "volume flexibility", "expansion flexibility" (these concerning to "system flexibilities"), "program flexibility", "production flexibility" and "market flexibility" (these comprised in "aggregate flexibilities").

[204] "The degree to which the adaptable design strategies described above are used in practise depends on a wide range of factors, the interplay between which will be different from building to building." (Pinder et al., 2012, p.33)

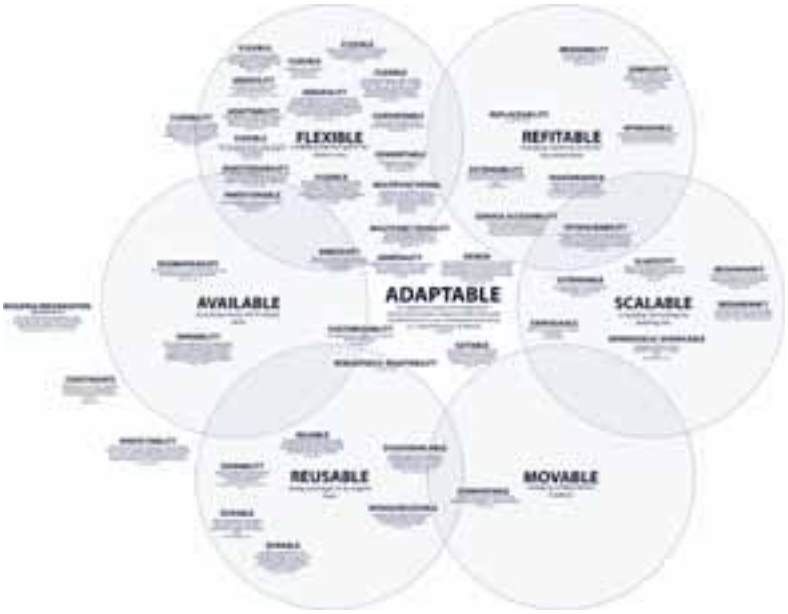


Fig. 26. "Mapping of literature against AF strategies"
(Schmidt III et al., 2010b, p.6)

It is concluded that this ability to accommodate change is prior established by the design solutions the building is provided with, leading to "a time-based view of design" and approaching Brand's (1994) perspective of building's endurance *over* time. This also engages a "dynamic and long-term view of the built environment", where buildings are continuously changing, according to the contextual changes that impact them, rather than fixed structures, as Habraken has put it in his 1998 book *The structure of the ordinary: form and control in the built environment* (Pinder et al., 2012, p.38).

Recent research on adaptability is undertaken by Adaptable Futures, a research group from Loughborough University (Eguchi et al. 2010, 2011; Kelly et al. 2011a, 2011b; Manewa et al. 2009a, 2009b; Pinder et al. 2011; Schmidt III et al. 2011, 2010a, 2010b, 2009a, 2009b, 2008). Their prolific research identifies adaptability to be: "a definable design characteristic with a principle consciousness towards time and layers" (Schmidt III et al., 2009b, p.1). This approach to adaptability also bears a clear definition:

> "Adaptability as a design characteristic embodies spatial, structural, and service strategies which allow the physical artefact a level of malleability in response to changing operational parameters over time." (Schmidt III et al., 2010b, p.1)

For this research group, these are ways for space to pursue adaptability, according to the performance of its elements. This interpretation gathers widespread concepts from the state of the art on adaptability, such as: "scalable", "refitable", "movable", "available", "reusable", "flexible", "versatile", "convertible", "adjustable" (Schmidt III et al., 2010b, p.6) (Fig. 26). According to this perspective, the research also

Fig. 27. "Summary of Strategies in relationship to other dimensions"
(Schmidt III et al., 2010b, p.7)

established a parallel between these "design strategies" and the "type of change", "a decision level", "a built-environment scale" (B-E scale) and "a time scale or cycle length" (p.7). This association can be compared to Brand's (1994) previously refereed "shearing layers of change", concluding on which strategies were associated with each layers (Fig. 27).

Several contemporary design buildings are shown in the book *Flexible: Architecture that responds to change* (Kronenburg, 2007) demonstrating that change can be accomplished by different designs because it also responds to different situations:

> "Architecture that is designed for adaptation recognizes that the future is not finite […] Adaptable buildings are intended to respond readily to different functions, patterns of use and specific users' requirements." (Kronenburg, 2007, p.115)

If previous approaches to adaptability have associated it to technology, in the sense that the introduction of ICT triggers new patterns of use and work processes, Kronenburg also conveys contemporary "adaptable architecture" to the promptly introduction of increasingly more developed technological devices (Kronenburg, 2007, p.116), having "adaptable servicing". It is also related to "multi-use", "loose-fit", "retrofit" and "adaptive reuse" and, within this contemporary approach, since adaptability provides for a longer building's life, it hence, leads to higher sustainability (pp.137-142).

The approach to adaptive reuse has been taken on by several authors in recent approaches like Kincaid's (2003) book *Adapting buildings for changing uses: Guidelines for change of use refurbishment*, where adaptive reuse is defined as: "a complex process which requires that the participants in the process have a clear understanding of how to determine what future uses will be most appropriate for a particular building in a particular location and for a given period in time." (Kincaid, 2003, p.10). This is linked with changing needs and also to the building's feasibility to hold other uses different from the initially conceived ones.

Recent publications and conferences concerning this subject matter have also been prolific, as the *14th Docomomo International Conference* (Docomomo, 2016) held

in Lisbon, that was centred in 'Adaptive reuse: The modern movement towards the future'[205], or its 2015 *Docomomo Journal 52* which was called 'Reuse, Renovation and Restoration' (Docomomo, 2015)[206]. All these have gathered a wide research community around this issue and consequently gather different perspectives and contributions towards knowledge advancement.

This chapter aimed at providing an overall outlook on the definition of adaptability, regarding the different contexts of approach. As it has been perceived, adaptability was much addressed in the 1970s by a wide array of authors[207]. This context was close to assessing building performance and understanding this problematics within a more analytical framework of research. Models hold significance for these perspectives on a relation between variables, namely environment and behaviour.

Having been addressed in previous studies for providing for an "indeterminate" future within a physical built space, adaptability has been studied in different building briefs, such as office buildings, much related to high performance workplaces, as well as hospitals and schools. By and large, the focus on "complex buildings" is enabled by the possible relations between closely defined requirements for specific functions and a general idea for the building as a whole. Moreover, these are buildings in which change and growth are considered to be most significant, since future requirements have to be met and be guided by legal, functional and social needs for future users.

The approach to "complex buildings" by Krüger (1992)[208] is, hence, relevant to understand what they are and that diverse programmes can be considered as such. According to Krüger, "complex buildings" are the "structuring artefact[s] of diversified spatial relations"[209] (Krüger, 1992, p.2), these have "a hierarchical organisation of elements and sub-systems", can be considered "interfaces between the different categories of users", are transformed by "growth and change factors" and can be decomposed for the purposes of their performance analysis[210] (*ibid.*).

[205] The following, in 2018 in Slovenia,will also revolve around this perspective, entitled: 'Metamorphosis. The Continuity of Change'.

[206] Docomomo holds a particular role in this behalf, raising awareness towards this subject and fostering the debate on the future of the modern movement buildings.

[207] This will also be noticed in regard to the methodologies to a assess adaptability. See chapter 3.2 Adaptability assessment methodologies: reviewing previous approaches.

[208] This paper will also be studied in detail regarding programmed and non-programmed activities and productive and supportive spaces, when developing our own methodology for identifying and assessing adaptability and specifically for the characterisation of spaces and activities. See 3.3. A methodology for identifying and assessing adaptability in learning environments.

[209] Free translation of the original quote in Portuguese: "artefacto estruturador de relações espaciais diversificadas" (Krüger, 1992, p.2).

[210] According to Krüger "complex buildings" are enclosed by the following features: "a hierarchical organisation of elements and sub-systems for their programming", "descriptive systems of their spatial and programmatic organisation for being considered interfaces between the different categories of users", "growth and change factors that enable their evolving transformations within their organisation" and "the decomposition of their parts for the analysis of their performance or the establishment of their programming" (*ibid.)*
Free translation of the original quote in Portuguese: "organização hierárquica dos elementos e sub-sistemas que estes edifícios apresentam na sua programação", "sistemas descritivos da sua organização espacial e

Hence, the adaptability approach from several of the referred building briefs, that have been applied to office buildings or hospitals, might also be translated onto schools, as all of them are "complex buildings" subject to growth and change on their structures.

These initial studies have been paramount for the approaches to adaptability onwards, which have been widespread in definitions, programmes and methods of approach, as it has been remarked. Besides, adaptability continues to be an aggregating subject matter that assembles a broad research community today.

Thus, the concept of adaptability is diverse *per se* and closer to other concepts that embrace change over time, according to the authors of reference. For this current research this chapter aimed at informing on the several advances towards adaptability, aiming to support the proposed methodology displaced on chapter 3[211]. This can only be constructed after a critical assessment on the concept of adaptability when applied to our current research question and to the case study of contemporary school buildings.

After tackling the conceptual frameworks under which adaptability has been studied, their purposes and connotations, the following part will specially address adaptability in school buildings[212], in order to provide an outlook on the different design strategies in which adaptability has been materialised, their design contexts and the learning practices that guided these projects over time. This intends to displace data on relevant moments when adaptability was considered towards schools and how and by what means has this been conceived in the design. Their acknowledgement will be informative towards the consideration of the current learning process and learning spaces, reflected upon chapter 2.3.[213]. After analysing the concept of adaptability and approaching it to the schools and to contemporary learning environments, the framework of this research is expected to be specified in order to continue on towards the methods that have been established to assess it in chapter 3.

programática face à sua caracterização como interfaces entre diferentes categorias de utentes", "factores de crescimento e mudança que levam a transformações evolutivas na sua organização", "decomponibilidade das suas partes tendo em vista a análise do seu desempenho ou o estabelecimento da sua programação". (*ibid.*)

[211] See chapter 3. Construction of the methodology.

[212] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

[213] See chapter 2.3. Adaptability for contemporary learning practices and environments.

2.2. Adaptability in school buildings: approaches for growth and change

> "Beyond the standard question of "how to provide facilities suitable to the educational objectives of the multi-option school" we find another more complex question, how to ensure that these facilities allow multiple answers to the needs of modern education and that they encourage the invention of new activities and behaviour not strictly foreseeable at the time of their design?" (Ader, 1975a, p.11)

After the previous study on adaptability and the contextual framework under which research on this subject matter has been established[214], this following part will address the materialisation of adaptability in school buildings throughout prominent examples of past schools.

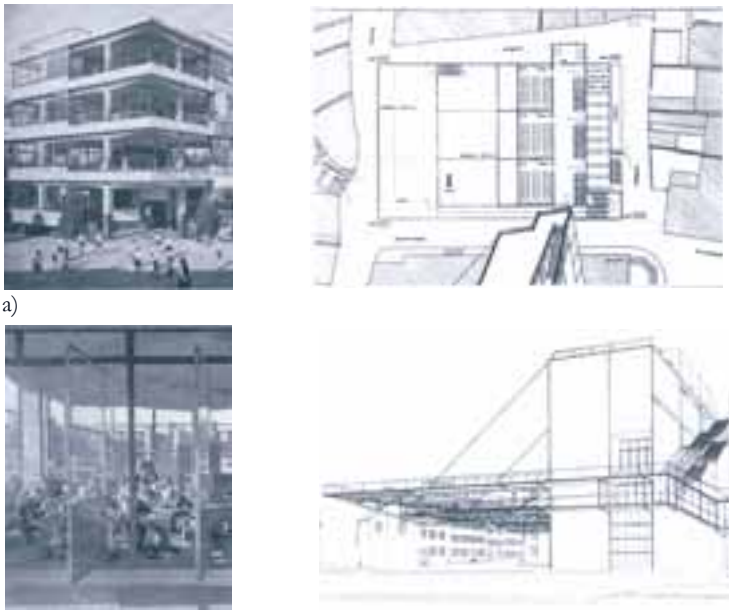
Kahn (1960) has addressed the school space along with learning, at its "beginning":

> "I think of school as an environment of spaces where it is good to learn. Schools began with a man under a tree, who did not know he was a teacher, discussing his realization with a few who did not know they were students. […] the existence will of school was there even before the circumstances of a man under a tree. That is why it is good for the mind to go back to the beginning, because the beginning of any established activity is its most wonderful moment." (Kahn, 1960, pp.64-65)

Nevertheless, the school space is no longer acknowledged solely by seminars or the exposition of contents. Learning is conceived outside the classroom and by means of diverse activities of knowledge creation and communication, it is, in fact, "an environment of spaces where it is good to learn", understood in an open and holistic manner. According to Hertzberger: "learning has to be more than just absorbing basic knowledge" (Hertzberger, 2008, p.8).

Along with the evolution of the pedagogical practices, the evolution of the school space derived from new means of teaching, but also as a search for new models of space and during the 20th century these are subject to experimentation

[214] See chapter 2.1. Adaptability: definition and adjacent concepts.



a)

b) c)

Fig. 28. a) Open-Air School, Cliostraat, Amesterdão, by Duiker and Bijvoet, 1927-30
b) Arnhemse Buitenschool Monnikenhuizen, Arnhem, by H. B. van Broekhuizen, 1930
c) Petersschule, Basel, by Hannes Meyer and Hans Wittwer, 1926.
(Hertzberger, 2008, pp.14, 19)

and rethinking. Therefore, learning environments as considered today, imply the reconsideration of their formal and material features for coping with the practices they accommodate[215].

In this chapter, experiences will be described that portray this change towards the current educational paradigm and that embody adaptability as it has been perceived in significant examples along the 20th century, so that the following part can explain the current educational paradigm and its correlation with adaptability according to the present educational, physical and social demands.

The initial quote placed above (Ader, 1975a, p.11) from the book *Building Implications of the Multi-Option School,* published in 1975 by the OECD, exposes the urge to cater for diverse activities and experiences in school space that are not perceived at the time of the brief, but to which the built school space will have to answer later on. The relevance of adaptability is hence, put forward for coping with the learning practices that also suffer transformation.

This chapter does not intend to chronologically detail the evolutionary course of the school space, but rather to point out moments, designs and authors that begin to identify spatial features that suggest the concept of adaptability and/or adjoining

[215] Contemporary learning will be further developed in the next chapter. See chapter 2.3. Adaptability for contemporary learning practices and environments.

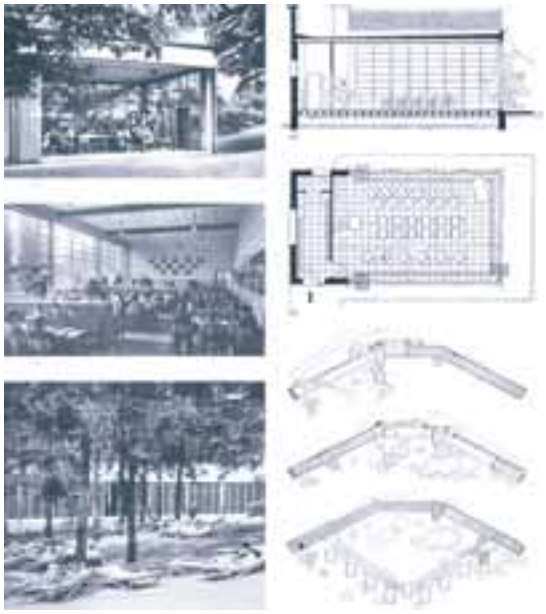


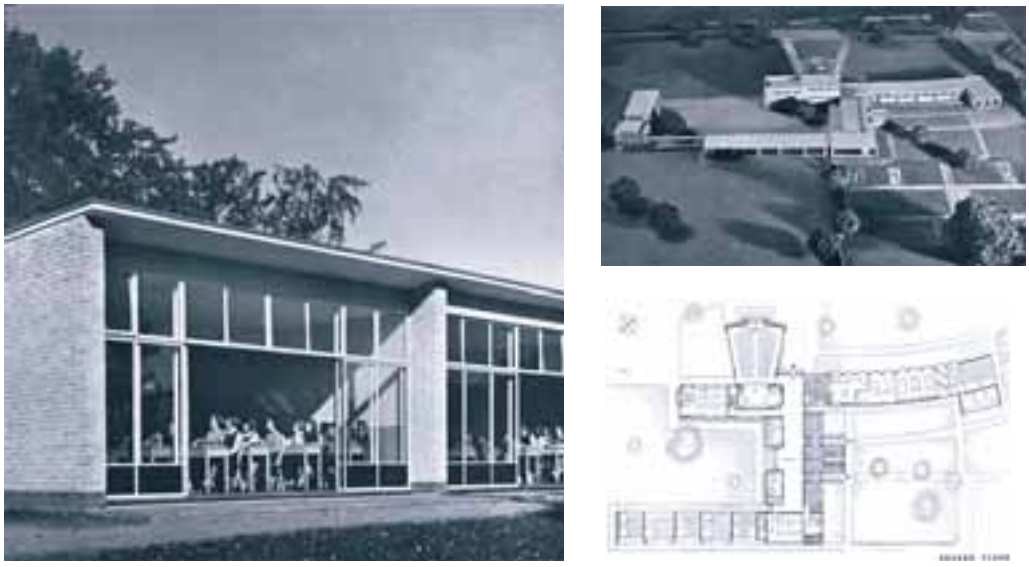
Fig. 29. Open-Air School, Suresnes, by Beaudouin and Lods, 1931-1935
(Hertzberger, 2008, p.18)

concepts such as flexibility or polyvalence, and also that favour informality and socialisation in school space as a means for learning, which consequently demand for adaptability.

. Approaches to future growth by means of cost-effective and industrialised solutions

Concerns about creating conditions for student comfort, lightning, openness and greater freedom beyond the central core of the classroom, had already begun to be considered from the early influences of the hygienist movements in the schools of the second half of the 19th century, passing through Dudok's schools (1st generation) and Hulshoff, Lansdorp, Marnette and Westerman schools (2nd generation), built in the 1920s and 1930s by the Public Works in the Netherlands; and also by the Open-Air schools by modern architects such as Duiker and Bijvoet, in Cliostraat, Amsterdam (1927-30) and Hannes Meyer and Hans Wittwer who designed the Petersschule, in Basel (1926) (Figs. 28 and 29).

Even though these schools did not change the traditional teaching-learning structures, they had the ability to consider the immediate environment provided to the pupils and were also deployed of the massive and traditional envelopes, being



a) b)

Fig. 30. Impington Village College by Gropius and Maxwell Fry. a) "a close-up of the end of the class-room wing, showing the sliding windows, facing south-east, that can be thrown open to the garden"; b) "model of the whole scheme" and plan

(The Architectural Review, 1939, pp.227,229)

perceived in a more approachable manner between the interior and the outdoors in transparent and healthier spaces (Hertzberger, 2008, pp.11-21).

Also, Impington Village College (Fig. 30) by Gropius and Maxwell Fry, in Cambridgeshire (1938-40), for 240 students between 11 and 15, showed concern for exterior openings from the classrooms to the garden, holding a "promenade" that "consists of a covered space 20 ft. wide and 140 ft. long from which all rooms in the building are approached" (The Architectural Review, 1939, p.232) (Fig. 30b).

More than the learning or design advancement, the relevance of this school lies in "the sense of congruity between form and social intention: the relaxed grouping of classrooms, community space and shared hall" (Saint, 1987, p.42). This bond between "learning and living" that guided the village colleges would subsequently support the "origins and shape of the integrated community comprehensive schools of the 1960s and '70s" (p.44).

Afterward, from the Second World War onwards, a paradigm shift has been observed in the concept of school space, not only to respond to the quantity needs – due to the post-war baby-boom and the increase in the level of compulsory schooling, but also in quality and adequacy to the new educational context. Schools intended to respond to the social and economic needs of higher qualifications, which implied a change of the educational models to answer to a "post-industrialized, knowledge-based society"

(Kühn, 2011, p.21). The respective architectural response sought for flexible schools models that would allow for change in accordance with future demands.

Despite previous experience in prefabrication in the 1930s, in 1957 the British Ministry of Education had already suggested that changeability in educational pedagogies had to be accounted for in post-war school building construction:

> "[…] these spaces must be adaptable not only to a present variety of uses, but also to the changes which the future is bound to bring, sometimes suddenly, sometimes imperceptibly." (Ministry of Education, 1957, p.15)

Thus, it was now up to the architects to structure responses to these new requirements, through spaces that allowed a wider variety of uses and different levels of interaction, from self-learning to individualised teaching, through dialogue and group work, along with the quantity needs for more schools guided by the rising educational principles.

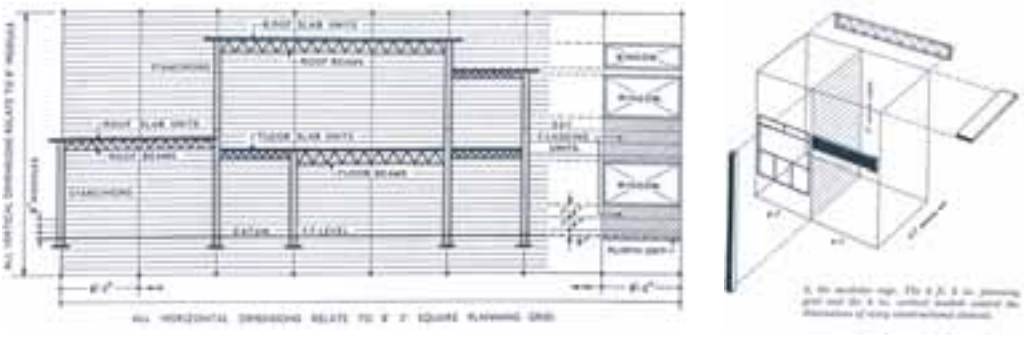
The pioneering English experience of Hertfordshire[216], aimed to account for an increasing birth-rate and the resulting spread in student population, which was particularly significant for the New Towns and that resulted in an estimate urge for 50 new more primary schools. The urgency for school building demanded that an industrialised production was considered that would respond to it in a more rapid way than the traditional construction building (Llewelyn-Davies and Weeks, 1952, p.367).

Aslin, the head of the architecture department for Hertfordshire County Council (Herts), along with Marshall and Newson as chief education officer, had the difficult task to conceive these schools by means of an innovative prefabricated construction that would comprise both the structure, light and heating servicing in a complete system[217].

Thus, based on an industrialised production, it sought to build schools as a rapid response to the needs created by the war, which was then enlarged throughout the country. It was intended that each school affirmed its individuality, the spaces should result in varied forms and the construction should be made with flexible components in a suitable manner for each site. The light steel grid with beams and columns had modules of 8 feet 3 inches (Fig. 31), the flat roof was made out of pre-cast concrete slabs and the exterior envelope used reinforced concrete slabs (p.368).

[216] Keath (1983) has studied this issue on his Doctoral Thesis. See KEATH, M. (1983). *The Development of School Construction Systems in Hertfordshire 1946-64*. Doctoral Thesis. London: Thames Polytechnic.

[217] "There was at the time no ready designed system of prefabricated building suitable for the purpose, nor were the architects trained in the appropriate design methods." (Llewelyn-Davies and Weeks, 1952, p.367)



a) b)

Fig. 31. a) "The system of construction, based on a number of standard components, used for all the Hertfordshire schools"; b) "The modular cage. The 8 ft. 3 in. planning grid and the 8 in. vertical module control the dimensions of every constructional element"

(Llewelyn-Davies and Weeks, 1952, p.368)

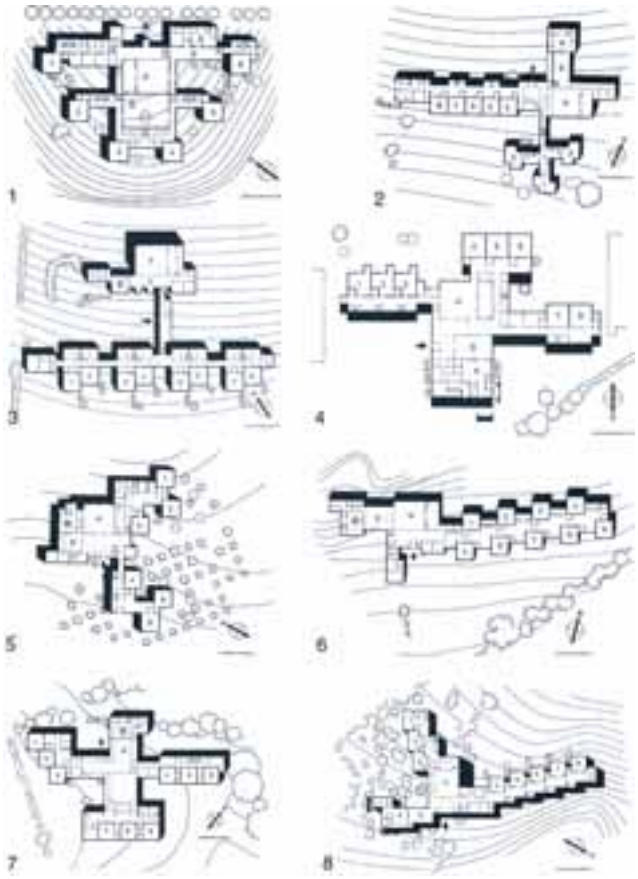


Fig. 32. "Diagrammatic plans of Herts primary schools, 1947-50, showing grouping, siting and contours. The shading indicates the north side, classrooms are shown by numbers. H=Hall; D=Dining; K=Kitchen. 1, Monkfrith Infants School, East Barnet. 2, Cowley Hill School, Borehamwood. 3, Belswains School, Hemel Hempstead. 4, Morgans Walk School, Hertford 5, Aboyne Lodge Infants School, St. Albans. 6, Spencer School, St. Albans. 7, Warren Dell School, Watford. 8, Templewood School, Welwyn Garden City."

(Saint, 1987, p.69)

Despite their individuality, these schools were guided by invariables, namely the valorisation of the children's requirements, which implied a preference for smaller scale schools, the importance of their appropriation and the possibility of several activities within the classrooms to be arranged as "workshops, studios and play spaces". The common spaces of the entrance, assembly hall and dining room were usually placed in a central core, connected between them and often divided by detachable partitions (p.370). The first was a school in Cheshunt in 1946-47 and by 1951 over 40 schools had been built (p.368) (Fig. 32).

Llewelyn-Davies and Weeks (1952) entitled the Hertfordshire experience as "a very great achievement" because: "The cost per place is similar to that of the best designed schools in traditional materials, the average time from start to completion is considerably less, and the use of prefabricated buildings has greatly increased the total number of schools built in the county since the war." (p.368).

In 1952 *The Architectural Review* has published four of these schools: Aboyne Lodge Infants School, St. Albans; Pentley Park Primary School, Welwyn Garden City; Junior School at Croxley Green; and Day Nursery at Garston. The latter had already the 3 feet 4 inches grid (The Architectural Review, 1952). In fact, criticism on the original grid's large span recommended by the Wood Report in 1944, which hindered the diversity of its internal partitioning, made it evolve later on to the smaller 3 feet 4 inches, having been recommended by the 1948 Report of Technical Working Party on School Construction, and afterwards to 2 feet 8 inches. All in all, this is considered to have launched "the possibilities of a new architecture" yet to be developed on its separate components and their assembly in a whole (p.387).

Beyond the use of the resources made available in the post-war times for employment and investment; the engagement of users, professionals and clients; and the aim for equal opportunities even in times of scarcity; Herts is also epitomised as "a new 'language of architecture" where flexibility was also accounted for:

> "The Herts architects created the ground work for a new 'language of architecture': not a style, not a mode of construction, but something approaching a complete technology of building which was broadly applicable and tolerably flexible, something which designers could work in and develop. This transformed the possibilities of prefabricated building." (Saint, 1987, p.111)

In fact, Herts achievement brought a "revolution in attitudes" that would "spread to the rest of the country". In regard for the post-war scarcity the Ministry announced the need for "annual programmes for school-building" for control over costs, which would rationalise the investment and lead to cost-effective solutions by "regular production and standardized techniques" (Saint, 1987, p.113). Under this scope, in 1949 the Ministry would establish an annual "cost per place"[218] for each children in

[218] This would be achieved "by combining a notional number of square feet per place and an estimated cost of building per square foot" (p.118).

primary and secondary levels but no specific design solutions were suggested given they kept to this figure (p.118). Solutions like lowering ceilings heights, diminishing circulation space, the use of double-loaded corridors and compact designs were, therefore, sought to cope with the figures proposed, along with the use of the hall both as a dinning space and circulation (Alegre, 2009, pp.64-65; Bullock, 2003, p.56-57)[219].

The Development Group, that was responsible for "research, building, theory, collaboration and experiment" (Saint, 1987, p.115), would then "design a series of school-building systems, each in partnership with a single manufacturer or builder" (p.131). This resulted in the development of 5 systems for secondary schools between 1949 and 1957 that had common features on the preponderance of using the 3 feet 4 inches module[220] and "light construction", avoided wet trades such as brickwork for economic purposes and were intended to have three or four storeys and "a view to the future interchangeably of components" (*ibid.*). These were innovative proposals that "involved starting from the beginning and inventing a new vocabulary of design which might be called upon to shoulder a complete building programme of schools" (p.135).

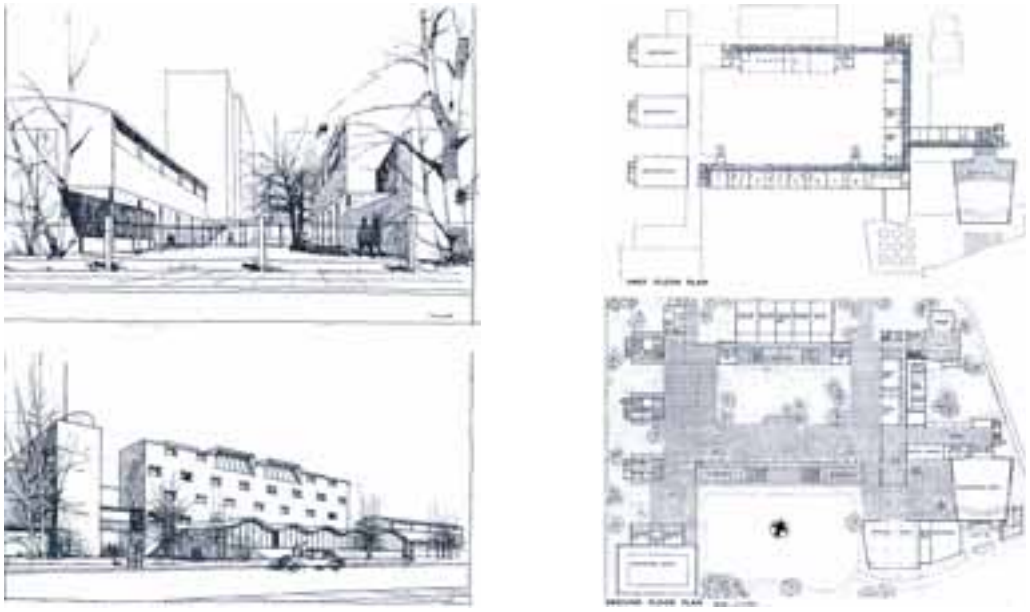
By and large, with the implementation of the Education Act in 1944[221] the State had full accountability for the education at all levels, from the Nursery to higher levels (Keath, 1983, p.22). Besides, the compulsory schooling age reached the age of 15 and it was also intended that all had schooling equally (Alegre, 2009, p.61). This urged to expand secondary schools to accommodate more students, to comprise the students' competencies and age ranges (Keath, 1983, pp.21-22) and, overall, to rethink the space.

Paralleling the primary school experiences, amongst the secondary schools there were three possible schools: Grammar School, Technical School and Modern School, providing for different educational or professional future paths. These could be separate, but they could also be gathered. Consequently, the comprehensive secondary schools were thought to comply with these three possibilities in a shared space to all the school population nearby (Alegre, 2009, p.93). This model implied "a broader variety of learning activities within, able to concentrate more resources

[219] "To reduce the cube of the building, for example, ceiling heights were trimmed, a limited though relatively pain-free way of reducing cost. By far the most effective way to cut costs was to reduce floor area, and to do so by reducing the amount of space used solely for circulation. In secondary schools the use of double rather than single-banked corridors offered immediate savings. In primary schools real savings were made by the shift from the 'finger plans' of the late 1930s-1940s to more the compact layouts of the 1950s, a shift made possible by the double use of the hall as dining room and circulation space. The Development Group estimated that this reduced the proportion of the area given over to circulation from twenty-three percent to seven percent, and in non-teaching accommodation from thirty-eight percent to twenty-five percent. Overall, these new compact plans made it possible to reduce the area per place by nearly forty percent in under five years without cutting the areas available for teaching, thus enabling architects to meet the demands for economy without compromising quality." (Bullock, 2003, p.56-57)

[220] Only one system of these did not use this module.

[221] Also called the Butler Act as it has been presented by Butler in the previous year.



a) b)

Fig. 33. a) Woodberry Down High School : « Top : the proposed high school from the west with two gymnasia in the foreground. Centre: from the north-east, showing the arts and crafts wing, with the workshops in the foreground.»; b) Woodberry Down High School, plans

(Matthew, 1949, pp.465,466)

and specialised equipment, for providing a quality education for all"[222] (Croft de Moura, 2001, p.249).

Leslie Martin and Robert Matthew's schools for the London County Council (LCC) in the beginning of the 1950s were already comprehensive schools. The first to be designed was Woodberry Down High School in 1949 (Matthew, 1949, p.465) (Fig. 33), but the London School Plan encompassed 67 comprehensive schools aiming at: "providing for all pupils equal opportunity for physical, intellectual, social and spiritual development, which, whilst taking advantage of the practical interests of the pupils, should make the full development of personality the first objective" (The Architects' Journal, 1951, p.75).

In 1956, Jordan critically analyses in *The Architectural Review* the LCC schools, at that time coordinated by Powell. After its often scattered predecessors in Impington and in Hertfordshire, the LCC schools assumed a more "rationalized solution of the compressed plan, formalized around an internal courtyard" (Jordan, 1956, p.323). Jordan highlights the school in Alleyn for its "highly flexible Assembly Hall, capable through moving screens and its varying levels, of serving lectures, concerts, exhibition, drama and social functions" (*ibid.*). The comprehensive schools were considered a part of the solution for the substantial increase in post-war population that was reaching

[222] Free translation of the original quote in Portuguese: "[...] abrangendo uma maior variedade de actividades dentro de si, podendo concentrar mais recursos e equipamentos especializados, a fim de conseguir uma educação de qualidade para todos." (Croft de Moura, 2001, p.249)

now the secondary schools and another 26,000 more places in secondary schools were needed by 1961, added to the 28,000 already accounted for (*ibid.*).

Additionally, 48 comprehensive schools in Scotland, built between 1958 and 1966, would be studied by the theoretical model presented by Markus and the Building Performance Research Unit (1972) in the University of Strathclyde[223]. The reasons for choosing comprehensive schools were listed:

> "In the present case the Unit's interest in developing an understanding of, and techniques for, building performance appraisal led to the need to select a building type in which a large number of similar examples could easily be reached, in which background information on the buildings could be readily obtained and in which there was some hope of assessing the actual product of the organisation which the building housed. From a social viewpoint we felt that a building type of which many examples were likely to be built in future years would provide the possibility of research findings actually being incorporated in future designs. All these considerations pointed to schools […]" (Markus and Building Performance Research Unit, 1972, p.52)

It is also stated the changes the schools have been suffering comprising: "the comprehensive system, advances in educational technology, breakdown of subject divisions, introduction of learning-based instead of teaching-based curricula", which have impacted both the practices within the building stock and their design anew (p.131).

The report from the Building Performance Research Unit on the comprehensive school has been published in the *RIBA Journal* in 1968 (Markus, 1968), where Markus argues for the "robustness of design solutions" that comprise adaptation, rather than "flexibility" or "open-endedness":

> "Robustness of design solutions should be the designer's first goal, for robust designs are able to withstand the pressures of social and economic change by their in-built capacity for adaptation. Yet, no sooner is this stated, than the fashionable catchwords 'flexibility' and 'open-endedness' are produced, as if they make further thought or forethought unnecessary." (Markus, 1968, p.425)

This gains added value for the comprehensive school that was already considered to have to cope with "curricular flexibility", "administration changes" and "community involvement, both in education and in the use of school facilities" (*ibid.*).

"The first full appraisal of a building in use" has been published in the *Architects' Journal* in 1970 on St Michael's Academy Kilwinning and intended to be a "detailed examination of the match between an ever changing *need* (education) and a *provision*

[223] See chapter 2.1. Adaptability: definition and adjacent concepts.

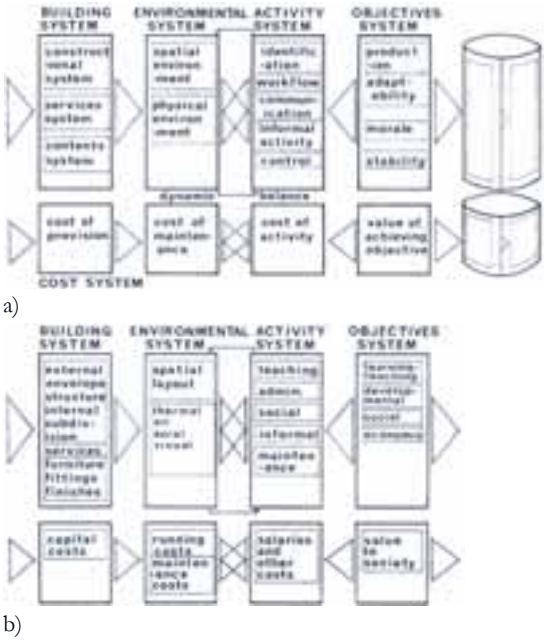


Fig. 34. a) "BPRU conceptual model"; b) "BPRU conceptual model applied to a school" (Building Performance Research Unit, 1970, p.10)

(the building environment) and it puts forward the perhaps starling idea that matching of activities to building spaces is a process which, far from finishing when the architect's work is done, continues as long as the building may last"[224] (Building Performance Research Unit, 1970, p.10).

This is also developed in the report from 1968, where Markus states that the spatial environment is "critical" for designing "robust solutions" and reports to the "patterns of activities". Still, the designer does not know in advance the activities' schedule and its possible changes and thus, he is guided only by "rules of thumb" for designing space for future timetabling. This is especially critical in schools, were the timetables set the activities in a very extensive way to children's experience in space (Markus, 1968, p.425). Moreover, the findings established that some schools had vacant spaces, even if they stated to be full, which demonstrates a mismatch between space and activities that research might account for (p.426).

A very significant development on the appraisal from 1970 is the Building Performance Research Unit's conceptual model applied to schools (Building Performance Research Unit, 1970, p.10) (Fig. 34b). The generic conceptual model related the "hardware of which buildings consist"; the "environment created by the building"; "the activity, or behaviour, of the users" and the "objectives of the organization which builds or occupies the building". This is perceived in a "circular system" that the cylinder metaphor can illustrate[225] (Markus, 1968, p.425) (Fig. 34a).

[224] Italics from the original quote.

[225] BPRU conceptual model has already been explained when addressing adaptability in a more general approach

In the model applied to schools, the central interactions between the environmental and the activity systems have been specified on each of the four systems, in regard to the interactions between "the education authority the school staff, the environment in which they work and the building fabric" (Building Performance Research Unit, 1970, p.10).

Finally, the appraisal has established that, amongst several other outcomes, both "curriculum and organisation of the school have all changed very considerably from the concepts upon which the brief for the design was based", which is also a reflection of people and human organisations' adaptation to the environment. Moreover, changes on the "school leaving age" and on the "curriculum" may involve further adaptability that the school can no longer cope with (p.46).

The study concludes that "the building and its environment" are subject to extensive variables besides the architect's input, and appraisal may be operative to inform on "the real design process", ultimately, for improving "the quality and value of buildings" (p.48).

Meanwhile, increasing needs of school were also stated on the *RIBA Journal* and according to its article on *Schools consortia and the future* (Wigglesworth[226], 1966) published in 1966, in the following 20 years it was believed that the school population would increase 50 per cent, which could not be paired with a similar growth in architects or manpower (p.265). Assuming that the traditional construction could not cope with these needs, this urged for a solution on prefabricated systems that was guided by previous past experiences on Hertfordshire and the multi-storey systems advanced by the Development Group in the 1950s.

CLASP (Consortium of Local Authorities' Special Programme) was one of the school building consortia[227], especially one that "started earlier, it grew to be bigger, and it has lasted longer", able to "fulfil the old Herts ideals about production, collaboration development and use" (Saint, 1987, p.175) (Fig. 35):

> "CLASP was – and is – two things. It was a system of building based upon light-steel construction, adapted to combat the difficulties of sites liable to mining subsidence; and it was the earliest venture in bringing British local authorities together and pulling their resources to build more and better schools. Both these advances sprang from the post-

and it is referred again in this chapter for its specific application to schools.. See chapter 2.1. Adaptability: definition and adjacent concepts.

[226] Wigglesworth was Assistant Chief Architect from the Department of Education and Science, in collaboration with the consortia.

[227] Other consortia have been constituted after CLASP: SCOLA (Second Consortium of Local Authorities) from 1961, SEAC (South-Eastern Architects Collaboration) from 1963, CMB (Consortium for Method Building) from 1963; CLAW (Consortium of Local Authorities in Wales) from 1963; ONWARD (Organization of North-Western Authorities for Rationalized Design) from 1965; and the Metropolitan Educational Building Consortium for the London Area (Wigglesworth, 1966, p.265).

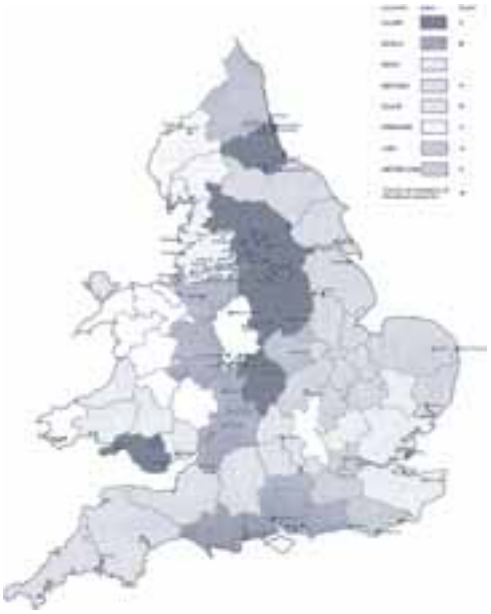


Fig. 35. "LEAs in membership of building consortia"
(Wigglesworth, 1966, p.267)

> war tradition of co-operative research, experiment and development in architecture, always strongest in the education building world, where ideals were high, clients amenable and approachable, and the Gropian vision of long-term production could be turned from dream to reality."
> (Saint, 1987, p.157)

The first CLASP school was concluded in 1957 at Mansfield and from there 448 more schools have been built (Wigglesworth, 1966, p.265). In 1962 Banham publishes an article in the *The Architectural Review* on CLASP, considering it "the most sophisticated as well as the most convincing prefabricative system that has ever gone 'on stream'" (Banham, 1962, p.350). Nevertheless, for the question "Is it, then, an *architecture autre*, an *other* architecture?"[228], Banham argues:

> "This is not, in any visible sense, architecture considered as one of the accepted fine arts; not architecture as the expressed will of a highly developed personality. And yet it carries its own visual conviction, the air of being the expressed will of something or some body of things, the product of some sort of highly developed creative force. Above all, it can clearly co-exist with architecture in the accepted sense without being reduced to that snob's desideratum 'background buildings.'"
> (Banham, 1962, p.352)

[228] Italics from the original quote.

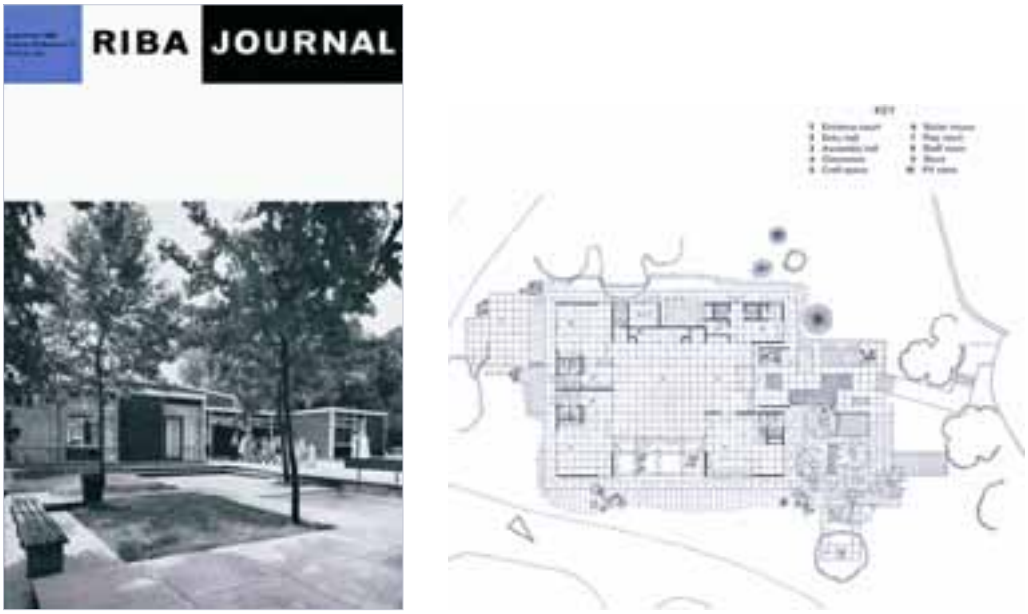


Fig. 36. The UK School at the Triennale
(Royal Institute of British Architects, 1960, cover, p.415)

Banham praises the CLASP School built at Milan for the Triennale in 1960, awarded with the Special Grand Prize by "the most sophisticated jury that judges any comparable even in Europe", as it proves that CLASP "it is mature enough to stand on its own feet" (Banham, 1962, p.349).

The UK School at the Triennale was also published in the *RIBA Journal* of 1960 (Fig. 36), depicting it as a "typical three-class primary school for about 100 children", by the architect Lacey, with a steel-frame and built with the CLASP prefabricated system of standard components (Royal Institute of British Architects, 1960, p.415).

Lacey would himself publish an article on the *RIBA Journal* of 1965 recalling the first Hertfordshire school of Cheshunt, that in retrospect, could have been predecessor of CLASP on their common intentions of: "(1) providing the buildings at the right time, (2) providing a stimulating and gracious environment, and (3) providing good value for money" (Lacey, 1965, p.298) (Fig. 37). He assumes that CLASP acknowledges the architect to arrange the components and define the design[229], providing that cost constrains are a "regulator" of that design and that the building construction is a means for achieving it[230].

[229] "The Consortia do not attempt to design buildings centrally; they provide the means, but the design of the individual buildings is still in the hands of the individual architects in the different offices." (p.303)

[230] "Economic factors of cost and man-power are accepted as regulators of design, with industrialized building methods as the contemporary means of providing the buildings at the right time." (p.304)

Cheshunt J.M.I. School, Hertfordshire. The first post-war Hertfordshire school. In retrospect the detailing appears coarse, but a direct line of development can be traced from this school to a wide field of industrialized building, including SEAC and CLASP.

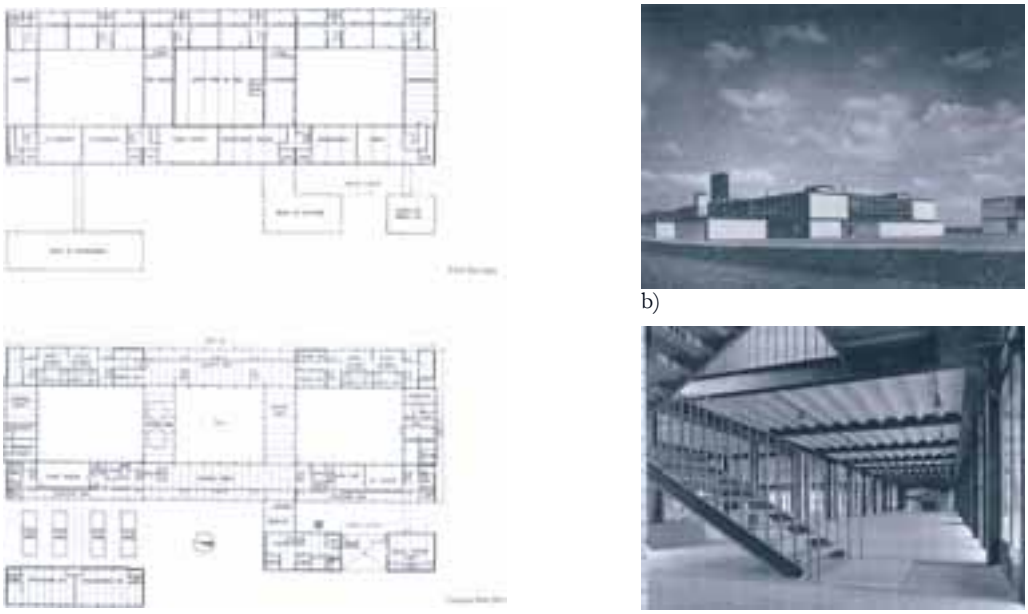
The entrance hall. One of the most significant features was the active use of colour to add enrichment and to emphasize the character of the spaces in the building

Fig. 37. "Cheshunt J. M. I. School, Hertfordshire"
(Lacey, 1965, p.298)

Lacey also addresses flexibility, when stating that CLASP holds a module of 3 feet 4 inches, smaller than the original 8 feet 3 inches used in Hertfordshire. This would enable a more flexible "planning arrangement" and a less visible expression of the structure. This continues to be developed even further on CLASP's Mark 4, with a "3 ft basis, but the spacing of internal partitions is on 1 ft grid and the arrangement of solid panels and window on the external wall has a 1ft flexibility". It is concluded that "to handle this greater flexibility competently will no doubt be more demanding, but in the hands of the skilful designer it should give new opportunities" (p.304).

Besides the public programmes, other schools were also conceived in more individual approaches to school design that also search for innovative spaces and solutions embedded in the contextual constraints of that time. The Hunstanton Secondary Modern School (Fig. 38) by Alison and Peter Smithson (1949-54) in Norfolk reveals that construction methods are being rethought by architects in a more authorial approach[231] and not only in the schools from the programmes mentioned. It was intended as a "three-stream mixed county modern secondary school for 450 children, with additional accommodation for primary and adult education" (The Architects' Journal, 1953, p.323).

[231] In 1953 the architects stated that this steel frame was "unique": "The system of construction is a result of our conception of the requirements of this particular school. It is therefore, unique to this school." (The Architects' Journal, 1953, p.325)



a) b) c)

Fig. 38. a) Hunstanton School, Norfolk, by Alison and Peter Smithson, 1949-1954, plans (Architects' Journal, 1953, p.324); b) "The school and separate gymnasium block from the north-west" (Architects' Journal, 1954, p.341); c) "Industrial finishes at Hunstanton: technology triumphant and celebrated, not subordinated to the priorities of teaching and learning." (Saint, 1987, p.185)

This school also demonstrates that schools' socialisation spaces for the students can be central in the design, as the assembly hall is the central space of the school near the dinning room and the internal courtyards in a compact plan.

On the report for the competition winning design (Hall, 1950) it is stated that from the 56 proposals "the majority of the competitors failed to show an understanding of the functions of a school, or contemporary school architecture, or failed to appreciate that, since the war, there has been an almost annual change in the planning and construction of school buildings" (p.486). Still, the winning proposal by Alison and Peter Smithson is considered to give "an outstanding contribution to school design" (*ibid.*). Superimposing the teaching spaces on the first floor is considered innovative. The internal courtyards conceived as open spaces are left to be appraised in the future. But another design option considered relevant is the alternative functions that the dinning room could enable:

> "In this scheme, use has been made of the dinning spaces for alternative purposes. The dining areas are extremely flexible and can be thrown into the Hall, or alternatively part divided by movable screens making additional teaching area overlooking the East Court." (Hall, 1950, p.488)

The duality that can be controversial in this school lies between the coldness of

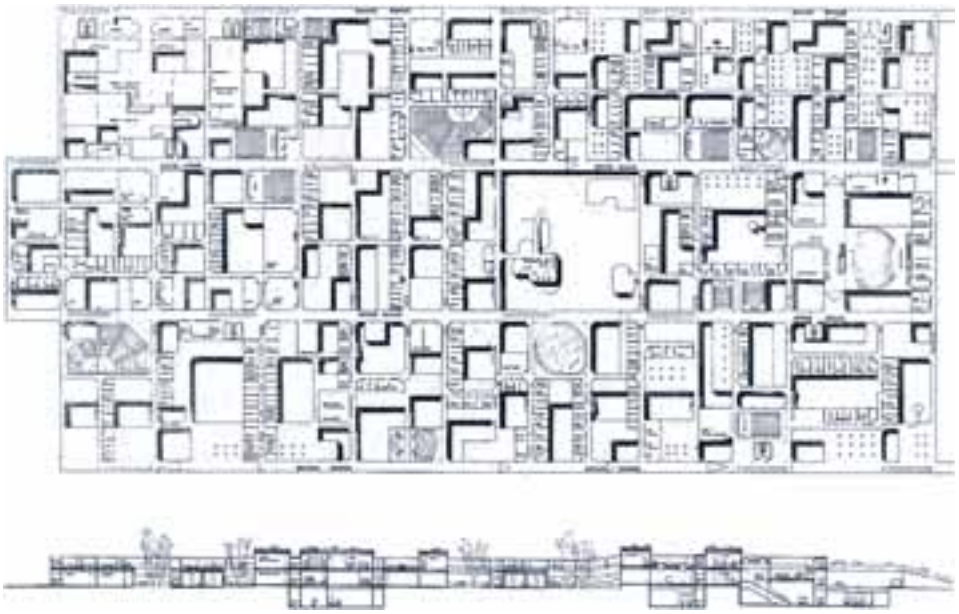


Fig. 39. Free University Berlin. Candilis, Josic and Woods, 1964
(Hertzberger, 1991, p.117)

the industrialisation and the rigor of the technique applied in a school that values spaces for gathering (Saint, 1987, pp.185-186), according to what would be Team X's inspiring principles. It was disputed whether "to define it as architecture at all" as closer to an "individualistic essay in the Miesian aesthetic" deployed from "soft" materials and perhaps disregarding the children that would occupy it (*ibid.*). To these architects have countered to have fulfilled both the educational and the design briefs in a "handsomer, cooler, stronger design than any other secondary school built since the war" (p.185).

The valorisation of the social and human dimension in the educational space is also evident in another project of other elements of the Team X: Candilis, Josic and Woods, whose project Free University Berlin (1963) (Fig. 39) displayed in a "single continuous structure functioning like a roofed academic agglomeration" would enable "a network of interrelationships and opportunities for communication", in which partial components could be added and subtracted according to those relations (Hertzberger, 1991, p.116).

This is been conceived as an "instrument" rather than a "monument", "for carrying out and developing multiform programmes that may also change over time" (Feld and Smithson, 1999, p.31). Peter Smithson, on the introductory text to the book *Free University, Berlin: Candilis, Josic, Woods, Schiedhelm*, claims for this building's consideration as "one of the few really innovative buildings of its period" (p.3).

. The debates on learning practices and educational spaces and the relevance of providing for the unforeseeable educational future

The 1960 Milan Triennale also held the *Educational Building Congress*, where it was decided to arrange a subsequent meeting in London. The *International Educational Building Conference* took place between 25th July and 2nd August, organised by the United Kingdom National Commission in association with UNESCO. The *RIBA Journal* announced the conference in June, presenting its goals:

> "One of the problems to be discussed at the conference is how best to share amongst the countries of the world the limited resources of professional, technical and administrative skills available for educational building. The conference will also be asked to consider the need for a permanent organisation for international collaboration in educational building" (Royal Institute of British Architects, 1962, p.208)

From this conference it was decided that four regional commissions would be set: Europe and North America; Africa; Latin America; Asia and Oceania. A fifth commission would focus on "international co-operation" hence, as Kretchmer (1962) sustained:

> "As a result of the conference, a clear pattern for world-wide co-operation in educational building emerges. It was agreed that an *international* centre should be created by UNESCO in close consultation with the International Union of Architects […]"[232] (Kretchmer, 1962, p.414).

In fact, this would be the basis for the future OECD's Programme on Educational Buildings (PEB) formed in 1972 (Alegre, 2009, p.76).

Sir Robert Matthew, who was then both the president of RIBA and the International Union of Architects, attended the conference and underlined the relevance of the English experience towards school building:

> "Our experience in Britain, where the successes in the field of social buildings have resulted from going back to first principles has had an important influence abroad. […] I am hopeful that the success of the London Conference on school building will lead to a similar world conference on housing, to be sponsored by the United Nations." (Matthew, 1962, p.407)

Accordingly, discussion on school design and its diverse possibilities was happening and the British achievements were paramount. In 1968, RIBA held a conference in

[232] Italics from the original quote.

Cambridge on *Building for education* (Royal Institute of British Architects, 1968). The Honorary Secretary of RIBA and Chief Architect of the Department of Education and Science, W. D. Lacey, reported the issues addressed in the conference as such: the search for design solutions that enable growth and change from both the organisation and the education methods were considered to have "high priority"; the school was valued as a centre for the entire neighbouring community and thus, the building should have "additional provision" to accommodate them; the school had urban representativeness and should be accounted for in urban planning; both administration and education should go hand in hand in the same pace of development, being reviewed to cope for each other's development; technical development should cope with functional requirements and users' needs aiming at a better school environment; higher and further education were amenable to growth and change to which the school building should account for; and it was also concluded that partnerships with professional sectors were implied to continue on with further developments in school buildings (Lacey, 1968, p.349).

These concerns demonstrate the changing models of thinking about educational practices and school spaces and the continuous search for newer ones, guided by the "changing relationships between teacher and taught, staff and student, the redefinition of teaching spaces as learning spaces, all having a dramatic effect on school planning" (*ibid.*).

Indeed, developments in educational methods demand new spatial and organisational structures that should convey social and community concerns, economic regards and accommodate the still unforeseeable changes that these developments might convey. Undeniably that accounting for change might imply future adaptability concerns, as well as the multi-purpose functionalities of a school for the provision for a whole community and the educational options that raised from distinctive possibilities, as the comprehensive school already established.

Flexibility is tackled, but it is closely associated with "dull monotonous spaces of uniform character", which relates it to pre-fabricated grids of uniform spans that convey also uniform interior layout, partitions and learning spaces. Adaptability is not spoken of, but the need for a space to provide "for the large group and for the individual" is specified as a "professional responsibility". After all the previous developments on school building and construction, Lacey states the need to "analyse a good deal more clearly what flexibility in use means before embarking on any new concepts" (*ibid.*).

Another contributor to this conference is Vaizey, Professor of Economics at Brunel University, confirming the "architectural implication of educational change" and proposing the built space to cope with the imminent change brought from this discussion, sustaining that:

> "[…] wherever possible the buildings should be easily changed from one use to another, and that only in the most extreme instances should any building be so designed that it can be used for one purpose and one purpose only." (Vaizey, 1968, p.352)

Vaizey addresses the changes also in the subjects taught, which can alter their representativeness in the curriculum and, ultimately, stop being lectured. These also carry administration and spatial changes and, in this regard, Vaizey argues for the direct need for flexibility:

> "The architectural implications of these changes in the curriculum seem again to point in the direction of flexibility and the need to face up to change." (Vaizey, 1968, p.353)

Technological advances such as "the computer-assisted learning" are here already stated as potentially enablers of future development in educational practices. Furthermore, it is also recognised the relevance of group work and "closely-monitored" pupils, parting with the traditional "system of classes" and asking for "flexibility" in space and for easy access to all learning situations:

> "If the individual child comes together with other children only when it is important for groups of children to be together because they have to learn to live and work as a group, or because it happens to be the easiest way to impart a particular kind of information, the emphasis within the school must be upon flexibility of lay-out. There will be a need for quite places for teachers to work with individuals or small groups of children, there will be needs for large places where big groups can congregate; the school needs to be organized in such a way that children can move quickly, easily and quietly from one bit of it to another […]" (Vaizey, 1968, pp.353-354)

Another contributor also takes this on at this the conference, focusing on 'The school building: an environment for learning' (Pearson, 1968). Pearson addresses "the role of the teacher" in what might be interpreted on new learning environments[233] that were starting to be depicted, and sustains the possible constrains a traditional school building might convey to the new relations between the school population and the learning situations where learning takes place:

> "If someone asked me what I considered to be the greatest change in education over the last 20 years it would be in the pattern of personal

[233] "We should see a school as designed around thousands of possible learning situations, outside the building as well as inside. School is a place where interests are roused and fed; it is the place from which great voyages of discovery about the works of man and the wonders of nature begin." (Pearson, 1968, p.372)

> relationships (pupils, teachers, parents, heads). But the physical limitations of walls and of institutional furnishings largely remain with us, and regrettably we still design too many classrooms which represent a pattern of human relationships now obsolete." (Pearson, 1968, p.372)

Also within this conference, Manning (1968) reflects upon the "needs, trends and design for the future" (p.377) and argues for the need to evaluate the British post-war school buildings of which "we in this country and this profession are very proud", but that are embedded "in such an aura of self-satisfaction that one feels it practically indecent to suggest that all is not quite as well as it might be" (p.376).

Manning praises the need to cater for the future: "not only today's [practices and needs] but what they might become tomorrow, and the day after", assuming that "neither education nor the use of buildings is static". Besides, Manning already tackles "formal *and* informal" [234] uses and sustains that buildings should accommodate them both "in as many ways as we can conceive". Thus, he argues for the need to identify if the buildings being built can actually accommodate them:

> "Our heritage of old schools, similarly designed to serve the educational practices of *their* day, have now to be adapted as well as is possible to the needs of contemporary educational practices. There is a great danger that contemporary school buildings will restrict tomorrow's educational practices more than yesterday's schools restrict today's practice."[235] (Manning, 1968, p.377)

At the end of this article, the American magazine *Progressive Architecture* is quoted by Manning for systematising the possible future "attitudes" of the profession. In fact, this magazine has specifically published an issue on change on the same year of this conference, guided by the assumption that change is a condition for the "school scene" (Progressive Architecture, 1968) (Fig. 40a):

> "The subtitle of this issue, "Change and More Change," indicates that the continuum of change is the key element in contemporary (and future) scholastic life. Just as in all other areas of human activity, closed-ended solutions in the field of education will not work if education is to be a viable activity of a dynamic man living in a dynamic society." (Progressive Architecture, 1968, editorial)

Change is dealt at several levels from the "technological tools" (pp.135-139) that were being developed (Fig. 40b), the "new spaces" (pp.143-144), the "changing role of the architect" (pp.157-158), the "learning environment evolution" (p.161)

[234] Italics from the original quote.

[235] Italics from the original quote.

a) b)

Fig. 40. a) *Progressive Architecture*, April 1968 (Progressive Architecture, 1968, cover, back cover); b) Technological tools (Progressive Architecture, 1968, p.137)

and the "school as a generator of urban form" (pp.162-164), besides many other issues that were being discussed and a profusion of examples of American school buildings.

Flexibility is also one of these pressing issues on the "school scene" as "the central factor emerging on school design". But it is here tackled as more than the "movable partition", instead it is suggested "a total flexibility encompassing the school building and the learning process itself" (p.154). Moreover, the provision of internal flexibility can be overlooked if the building as a whole does not cope with the superimposed flexible solutions. It could be argued that the magazine is suggesting a broader assumption of flexibility that surpasses the interior layout, towards the whole building and deployed of physical small-scale transformations, which can be regarded as adaptability, even though this is not stated[236]. This is supported by the suggestion of what the publication entitles as "extreme flexibility" on "structure, space enclosures, finishes, mechanical and electrical" and "restraint in the design", establishing that a "simplified design can more easily meet the needs of change" (*ibid.*).

Hence, in 1968 the debate on schools was transversal in England and the United States. In 1969 Giancarlo de Carlo (1969)[237] writes to the *Harvard Educational Review*, the article *Why/How to Build School Buildings,* raising four paramount questions on school spaces and proving a critical thinking on their answers:

[236] The concept of adaptability and the difference between adaptability and flexibility have been previously studied in chapter 2.1. Adaptability: definition and adjacent concepts.

[237] Originally published in the *Harvard Educational Review, Vol. 39, No. 4*, 1969 and consulted in the reprint edition included in: Coates, G. (Ed.) (1974). *Alternative learning environments*. (pp.96-108). Stroudsburg, Pa: Dowden, Hutchinson & Ross.

> "W1. The first question: "Is it really necessary for contemporary society that educational activity be organized in a stable and codified institution?"
> W2. The second question: "Must educational activity take place in buildings designed especially for that purpose?"
> W3. The third question: "Is there a direct and reciprocal relationship between educational activity and the quality of the buildings in which it goes on?"
> W4. The fourth question: "Must the planning and construction of buildings for educational activity be entrusted to specialists?"" (de Carlo, 1969, p.96)

The answer to the first question concerning the need of the school as an institution is significantly influenced by the students' protests of 1968 by demonstrating a disbelief in the school[238]. De Carlo adds that "the least suitable place in which to carry out educational activity is the school building, because encapsulating teaching and learning in a unitary, isolated, and closed off space, it tends to cut off contacts with the complex content of society." (p.104). Furthermore, he suggests: "In this prospective we can imagine the school as a double network – laid out in the environmental context – of places in which multiple activities go on, including education, and places in which the more specific instruments of educational activity necessary for the finding, elaboration, and transmission of knowledge are concentrated." (p.104). And, thus, de Carlo argues for the "non-place school, disaggregated and dispersed" (p.105), which inherently questions the space and the building.

Moreover, de Carlo argues for "new comprehensive structures" that should be regarded on the school building. The diverse programmes within the school are suggested to be more interconnected, gathering diverse activities in a holistic space for learning. These spaces can either be open to the external community or be shared with this community but located elsewhere (p.106).

For answering the second question on the need for a specific building for learning, de Carlo sustains that even though buildings are needed, they represent only a "part", the other part is brought by the experience and thus, occurs beyond the school building.

The third question proposed for discussion concerns the possible association of the learning activities to the buildings' quality. This holds particular relevance because de Carlo argues for the evolving nature of the buildings according to its environmental surroundings, which disregards fixed settled forms and suggests the

[238] "With the student revolt, education has returned to the city and to the streets and has, thus, found a field of rich and diversified experience which is much more formative than that offered by the old school system. Perhaps we are headed toward an era in which education and total experience will again coincide, in which school as an established and codified institution no longer has any reason for existence." (p.98)

need for "unstable configuration continually re-created" for the still unforeseen future[239](p.102).

This statement also puts forward the following answer to question four, on the demand for the specialists. De Carlo goes against the strong institutional space, its fixedness in aesthetic intentions rather than its engagement with time and use[240] (p.103). The higher entropy within space would mean the accommodation of a broader and fuller experience and not limited to a sole "connotation" or "event":

> "The institutional objective pursued – and worse, rarely reached because of a recurring technical imperfection – is the least possible entropy, which means the minimum quantity of connotations necessary to designate the event, the contrary of what happens in every spatial situation endowed with universal meanings and, therefore, rich in signs accumulated and stratified, in time, through a continual involvement with society." (de Carlo, 1969, p.103)

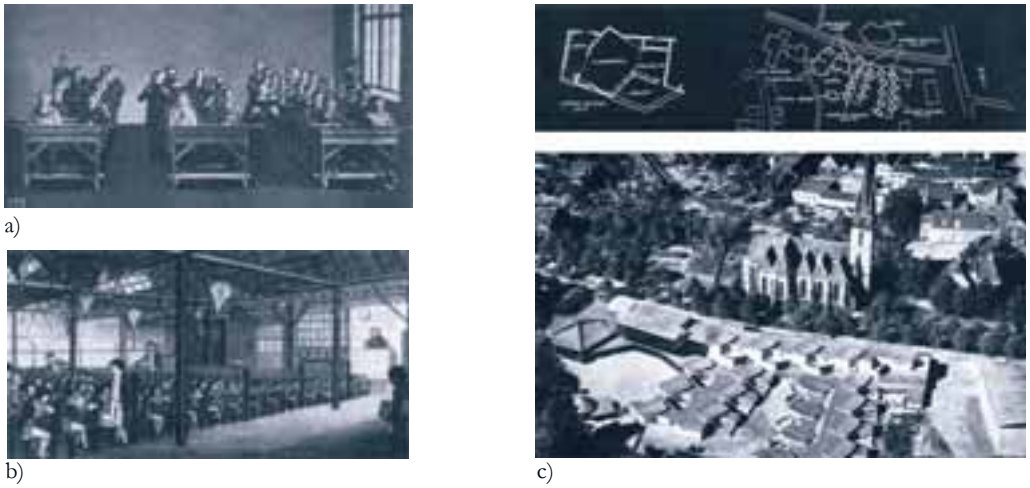
Consequently, de Carlo makes the final remarks, considering that the design of schools can no longer be bounded and strict, enabling an "intense education" by "multiple active experiences". Thus, the design is no longer finished by the architect, but "continually readjusted by those who appropriate it (the students, the teachers, the people who use it for other things as well" (p.107). This is central for assuming the school as a lived space that comprises various activities facilitated by space and not bounded by it.

The considerations taken on by de Carlo, are embedded in the questioning of the school and its spatial environment as previous contributions have already shown, such as the 1968 Conference or periodical publications like *Progressive Architecture* regarding change, also from the same year. Change is acknowledged and discussed, on the activities the school space may accommodate but also on their possible unforeseeable variances:

> "The job of the architect who designs a school is to outline the organizational structure which should realize educational activities in space, whatever the complexity and the degree of contamination with other activities which they may take on with time. The

[239] "The school should not be an island but part of the physical context, or more precisely, the physical context as a whole, conceived as a function of the requirements of education. It should not be a closed apparatus but a structure spread out in the network of social activities, capable of articulating itself to their continual variations. It should not be an object represented according to the rules of an aprioristic aesthetic code, but an unstable configuration continually re-created by the direct participation of the collectively that uses it, introducing into it the disorder of its unforeseeable expressions." (p.102)

[240] "[…] the physical forms shape themselves as finished, inflexible representations, presumed to be that much nearer to aesthetic perfection the less space they leave for the accidental character of time and use." (p.103)



a)

b)

c)

Fig. 41. a) Simultaneous teaching. Class (Alegre, 2009, p.28)
b) Mutual teaching (Lancaster method). Classroom, 1811 (Alegre, 2009, p.28)
c) Geschwister-Scholl-Schule (Lünen, 1956-62) by Scharoun (Architectural Forum, 1961, p.107)

> organizational structure will contain within itself the seeds of the formal configuration to which it will give rise or the basic ingredients of which it will be composed, or completely defined fragments around which its future development will evolve according to the circumstances, the intentions, and the reactivity of the situation in which one is working. The most important thing is that structure and form leave the greatest possible space for future evolution, because the real and most important designer of the school should be the collectively which uses it." (de Carlo, 1969, p.107)

These thoughts and the eager for searching new solutions for them, along with experience in new constructions methods that had been occurring, enhance the discussion on the school building, its layout, its means to achieve it and the students' engagement and relevance for designing space to house them anew.

Beyond previous past experiences such as the conventional classrooms of the "simultaneous teaching" (Fig. 41a) system where students are lined in rows facing the educator, or Lancaster's large classroom for the "mutual teaching" system where students are taught all together with the aid of monitors (Fig. 41b), the search for new learning environments continues to be pursued (In_Learning, 2010; Alegre, 2009, p.26-35).

Thus, the classrooms as the "basic unit of the school building"[241] were being rethought for: their configuration, surpassing the traditional rectangle and experimented in

[241] Free translation of the original Portuguese title: "A sala de aula como unidade base do edifício escolar e a evolução do edifício escolar". For further reading see Alegre (2009, pp.81-92)

octagons or hexagons (such as attempted by Scharoun); the environmental features that enable physical comfort; the openness to adjoin external spaces providing air and light; and also in their functionality for allocating simultaneous learning activities portrayed by different sets of pupils in a more enriching and flexible space for a broader learning experience (Alegre, 2009, pp.81-92).

The search for classrooms that responded to pedagogical changes and that accommodated a variety of activities within was particularly evident in the Munkegaard School (Soborg, 1949-57) by Jacobsen; in Geschwister-Scholl-Schule (Lünen, 1956-62), Darmstadt (1951) and Marl (1960-71) by Scharoun. In Lünen, Scharoun attempts to materialise his *Klassenwohnung* or classroom-dwelling idea, embedding in the classroom the feeling of a home. The "upper-school unit" is encompassed with the neighbouring spaces for "coats" and "projects" and a "court" for groups of pupils, enabling a flexible arrangement of the groups while undertaking different sets of activities, both in the classroom and in the surrounding spaces (Architectural Forum, 1961, p.107; Alegre, 2009, pp.135-136) (Fig. 41c).

Hertzberger (2008) sustains that Scharoun is an architect that "applied himself to space for learning with dedication and conviction", intending to materialise his educational prospects of introducing the individuals into the society in his schools, even if his "open floor plans of an almost nest-like structure" did not reveal further expansions (pp.157-159).

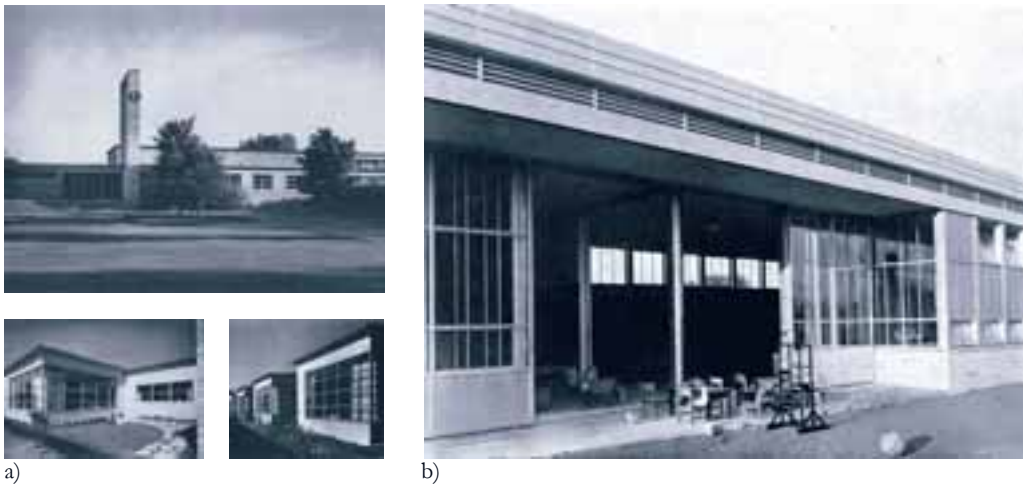
Previously, in the US the Crow Island School in Winnetka, by Eliel and Eero Saarinen with Perkins, Wheeler and Will (1939-40), already displayed L-shaped classrooms with individual gardens gathered along a pinwheel plan, raising awareness for subsequent schools (Ogata, 2008, p.566) (Fig. 42a).

In addition, Neutra's (1935) article *New Elementary Schools for America*[242] or his Corona Avenue Elementary School (1934-35) also represented the search for new learning spaces. Neutra argues for the review of the cell of the classroom as a central issue, also integrated whiting the whole (Neutra, 1935, p.49). He also mentions his the studies on an "active school" commissioned for Los Angeles (p.53) and the environmental comfort of the classrooms that also suggests the outside space[243], in what could be argued as a closer approach to the open-air schools (Fig. 42b).

Afterwards, in a specific manner, post-war schools focused on the flexibility of the classroom for distinctive learning allocations, also prolonging it to the communal places shared by all and onto the overall scheme of the school throughout the day.

[242] See Neutra, R. (1935). Nouvelles écoles élémentaires pour l'Amérique. *L'Architecture d'Aujourd'hui, 7eme année, n.º 5, Mai 1936,* 49-55. Originally published in Neutra, R. (1935). New Elementary Schools for America. *Architectural Forum*, *January 1935*, 24-35.

[243] From the original French quote: "L'éducation strictement confinée à « l'intérieur » sera réduite au minimum." (p.55)



a) b)

Fig. 42. a) Crow Island School, Winnetka, 1939-40, Eliel and Eero Saarinen, with Perkins, Wheeler and Will (Architectural Forum, 1955, pp.130, 131, 132)
b) Class of a primary school, Neutra, 1934-35 (for small children) (Neutra, 1935, p.51)

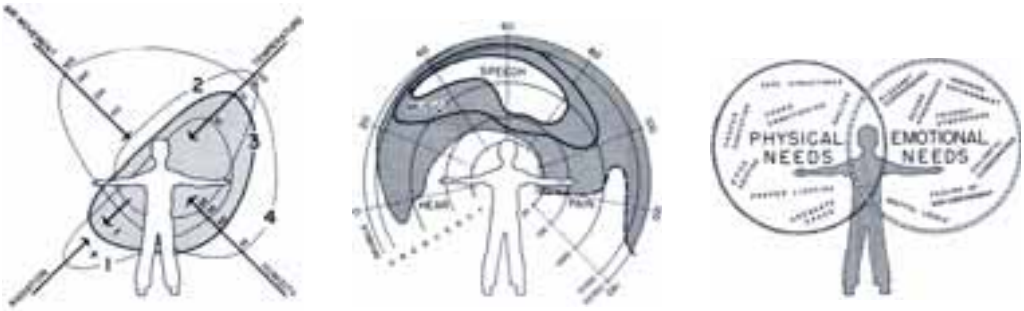
This was often pursued either by physical transformation of the interior partitioning by "flexibility", or by the possibility of accommodating several activities for a "polyvalent space use" (Alegre, 2009. pp.91-92).

Indeed, besides the use of industrialised solutions for cost-effectiveness and rapid processes, post-war school construction went along with flexibility, considered not only on the interior units, but regarding the structure understood in the whole scheme:

> "The desire for "flexibility," a key term of postwar building, enhanced the popularity of new materials and finger or cluster plans for school plants. "Flexibility" was both a desirable quality for the structural aspects of the building, embodied in open corridors, non-load-bearing partitions, and zoned ventilation and heating systems, but it also included the provision of folding walls for small groups, moveable cabinets, and lightweight furniture deemed vital to new methods of instruction." (Ogata, 2008, p.568)

"Low-rise schools" with "continuous fenestration" were sought when recalling the perils of the war that claimed for easy evacuation but also for the desire of future growth, stairs were perceived as "hazardous and unnecessarily expensive" and the steel industry also endorsed this solution as "cost-effective, rapidly built, and flexible" (*ibid.*).

In the American scene, Kumpf in 1952 already tackled *The adaptable school*, assuming that the "newly emerging needs" (Kumpf, 1952, p.4) were greater than ever and arguing that:



a) b) c)

Fig. 43. a) "Air and the pupil" ; b) "Sound and the pupil"; c) "School planning starts and ends with the pupil. Every factor must relate in some way or other to the school child. […] We want schools that serve the needs of our youngster - emotional needs as well as physical needs"

(Caudill, 1954, pp.2, 6, 7)

> "Educators today are faced with a challenge to their educational procedures which transcends that of any previous period in educational history" (Kumpf, 1952, p.3).

Thus, if the learning processes were changing, then adaptability[244] was considered to cope with that change by matching the new learning processes and the new needs:

> "Only adaptability can serve as the test of modern education in a world in which the only thing of which we can be certain is change. A prime cause of stagnation and sluggish adjustment of educational practices in the past has been the static nature of the criteria by which the adequacy of these practices was judged. Now, through the application of the criterion of adaptability, a dynamic instrument is available that places no limitations on progress." (Kumpf, 1952, p.4)

Schools were already considered under the scope of heath, civic, leisure and creative requirements. Therefore, an adaptable school was perceived as a school that could accommodate the change on all these dimensions and was "capable of continued modification to keep pace with the changing needs and concerns of children as brought about by world and local developments" (p.6).

Two years after this book and also focusing on the American reality, Caudill (1954), who had also praised the Crow Island School innovative solution, publishes *Toward better school design*, also assuming the "progress in educational architecture" as

[244] "[…] adaptability means the discarding of outworn practices and the adoption and invention of newer practices to meet newly emerging needs" (p.4).

Fig. 44. "Formality vs. Informality"
(Caudill, 1954, pp.22-23)

"tremendous" (p.iii). The introduction written by Neutra also states the relevance of rethinking the school as it "stems from the community and again powerfully feeds back into it" (Neutra, 1954, p.xi), establishing that:

> "If there is *any* place or occasion where the need for planning and its urgency cannot be doubted, it is in matters of a school system or a schoolhouse."[245] (Neutra, 1954, p.xi)

Caudill's comprehensive approach to schools and the contemporaneity of the issues raised is significant. He addresses the prominent subjects for schools such as: light, air (Fig. 43a), sound (Fig. 43b), time, atmosphere, scale, colour and texture, comfort and security, towards the pupils' physical and emotional well-being (Caudill, 1954, pp.1-20) (Fig. 43c).

Then, Caudill revolves around education, discussing "the aims of education of today's elementary and secondary schools from those of yesterday's schools" (p.21). Formality and informality are already discussed, pondering that informal learning was achieved by reciprocal communication from the student to the educator and also amongst students (Fig. 44). This implied that the classroom might hold group work besides seminar and content provision from the teacher: "The formal and directional type of classroom must give way to the informal, non-directional type." (p.23). It also implies rethinking the "classrooms arrangements" beyond the formal setting (p.29) (Fig. 45).

These thoughts also involve "flexibility", considering that buildings should accommodate "inevitable educational changes" and that these might still be

[245] Italics from the original quote.

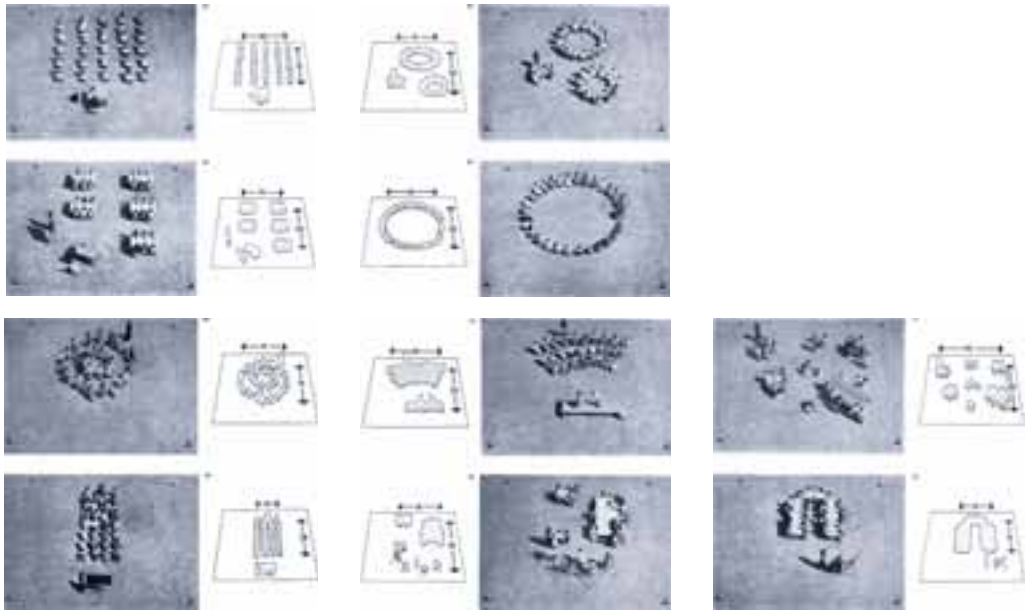


Fig. 45. "The following series of photographs, posed by an actual elementary class, demonstrates the space requirements of typical classroom activities"

(Caudill, 1954, pp.30-34)

unknown[246] (p.36). Flexibility is developed further on the book, where it is detached between "four qualities of space - fluidity, versatility, convertibility, and expansibility" (p.139) Caudill assumes to have claimed for flexibility and "made it the most common word in our planning nomenclature", but also recognised the prevailing difficulty of building for flexibility (*ibid.*). Nevertheless, Caudill considered it to be a central issue for future practice and recurrent to the previous four possibilities:

> "It is reasonable to expect that we shall in future years see schools based on the open plan which will afford a free flow of space in the general teaching areas. The architects, educational consultants, and school administrators who plan these schools will talk more about fluidity, versatility, convertibility, and expansibility of space and the ways to achieve these desired characteristics of a good school plant, and talk less about concrete block versus plaster partitions. The planners of these flexible schools will be space architects, not room layout draftsmen. They will put new emphasis upon volume instead of mass; they will work with space as their medium: they will think in three dimensional space instead of two. And flexibility will be the keynote of their architecture. (Caudill, 1954, p.140)

[246] "[…] since the function of any building changes from year to year, each should be designed to allow changes to be made efficiently and economically without marring the beauty or distorting the truth of expression." (p.37)

a)

b)

Fig. 46. a) "Perkins and Will, Heathcote School, plan" (Ogata, 2008, p.573); b) "Flexible school made up of classroom clusters, 1954. The Architects Collaborative" (Royal Institute of British Architects, 1956, p.231)

Furthermore, the cluster plan at this time also recalled for "flexibility, domesticity, and economy" (Ogata, 2008, p.572). Groups of classes arranged together in clusters determined a new learning experience from the school, opening the spaces to each other and focusing on group activities within a central core[247]. This was the case of Heathcote Elementary School by Perkins and Will, from 1953 in Scarsdale (Fig. 46a).

In 1954 Gropius's established firm The Architects Collaborative (TAC) conceives a school prototype that the RIBA considers to be "flexible" (Royal Institute of British Architects, 1956, p.231) (Fig. 46b). Its scheme was based on a "syncopated grid of square classrooms created intimate gardens and "outdoor classrooms" that were interspersed throughout the school grounds" which could accommodate future expansion. In this grid sets of four classrooms were assembled around a core. Internally spaces had "moveable self-contained spaces" that also comprised flexibility considerations (Ogata, 2008, p.575).

In the same year Gropius writes *Eight Steps Toward a Solid Architecture* where flexibility was suggested as one of these steps[248], disregarding "Preconceived ideas of form, whether the outcome of personal whims or fashionable styles, tend to force the stream of life in a building into rigid channels and to hamper the natural activities

[247] "In organization and details, the prominent cluster schools of the early and mid-1950s reflected a new sensitivity to the child's perception." (Ogata, 2008, p.572)

[248] "2. Design buildings to accommodate the flexible, dynamic features of modern life – not to serve as monuments to the designer's genius " (Gropius, 1954, p.177)

of the people for whom the buildings were built." Gropius claims for buildings as "receptacles for the flow of life which they have to serve" and that were "fit to absorb the dynamic features of our modern life" (Gropius, 1954, p.177).

The search for flexibility was also associated with the interior design of the classrooms and its layout that accommodates several activities as considered at the time and no longer centred only on the educator:

> "Just as "flexibility" became the byword among school architects and planners, the flexible classroom was promoted as a fundamental aspect of modern school design and modern pedagogy." (Ogata, 2008, p.579)

In 1950 Cocking and Mercner provide a clear definition of flexibility and adaptability, also considering the "multiple use" of shared areas of the school to be beneficial:

> "Flexibility is the ability to alter the size of a room, and adaptability is its ability to change with social and educational changes." (Cocking and Mercner, 1950, p.56).

Another attempt to research for different learning spaces were the open-plan schools, built since the 1950s in the US, deployed of separate classrooms and congregating groups of students in large spaces (Fig. 47). Despite the possibilities that the co-existence of the students socially enabled, these spaces did not have the specificities needed for the classrooms, the privacy required for each group to work, or the smaller individual features to engage the groups.

In the 1960s school construction projects were being undertaken and in the United States of America, the School Construction Systems Development, developed by Ezra Ehrenkrantz for the Educational Facilities Laboratories[249], intended to test a modular system for rapid and cost-effective school construction, grounded on the Hertfordshire previous experience (Ogata, 2008, p.582). These schools had only one floor and had the technical devices for ventilation and artificial lighting arranged on the roof, in order to accommodate different groups and activities and to create different environments (Kühn, 2011, p.22). Besides rapid and cost-effective construction these schools also acknowledged future change and so, their spans could be divided into smaller spaces without uniformity constraints (Ogata, 2008, p.582). This would guide the open school conception of both "long spans and systems of low or demountable walls for internal flexibility" (p.583).

However, the discomfort caused by the artificially lit interior, as well as the community's inability to use these schools, especially their lack of engagement in

[249] "In the 1960s and 1970s, Educational Facilities Laboratories, a non-profit corporation funded by the Ford Foundation's Fund for the Advancement of Education, brought together educators, architects, manufacturers, and government officials responsible for school building to encourage new ideas about both curriculum and architecture." (Ogata, 2008, p.581)

Fig. 47. "An open-plan school in the United States"
(Manning, 1968, p.378)

the process, prevented the flexibility project from materialising into appropriation and living:

> "But floor plan layouts are just one aspect of innovation: as in other areas, this has to be distinguished from idea and innovation. Both of these are but two stages in a wider process that includes a change in attitude on behalf of many stakeholders." (Kühn, 2011, p.22)

In 1968, a report for the Educational Facilities Laboratories is published on *Educational Change and Architectural Consequences* that already assumes the "unprecedented phase of questioning, changing, and experimenting" (Gross and Murphy, 1968, p.15) that education was traversing and suggests a school design guided by "the spirit of change", encompassing "flexibility, variety, variability, pedagogical receptiveness – above all, a quality of openness both human and architectural". After depicting learning situations that were already valued at the time, such as "independent study", "dialogue" or "small-group discussion", the report presents possible designs of schools, not as a panacea, but as a systematisation of the "best current ideas on environments for learning" they consider to answer the "educational problems" (p.40).

At the same time other programs were also being developed elsewhere. The Swedish SAMSKAP program, set up in 1962, consisted of cooperation between architects and educators for school construction in the Malmö region, as an example of the possibility of dialogue and the conception of multi-purpose space. Furthermore, the Canadian Study of Educational Facilites (SEF) of 1966 developed a school building system for Toronto schools with maximum flexibility and minimum costs. Other programs are also closely related to industrialisation and rapid construction such as: Finsplan (Denmark), Coignet and Ballot (France) - based on concrete

structures; Feal (Italy) and Crocs (Switzerland) - based on metallic structures (Oddie, 1975). Moreover, the CLASP came to be applied in Portugal, in schools such as the Laranjeiro Secondary School (1974).

Specifically, in Portugal[250], the schools were being widely developed by the OECD Mediterranean Region Project, directed by Oddie, under the scope of the DEEB (Development and Economy in Educational Building), which also involved Spain, Greece, Italy, Turkey and the former Yugoslavia, from 1960 to 1975. This sought to meet the professional qualification needs of these countries as a form of investment on their development (Martinho and Silva, 2008; Blyth, 2011, p.13; Heitor, 2001a).

This suggested that Portugal should expand "post-primary" teaching and also the use of cost-effective and prompt solutions for school building. Thus, between 1964 and 1966, a work group is established to rethink Portuguese "strategies, architectural typologies and regulations"[251] for school building (Heitor, 2014, p.503). This work group proposed pre-fabricated and modular elements in standard projects and traditional construction methods, using a pavilion layout, which could be set in different site locations. The classrooms encompassed heating, light and sound requirements and comprised "a square layout and the increase in area, enabling higher flexibility of use"[252] (p.504).

From this, the 'Pilot Project. Primary School'[253] for 160 students was located in Mem Martins School and was built in 1966 (Fig. 48a), directed by the architect Maria do Carmo Matos[254]. This already showed environmental and comfort concerns and emphasised the concept of flexible work areas, through the spatial design based on a polyvalent central patio with four hinged square classrooms in groups of two with supportive areas and which resorted to easy to use furniture and storage, enabling students' work either individually or in groups (Martinho and Silva, 2008; Heitor, 2011a; Heitor, 2014).

The Mem Martins School and the parallel research developed at this time served as the basis for the subsequent school architecture produced in Portugal. The open area primary schools in Loures, Moita and Abrantes, had a common use space between groups of three square classrooms and used movable furniture instead of partition walls that enable the establishment of diverse spaces according to the learning activities. These can be considered to hold the principles of flexibility of the schools

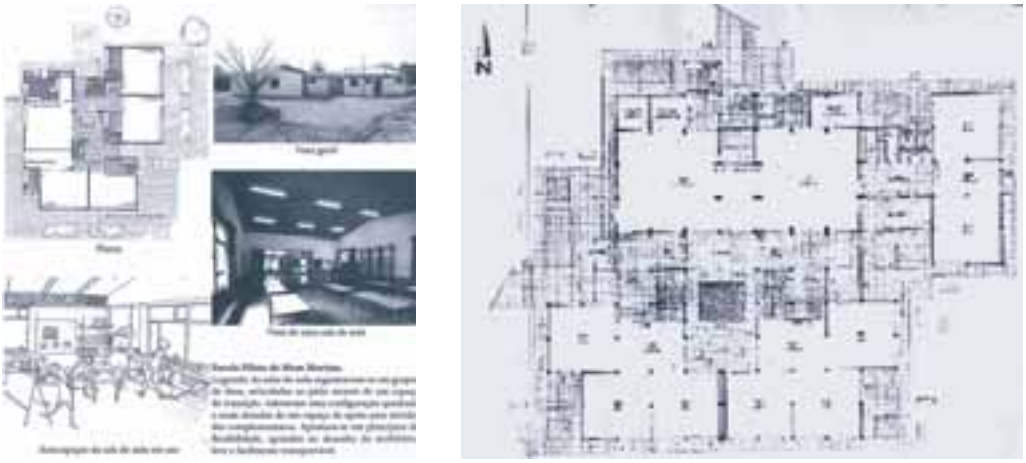
[250] For further reading on Portuguese school building, namely on the *liceu* building, see Moniz (2007) and Alegre (2009).

[251] Free translation of the original quote in Portuguese: "[...] a definição de estratégias, tipologias arquitetónicas e normativos para a construção de edifícios escolares em Portugal" (Heitor, 2014, p.503)

[252] Free translation of the original quote in Portuguese: "[...] experimentando a forma quadrada e o aumento de área, permitindo maior flexibilidade no uso." (p.504)

[253] The second pilot project to be located in Mafra and coordinated by Augusto Brandão was not built (Heitor, 2011a).

[254] Maria do Carmo Matos has done an internship on the Development Group in 1966, hence being influenced by the English post-war school building (Alegre, 2009, p.274).



a) b)

Fig. 48. a) Mem Martins School, 1966 (Heitor, 2014, p.507. From: Mistério da Educação e Ciência, Secretaria Geral, Direção de Serviços de Documentação e Arquivo); b) "Plans of the first "P3" school built in Quarteira and inaugurated in 1974 (Martinho and Silva, 2008, p.5)

designated as P3 in 1970, within the Standardized Project of Primary Schools[255] for simple, cost-effective and easy maintenance school solutions (Heitor, 2011a).

The P3 schools, built transversally in the all country[256], also showed flexibility criteria, allowing the change of uses without entailing changes in the built space. These had two overriding objectives: a pedagogical objective – in order to allow various activities of individual and collective learning; and a constructive objective – the use of modules and little variation of constructive elements, holding as a reference the English post-war project for pre-fabrication. The P3 schools aimed at being easily expandable and adaptable to the changes in the number of students. Its spatial core allowed variations in size and its modular construction enabled the compression or expansion of the school, resulting in a great variability of the scheme. These also resorted to a spatial arrangement that endorsed the congregation of diverse learning activities on the whole building (Heitor, 2011a).

The first P3 school was from 1974 and was located in Quarteira (Fig. 48b). It had adjoint classrooms gathered together with shared supportive spaces and displayed around a central courtyard for several activities (Gonçalves, 2011, p.135). The basic layout for the P3 schools was conceived with a higher central area and its respective supportive spaces closely connected with the classrooms. This held several diverse activities from meetings and even external gatherings, to leisure, gym and eating, which was also considered a learning space for a larger group (p.138). The project

[255] From the Portuguese "Projecto Normalizado de Escolas Primárias".

[256] In 1985 there were already 371 P3 schools in Portugal (Martinho and Silva, 2008).

was conceived with "core spaces and connective modules"[257] that enabled a variety of final solutions and also acknowledged the possibility of future expansion (p.136). The classroom spaces could be partitioned by means of furniture, for a more individualised learning (p.137).

Nonetheless, due to the difficulties of teaching in an innovative space, namely by its openness, the need for new habits and routines and a lack of engagement of the community, compelled people to be resistant to appropriate these spaces and to teach within them, hindering the learning process envisaged for these spaces:

> "Soon walls were built inside the nuclei and the open space areas were successively closed. The pedagogical practices did not change with the architecture, and some teachers transformed the open plan design into traditional classrooms where they could teach more comfortably." (Martinho and Silva, 2008, p.6)

From the 1970s and strongly pursued in the 1980s, the urge for rapid and cost-effective school building led to the construction of schools using a scattered pavilion layout and industrialised construction methods in simple schemes, also resorting to systems such as CLASP. This implied the decrease in circulation areas and non-curricular spaces and, hence, the increase in the "functional flexibility" of the conceived ones, aiming at an "intensive use of all school spaces", resorting to separate standard building blocks. The so-called *3x3* standard-project was widely used in secondary schools. It used the square classroom of 50m^2 as the basis for the all scheme, contiguous to a central core with the vertical circulation and resembling a cubic volume of 21,60 x 21,60m with a span of 7,20m, with varying height (Fig.49). Over time, during the 1980s, this model was developed towards a more "compact" solution from 1988, which aggregated the 3x3 blocks (Heitor, 2014, pp.513-514; Heitor and Alegre[258], 2010, pp.143-144).

Between 1978-88 the concept of "families of solutions" was tested by a team from the General Directorate of School Buildings[259], coordinated by Jorge Gouveia, Jorge Farelo Pinto and Teresa Santos Silva, which allowed greater freedom for gathering the programs, depending on their location, resulting in a broader range of typological solutions, also and similarly to the 3x3 blocks, through the use of a modular structure of 3,60 x 3,60m, equal to either curricular and collective spaces. This concept is materialised in schools such as in Torres Vedras's: Madeira Torres Basic Secondary School and Padre Francisco Soares Basic School[260] (Heitor and Alegre, 2010, pp.145-146; Heitor, 2014, p.516).

[257] Free translation from the Portuguese: "núcleos e módulos de ligação" (p.136).

[258] This publication is coordinated of Teresa Heitor and its text is by Alexandra Alegre.

[259] From the Portuguese 'Direcção Geral das Construções Escolares', the entity for school building construction then.

[260] Original Portuguese names of these mentioned schools: Escola Secundária de Madeira Torres, Escola Básica 2,3 de Padre Francisco Soares.

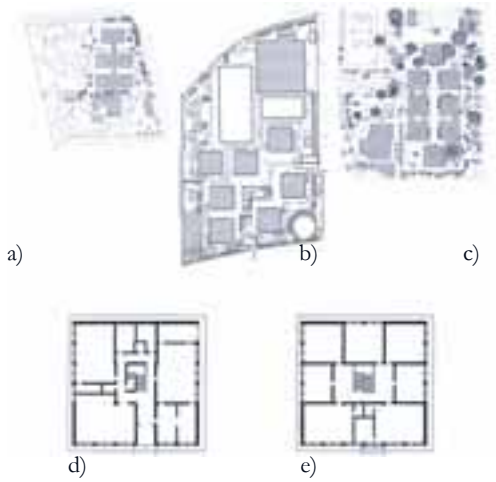


Fig. 49. "3x3 Project: different site locations": a) José Saramago Secondary School, Mafra; b) Dr. António Carvalho Figueiredo Secondary School, Loures; c) Ponte de Sôr Secondary School, Ponte de Sôr; d) Plan of the standard-block – ground floor; e) Plan of the standard -block – upper floors (Heitor, 2014, p.515)

. Making way for multi-option, lived and adaptable schools

Following the DEEB at the international level, the Programme on Educational Building (PEB), precursor of the current Centre for Effective Learning Environments (CELE), began working in 1972, for "improving the quality, speed and cost-effectiveness of school construction" (Blyth, 2011, p.13). These requirements were also associated with the changing pedagogical practices and curriculum profiles that claimed for innovative spatial solution consistent with these changes (*ibid.*):

> "Accommodation no longer consists of uniform classrooms, each equipped with thirty desks, a teacher's chair and a blackboard. Standard classrooms give way to a great variety of space. There are still areas for formal instruction, lectures or demonstrations, but these are replaced in part by: space for work in small groups, for discussions, for seminars, space for independent study and investigation […]" (OCDE, 1973, *apud* Blyth, 2011, p.14)

Attention has also been given to ways of rationalising the school space (OECD, 1976; Ader, 1975a, 1975b; Oddie, 1966; Oddie, 1975), in order to serve the community more comprehensively and extensively. At this time, adaptability was much related to industrialisation and went along with the easiness in shifting spaces and, hence, the effectiveness of long-time investment by spatial efficiency (Oddie, 1966) and industrial production (Oddie, 1975[261]).

[261] See: Oddie, G. (1966). *L'utilisation efficace des ressources pour la construction scolaire: options et techniques*. Paris: Organisation de Cooperation et de Developpement Economiques.

It is interesting to focus in the following quote from 1966, which already assumed a potential pedagogical development related to "innovation, development and research" regarding the future developments brought along by "educational needs":

> "It is clear that effective use of resources will only be possible through innovation in all aspects of school building. This is particularly evident when education is to be radically reformed. Thus the current trend towards diversified education provided in the same school requires profound innovations, both in terms of the quantitative balance and the character of the school premises."[262] (Oddie, 1966, p.147)

In another sense, adaptability is also related to the response for a "multi-option school" (Ader, 1975a). The multi-option school specifically "offers all pupils a common education" and "offers each pupil the possibility of choosing from a wide range of activities" (p.6). In the 1975 publication on this behalf, under the scope of PEB, it is analysed and reflected upon the spatial implications of this school, but not for commending or imposing solutions, because this school's intricacy may not be fully fulfilled by a model (pp.5-6).

Planning the school for sheltering the activities brings difficulties when matching them to spaces, and it is suggested to accommodate them in "sets of facilities". Nevertheless, difficulties are pointed out regarding the compatibility between activities and "sets of facilities"; the divergence between spatial specialisation and polyvalence; and the internal organisation and relation between separate spaces (p.7).

Also in this same publication from 1975, space and learning, or "the layout" and "the type of education provided in it" are assumed to be in a dyadic relation, which is considered to "had long been neglected"[263]. Hence, the innovative multi-option school entails to think about the school space afresh, comprising the present and the future evolution of the space and of the programme, overlooking previous learning routines and corresponding spatial conceptions (p.11). The school of

Oddie, G. (1975). *L'école et la construction industrialisé*. Paris: Organisation de Cooperation et de Developpement Economiques. Programme sur la construction scolaire.

[262] Free translation to English of the French quote: "Il est manifeste qu'une utilisation efficace des ressources ne sera possible qu'au prix d'innovations dans tous les aspects de la construction scolaire. Ceci est particulièrement évident lorsque l'enseignement doit faire l'objet d'une reforme radicale. C'est ainsi que la tendance actuelle en faveur d'un enseignement diversifié dispensé dans une même école exige de profondes innovations, tant en ce qui concerne l'équilibre quantitatif que le caractère des locaux scolaires." (Oddie, 1966, p.147)

[263] "More recently - within little more than the last ten years for some countries and much less than that for others - the emphasis has shifted to problems of quality. Some countries have been encouraged by the magnitude of their programmes to concern themselves with improving the effectiveness of the solutions proposed; in other countries, the obsession with numbers, having become less pressing, has given way to a greater reflection on the nature of the facilities to be provided. Thus, both educationists and those responsible for school building have become conscious of a fact which had long been neglected, there is a close, and some times decisive, relationship in school buildings between the layout of the accommodation and the type of education provided in it." (Ader, 1975a, p.10)

multiple choices is projected in a present-future relation, implying a certain degree of "indetermination"[264] of the options and their evolution onwards, and consequently of the spaces to accommodate these indeterminate activities (p.50), that prevents its inertia in rigid models:

> "If the role and conditions of education are to change radically with time, the facilities provided for it must be adaptable to that change. No one formula for education (or given type of school such as the multi-option school) can be regarded as definitive. At the most, it can be said that it provides the most satisfactory answer to the educational needs of today's society. It must therefore be considered and studied in a context of change." (Ader, 1975a p.10)

But it is above all in the OECD's 1976 publication *Providing for future change: Adaptability and flexibility in school building*, that the relevance of adaptability for schools is clear and understood as a quality factor. This publication results from an OECD's study and identifies the concept of adaptability, exemplifying it using case studies. It is also stated to be putting forward "a new set of problems", associated with change to which the schools would have to comply:

> "[…] the educational requirements which school buildings have to meet evolve rapidly and unless the buildings can be made to accommodate future change, they are liable to early and costly obsolescence." (OECD, 1976, p.5)

This holds significant importance towards the current study on adaptability in school buildings. Firstly, because it recognises that learning requirements "evolve rapidly", which is related to the assumption that the school community - on their specificities and number - and the learning practices and learning activities, imply spatial needs that would be likely to change in the future. This confirms that learning was already considered to be changing from the traditional expository seminar and that the future needs were still unknown, in regard to what the learning activities were besides the more conservative ones, how could they be considered in space and within the remaining activities, and how often could they be accomplished:

> "The latter type of changes are more complex than it may at first appear, since the educational methods now gaining currency are increasingly characterized by the frequency of change in the nature, balance, sequence and interrelations of activities." (OECD, 1976, p.5)

Secondly, the recognition that the space would have to cope with these changes that

[264] "The rigour which is implicit in the briefing and design process does not preclude a certain degree of indetermination in all multi-option school projects the practice of an education of options leads to a random factor in forecasting requirements, the allocation of the different spaces within the school must be capable of variation and it must also be possible to change teaching practices as time goes by." (p.7)

were expected to occur in the future is also very significant. This admits the need for adaptability from the start, as it is defined further on. Thirdly, that adaptability would prevent "early and costly obsolescence", in the sense that would enable the building to continue to answer these requirements. Fourthly, that adaptability is cost-efficient when it avoids the abandonment of an investment. Finally, adaptability is related to spatial provision, that it is also associated with educational practices, "providing for future change", as the name of the publication puts it, which relates future practices to the current physical structure.

It is within this publication that adaptability and flexibility are clearly distinguished, in the sense that the first implies "large magnitude/low frequency change" and the latter "low magnitude/high frequency change" (OECD, 1976, p.5), which would infer that "the greater the flexibility the less the need for adaptation"[265] (p.87):

> "- adaptability, the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition in respect of either the constructional elements, services or the finishes of the building - essentially large magnitude/low frequency change; and
> - flexibility, the quality of a building which permits variation in activities, timetabling, class size, etc., of a school without the need for adaptation as defined - essentially low magnitude/high frequency change." (OECD, 1976, p.10)

The OECD 1976 publication also pinpoints the advantages brought by adaptability, associated with the possible future changes on the learning practices and on the size of the learning spaces according to the demographics of the school community, and also the search for "the best match between environment and education" according to the design choices possible for architects to make early on (OECD, 1976, p.9).

The report suggests that adaptability can be perceived in different ways according to the type, frequency and magnitude of that change. These could be in: "the type and/or level of education", "the balance of activities", "the inter-relation of activities", "activity sequence", "group organisation and mode of learning", "introduction of new activities", "technological innovation", "non-educational change", "foreseeable change" and in the "supply of teachers" (pp.10-11).

Throughout this report, design options are considered for coping with change, such as: a differentiation between "general" and "committed" spaces; the possibility of expanding the building, providing spare space in the surrounding area; correct

[265] Besides, in 1975 Oddie had also provided a straightforward definition of adaptability, also within a OECD publication, comparing it to flexibility that coincided with this one. This approach has already been explained in the previous chapter for the concept of adaptability. See chapter 2.1. Adaptability: definition and adjacent concepts.

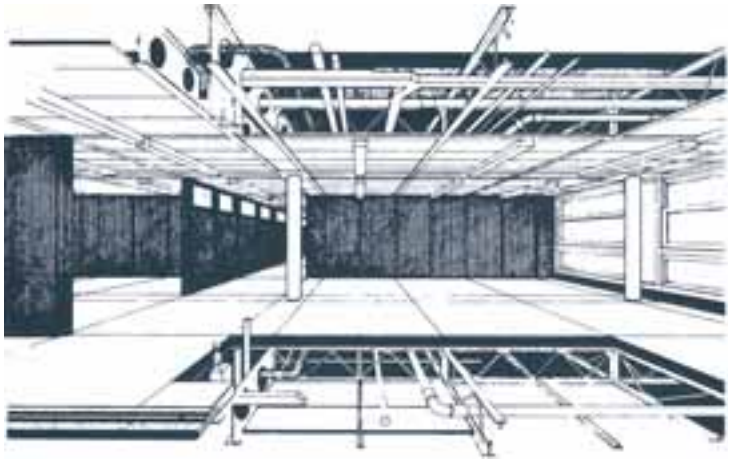


Fig. 50. "A floor or roof structure which allows the easy incorporation of new horizontal services runs, an important feature of adaptability"
(OECD, 1976, p.99)

solar exposure of the building; the possibility of relocating technical installations and supportive elements for artificial lighting, mechanical ventilation, heating and controls; the rooftop possibility to allow the installation of all the technical cabling, releasing the spaces from this gear (Fig. 50); removable, independent and easy to store equipment and furniture. The structure shall also allow the replacement of panels and elements of the rooftop or of the walls. It must also be modular and easily expandable/retractable, in which the elements can be added, removed or replaced. However, a non-uniform structure is suggested, because structural uniformity would imply spatial uniformity[266], which is not considered an appropriate solution for coping with the need for spatial variety for learning (pp.84-103). Overall, acknowledging change and providing for adaptability involve educational, management, economic and planning, technological and design factors (pp.107-108). Finally, the report ends with the recognition that further work would have to be developed on this subject matter regarding contextual specificities on more case studies (p.108).

By and large, the report conclusively identifies spatial design options for providing for adaptability namely the design of "single-story buildings"[267] and "leaving space on the site for future extensions", which relates to future interventions. Providing for current requirements is considered here to be related to flexibility and it is also recommend to: "provide an excess of workplaces over the number of occupants";

[266] "What is needed is a less regular grid that offers variation or choice in structural spans and can thus provide for the diversity required." (p.98)

[267] Multiple storey buildings have more demanding ventilation and lighting requirements and a single-storey building has a direct connection to the outdoor spaces, greater ease for organising the technical elements in their relation to the structure and less obstacles for circulation.

"widen the range of activities which general space can accommodate by means of, for example, mobile furniture and equipment"; "widen the range of specialised workplaces"; "optimise the proportion of general to committed space"; "a plan form which permits a continuum of activity zones punctuated or articulated with committed spaces", "avoid complex lighting, ventilation and circulation problems" (p.108).

Additionally, it is also concluded that adaptability is deeply associated with the "variety of environment" and its ability "to add, replace or remove" the "building elements" at large, beyond "relocatability of partitions". Finally, a critical revising is set to previous solutions that use a structural frame, suggesting it to hold a variability of possibilities for also coping with a variety of activities:

> "The use of a structural frame rather than load-bearing walls goes a long way towards easing the problems set by future change. But uniformly long floor or roof spans contribute little to adaptability and can prove expensive, diverting resources away from where they are really needed. More important is to adopt a structural frame which offers the possibility of arrange of spans or structural layouts in order to match the diversity of accommodation which, in practice, is what is needed." (OECD, 1976, p.108)

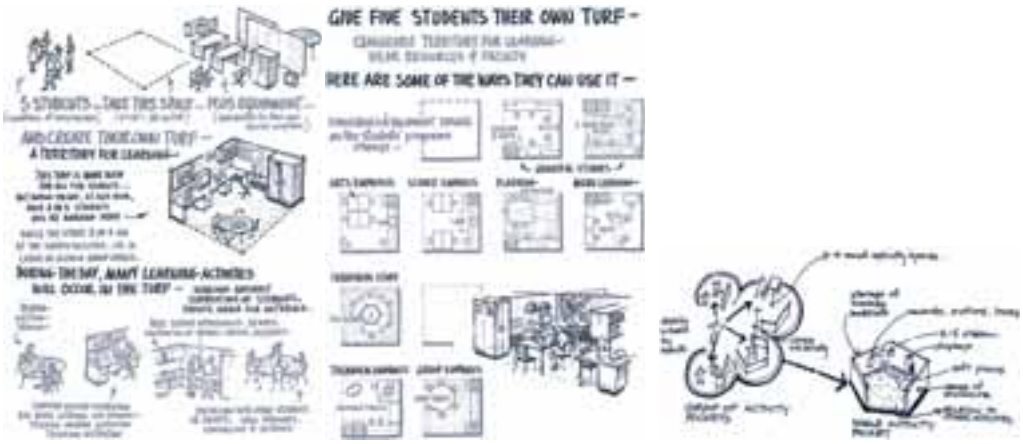
Assuming the variability of learning spaces, the relevance of informality and individual learning, Leggett, Brubaker, Cohodes and Shapiro (1977) created the concept of 'turf' (Fig. 51a), as a work unit for five students, in a multifaceted space for various uses and forms of learning, organised in sets of twenty that result in a 'cluster'. Their gathering in a set of ten makes up a school, and finally the grouping of several schools creates a 'multischool':

> "The Basic unit of the school is a turf designed for five students. This will serve as a home base, study area, problem-solving area, and learning space and, in fact, provide space for learning. When specialized facilities or staff are needed, the student moves to the appropriate areas in the school for a part of the day." (Leggett et al.,1977, p.65)

Also referring to Leggett et al.'s 'turf' concept, Moore and Lackney (1994) confirm that "well-defined activity pockets" are a spatial option that conveys wider student engagement and, as these "redirect traffic, demarcate class boundaries, and create small areas for privacy" they potentially convey "increased achievement" (Moore and Lackney, 1994, p.30) (Fig. 51b).

From the 1995 seminar in Lyon on 'making better use of school buildings'[268]

[268] Consulted version on French. See: Séminaire a l'élargissement des Fonctions des bâtiments Scolaires (1996).



a) b)

Fig. 51. a) Illustration for the concept of "turf" (Leggett et al.,1977, pp.66, 67); b) "Well-defined acticity pockets" (Moore, and Lackney, 1994, p.30)

(Séminaire a l'élargissement des fonctions des bâtiments scolaires, 1996) it is also understood that school design should conceive "places that easily adapt to a variety of uses, either simultaneous or succeeding"[269], acknowledging "co-utilisation of the locations and an easy co-habitation of different groups of users"[270], which could be related, according to the publication to flexibility (p.26).

The definition of adaptability and its differentiation from flexibility presented in the 1976 OECD publication is very significant and continues to be used further on. Clynes (1990) also within a publication by the OECD, assuming that flexibility and adaptability are often used in a "vague and interchangeable manner"[271] quotes these previous definitions from the 1976 publication for more accurately analysing *Adaptability and flexibility in school buildings and places*[272](Clynes, 1990, p.13). Then, Clynes adds a further explanation on this regard for distinguishing the two, where adaptability implies "substantial" or "large magnitude" change, whereas flexibility enables to more frequently change activities:

> "In terms of adaptability, the approach is different. In this case, adapting to changes involves modifying the construction and its layout

Diversifier les utilisations des établissements scolaires. Séminaire consacré à l'élargissement des fonctions des bâtiments scolaires tenu à Lyon, 1995. Organisé par le Programme pour la Construction et l'Équipement de l'Éducation. Paris: Organisation for Economic Co-operation and Development.

[269] Free translation from the French quote: "[...] concevoir des locaux qui s'adaptent facilement à une pluralité d'usages". (Séminaire a l'élargissement des Fonctions des bâtiments scolaires, 1996, p.26).

[270] Free translation from the French quote: "[...] co-utilisation des locaux et une cohabitation aisée de différents groupes d'usagers [...]" (p.26)

[271] Free translation of the original full quote in French: "Dans des contextes divers, on emploi bien souvent les termes d'adaptabilité et de flexibilité d'une manière vague et interchangeable". (Clynes, 1990, p.13)

[272] From the French edition: *L'adaptabilité et la flexibilité des bâtiments et locaux scolaires.*

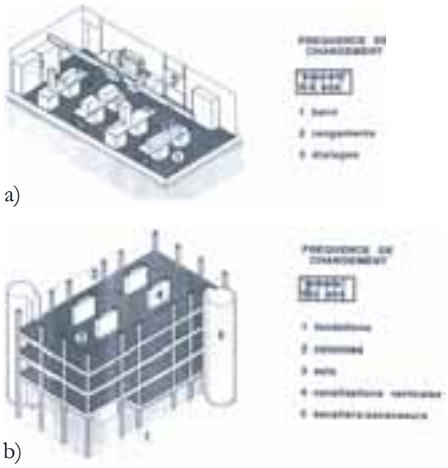


Fig. 52. a) Fixed structure; b) Adaptable equipment
(Clynes, 1990, pp.23-24)

> more or less substantially in order to create a framework that meets the specific needs of the current use."[273] (Clynes, 1990, p.17)

This publication also presents "design strategies"[274] suggesting: separate or unique buildings have both advantages and that the final solution should be achieved through collaboration between the "client, the users, and the conceivers"[275]. It is also recommended the building should have an envelope for comprising common users' needs and provided with more specific provision areas. For this purpose Clynes proposes a more "permanent module" that holds the remaining ones, composed by: structure and ground, vertical circulations and firewall partitions[276]. The other components, like furniture, can be more frequently changed, in an "hierarchy" approach between components (p.24) (Fig. 52). This could be paralleled with Brand's "shearing layers of change" where a frequency of change is considered for each element, or also to Habraken's "support" and "infill".

Besides, other strategies are also suggested such as: small size sections, a supporting structure, avoiding load-bearing partitions and the location of servicing within them, a straightforward path for technical ducts, a continuous ground level, placing the openings so that future expansion can be possible and the use of removable furniture (Clynes, 1990, p.26).

[273] Free translation from the original French quote: "En ce qui concerne l'adaptabilité, l'approche est différente. En l'occurrence, l'adaptation aux changements consiste à modifier plus ou moins sensiblement la construction et son aménagement afin de créer un cadre qui réponde aux besoins spécifiques de l'usage du moment." (Clynes, 1990, p.17) (Underlined word from the original quote)

[274] Free translation from the original French quote: "stratégies de conception".

[275] Free translation from the original French quote: "le cliente, les usagers et les concepteurs" (p.21)

[276] Free translation from the original French quote: "la structure porteuse et les sols, la circulation verticale et les cloisons pare-feu." (Clynes, 1990, p.24)

Fig. 53. Montessori School, Delft, by Hertzberger, 1960-2010
(Scholen, 2009, p.165)

Bridging what has been experimented in past schools to contemporary learning practices and environments, Hertzberger's wide thoughts on schools date back from the 1960s and continue onwards to his most recent schools, for a critical revision of the learning spaces and the educational practices they holds. In the Montessori school, in Delft, (1960-2010) (Fig. 53), the informal spaces of encounter and socialisation were already assumed as learning spaces and the classroom as a space for several learning experiences, which was to be interpreted in Hertzberger's extensive work to date on his *Lessons for students in architecture* (Hertzberger, 1991, 2000, 2008, 2009).

Aware that the school's scheme is bonded to the children's "relational skills" within, Hertzberger argues for the school "as a catalyst for contact and exchange" that "strengthens the cohesion with the school population" (Hertzberger, 2008, p.118). So, the school is liable to the children's activities, relations and movements and the design:

> "The quality of the space is not a given in itself but gains expression through the people populating it and the acts it incites from them. When not in use, the building is nothing more than an empty shell." (Hertzberger, 2008, p.118)

This goes along with the concept of the Montessori system where children are developed within the environment they are interacting with, experiencing it freely rather than in strict or compulsory manner, and also on the relations amongst children and between children and educators. According to Hertzberger, this opening may be considered as a more practical contact with the world instead of a theoretical approach carried out in traditional learning systems (p.77). The Montessori's "original network of walls" enabled the children to make further extensions and to play on the sandpits. Although this has been replaced without the architect's approval, it was originally intended as a playground for children to actively engage in social relationships instead of the more traditional playground (pp.180-181).

Fig. 54. a) "Basic classrrom" vs "Articulated classrroom": "Articulated leads to multiple centres"; b) Conceptual model of the classroom as a shell; c) De Monchy School, Arnhem, 2004-2007 (Hertzberger, 2008, pp.24-25, 32, 65)

The shape of the classrooms was also sought for answering the Montessori method, developed from the initial Montessori schools in Amsterdam from the 1930s[277]. This classroom does not require a parallelepiped configuration, favouring an "articulated classroom" (Fig. 54a), prone to varied activities simultaneously occurring in space and with different centres of attention, but organised in a cohesive spatial logic (p.36). According to the Montessori method, this space, created from the shape of a "snails's shell", should allow children to work alone in activities chosen by their own, preventing them from distracting one another. So, the rooms are "L-shaped", without walls in a conjoint environment, as it happens in the Montessori School in Delft (pp.24-33) (Fig. 54b).

Also according to Hertzberger, as an alternative to the classroom-based model, it is suggested the "classroom dethroned", in which the whole building embodies and enhances learning, which transcends the formal rooms to more informal spaces. From a pedagogical point of view it creates distinctive spaces, with singular environments and also enhances the individual learning of each student. From an economic, but foremost from an educational point of view, this is also favourable, because each space, either formal or informal, is useful for the transmission and construction of knowledge (Hertzberger, 2008, pp.22-33) (Fig. 54c[278]).

Thinking beyond the classroom, in the Apollo Schools in Amsterdam (1980-83) a central space, in an amphitheatre arrangement, gathers all the children from the six surrounding classrooms displaced in a "split-level design", conveying a sense

[277] The first Montessori School in Amsterdam has been built in 1920s (Hertzberger, 2008, p.26).

[278] According to Hertzberger, in the school displayed in the image "the classroom principle has been abandoned entirely" (Hertzberer, 2008, p.64).

Fig. 55. Apollo Schools Amsterdam, 1980-83. "Top-lit central amphitheatre connects six classrooms on three levels"Apollo Schools Amsterdam, 1980-83

(McCarter and Herzberger, 2015, p.158)

of unity to the whole primary school, visual acquaintance from the centre core and assuming this space of gathering and socialisation also as a relevant learning environment for diverse uses (Hertzberger, 1991, p.213) (Fig. 55). Other spatial solutions from Hertzberger's schools also demonstrate these upper concerns: the open areas of the Extended Schools in Arnhem (2004-2007) that are only separated from the corridors by a glass partition, the open spaces of De Monchy School, also in Arnhem (2004-2007) with 12m spans that can be internally divided by glass accordion partitions (Hertzberger, 2008), the use of steps to create learning environments for gathering groups and for articulating spaces such as the Titaan College in Hoorn (1999-2004), the spatial prominence of the circulations, in-built furniture, the niches, the thresholds, the variations on ceiling height, …

For conceiving such schools Hertzberger addresses the building at large, ensuring its spatial cohesion, in which each space has its "identity" and contributes to the whole[279] (Hertzberger, 2009, p.13). Thus, each space, considered as a "spatial unit"[280], holds a smaller scale and also encompasses the larger, communal building (p.11). Therefore, all spaces from classrooms to patios, corridors or stairs, contribute to the school building, and hence, to learning. This is the basis to understanding the amphitheatre in the centre of the Apollo Schools as the communal learning and social space, but also to comprehend that all niches can hold activities where knowledge is conveyed

[279] "The spatial theme, encompassing the building as a whole, does not just encapsulate the sense of community, it also expresses and emphasizes it. Theoretically speaking, it could actually promote the process whereby each of the separate elements acquires its own clear identity." (Hertzberger, 2009, p.13)

[280] "A spatial unit could be described as a space that achieves a certain equilibrium between a sense of seclusion and a sense of community. Where a learning situation is concerned, this mean fulfilling the conditions that enable you to concentrate on your work while at the same time being aware of others and what they are doing." (Hertzberger, 2009, p.11)

Fig. 56. Apollo Schools Amsterdam, 1980-83
(Herzberger, 1991, p.215)

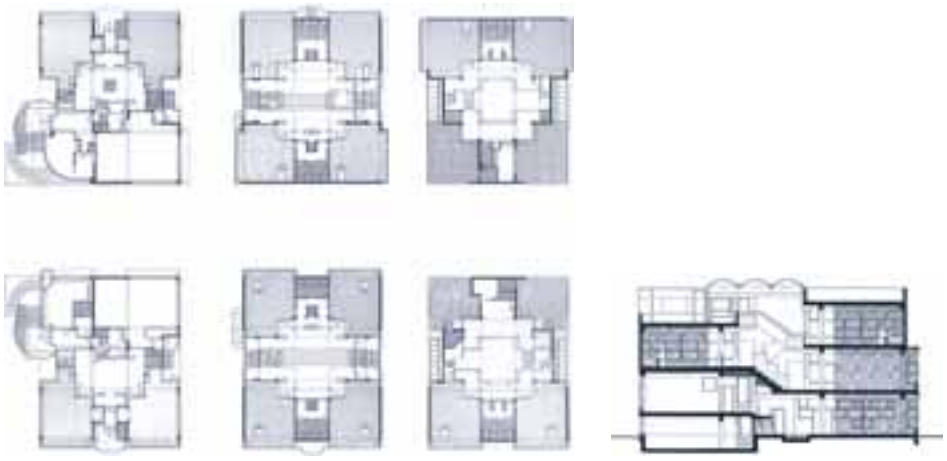
at different scales (Fig. 56). So, more than a circulation space, corridors are also learning environments[281]. This assumption leads to Hertzberger's "learning street":

> "What were once straightforward circulation passages are transformed into a true learning area where you can walk as well as work and where passers-by may get drawn to the workers without disturbing them. Here, it is the spatial qualities more than anything else that determine whether you fell at home or lost and whether you are encouraged to further explore the world you find yourself in." (Hertzberger, 2008, p.114)

Hertzberger suggests "spatial means" to provide for such relations, such as: the use of "split-level division" that enables visual contact and connects the spaces between them; a "network of open indoor spaces" and also "making mobility in the building visible" (Fig.57). These can be all comprised within a "open learning environment", similarly to a city (p.124). Therefore, in addition to the analogy of the street, the author also advocates the approach of the school to the community and to the city, pondering "the school as a micro-city" (pp.112-201).

The concept of the space "in-between" is also displayed in the Montessori School as the thresholds between the spaces that bind and connect them. This is taken up in the school's entrance that gathers the community, the children and the parents (Hertzberger, 1991, pp.32-33). The spaces between the various cells of the building constitute meeting places, articulated in "streets" and "squares" within

[281] "Completely eliminating corridors and adding corner areas, making the space suitable for communal use by diverse groups of pupils, created greater social cohesion and more places for smaller groups, while whole-class instruction could continue to take place in classrooms." (Hertzberger, 2009, p.9)



a) b)

Fig. 57. a) "Plans of Willemspark School (top) and Montessori School (bottom)" (edited)
b) Apollo Schools Amsterdam, 1980-83, Section
(McCarter and Herzberger, 2015, pp.154-155)

an "educational promenade" (Hertzberger, 2008, p.115) (Fig. 58a). According to Hertzberger, firm upholder of the spaces of socialisation in schools as enablers of experiences, schools should accompany and respond to social structures and even serve as an example for the city:

> "In the Montessori School the communal hall has been conceived in such a way that the hall relates to the classrooms as a street relates to the houses. The spatial relation between class-rooms and hall and the shape of the hall were conceived as the 'communal living-room' of the school." (Hertzberger, 1991, p.62)

Appropriation is intended from space that affords the possibilities for "the users to fill in the spaces according to their personal needs and desires" (p.24) and that also engages people to space by "delegating responsibilities for the environment to the users" (p.25) in such a way that "users become inhabitants" (p.28). This is considered possible to several different programmes such as office buildings like the Centraal Beheer Offices, in Apeldoorn, Netherlands, (1968-72, 1990-95) and it has been taken into account for the Montessori School. Each classroom is conceived as a space for a specific group in "autonomous units" displaced throughout the hall resembling a "communal street" and each group is in charge of it and appropriates it as their "home" (Hertzberger, 1991, p.28) (Fig.58b).

Also related to appropriation, Hertzberger reflects upon "functionality, flexibility and polyvalence". The modern functionality is disputed because "all too specific solutions leads not only to disfunctionality but also to serious inefficiency", conveying obsolescence (Hertzberger, 1991, p.146).

a) b)

Fig. 58. a) Montessori School, Delft, by Herman Hertzberger, 1960-2010. "Main street through the building, formed by a chain of places" (Herzberger, 2008, p.115)
b) "From user to dweller" (Hertzberger, 1991, p.29)

Consequently, Hertzberger also discusses flexibility as the subsequent "catch-word", but argues that it suggests the "absence of identity" in order to cope with different uses. This had, in fact, been a supposition that previous architects already had on flexibility leading to 'dull' solutions. As Hertzberger puts it, this could be interpreted as the opposite of a specific functionality, for being open to all uses but deployed of any particular distinctiveness[282]. Therefore, flexibility cannot be the most adequate solution for the issue at hand:

> "Flexibility signifies - since there is no single solution that is preferable to all others - the absolute denial of a fixed, clearcut standpoint. […] Flexibility is ostensibly inherent in reality, but in actual fact it only has to do with uncertainty; with no daring to commit oneself, and therefore with refusing to accept responsibility that is inevitably bound up with each and every action that one takes. Although a flexible set-up admittedly adapts itself to each change as it presents itself, it can never be the best and most suitable solution to any one problem; it can at any given moment provide any solution but the most appropriate one. Flexibility therefore represents the set of all unsuitable solutions to a problem." (Hertzberger, 1991, p.146)

Besides, school space to engage the school community should have "a multi-coloured variety of infills" and should also hold "shelves, compartments, nooks, ledges

[282] "Flexibility became the catch-word, it was to be the panacea to cure all the ills of architecture. So long as the design of buildings was neutral, it was thought, they could be put to different uses, and they could therefore, in theory at least, absorb and accommodate the influences of changing times and situations. That at least would be one point gained, but neutrality in fact consists of the absence of identity, in other words, the lack of distinctive features." (Hertzberger, 1991, p.146)

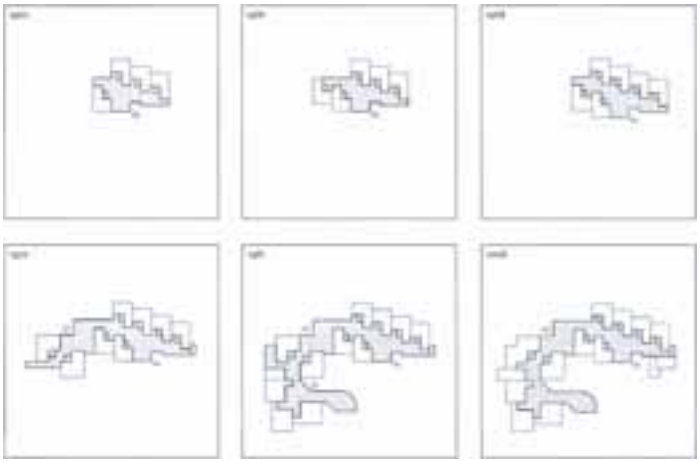


Fig. 59. Montessori School, Delft, by Herman Hertzberger, 1960-2010, plans of construction stages (Herzberger, 2008, p.115)(Herzberger, 2008, p.115; Hertzberger, 1991, p.29)

[…]" that flexibility does not account for (Hertzberger, 2008, p.103). Hertzberger determines that: "You can't create a learning environment with flexibility." (p.108). A learning space needs "to be able to accept the most varied contents within the intimacy of the place" and also provide "substance and meaning" to the space and lead to appropriation by the users (p.103).

Rejecting functionality and flexibility, Hertzberger argues for *polyvalence*, as the possibility to cope with different experiences within buildings and "to adapt themselves to diversity and change" (Hertzberger, 1991, p.148). This is guided by the users' appropriation[283] and not strictly or formerly defined, also enabling the building's character:

> "The only constructive approach to a situation that is subject to change is a form that starts out from this changefulness as a permanent - that is, essentially a static - given factor: a form which is polyvalent. In other words, a form that can be put to different uses without having to undergo changes itself, so that a minimal flexibility can still produce an optimal solution." (Hertzberger, 1991 p.147)

More than leaving the space for further completion by the users, Hertzberger praises for a design that encompasses different possibilities, in an open and expanded manner (p.170), which could be understood as a closer assumption to adaptability, even if this is not stated as such. However, Hertzberger effectively states the need

[283] "The point therefore is to arrive at an architecture that, when users decide to put it to different uses that those originally envisaged by the architect, does not get upset and confused and consequently loses its identity. To put it even more strongly: architecture should offer an incentive to its users to influence it wherever possible, not merely to reinforce its identity, but more especially to enhance and affirm the identity of its users." (p.148)

Fig. 60. Amstelveenseweg Orphanage, Aldo van Eyck, Amsterdam, 1955-60
(Eyck, 1999, p.50)

for coping with change without physical transformation, which is the basis of the definition of adaptability:

> "There is enough upheaval as it is with the unceasing modifications to educational renewal and the march of new projects, to say nothing of school extensions and the reorganization these require. If you want children to feel sufficiently at home and regard the school as a familiar world, this is reason enough to strive for a stable spatial structure able to take up change without changing itself." (Hertzberger, 2008, p.111)

The phased evolution of the Montessori school suggests a metabolic logic, in which further spaces have been added to the original five classrooms of the primary school built in 1966[284] (Fig. 59).

Tackling the approach to Hertzberger's school, the reference to the Orphanage by Aldo Van Eyck (1955-60) is unavoidable, where a metabolic logic prevails in the scheme's composition (Fig. 60). Hertzberger also praises the "building order" in a structuralistic approach to the design and Van Eyck's Orphanage is understandably tackled as "the first executed structuring with a building order, in the sense of a unity in which parts and whole determine each other reciprocally", resembling to hold "'streets' and 'squares'" as a "small self-contained city" which Hertzberger defends (Hertzberger, 1991, p.126).

[284] In the book from 2008, Hertzberger specifies the Montessori school to be from 1960-66, but in the 2015 book about Hertzberger's work (McCarter and Hertzberger, 2015), the Montessori is dated from 1960-2010, considering this continuous expansion over time.

a) b) c)

Fig. 61. a) School scheme with 16 classrooms, celule B, Manuel Tainha, Olivais Sul, 1965-68 (Parque Escolar's archives, conference *Fazer a Escola*, 2010); b) Cedro Elementary School, Fernando Távora, Vila Nova de Gaia, 1957-61 (Banderinha, 2012, p.233); c) Cedro Elementary School, photograph, 2016 (Carolina Coelho)

Recalling the Orphanage, Hertzberger describes his experience on that space:

> "My very first cursory confrontation with the Orphanage, still under construction at the time, was enough to convince me that this wonderful new building was going to be an entirely new kind, based on a different mechanism and heralding another kind of architecture." (Hertzberger, 1991, p.128)

In the Portuguese context, this could be analogous to the school of Tainha (1965-68) for Olivais Sul, which seeks similar compositional principles (Fig. 61a). Tainha's subsequent Secondary School of Olivais Velho, from 1972, also recalls Hertzberger's learning street within a more compact scheme between four functional areas developed along two axis (Heitor, 2014, pp.512-513).

Also in Portugal, Távora's Cedro Elementary School (1957-1961) (Figs. 61b, c), contemporary of Taínha's school, advocates a new form of socialisation and learning, valuing the courtyard as a meeting place where children play and where the school was conceived for a specific site rather than within a standard-type construction[285]. It is a clear break from the schools of Raul Lino and Rogério de Azevedo, their contemporaries, included in Plano dos Centenários (1940-70) and made uniformly from standard projects defined by the DGEMN[286], based on Oliveira Salazar's ideas of authority, discipline and order. Often in these schools there were separate

[285] It is highlighted the analogy on the value of community spaces to Távora's Vila da Feira Municipal Market (1954-1959).

[286] Direcção-Geral dos Edifícios e Monumentos Nacionais was the Portuguese authority on built heritage at the time.

circulation spaces for pupils and educators, schools were structured around one to four classrooms and the relationship between spaces was very segregated (Pimenta, 2006, pp.104-111, 146):

> "[...] the places are not interchangeable and, on the contrary, they differ according to rigid symbolic boundaries, safeguarded by severe control practices"[287] (Pimenta, 2006, p.111)

In fact, and despite the differences in language, the earlier schools[288] can be considered as spaces designed for the community, precisely because of the value they make of the living experience in communal places, as enriching learning spaces, whose pedagogical perspective extends onwards to date.

At the end of this chapter conclusions can be drawn on the approaches to adaptability in schools during the 20th century. All in all, the approached key moments have shown that adaptability has not been specifically addressed, in the initial stages of questioning the schools and the educational methods.

Similarly to what has been concluded on the previous chapter concerning the state of the art on the concept of adaptability, also for depicting the state of the art on adaptable schools, other adjacent concepts must be studied as well as previous approaches to schools that had already demonstrated spatial concerns for change and even for flexibility, making way for the assumption of adaptability *per se* in school design.

In fact, not all the key moments and projects that have been tackled show adaptable schools, but they can be considered precursors of adaptability and foremost of the understanding of potential growth and future change that is already comprised in their design, even if other solutions or other specific concepts are intended. Furthermore, and also as it has been demonstrated, the exogenous constraints to the school context are embedded in the design solutions and guide the options on the construction methods, the formal scheme or the interior layout. As the post-war school buildings expresses, these have been led by cost-effective and industrialised solutions, but related to concerns on future growth. Then, from Hertfordshire to the consortia solutions, school building already perceived the future changes on the educational methods that were being fostered and also the possible growth from the school population.

Nevertheless, the critical thinking and the questioning of the overall space, or the internal partitioning, also paralleled with the teaching-learning processes, launched the search for a school environment that provides for the contemporary learning and for

[287] Free translation of the original quote in Portuguese: "[…] os lugares não são inter-mutáveis e, pelo contrário, se diferenciam segundo rígidas fronteiras simbólicas, salvaguardadas por severas práticas de controle" (Pimenta, 2006, p.111).

[288] The schools referred beforehand of Távora, Tainha, Hertzberger and the remaining ones previously studied on this chapter.

the users' needs and the society's requirements at that time. Besides corresponding to contextual and educational needs, these also confirm the continuous pursuit for new spatial environments at different scales, from the interior of the classroom - its form, light and air conditions - to the communal spaces shared by all the school community, the relation between the envelope and the external patios or courtyards, and even to the thresholds between the interior and the exterior and the building overall.

Besides, not only is the shape of the classroom or the building innovative, but also the possibilities these encompass regarding the learning experience provided within them. So, the experiments with the structures, the search for wider spans, for more open spaces and its critical revision on spaces that enable a more fine-grained partitioning, in a sense of higher privacy and learner-centred environment, all represent the search for spaces to cope with the learning experiences understood at each time. These can be precursors of adaptability or can even show that solutions for school space were being tested that intended to involve the educational methods but also to leave space open to future possible changes these might have.

Dealing with change can be understood in different ways, as seen. From the interior partitioning with lightweight materials that can be moveable and frequently changed for students' activities, or large-scale expansions on the buildings, more easily conceived in single-storey, cluster schemes or resorting to an industrialised structure. Adaptability, as the ability to cope with change in a large magnitude solution, is addressed later on, understanding the building as a whole and assuming this as more critical than interior partitioning of an original layout that might not at all be provided for change. Thus, inner flexibility or piecemeal solutions may not accommodate the wider and more permanent needs that can only be answered by overall adaptability.

Despite the possibility of change in the buildings being often associated with a more uniform prefabricated structure, from the 1950s concerns with rapid and cost-effective solutions, this is not at all compulsory. Thus, solutions have been drawn ever since, critically reviewing the lack in spatial distinction of these schemes for a sense of intimacy the school and its spaces should impart in a more individually-centred environment, enabling appropriation and a sense of belonging, particularly relevant for a school and for the children's development.

So, after experiments with open spaces and even the highly questioning of the school space *per se*, as the debate from the 1968 RIBA conference *Building for education* shown and which was even more evident in de Carlo's writings one year afterwards, the 1970s represented the search for an already established concept of adaptability that went along with a variety of curricular options in the multi-option school and the assumption of both the possible changes and the diversity of activities and subjects to be provided in schools. This variety on curriculum and practices also involves a lack of uniformity in space, the need for a space to cope with different subjects in the classroom, but also with different activities to support their learning.

All the previous experiments duly embedded in the need of their times and contexts, have supported the continuous search for spatial solutions and also the acknowledgement that these do not have to be alike and need to be thought anew. This comprises the cell of the classroom, its relation to the shared spaces and also the overall building.

Adaptability's relation to the pace of change naturally engages an open design to future possibilities and does not imply a model or a fixed structure. It leaves the possibilities of change to happen, to cope with the uncertainty in a certain design, not strict or fixed, but steady and completed.

The state of the art of adaptability when applied to schools is naturally widespread in contexts, countries and moments in time. It also engages the smaller to the larger scale of design, besides the understanding of the society, the construction and the requirements in each of these moments. These have all contributed to a more holistic understanding of the search for learning spaces in the past century, the diversity of possibilities and the ways to answer them. These have also led to their critical revision, to the present situation and to the continuous search, because the learning methods, the technologies and the curriculum continue to evolve and space will have to enable and enhance them. The following chapter will relate the contemporary spatial practices to the school spaces and will report adaptability to the learning environments, as these are currently understood.

2.3. Adaptability for contemporary learning practices and environments

> "If the idea of designing buildings as completed compositions, like sculptures, has long ceased to be relevant, this applies pre-eminently to schools, which are more susceptible to the restlessness of our demanding society than any other buildings." (Hertzberger, 2009, p.9)

As seen throughout chapter 2[289], it intended to identify the concept of adaptability and to explain the definition pursued for this current Thesis, recognising its specific application onto the school brief and how adaptability has been conceived and materialised in past school buildings.

This following part aims to focus on the current learning practices, explaining their specificities and their correlations with the school space. In fact, it is relevant to review the spatial requirements for accommodating the current learning activities because the Thesis here presented intends to focus on the school building as it is perceived today and which holds a contemporary curriculum. Only after identifying the concept of adaptability when applied to the school brief and according to the contemporary learning activities that are acknowledged today, can the methodology proposed on this Thesis be constructed, which will be described in the following chapter[290].

This part will address the relevance of adaptability for comprising with the learning processes and the learning practices in the sense that, despite school's physical fixedness, it has to be able to cope with the developing demands and curricula changeability, as Hertzberger (2009) puts it on the upper quote. Then, and recognising the relation between the school space and the learning practices, emphasis will be put on the spatial implications that the evolution of the learning practices have brought for adequately sheltering the teaching-learning processes. Finally, contemporary learning practices will be addressed and explained. Acknowledging that the contemporary paradigm is embedded with specific spatial requirements then, the concept of adaptability as the ability to continue to accommodate the changing activities, will reflect upon what those activities are, and what are the spaces' needs to hold them.

[289] Chapter 2. State of the art and critical revision of the concept of adaptability.

[290] See chapter 3. Construction of the methodology.

As the learning practices are currently decentralised from the classroom and comprise direct learning amongst peers, besides the sole knowledge provision by the educator, the learning process guided by informality also recognises informal spaces and social activities as moments for knowledge creation and transmission. Therefore, adaptability in educational spaces will have to be rethought from previous experiences addressed in chapter 2.2[291], because the learning activities are broader and the spaces to hold them surpass the formal classroom to a wider array of communal spaces, as interfaces for learning to occur. Thus, the methodology to assess adaptability in current educational spaces proposed in this current Thesis[292] will have to acknowledge that.

. Adaptability for comprising the learning processes and the learning practices

From the initial motivation that explores the connection between Architecture and Life, the school brief is considered to be a prominent case study. More than a stage, the built space is a facilitator of the current pedagogical curriculum[293]. Monahan (2000, 2002) addresses the concept of "built pedagogies"[294] and Heitor (2005) resorts to schools as an "educational tool":

> "School buildings are a particularly specialised type of public/ institutional buildings. They are designed to make use of space as an educational tool regarding both the transmission of (socio-cultural-scientific-technical) knowledge and the promotion of the learning capacity. They represent the physical place where to meet, search for information, and study. A place where children and youth can get together with other age groups, associate with each other, and take part in things together - a place of vital importance for their social growth." (Heitor, 2005, p.44)

All in all, from a social, academic and professional current perspective, the study of the secondary schools today is justified, as a case study of a space enabler of the learning process that simultaneously influences and potentiates what happens within, like a "life container" (Byrne, 2007, pp.23 -24) that matters to be investigated.

[291] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

[292] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[293] This has already been introduced in 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[294] "Given the premise that built environments enable and constrain certain modes of social action and interaction, educational structures embody curricula and values by design. I call these embodiments built pedagogies. My ongoing research probes user (student/teacher) appropriation of built technological pedagogies and the degree to which flexible spaces can be structured for participation." (Monahan, 2000, p.1)

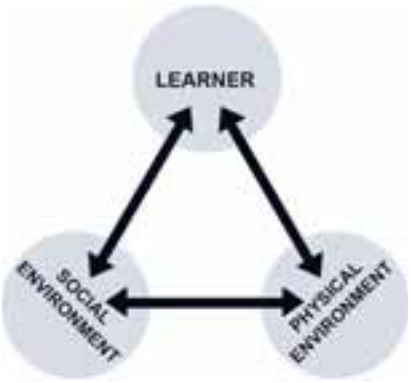


Fig. 62. "The transactional worldview examines the interrelationship between the social and the physical environments and the learner."
(Lippman, 2010, p.20. Authors: Peter Lippman and Marius Calin) (edited)

Furthermore, Barker (1968) advocates the concept of "behavior settings", from which Lippman (2010) proposes "transactional settings" applied to school space, which influence and are inversely influenced by events (Fig. 62):

> "Behavior settings must be understood as transactional (or mutually influential), because it is the relationships between the human and the nonhuman elements that influence the learner and provide the opportunities for learning. A transactional worldview recognizes that learners influence their social and physical learning environments, which in turn influence the behavior of the learners […]" (Lippman, 2010, p.19)

The choice of the school brief as a paradigmatic case study on the relation between space and society is also supported by Bernstein's studies (1971, 1973, 1975, 1990[295]) on sociology of education, where he makes clear the analogy between social and cultural reproduction. Bernstein goes further by stating that the children's social and pedagogical knowledge acquisition in the school influences their behaviour towards society at large:

> "I want to talk about some of the consequences of education where the school acts as a major source of social, occupational and cultural change. It is well known that the school transforms the identities of many of the children: transforms the nature of their allegiances to their family and community, and gives them access to other styles of life and modes of social relationships. […] The child's response to the school is likely

[295] See also a critical assessment of Bernestein's studies by Domingos et al. (1986).

> to transform the way in which he thinks and feels about his friends, his community, and society as a whole." (Bernstein, 1975, p.37) [296]

Domingos et. al. (1986) also reflect upon the context of education and consider a potential coincidence with the social construction of the society, its constraints, its organisation and its forms of discourse, which may imply that the educational system mimics the social construction within its respective context[297].

In 1999, Bernstein organises the ways of knowledge transmission and acquisition in "horizontal" and "vertical"[298] discourses. Moreover, for this knowledge transmission to have greater potential this will imply a more participated and social place, for the school both as an institution and a space, where knowledge exchange and communication may occur. Quoting Bernstein:

> "The greater the reduction of isolation and exclusion, the greater the social potential for the circulation of strategies, of procedures, and their 'exchange'." (Bernstein, 1999, p.160)

Loureiro (1998, 2000) in her Doctoral Thesis[299], also considered Bernstein's approach to schools[300], which also revolves around the parallel focused here between

[296] This is stated by the study on Bernstein by Domingos et al. (1986): "Indeed, although the sources of radical change reside in the economic and political structures, it is in the family and in school that mental structures are shaped. These are the agencies that generate ways of thinking and feeling that may militate in favour or against the changes in cultural reproduction." (p.7)
Free translation of the original quote in Portuguese: "Com efeito, se bem que as fontes de mudança radical residam nas estruturas económica e política, é na família e na escola que são moldadas as estruturas mentais. São pois estas agências que geram formas de pensar e de sentir que poderão militar a favor ou contra as mudanças na reprodução cultural." (p.7)

[297] Full quote in English: "The sociology of education, as an institutionalized discipline is a relatively recent creation and is involved in a wider debate. [...] The international context of education, its content and institutional forms, perform, in a condensed or explicit, and visibly or invisibly, the constraints and possibilities of a given society and contain the distribution of power and the principles of social control. As a result, educational structures are only comprehensible when envisaged within the total society." (p.1)
Free translation of the original quote in Portuguese: "A sociologia da educação, que como disciplina institucionalizada é de criação relativamente recente, está envolvida num debate mais amplo. […] O contexto internacional da educação, seus conteúdos e formas institucionais realizam, de modo condensado ou explícito e visível ou invisivelmente, os constrangimentos e possibilidades de uma dada sociedade e contêm a distribuição de poder e os princípios de controlo social. Como consequência, as estruturas educacionais são apenas compreensíveis quando perspectivadas em função da sociedade total." (p.1)

[298] Bernstein defines horizontal and vertical discourse: "A horizontal discourse entails a set of strategies which are local, segmentally organised, context specific and dependent, for maximising encounters with persons and habitants." (1999, p.159).
"[…] a vertical discourse takes the form of a coherent, explicit, and systematically principled structure, hierarchically organised, as in the sciences, or it takes the form of a series of specialised languages with specialised modes of interrogation and specialised criteria for the production and circulation of texts, as in the social sciences and humanities." (*ibid.*).

[299] Loureiro, C. (2000). *Classe, controle, encontro: o espaço escolar.* Tese de Doutoramento – apresentada à Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo.
After an earlier paper from 1998. See: Loureiro, C. (1998). Paradigmas do prédio escolar. *Nutau: Arquitetura e Urbanismo: Tecnologias Para o Século XXI, 2.,* 1998, São Paulo.

[300] For further reading on Loureiro's approach to Bernstein see Loureiro (1998) '3.1.2 Primeiro argumento: a organização social da escola' (pp.71-76).

"social organisation and spatial pattern"[301] (Loureiro, 2000, p.5). This correlation is assumed to be not only displayed by "visible", "symbolic" or "functional" variables, but also acknowledged by configuration, in regard to the relations within the spatial structure. In this sense, the correlation between "social attributes" and "spatial patterns" is interviewed by "the relational spatial structure of the building", though "configuration" [302](p.10).

Loureiro then tackles the "social logic of space" (Hillier, 1984) and resorts to space syntax to approach this issue. Final results overlap the opening hypothesis, concluding that space, analysed from its configuration, withstands both "social relations of interaction, encounter, control and surveillance" and also its functional organisation (Loureiro, 2000, p.310)[303].

The educational system as a stage and also an enabler for the production of the society is also confirmed by the OECD, that quotes: "Schools are places of urban cohesion, since they are places where everybody can develop and grow accustomed to a sense of belonging to local society" (Jourda *apud* OECD, 2009).

Furthermore, for its communitarian condition and for the activities that there take place, the school brief can be considered a participated and very lived in place for a wider community (Bingler, Quinn and Sullivan, 2003). It can also be a generator of local and regional centrality that also enables diverse uses undertaken by various users within the school community: students, teachers and staff, but also parents and members of a neighbouring area that occupy the public school spaces with external activities.

Moreover, the school brief is also an appropriate case study for an academic study in the relation between space and use, because of the general patterns of programmed activities on the weekly schedule, combined with the variability of the daily and changeable events that can occur in that space, namely characterised by informality. As for the architect's accountability towards the society when working on the school brief, both Lippman (2010) and Hertzberger (2008) underline its importance:

> "Just as we see learning as second nature and an enlargement of one's

[301] Free translation of the original quote in Portuguese: "O tema mais amplo deste trabalho é o estudo da relação entre organização social e padrão espacial." (Loureiro, 2000, p.5)

[302] Free translation of the original quote in Portuguese: "O argumento da relação entre atributos sociais e padrões espaciais é estendido, neste trabalho, buscando superar, de certa forma, as dificuldades apresentadas na teoria arquitetônica corrente. O argumento central é de que se alguma relação há, ela não se revela ou se esclarece apenas através da ordem visível, ou seja, dos aspectos visíveis, ou simbólicos da forma, aparência ou caráter do espaço, ou pela função, mas sim encontra-se subjacente na estrutura espacial relacional da edificação. O argumento será explorado com o recurso ao conceito de configuração." (p.10)

[303] Free translation of the original quote in Portuguese: "Os resultados da aplicação dos procedimentos dão suporte à pressuposição inicial. Estes apontam para as potencialidades da configuração espacial em dar suporte a relações sociais de interação, encontro, controle, vigilância e outras necessárias para que a função se realize." (Loureiro, 2000, p.310)

> space, it should be second nature to architects to prime space to those ends." (Hertzberger, 2008, p.9)

So, this research is applied to school buildings because they represent a clear example of a space whose features are crucial for the definition of the living experience[304]. They represent a facilitator of experiences and specifically of the learning process, as shown by several authors like Oblinger (2006), Kuh et al. (2006) and Woolner (2015), who also assumes the physical, social and educational role of the school building, as central to its design:

> "[…] schools are both physical spaces and communities of educational and social practices. The relationship of these two aspects of school are vital for its success and are foundational for developing interdisciplinary understandings of school design." (Woolner, 2015, p.10).

Schneider (2002b) explores this relationship between the school space and learning, concluding that: "School facilities affect learning. Spatial configurations, noise, heat, cold, light, and air quality obviously bear on students' and teachers' ability to perform." (Schneider, 2002b, p.16). Additionally, the author also concludes that building age is not itself a definite criterion that impacts student performance, and that small school dimension holds a constructive feedback, whereas small class size is still indeterminate because it involves more classes or potentially more schools (pp.16-17). On another article published in the same year, Schneider (2002a) addresses specifically public schools from Washington and Chicago and reaches similar outputs:

> "This study confirms that poor facilities contribute to the high turnover rates endemic to central urban school districts; in turn, high teacher turnover leads to increased recruitment and training efforts that drain schools of financial and human capital, both of which are essential to educational success." (Schneider, 2002a, p.21)

In fact, both physical and psychological features are recognised as proven catalysts for the learning process. Moore and Lackney (1994) study the school space with the students' performance both focusing not only on the built environment concerning its materials, textures, technical requirements, soundproofing, lighting, thermal conditions, configuration, proportion, area, or integration / segregation of spaces; but also regarding space as a mediator of psychological, social and educational inter-relations that are also influential to student performance as "mediating variables". These authors established a theoretical model between physical "independent

[304] The presentation of the case study, as an example of the significance of the living experience to the design, has already been published in a peer review journal as: Coelho, C. (2015). The Living Experience as a design content: from concept to appropriation. *Ambiances Review, International Journal of Sensory Environment, Architecture and Urban Space [En ligne]. Experiential simulation.*

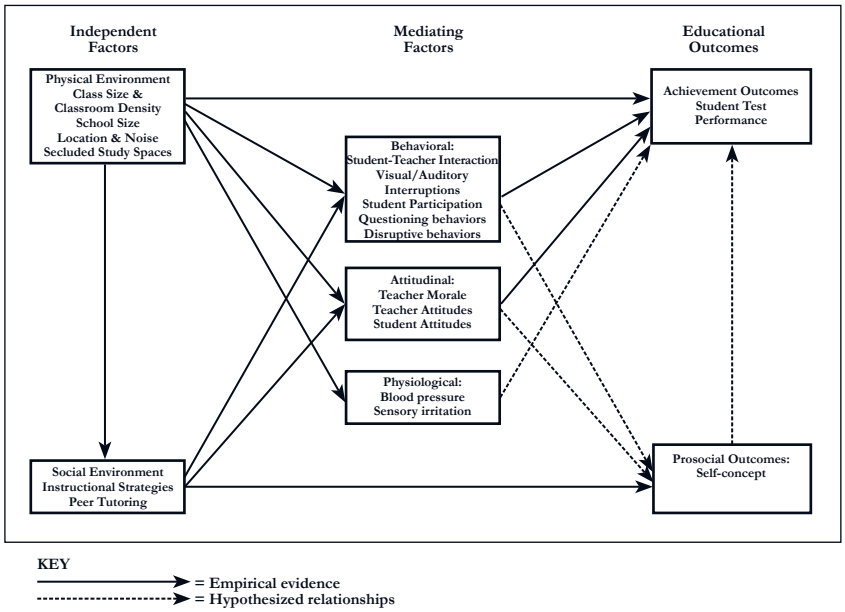


Fig. 63. "A mediational-interactional model of environmental factors affecting educational outcomes" (Moore and Lackney, 1994, p.15) (edited)

factors", behavioural "mediating factors" and the "social environment" with its respective pedagogical practices, in their mutual interconnection and towards an "educational outcome" (Fig. 63):

> "[…] the physical setting, in addition to more familiar psychological and social variables, has both direct and mediated affects on prosocial and achievement outcomes, the conventional bottom-line quantitative measures of educational performance." (Moore and Lackney, 1994, p.13)

Scott-Webber (2014) uses a Venn diagram to associate pedagogy, space and technology (p.163) in a "holistic ecosystem" that establishes affordances between the three. In its central position is "active learning", embedded from the three (Fig. 64). This diagram represents the "Active Learning Ecosystem framework" conceived to "bring together disciplines from pedagogy, technology, and space in one place to develop intended design solutions supporting the learner, the learning, and the learning place for the learner of this 21st century" (p.166). Overall, this framework is significant because it establishes associations individually between education, space and technology and amongst all towards active learning, which implies its reconsideration anew.

Peatross and Peponis (1995) explore the link between space and education from a configurational perspective, analysing space "not only as a dependent variable reflecting pedagogical principles, but also as an independent variable capable

Fig. 64. "Active Learning Ecosystem framework"
(Scott-Weber, 2014, p.163)

of generating its own pedagogical effects" (Peatross and Peponis, 1995, p.367). Grounded on Bernstein's (1975) knowledge transmission and Durkheim's (2014[305]) "mechanical" and "organic solidarity", Peatross and Peponis analyse space's configuration towards encounters and density, and foremost its weight on "pedagogical patterns" and "socialization" (p.379)[306]:

> "Our argument, to be developed shortly, is that space not only reflects the educational system at hand, but also affects the spatial pattern of socialization in such a way that these pedagogical codes may be shifted." (Peatross and Peponis, 1995, p.369)

Therefore, pedagogical developments in the schools' curricula and in the learning process, along with social changes from the profiles of the school community from the students, educators, school board, staff and parents, besides the on-going technological achievements, all imply rethinking the learning process and the learning spaces, reconsidering them at several levels like their configuration, technology and materials.

. The evolution of the learning practices and the spatial implications

The teaching-learning practices that guide the 21st century will now be addressed, assuming a new educational paradigm in its direct relation to the school space, not aiming at an exhaustive study of the pedagogical evolution to this day, but the assumption that current learning practices differ from previous ones and imply specific spatial requirements:

[305] Consulted edition from 2014, original French edition from 1893.

[306] For that purpose the authors resort to space syntax approach to two case studies.

> "Education [...] is exposed to rapid and profound changes... [...] The material infrastructure of education - the places and spaces where we learn and teach - has an important role to play in both participating for change and adapting to it."[307] (OECD, 1996, p.xi)

Gaffney et al. (2008) recognise this "educational reform" where interaction plays a relevant role[308] and Heitor and Pinto (2005) stress that this change deeply impacts "school environment":

> "Developments in educational research place stress upon conventional school buildings and their design, suggesting that school environment in the 21st century will be radically different from that of the 20th century [...]" (Heitor and Pinto, 2005)

Thus, it will be important to study how these pedagogical practices are processed today, in what way and by what means; their implications in the design of contemporary school space; and the interrelations between space and pedagogy.

In 1857 William Henry Knight paints *The Village School* (England, 1857) (Fig. 65a) depicting a school scene where the teacher holds a cane to punish his student. Another example of a similar school scene from the same time period is Albert Anker's 1848 portrait of a classroom (Fig. 65b) in a German village, where students are separated by gender and the male students are in the front (Kühn, 2011, p.20).

This scene is appropriate to depict the profile of the student of the industrial age: the dedicated, efficient and uncritical worker, educating "people who could efficiently operate within a system without questioning it" (Kühn, 2011, p.20). Today, the passive theoretical exposition and the rigidity of the hierarchical teacher-student relationship have been replaced by the students' ability to built their knowledge, decentralised from the classroom and the teacher (Fig. 65c).

Vygotsky's (1978) concept of "interpsychological"[309] defines the child's development to be socially engaged[310]. This could be thought in terms of spatial dynamics,

[307] Free translation to English from the French quote: "L'enseignement [….] est exposé aux aléas de changement rapides et profonds. […]. L'infrastructure matérielle de l'enseignement - les lieux et les espaces dans lesquels on apprend et on enseigne - a un rôle important à jouer à la fois pour participer au changement et pour s'y adapter." (OCDE, 1996, p.xi). Consulted edition in French OCDE - Organisation de Coopération et de Développement Économiques.

[308] "Over the years, quite a few pedagogical advances have been demonstrated to work effectively […] The common factor in most of them is interaction." (Gaffney et al., 2008, p.18)

[309] "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals" (Vygotsky, 1978, p.57)

[310] See also Piagte's approach (Piaget, 1948, 1971, 1975).
For further reading on Vygotsky's and Piaget's approaches to the child's "construction of the arithmetic knowledge for addition and subtraction operations" (free translation from the original Portuguese abstract

Fig. 65. a) *The village school*, by William Henry Knight, 1857
(Image's source: www.leicestergalleries.com/19th-20th-century-paintings/d/william-henry-knight/10393)
b) *The village school in 1848*, by Albert Anker, 1896
(Located on the Kunstmuseum, Basel. Image's source: www.the-athenaeum.org/art/full.php?ID=111125)
c) Titaan College Hoorn (NL), 1999-2004, by Herman Hertzberger
(Mccarter and Herzberger, 2015, p.219)

assuming that spaces for group gathering and social interaction are significant to be accounted for in children's learning spaces, which emphasises the widening of the learning moments from seminars and content endowment activities, towards group engagement and socio-cognitive interaction.

Wenger (2000) also argues for learning to be socially situated: "knowing is an act of participation in complex 'social learning systems'" (p.226) and the learning process is bounded by the "competences" provided, but also by our social context and our own "experience" [311] and changes along with them:

> "Learning so defined is an interplay between social competence and personal experience. It is a dynamic, two-way relationship between people and the social learning systems in which they participate. It combines personal transformation with the evolution of social structures." (Wenger, 2000, p.227)

Therefore, learning may occur on the interface between people and it is the

of Maria da Conceição Ferreira's Doctoral Thesis, 2003), see Ferreira (2003, 2008, 2010) and Ferreira and Fernandes (2012).

[311] "Knowing, therefore, is a matter of displaying competences defined in social communities. […] Socially defined competence is always in interplay with our experience. It is in this interplay that learning takes place." (*ibid.*)

gathering of people and the sharing of their knowledge that enable "communities of practice". These are considered: "[…] the basic building blocks of a social learning system because they are the social 'containers' of the competences that make up such a system." (Wenger, 2000, p.229).

Also according to Wenger, they enable learning based on "three elements": the mutual relation between all members of the community which makes each member intending to "contribute" to it, the interactions between the members produce a "mutual engagement" and all have a "shared repertoire of communal resources" that enables them to communicate (*ibid.*). This could be applied to school, recognising that students may constitute "communities of practice" between their peers and within those moment of interaction, learning occurs. If their meeting implies learning, then it can happen not only in the classroom, but also in informal spaces where students can actively socialise.

From the previous understanding of "communities of practice", schools may be understood as places that shelter those communities, defined by Lippman as "learning communities" and classrooms as "learning centers", as a "learner-centered environment" (Lippman, 2011, p.22). Within these environments and before this learning context, the educator passes from "content provider" to "facilitator" and is no longer the sole vehicle for knowledge (*ibid.*) (Fig. 66). It could be added that if the communities may change their members, from students, to faculty and staff, the environment "must therefore also be designed to accommodate and support these transformations" (*ibid.*), which leads to a pressing urge for adaptability applied to "learner-centered environments".

This concept is also addressed by Bransford, Brown and Cocking[312] (1999, pp.133-136) in *How people learn: Brain, mind, experience and school*, seeking to suit the spaces in an individual manner per student and not generically for all:

> "Overall, learner-centered environments include teachers who are aware that learners construct their own meanings, beginning with the beliefs, understandings, and cultural practices they bring to the classroom. If teaching is conceived as constructing a bridge between the subject matter and the student, learner-centered teachers keep a constant eye on both ends of the bridge. The teachers attempt to get a sense of what students know and can do as well as their interests and passions – what each student knows, cares about, is able to do, and wants to do." (Bransford, Brown and Cocking, 1999, p.136)

Additionally, informality represents a significant feature of contemporary learning,

[312] "We use the term "learner centered" to refer to environments that pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to educational setting." (Bransford, Brown and Cocking, 1999, pp.133-134)

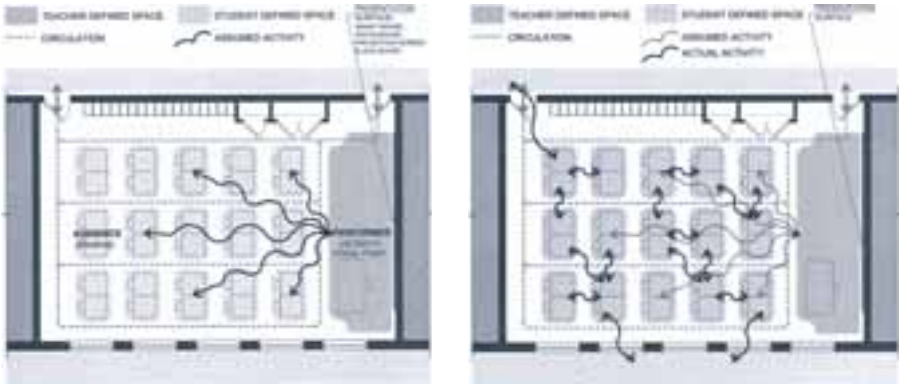


Fig. 66. "Secondary environment: the layout of the traditional classroom where the teacher is the performer/local point of the learning environment." Vs "Potential activities occur routinely in a traditional classroom where the teacher is the performer/local point of the learning environment."

(Lippman, 2010, pp.13-14. Authors: Peter Lippman and Marius Calin)

accommodated in also informal spaces beyond "the formal instructor-facilitated setting" of the classroom, such as "libraries and physical spaces that facilitate group and individual academic activities and computer-assisted learning". Informal spaces and technological devices and practices overall bring changes regarding the space, as "physical" and "virtual"; the learning moments, as programmed or "flexible" and "individually selected by the learner"; and the "content of learning", as embedded in the curriculum or "self-directed" (Hunley and Schaller, 2006, pp.167-168). This implies that space can be both formal and informal, the activities can be programmed or non-programmed, and learning can be accomplished by both curricular and extra-curricular activities[313].

From the assumption that learning can occur outside the classroom, Lippman (2010) refers to "primary" and "secondary environments", in which the first holds a more recurrent and engaged experience of learning, and the latter a more spontaneous, occasional and "anonymous" one[314] (Lippman, 2010, p.11).

Thus, knowledge can be provided also in "secondary environments", implying that a variety of spaces are added to the formal classroom, which also enables these "communities of practice". Thinking about these spaces in a gathered way and also expanding them to each one's "neighborhood" is paramount to understand the school facilities, holding a broad range of learning activities[315]. Still, these must

[313] The differentiation between learning activities but also its overall consideration as learning moments will be central for the entropy analysis of the proposed methodology that categorises these activities. See chapter 4.2.2. Description of all possible activity allocations to educational environments.

[314] "*Primary environments* promote opportunities for people to meet regularly, develop personal relationships, and participate in a variety of fundamental goal-directed activities. *Secondary environments* are places where the relationships are essentially temporary and anonymous (Stokols, 1999)" (Lippman, 2010, p.11) (Italics from the original quote).

[315] "School environments must not only have the qualities of religious institutions and community centers but

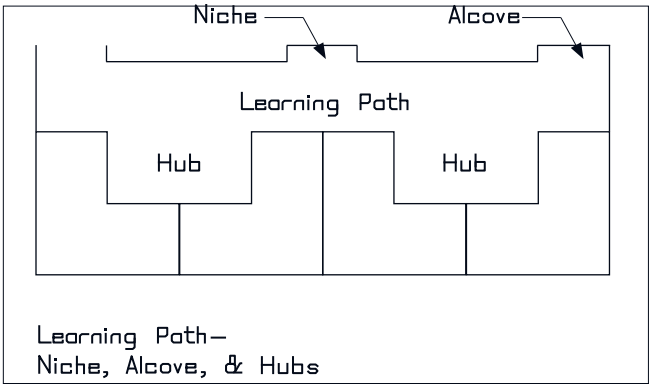


Fig. 67. "Learning Path – Niche, Alcove, & Hub"s"
(Lippman, 2002, p.5) (edited)

be thought as a "layered environment" that gathers corridors and classrooms in a whole space and that shelters that diversity of activities:

> "Classroom spaces promote passive engagements […] If students are to acquire practical skills, the organization of both corridors and classroom spaces need to be reevaluated as layered environments that promote individual, one-to-one, small-group, and large-group transactions […]" (Lippman, 2010, p.13)

Considering learning beyond secluded and formal spaces, circulations also embody a relevant role that exceeds movement and grasps informal learning and "transactions" as a "learning path". Lippman (2002) acknowledges them as "activity settings that are integrated, flexible, and mediated systems" (p.5). These can also be punctuated by "niches, alcoves, hubs and nodes"[316] (Fig. 67), which can display furniture like chairs, tables or technological devices, available for group and individual learning activities, extending learning activities outside the classroom, so that "[…] the scientific knowledge gained in the classroom may continue and extend the appropriation of knowledge as individuals transact within the school setting" (*ibid.*).

Boys (2011) in his book *Towards creative learning spaces: Re-thinking the architecture of post-compulsory education* claims that rethinking the "conceptual framework" of

also must provide a variety of learning opportunities for the diverse ways in which people acquire knowledge [...] Unfortunately, most learning environments have not been designed to address the variety of ways in which people acquire knowledge and master skills […]" (Lippman, 2010, p.12).

[316] Lippman explains the difference between these spaces, which is displayed in the figure. Niches hold high relevance for our current Thesis and will be considered further on, because the case study chosen: Quinta das Flores School, holds several niches along the main corridors in both the first and second floor plans. See 4. Application of the methodology in the case study.

learning spaces implies a full consideration not only of formal and informal spaces, but a wider assumption of teaching and learning practices that these comprise, concerning: "widening participation, communities of practice, inclusive pedagogies, business and community engagement, entrepreneurship, research and consultancy, new technologies, health and wellbeing, resource-effectiveness and sustainability." (Boys, 2011, p.5) Indeed, all these parameters could be critically reflected upon in their relation to a comprehensive concept of school space. The overall learning space is translated onto environments that hold this broad learning experience, where practice, group gathering and creative thinking are perceived as significant for learning and for educational spaces.

Engaging the community or focusing on participation is also a stressed subject by literature, which considers a participated design as more appealing one, and enabler of a more comprehensive space use and of a higher sense of belonging. Besides, the broader participation of the community also affords a more operative and "resource-effective" use of the school facilities, widening its activities and foremost its users. Naturally, the wellbeing of this community has to be considered, providing physical and emotional comfort to its users within space. Finally, the use of ICT (information and communication technology) is paramount to recognise the current learning and socialisation modes that also report to spatial practices and use patterns.

All in all, these represent relevant components of contemporary learning practices to be thought in a holistic manner, by means of a full and comprehensive gathering of learning moments and not by restricting these activities to contrasting scenarios, or simply by perceiving the learning practices as opposing formal and informal activities. Boys expresses the first as "and/and" situation and the latter in the sense of "either/or" (Boys, 2011, p.6) (Fig. 68).

According to Boys, more than a representation of learning that provides meaning by what is perceived, space also enables physical and emotional stimuli to its users, besides the social meaning that it conveys and the attitudinal and cultural knowledge it affords (Boys, 2011, p.10), recognising that: "Space is therefore one of our means of thinking about the world and of embodying thought into action." (p.6).

The belief in this learning model is anchored in predecessors such as John Dewey - in the development of the students' capacity for reasoning and criticism; Maria Montessori and the Montessori Method - which encouraged the primacy of student activity and individuality for the parallel development of the body and the intellect; and Helen Parkhurst and the Dalton Plan - which provided specific training for each student according to their interests and abilities.

a) b)

Fig. 68. a) "Formal and informal learning spaces shown as a pattern of 'either/or' binary oppositions and associations"; b) "Learning space shown as a pattern of 'and/and' encounters and practices" (Boys, 2011, pp.5, 7) (edited)

In fact, today's student profile is more creative, reflective and capable in the network of relationships. It has the capacity to deal actively and responsibly with the new situations and contexts of change, through its capacity for decision, criticism and initiative. Besides, the teaching-learning practice is more "individual-based", focusing on individual profiles and specificities (Hertzberger, 2008, p.8).

At the same time, in the 1980s, the changes brought about by the rapid technological advances in the field of new information technologies became a preponderant theme for the design of the school space, which now integrates the *non-face-to-face* component (Figs. 69a, b).

Besides, the book, today, is no longer the only learning tool, nor the memorisation of facts the only teaching paradigm. From the new information technologies as a vehicle of knowledge, the available information is immeasurable, which implies a new conception of space to house digital information terminals as well as technical requirements on the most demanding physical spaces:

> "Through the application of information technology, today's learning spaces have the potential to serve the new learning paradigm and at the same time meet the needs and expectations of the most recent generation of students: the Net Generation[317]." (Brown, 2005, p.174)

Furthermore, learning also occurs within the network itself, 'spaceless' or spread along diverse learner-centred environments, not necessarily on the same room

[317] Oblinger and Oblinger (2005) refer to "net generation, while OECD (2012) refers to "digital generation".

a) b)

Fig. 69. a) "Contemporary thought about learning and teaching', division, Orphelinat (orphanage National des Chemins de Fer, Colonie d'Avernes, France, c. 1920"
(Burke and Grosvenor, 2008, p.11) (edited)

b) "Wireless Laptops Provide Information Access and Clearer Sight Lines"
(Oblinger, 2006, p.224, Photo: Andrew Nolte ©2005 Estrella Mountain Community College)(edited)

or on the same building. Indeed, technology enables higher "connectivity" or "connectedness", as the "ability to link with others" by means of "dedicated networks, fixed or mobile, or through the Internet"[318]. This provides a wider or newer network for social interaction and the gathering and communication of new or existing information (OECD, 2012a, pp.16-17).

Brown and Lippincott (2003) concur with this assumption, stating that traditional classrooms are not the sole space for learning, which implies the consideration of a more holistic concept of "learning spaces" and that the concept of classroom *per se* is progressing for handling with a "new functionality", mostly due to new learning practices and new technology that comprise learning in groups beyond the classroom:

> "In the past, if you spoke of something like "learning spaces" in the context of higher education, attention focused on classrooms: physical spaces designed to support face-to-face teaching and learning. […]
> While classrooms can still be regarded as our core learning spaces, it is obvious that a host of new factors and opportunities has dramatically changed this landscape. Indeed, so much is changing that we are forced

[318] According to OECD (2012a) technology referred in the 1980s to information technology, such as computer and applications like "word processing, database management and calculation", then it spread to "devices intended to digitally support media, such as laser discs and DVDs" and it then expanded with the Internet in the middles of the 1990s to "all technologies and applications intended to support communication and provide access to digital information and media", which has also been widened to online access through mobile phones. All in all, according to OECD, "information and communication technologies" include: "computers, networks, mobile phones and all the hybrids or new technology developments such as smart phones, tablets, digital paths or netbooks as well as the applications that can be run on them." (OECD, 2012a, p.16).

> to use a broader term like learning spaces to capture this wider range of venues for teaching and learning. Focusing just on classrooms is no longer an option." (Brown and Lippincott, 2003, p.14)

This will bear influence for the design of physical spaces and their technological requirements, but also the teaching-learning practices and the relation between various environments within the building and amongst several schools:

> "Multiuser virtual environments and ubiquitous computing will allow users to move beyond the desktop interface to much more immersive environments that enhance learning. In turn, learning styles will evolve based on mediated immersion and distributed learning communities. [Chris] Dede details the implications of neomillennial learning for investments in physical facilities, technology infrastructure, and professional development." (Oblinger and Oblinger, 2005, p.9)

All things considered, the knowledge provided to the students in the classroom may be evaluated and communicated in other spaces. So learning spaces regard the way in which they enable or hinder this knowledge transference, spatially and socially located. Hertzberger puts it in a very clear quote: "new forms of learning will require new spatial conditions alongside the traditional teacher-fronted lessons." (Hertzberger, 2008, p.8)

With the changes in educational methods and in the space where they take place, today's learning areas are amplified for the development of activities beyond passive exposure, such as group work, individualised learning and the creation of networks of relationship between students and subjects. According to Kühn (2011) the space that held 60 students in the 19th century with the premise: "one square meter per child, one-and-a-half square metres for the teacher and one-and-a-half square meters for the stove" (Kühn, 2011, p.20), today allows the allocation of 25 (*ibid.*).

Gradually, the classroom ceased to be the unique centre of education (Fig. 70a), being rethought at the formal, material, environmental and pedagogical level in its relation to the whole (Fig. 70b), as proven by different configurations of the school spaces in the Darmstadt (1951) and Marl (1957-58) schools by Scharoun. This is specified by Alegre (2009):

> "A more detailed analysis of the evolution of its spatial characteristics, enables the identification of the levels in which changes occurred: at the formal level with the change on the dimension of the space and on its geometric configuration, traditionally of rectangular plan;

a) b)

Fig. 70. a) Photo from the exhibition on the "100 years of Heritage: memory and identity – Portugal 1910-2010", in Palácio Nacional da Ajuda, Lisbon, 2010, coordinated by Jorge Custódio (Luís Miguel Correia)

b) Informal spaces for learning: creative learning and group interaction (OECD, 2011, p.12)

> in terms of habitable conditions, with improved natural lighting, transversal ventilation, and heating; at the level of the opening of space from the classroom to the outside; and at the level of the functional organisation of space, expressed in a greater spatial flexibility, enabling new groupings of students and new uses of space. The redesign of school furniture adapting it to the scale of the child and to the new pedagogical guidelines, was, also, decisive in the conception of this new spatiality. "[319] (Alegre, 2009, pp.82-83)

The diversity of the students is enhanced by the diversity of teaching-learning methods and consequently by the diversity of spaces to accommodate them. Thus, the spaces assume different configurations according to the variability of uses such as: spaces that allow the discovery and the independent creation of knowledge; spaces for group work and knowledge sharing; spaces for lecture and knowledge exposition; spaces of knowledge evaluation; spaces of social encounter and spaces of individual reflection; multipurpose spaces and specialised spaces; and predominantly non-curricular spaces and informal spaces, where the socialisation also enables learning:

[319] Free translation of the original quote in Portuguese: "Uma análise mais detalhada da evolução das suas características espaciais, permite identificar em que níveis incidiram estas alterações: a nível formal com a alteração da dimensão do espaço e da sua configuração geométrica, tradicionalmente de planta rectangular; a nível das condições de habitabilidade, com a melhoria das condições de iluminação natural, de ventilação transversal, e de aquecimento; a nível da abertura do espaço da sala de aula para o exterior; e a nível da organização funcional do espaço, expressa numa maior da [sic] flexibilidade espacial, possibilitando novos agrupamentos de alunos e novos usos do espaço. O redesenho do mobiliário escolar adaptando-o à escala da criança e às novas orientações pedagógicas, foi, também, determinante na concepção desta nova espacialidade." (Alegre, 2009, pp.82-83) (Underlined text from the original quote)

> "The emergence of the constructivist learning paradigm has led to a focus on learning rather than teaching. It allows us to revaluate classrooms and to consider informal learning spaces as loci for learning. If learning is not confined to scheduled classroom spaces and times, the whole campus - anywhere and at any time - is potentially an effective learning space." (Brown and Long, 2006, p.116)

A report from the National Survey of Student Engagement (NSSE) 2003 on Boise State University (Belcheir, 2003) already demonstrated that students' learning was perceived by the individual creation of knowledge, the independent search for sources to assemble in the students' work, a students' profile set by critical thinking and inquisitiveness and group discussion were some of the most relevant activities that students considered to be a part of their learning process. From the 305 students that participated in the survey, it as found that: "Working on papers or projects that required integration of ideas from a variety of sources, asking questions in class, and discussing ideas from classes outside of class were reported by both freshmen and seniors as some of the most frequent activities that impacted learning" (Belcheir, 2003, p.1). According to Belcheir, this is considered to be frequent in urban institutions and not specific of this school's feedback (*ibid.*).

All in all, contemporary learning practices enclose the use of new technologies for knowledge acquisition, study and evaluation; informal spaces not defined by the boundaries of their walls and the contents exposed within classes; socialisation as a means for communication and peer interaction; and active and creative activities, all with learning potential. This results overall in new student and educator profiles and the acknowledgement of new contexts where the teaching-learning process can occur.

From these changes derive respective spatial models and design options for the learning environments, and also a research for concepts and solutions *per se* that respond and enhance those practices and that change. The space in which teaching occurs recognises a new profile as "learner-centered environments" (Bransford, Brown and Cocking, 1999). The passive theoretical lecture and the rigidity of the hierarchical teacher-student relationship have been replaced by the students' empowerment to build the knowledge, decentralised from the classroom that gradually ceases to be the sole learning space. Learning environments accommodate the creation, sharing, exhibition and evaluation of knowledge, as well as social encounter and individual reflection.

At the same time, and as seen, the changes brought by the rapid advancement of new information technologies are predominant for the design of the school space, which now integrates the "Net Generation" component (Oblinger and Oblinger, 2005) and its technical requirements.

Thus, changes in the school space and its characteristics such as morphology, acoustics, temperature, lighting and air quality play a preponderant role as mediator of psychological, social and educational interrelationships and the uses of the community. These transformations, compared to new forms of teaching and their impact on learning, also determine their relevance as an investment factor, "providing an anchor for social revitalisation and economic development" (Heitor, 2011b, p.35).

. Contemporary learning practices and the concept of adaptability

The previous recognition that new pedagogical strategies imply rethinking the use, the configuration and the location of the learning spaces is also supported by Brown and Long's (2006) quote:

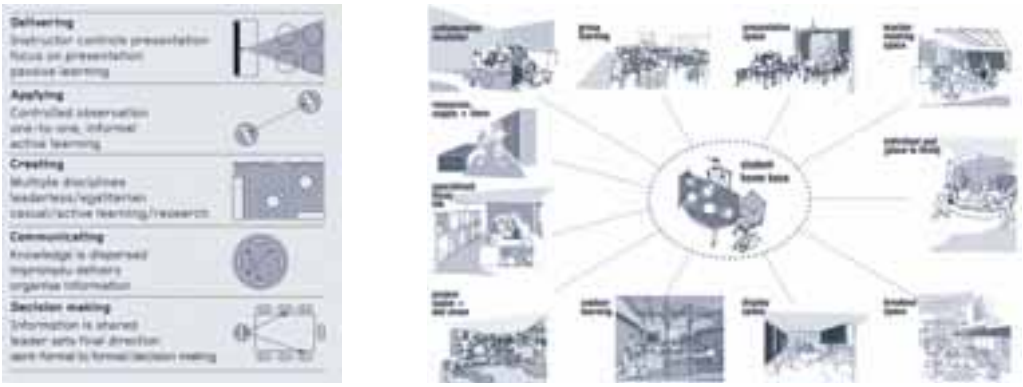
> "New strategies for enabling learning and accommodating the multiple demands on student time have led to rethinking the use, design, and location of learning spaces." (Brown and Long, 2006, p.116)

Besides, this contemporary learning paradigm implies not only a reconsideration of the classrooms, but also of the overall school space and the acknowledgement of other active learning environments that "support mobility", "enrich pathways, by […] providing opportunities for creative interaction" and "blend and blur activities" (Worthington, 2007, p.18).

Overall, and as already seen, the contemporary learning experience contemplates formal and informal activities occurring in formal and informal spaces in the school. Activities such as group work, formal classes, group presentations, evaluation moments and general conferences, besides socialisation and peer interaction (both in scheduled events during classes, as well as in spontaneous meetings decentralised from the classroom), all represent moments of a thorough learning experience. Thus, each of these activities implies specific spatial features (Fig. 71a), which will have to be accounted for in the existing and future educational buildings. In fact, today's schools bear mixed curricular options that add further complexity to the design (Fig. 71b).

Accordingly, adaptable learning spaces accommodate a more extensive range of activities and users, which are able to cope with curricular, technological and social changes in a long-run, by lessening the frequency of future interventions in the built object due to its pre-perceived provision in the design[320].

[320] An initial explanation of the adaptability methodology developed in this Thesis has been explained in the *3rd International Symposium Formal Methods in Architecture*, in 30 November - 2 December 2016, with further publishing of the paper on which the communication was based. It will be published as: Coelho, C. (in publication). A Gathered Methodology Towards Enhancing Adaptable Learning Spaces. In D. Viana, F. Morais, J. Vaz (Eds.).



a) b)

Fig. 71. a) "Linking pedagogy and space"
(Fisher, 2006, p.17 Source: Fisher, K, TEFMA Seminar, Brisbane (March, 2005) and Christchurch (July, 2005), adapted from Scott-Webber (2004)) (edited)

b) Learning settings
(Fisher, 2005a, p.10)

The school brief has been the subject of several publications and architectural studies by different authors like Sanoff (North Carolina) (2010, 2007, 2001, 2000, 1992), Hertzberger (Delft) (2010, 2009, 2008, 2000, 1991), McCarter and Herzberger (2015), Lackney (Wisconsin-Madison) (2003, 2001; Moore and Lackney, 1994) and Fisher (Australia) (2007, 2006, 2005a, 2005b, 2001). It has also been the main subject of several and relevant academic events (OECD, 2009; OECD/CELE 2009; OECD, 2005a, 2005b; Séminaire à L'élargissement des Fonctions des Batiments Scolaires, 1996).

All in all, school buildings are being rethought, not only at a national level by the Secondary School Modernisation Programme in Portugal, but also internationally, by similar programmes and renown international institutions, like the American Schoolworks, composed by mediators that support the school communities for a participated experience in the school environment, besides the English 'Building Schools for the Future' (Department for Education and Skills, 2003; National Audit Office, 2009), the Scottish 'Building our future' (Scottish Government, 2003a, 200b) and the American National Clearinghouse for Educational Facilities (Bingler, Quinn and Sullivan, 2003; Nair and Fielding, 2005)[321].

Autonomously, the discipline of Architecture has been currently exploring the dichotomy of space and use, in the search for answers and the conceptualisation of methods that answer both today's and tomorrow's needs by means of adaptable solutions to the current issues and the possibility of future change.

Formal Methods in Architecture and Urbanism. Cambridge: Cambridge Scholars Publishing.

[321] This is also referred in Veloso, Sebastião, Marques and Duarte (2015, p.71).

In the book *Linking architecture and education: Sustainable design for learning environments*, Taylor (2009) ponders on the relevance of this dyadic relation between "architecture and education", which could be deepened during the programming stage for architects and stakeholders[322]:

> "Inclusion of stakeholders in the programming process from the beginning helps participants see the planning and design process as an organic whole. Discoveries made in early programming later form the basis for the design, usage, and assessment of the learning facility upon completion. Linking architecture and education at each stage of the planning and design process also provides a new value system for determining the worth of different elements of the project, especially in light of budget constraints. […] " (Taylor, 2009, p.120)

Taylor resorts to Preiser to advance on the needs architecture should fulfil related to "body, mind and spirit" towards the "habitability". Physically, space needs to be healthy and safe, prevented from using dangerous elements, economic and environmentally suitable and land use concerned; in regard to the mind, space needs to focus on "adequate space, spatial relationships, adjacency, and communication systems" and also on the role of technology[323]; to be psychologically effective space has to be concerned with aesthetic, colour, lighting, sensitiveness, cultural context, … amongst other requests (Taylor, 2009, p.121) (Fig. 72). This is central to acknowledge educational architecture's programming as important for future stages and also to recognise learning and cognitive prerequisites and comfort requirements in a congregated process along with physical requests (p.122). All these contribute for "good design" with bettered habitability, which is relevant for schools where children's bodies and minds are being developed[324].

By and large, these cannot be tackled on the programme by fixed models, even if standards can act as regulator of the requirements, but those needs have to be critically and contextually analysed and within a gathered and participated process with the users:

> "Qualitative standards for architecture that truly support school function, learning, and student happiness are not necessarily built into codes and educational specifications. Architectural adequacy standards establish the acceptable levels for the physical condition, capacity,

[322] "The programming process can educate all stakeholders about the true educational value of well-constructed schools." (Taylor, 2009, p.120)

[323] "Technology, spaces that support changing educational delivery systems, multiple use, flexibility, adjustable lighting, storage, and deployability and ergonomics of furniture also support performance. An environment rich in cues or prompts for learning [...] supports learning, the mind, and cognition." (Taylor, 2009, p.121)

[324] "Their spirits suffer when learning environments are dirty or in disarray, in need of repair, too large and impersonal, devoid of local culture or sociable elements and locked away from community, or lacking spaces for individual reflection and privacy. Time spent in poorly designed and unhealthy portables also sends a negative message. Good design responds to these threats to the habitability of learning environments." (p.125)

Fig. 72. "The Habitability Framework: Transfer of Maslow's Levels of Human Functioning to Habitability Levels of Architecture"
(Taylor, 2009, p.133 © 2007 Anne Taylor Associates)

> educational suitability, and technological infrastructure of school buildings. Standards are vital for their "watchdog" function and for the basic safety and access they provide for the users of public buildings. Unfortunately, in the interpretation of standards, square footage and efficiency have been set up against imagination and creativity, as if the two viewpoints were completely incompatible. More needs to be done to connect school facilities design to educational best practices and user satisfaction, and we need to expect more of all participants in the planning process." (Taylor, 2009, pp.121-122)

Within this comprehensive approach to educational spaces and the "link" between architecture and education, Taylor also remarks the relation between the "community and the learner" (Taylor, 2009, pp.247-275)[325]. Schools can be a physical and social aggregator, attracting the community to its facilities and learning environment, in such a way: "Schools are a part of, not apart from, community." (p.247). In this sense, these are also embedded in the cultural and social context of that community and reflect it within space and by the activities, events and experience that its space holds.

Schools can engage a larger community or can even welcome external users after the curricular schedule, as "mixed-use facilities" (Taylor, 2009, p.248); or hold relevance towards its "neighborhood revitalization" by means of "retrofitting schools and adaptive reuse of existing community facilities" (p.249) and for improving its land use and urban representativeness[326]. Taylor addresses the concept of "total community" widespread beyond its physical premises and students:

[325] This can be related to Bernstein's studies previously analysed at the beginning of this chapter.

[326] Both these situations occur in the present with Quinta das Flores School, the case study of our current Thesis.

> "It is time to dissolve the literal and figurative walls that isolate schools from their communities. The total community is an interdisciplinary environment that can be seen as a treasure chest of learning manifestations and educational resources." (Taylor, 2009, p.247)

This is also taken up by Bingler, Quinn and Sullivan (2003) in *Schools as Centers of Community: A Citizen's Guide for Planning and Design*", in which schools can play this role when: "They more effectively integrate with the community, or they extend the learning environment to use the community's full range of resources." [327] (Bingler, Quinn and Sullivan, 2003, p.3). According to these authors "the learning environment should be flexible and adaptable" to changing needs that answer to shifting community requirements, evolving learning contents and practices and emerging technologies (p.13). These constraints will imply the reconsideration of educational spaces and cannot be compelled to a strict solution (*ibid.*).

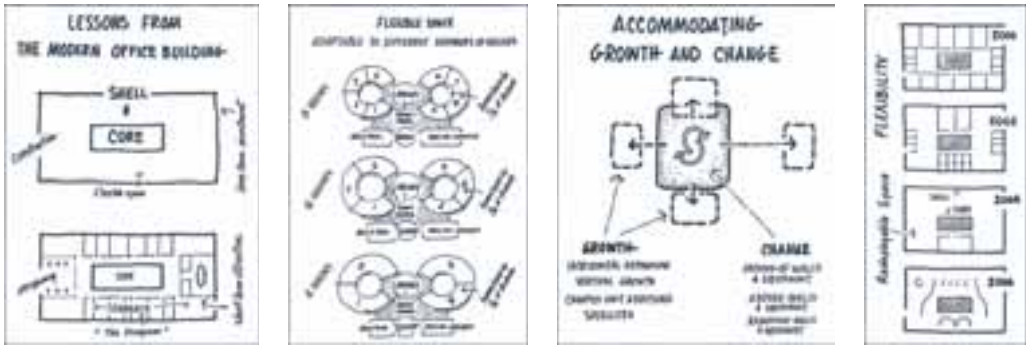
Consequently, the concept itself of adaptability applied particularly for this brief, becomes quite significant, having already been interpreted by a broad range of authors and applied to different briefs, such as dwellings (Habraken, 1972; Rabeneck et. al., 1974), hospitals (Cowan, 1963) and office buildings (Duffy and DEGW, 1998)[328].

Particularly, on educational spaces, adaptability assumes extensive significance, during the design process, but also along all the building's lifecycle through individual or collective appropriation. Indeed, the possibility of a school to be adapted to future uses, and yet still unpredictable needs, while evolving along with them, will provide a thorough spatial answer from the building, will have impact on student achievement and will represent a more sustainable and lasting investment for longer.

In the book *Planning and Designing Schools*, Brubaker (1998) addresses architects' concerns on the forthcoming needs of schools and users that are still unforeseen by tackling adaptability and flexibility from previously experiences in office buildings (Fig. 73). Brubaker assumes that flexible spaces are "open and not irrevocably committed to only one plan of rooms" and that their "mechanical and electrical systems are easily modified to satisfy new needs" (Brubaker, 1998, p.33). Schools could either be newly designed or provided by adaptive research-use, but all should embrace future uses, which could be related to future changes into another building

[327] "At their best, schools that serve as centers of community should:
• Help meet a community's leisure, recreational, and wellness needs
• Be accessible to people of all ages
• Encourage more active parental involvement in school activities
• Support relationships with local businesses that are productive to students and supportive of the local economy
• Promote participation by members of the community in a variety of ways […]
• Be places where creative space configurations expand school use, where learning occurs after school […]" (Bingler, Quinn and Sullivan, 2003, p.8)

[328] See chapter 2.1. Adaptability: definition and adjacent concepts.



a) b) c) d)

Fig. 73. a)"Flexible space between outer shell and inner core"; b)"Schools need some adaptable space"; c)"Schools must grow and change" ; d)"Office buildings provide re-deployable space" (Brubaker, 1998, p.32,34)

brief. In this sense: "The school of the future will be planned with future reuse in mind." (p.34)

For designing a school, Brubaker tackles some ideas: the fact that its "form" is determined by the programme set and by its location site (Brubaker, 1998, p.34) and the need for adaptable space "to accommodate a variety of learning styles" within different size rooms (p.35). Schools are also considered places that engage a larger community, and innovation is required to accomplish more "effective" learning (p.37). Despite previous educational experiments, classrooms are recognised as still present in the school design[329], even if different plans can house a set of classrooms: from the "compact gridiron", to the "organic", to the "double-loaded corridor", the "single-loaded outdoor circulation", the "paired classrooms", the "clustered five-sided classrooms", the "hexagonal or octagonal classrooms", the "small house plan", the "medium-size house", or the "open plan" (pp.44-46).

In this book, obsolescence is addressed, suggesting the provision for: social and usable changes, the inclusion of technology, community participation, acknowledging the users, maintenance, supportive and storing spaces and flexible equipment. But it is also deeply related to "the design of flexible learning and teaching spaces" (Bordwell, 1998, pp.151-154). Finally, in Brubaker's "vision and choice for the future" [330] it is concluded that schools need to be individually considered, recognising possible changes on future needs, where both flexibility and adaptability play a major role:

> "Schools, like people, should be one-of-a-kind organisms. They need space that is adaptable to changing needs. They need flexible facilities

[329] "The standard classroom survives. Efforts to change it, cluster it, add technology, subdivide and reconfigure it, and reshape it have met with some success, but the classroom for thirty students (or for twenty-eight or twenty-four or twenty) still exists in almost all public and private schools." (p.44)

[330] Title of the last chapter of the book (Brubaker, 1998, pp.191-194)

> that can, at a minimal cost, be converted from classrooms to seminars, to individual study space, to study rooms for five students. Architecture for education should facilitate the evolution of future schools." (Brubaker, 1998, p.192)

In the publication *The Impact of School Environments: A literature review* (Higgins et al., 2005) it is concluded that school's physical provision impacts educators and students, specifically: "[…] inadequate temperature control, lighting, air quality and acoustics have detrimental effects on concentration, mood, well-being, attendance and, ultimately, attainment." (p.36), as previous literature references had already established. Nevertheless, this association concerns other contextual variables that cannot be abstracted from the actual scenario where they are embedded. So, after a literature review, the publication suggests design solutions to be "individualised, organic and local", which makes adaptability and flexibility as valuable assets:

> "Indeed, the most successful are likely to be those which are seen as interim solutions and which have within them elements of flexibility and adaptability for new cohorts of learners and teachers, new curriculum demands and new challenges." (Higgins et al., 2005, p.37)

More recently, in a RIBA publication on *Future Schools: Innovative Design for Existing and New Buildings* (Mirchandani and Wright, 2015), "managing change" also holds a central position for school buildings that "are the very foundation of the future social, cultural and economic wellbeing of our country" according to the then RIBA's president Stephen Hodder (Hodder, 2015, p.viii). Specifically, change can be prompted by different situations such as: "government policy", "evolving learning practice", "local circumstances", "routine cycle of change", "evolution of the school as an institution" and "new headteacher", which establishes this to be related to physical, legal, social, educational and institutional constraints. So, managing the "pace of change" is concerned to continuous renewals on space so that it performs to its best for the noticed needs, according to the available resources, as an "adapting to thrive" standpoint (Johnson, 2015, p.147).

In the publication *Building Excellence: Exploring the implications of the Curriculum for Excellence for School Buildings,* Worthington (2007) also approaches change, assuming: "Buildings as a catalyst for change" (p.15). Change can, thus, be an opportunity for strategic decision-making on the building's uses, spaces and management (p.17). By addressing change within the DEGW's work, "four levels of decision-making" and respective timespans: "shell", "services", "scenery" and "settings"[331] are embraced throughout the building's lifecycle (p.15). But overall, these decisions are primarily related to learning and committed to people on regard to "human interaction" and "quality of life", rather than technology or specific subjects (p.18).

[331] Recalling Duffy and Brand's layers of change.

The focus on adaptability has been a constant in studies published by the OECD[332], but if in the 1970s this concern approached the prefabrication, modularity and possibility of rapid change of components, as a way to rapidly change the space, currently it translates into customisation, "on creating a variety of spaces in a range of different sizes" (Blyth, 2011, p.16). According to the OECD criteria, adaptability today remains a qualifier of the school space and a requirement for schools of excellence, which coexists with the social involvement of the community in the building.

OECD's publications: *Designing for Education. Compendium of Exemplary Educational Facilities 2011* (OECD, 20011), *PEB Compendium of Exemplary Educational Facilities* (OECD, 2006a), *21st Century Learning Environments* (OECD, 2006b) and *Designs for Learning: 55 Exemplary Educational Facilities* (OECD, 2001), all highlight representative school buildings from distinct contexts and countries within the time frame of each referred book.

In a more recent publication (OECD, 2011) the school building was appraised according to the following criteria: "innovative design, fitness for purpose sustainability and safety" (p.45). In addition, it is also appreciated that schools enable appropriation admitting different uses and users, resort to new technologies and enhance current pedagogical practices:

> "[…] these facilities illustrate an architecture that is "owned" by its community, spaces that permit and encourage individual and group learning, a variety of spaces and volumes that inspire educators, students and parents alike and enable users to enjoy learning and living together." (OECD, 2011, p.45)

Consequently, OECD considers as exemplary "facilities that support today's education needs, facilities that serve as a learning tool for students and are responsive to curriculum changes" (OECD, 2011, p.46). Adaptability is therefore a significant requirement for a school to continue to pursue and potentiate the evolving learning model and its technological approach, crucial for today's framework.

It is also noteworthy at this point that this publication by the OECD lists as "exemplary" 60 schools from 28 countries, in which Portugal is represented with 6 schools (OECD, 2011). The publication is structured by three teaching levels and the reference to Portuguese schools can be found twice in each teaching level. Arcos School Complex (in Óbidos, by Claúdio Sat) (Fig. 74a) and Gabriel Pereira Secondary School (in Évora, by João Lúcio Lopes) are referred within the schools of multiple levels. Popular Kindergarten (in Cacém, by Nadir Bonacorso and Sónia Silva) and Kindergarten of Bicesse (in Cascais, by José Martinez Silva and Miguel Beleza) are listed in the pre-primary and primary schools. For the secondary level, which is the one to be studied under this research, the mentioned schools are:

[332] For earlier ones see Oddie (1966, 1975) and OECD (1976).

a)

b)

c)

Fig. 74. a) Arcos School Complex, Óbidos (Sat, 2010, p.89) (edited)
b) Passos Manuel Secondary School, Lisbon (Heitor, 2011, pp.10-11) (edited)
c) Soares dos Reis Artistic School, Porto (OECD, 2011, p.217)

Passos Manuel Secondary School (in Lisbon, by Victor Mestre and Sofia Aleixo) (Fig. 74b) and Soares dos Reis Artistic School (in Porto, by Carlos Prata with Nuno Barbosa) (Fig. 74c)[333].

Other schools could also be mentioned, as well as other publications namely by the OECD. In 2006 OECD publishes *21st Century Learning Environments* from a conference in the United Kingdom in 2004 with contributors from 22 countries[334]. The "emerging themes" for the school building were considered as: the context of change and its impact for designing schools; new technologies; inclusive access to education[335]; sustainable design; community participation in the design; designing schools for enhancing learning[336]; and design quality (OECD, 2006b).

[333] Original Portuguese names of these mentioned schools: Complexo Escolar dos Arcos, Escola Secundária Gabriel Pereira, Jardim de Infância Popular, Infantário de Bicesse, Escola Secundária Passos Manuel and Escola Artística de Soares dos Reis.

[334] This conference aimed to "investigate how different countries define and use innovative design in past and present learning environments, and to discuss how current trends and approaches in innovative design will affect future learning environments." (OECD, 2006b, p.7).

[335] The publication states the relation between school communities and society, which could be associated with the previous studies by Bernstein: "Schools communities can serve as models and catalysts for societal change and integration. An educational facility that is designed to facilitate access to education for all – students with special educational needs, students from minority and disadvantaged groups, and the community in general – all year round sends a powerful message to tomorrow's knowledge workers and community leaders." (OECD, 2006b, p.23)

[336] This publication clearly states "educational facilities as a learning tool" as a relevant and "emerging theme": "School buildings and their surroundings are a useful resource for teaching and for fostering independent, enquiry-based learning. Building designers can use the architectural elements, the building systems and the external spaces to provide many different learning opportunities for students in new and existing schools." (OECD, 2006b, p.41)

These are invaluable criteria that comprise the concept of adaptability in several manners. First and foremost, OECD addresses change and develops a first "emerging" topic for 21st century schools entitled "the challenge of designing schools in a changing world". Change is, hence, understood as paramount to design educational buildings regarding "the demands of the new knowledge society" (OECD, 2006b, p.11). Questions are therefore placed from this assumption on: "How can school design best meet the needs of 21st century learners and educators?"; "How can new and existing built environments best accommodate increasingly diverse teaching and learning environments?" and "How can design transform existing facilities to achieve future educational goals?" (*ibid.*). These can be related directly to adaptability and the assets that its conception brings to the design. It could be argued that an adaptable building can cope with future and still unanticipated teaching and learning needs; interventions on existing buildings for providing them with more adaptable design solutions or providing them from the initial design can enable to accommodate the array of learning activities considered today; and finally, adaptability provides for future objectives regarding educational practices.

The publication in itself mentions flexibility rather than adaptability and assumes the needs for "creating flexible spaces for flexible learning" within this subject matter. It is here stated that:

> "Form does not always follow function. School buildings could fail us if they cannot be adapted to suit new learning styles." (Bunting *apud* OECD, 2006b, p.12)

Although this need of coping with "an ever-increasing range of teaching and learning scenarios and technologies" is here related to flexibility, its relevance for the assumption of change and the correlation between school design and multiple and changing learning practices is very significant. Besides, flexibility is understood as possible both in existing facilities as well as in new designs.

Naturally that the remaining subjects are also associated with adaptability, in the sense that adaptability enables building's to cope with the continuous changes conveyed by the information technology. Besides, adaptability also promotes a more inclusive access to education, because it enables more and changing activities that can be undertaken by a variety of different users with specific learning profiles. Furthermore, adaptability can also be perceived as a more sustainable design option that can be more lasting through out the building's lifecycle, not requiring more frequent physical rehabilitations. Adaptability also engages the users with their appropriation of space and it is also user appropriation that recalls an adaptable environment to the forthcoming activities and actions within the building. By and large, adaptability could be understood as a way of providing for the quality of the design that actually meets the current and future educational, social and physical needs.

Also from 2006 is another publication by the OECD on *Exemplary Educational*

Facilities where "flexibility" is a criterion for acknowledging the selected schools, along with "community needs", "sustainability", "safety and security" and "alternative financing" (OECD, 2006a). One Portuguese school is here identified for its flexibility, which is Malagueira School[337] in Évora by Farelo Pinto and concluded in 2004 for pre-primary, primary and lower secondary levels for students ranging from 3 to 15 years old. Flexibility is here used as a form of integration of uses, users and levels of education, in the creation of a "vibrant learning environment" (OECD, 2006a, p.69).

Before this publication, others from the OECD have also addressed adaptability and have identified Portuguese schools as exemplary current learning environments, keen on the identified criteria of excellence.

In 2001's OECD publication there is also the assumption of change and the need to adapt buildings to new present and future contexts, from a standpoint of environmental, economic and socio-sustainable progression, envisioning the school as an active pedagogical catalyst that mimics social dynamics. Some spatial, technical and structural requirements are mentioned more prone to change, such as: the use of "framed structures with non-load bearing partitions"; "generous provision for mechanical, electrical and electronic services"; "projects with clean lines, clad with durable materials"; "compact plan forms that minimise the surface area of the external envelope will help to reduce heat loss an energy costs" and other sustainable and environmentally-friendly design solutions; as well as "greater choice and variety in course options generate a wider range of group sizes" in the sense of "a wide mix of size and type of teaching spaces" (OECD, 2001, p.ix). These are perceived as ways of preserving future investment, reducing maintenance costs and responding to future needs. This is clearly sum up in the following quote:

> "Educational facilities need to accommodate both the known and identifiable needs of today, and the uncertain demands of the future. They should provide an environment that will support and enhance the learning process, encourage innovation and be a tool for learning and not a monument to aesthetics. They need to be conceived not as an exclusive provision for the few, but as a resource to support lifelong education and recreation for all. They should provide good value for money. They should seek to minimise running and maintenance costs, ensuring that today's design decisions do not impose an unnecessary burden on future generations. Finally, they need to be designed to safeguard the wellbeing of the planet as well as the wellbeing of the individual." (OECD, 2001, p.vii)

In addition to the existence of Portuguese schools in the remaining chapters, like: Rodo School Complex, Vasco da Gama Basic School and Júlio Brandão School;

[337] From the Portuguese original name: Escola E.B.I./J.I. da Malagueira.

Portuguese schools are also mentioned as reference schools with regard for "strategies for managing the educational infrastructure": the Professional School of the Alentejo Region (EPRAL), the Miragaia Basic School and the Basic and Secondary School of Laranjeiras[338]. These latter schools were recognised by their ability and provision to cope with "long-term educational change", "reduced resources for maintenance", "pressures for more intensive space utilisation", among others (OECD, 2001, p.ix).

In the publication regarding schools of today and tomorrow[339] (OCDE, 1996), the relevance given to the use of space and specifically to its adaptation to change reaffirms itself as a constant that goes transversally through all these publications. The English Victoria Infants School is praised for its flexibility and the Australian Woodend Primary School for its "future adaptability" to possible changing uses[340].

Overall, the previous 1996 criteria continue to show coincidences with the most recent ones on the relevance given to the use of new technologies and the adaptation of the spaces to the new educational reality. Once again, Portuguese schools are presented as world references for new school facilities, exemplified here by the Marquesa de Alorna School (by José Sobral Branco, 1989) and the Mértola School[341] (by Anabela Carvalho, João Girbal and José Filipe Ramalho, 1992).

In addition to the OECD, there are publications from other organisations such as the Commission for Architecture and the Built Environment (CABE, 2007; CABE, 2006), the National Clearinghouse for Educational Facilities (Bingler, Quinn and Sullivan, 2003; Nair and Fielding, 2005[342]), Commission of the European Communities (2007) and Educause (Oblinger, 2006; Oblinger and Oblinger 2005), that focus on the design of 21st century learning environments. Flexibility and adaptability are often referred concepts for a school of excellence and considered "important issues to consider early on" (CABE, 2007, p.60)[343].

Specifically, in the Portuguese context, secondary schools presented models built since the end of the 19th century (Parque Escolar[344]). Faced with the growing

[338] Original Portuguese names of these mentioned schools: Complexo Escolar do Rodo, Escola Básica 1,2,3/JI de Vasco da Gama, Escola EB 2,3 de Júlio Brandão, Escola Profissional da Região Alentejo (EPRAL), Escola de Ensino Básico 2,3 de Miragaia, Escola Básica and Secundária das Laranjeiras.

[339] The title of this publication is *Écoles d'aujourd'hui et de demain: un florilège international d'établissements scolaires exemplaires* (OCDE, 1996).

[340] It is also noteworthy the presence of a music conservatory among the referred schools - the Turku Music Conservatory in Finland that was the result of a reconversion of a shipyard in 1994 (OCDE, 1996).

[341] Original Portuguese names of these mentioned schools: Escola Marquesa de Alorna and Escola de Mértola.

[342] Nair and Fielding (2005, p.11) consider "flexible spaces" as one of the "25 school design patterns" that "represent a fairly complete range of the various design principles that define best practice".

[343] "However, rapid changes in technology and the potential it creates for personalised learning make the requirements for the schools of the future less clear. There can be no certainty about group sizes for teaching or about the need for private study areas or the extent of remote working from home or other locations. School buildings therefore need to be adaptable." (*ibid.*)

[344] https://www.parque-escolar.pt

need to upgrade school spaces, the Secondary School Modernisation Programme, undertaken in phases from 2007 onwards, aimed at rehabilitating the existing buildings[345]. The fact that interventions in school spaces adapted from the pre-existent have always lived together with the continuous functioning of the spaces and the experience of its inhabitants, has made this a necessarily lived-in process, assuming its cultural identity in the dynamics of the community engagement in the design processes undertaken[346].

There are also several recent Portuguese publications that address current curricula (Veloso, 2013; Veloso and Abrantes, 2013; Veloso, Marques and Duarte, 2014; Veloso, Sebastião, Marques and Duarte, 2015). Veloso and Abrantes (2013) regard student performance, on its actual outline and on the specificities that relate it to the teaching-learning process (Veloso and Abrantes, 2003, p.2), and Veloso (2013) also contributes to this input by analysing the external assessment of the schools and its approach towards student achievement and on the information these provide towards the "learning, organisational and leadership models of the schools" [347] (Veloso, 2013, p.1).

On the other hand, the book *Espaço e Aprendizagem* (Veloso, Sebastião, Marques and Duarte, 2015) tackles spaces and learning, with a specific focus on the Portuguese school modernisation programme[348]. This publication can be analysed in close regard with the final report on the renewal of secondary school buildings' impact towards teaching-learning processes and practices (Veloso, Sebastião, Duarte and Marques, 2011[349]). As already specified for the Portuguese reality and previously examined for school buildings at large[350], the intervention on school buildings is brought by their disability to cope with current educational policies and practices and, reciprocally, it also engages a re-examination of the practices that these renovated spaces accommodate and reinstate new routines and spatial appropriation over time. Its representativeness involves the physicality of the building, the social structures and the behaviour patterns it shelters, and it is also urban[351]. Conclusively, the authors determine that the buildings' modernisation bears significance towards the built spaces' provision and their community engagement. Ultimately, these can be enhancers of students and faculty's overall achievement:

[345] See chapter 1.5.1. The Portuguese case study.

[346] Along with spatial changes also curricular changes have occurred from this rehabilitation that have lead to the case study of Quinta das Flores School. See chapter 1.5.2. Artistic schools as a specific case study.

[347] Free translation of the original quote in Portuguese: "[...] modelos de aprendizagem, organizacionais e de liderança das escolas."

[348] For further information on the relation between the learning structures and the school buildings in the Portuguese reality, from an historical perspective, see chapter 2: "Política educativa e arquitetura escolar" (Veloso, Sebastião, Marques and Duarte, 2015, pp.45-65).

[349] With the collaboration of Tânia Rocha, Telma Leal, Tiago Costa. Having the following consultants: Gonçalo Canto Moniz, Madalena Ramos, Pedro Reis.

[350] See 1.5. The case study.

[351] This is also perceived in chapter 4 "Espaços escolares, arquitetura e aprendizagem" (pp.113-157) (Veloso, Sebastião, Marques and Duarte, 2015) and chapter 5 "A apropriação do novo edifício" (pp.159-187).

> "The majority of social actors interviewed agree that it is through the new conditions created that there can be an impact of renewal on teaching-learning practices and school outcomes."[352] (Veloso, Sebastião, Marques and Duarte, 2015, p.177)

Extensive conclusions are drawn in the report, stating that the influence of spatial rehabilitation towards the teaching-learning practices "is not, at all, direct and its assessment is extremely complex", because these are supported by other mechanisms that are difficult to separate for a straightforward correlation (Veloso, Sebastião, Duarte and Marques, 2011, p.331). However, from the extensive research proceeded for the report, there is a noticeable appreciation towards school's physical ability in terms of the "quality", as well as "functionality, organisation, aesthetic and furniture provision". These can be associated to "spatial dynamics" and communities' achievement (*ibid.*).

It has also been remarked to be very significant, the higher and diversified spatial use by both the internal users and the external community, which enables a more open school and a deeper sense of "pride" and "accountability" of the community (Veloso, Sebastião, Duarte and Marques, 2011, pp.332-333; Veloso, Sebastião, Marques and Duarte, 2015, pp.193-194).

It is also necessary to emphasise the need for constant change that is demanded from the school space, assuming that the pedagogical programs alter with relative frequency; that the faculty and students also vary according to the social, economic and demographic circumstances; and also that the new technologies imply spatial changes. A relevant challenge for the present time will be to design schools as living organisms, which will continue to respond over time to what is asked of them, problematizing the concept of a fixed structure in an adaptive space (Fig. 75).

A critical reflection by peers has also occurred at a practical and at a theoretical level, proven by conferences in Portugal, such as: *Evaluating Quality in Educational Facilities* (Lisbon, 2005[353]) and *Fazer a Escola* (Lisboa, 2010[354]), besides the already concluded works on the evaluation of the quality of the service (Heitor and Silva, 2009; Parque Escolar, 2009b) and post-occupancy evaluation (Watson, 2005). It will then be up to the practice as well as the academia, to understand the new contours of the current context of the Portuguese secondary schools and to contribute, in an operative way, to the knowledge advancement of architecture.

[352] Free translation of the original quote in Portuguese: "A generalidade dos atores sociais entrevistados concorda que é pelas novas condições criadas que pode haver um impacto da renovação nas práticas de ensino-aprendizagem e nos resultados escolares." (*ibid.*)

[353] See Heitor, T. (2005). 'Potential Problems and Challenges in Defining International Design Principles for Schools'. In OECD (2005). *Papers from OECD/*PEB *Expert's group Meetings on Evaluating Quality in Educational Facilities*. Lisbon.

[354] An International Seminar on the Architecture of Schools, with the presence of Manuel Tainha and Herman Hertzberger, in the National Laboratory of Civil Engineering in Lisbon, in 20th May 2010.

Fig. 75. Soares dos Reis Artistic School
(Heitor, 2008a, p.35) (edited)

As already pointed out, the aim of this research is to develop an original methodology to identify the learning experiences in a school building, to assess the building's potential to bear other learning experiences, and to point out the management or contextual constraints that can both hinder or potentiate them. Ultimately, recognising the spatial features that can be considered in the design, which enable a broader range of activities to happen in the educational spaces, these enhance the building's potential as a facilitator of different actions and as an active catalyst of knowledge, for a longer period of time and a wider community.

For that purpose chapter 2, overall, intended to provide information on the 'State of the art and critical revision of the concept of adaptability' so that the following chapter 3 can focus on the 'Construction of the methodology' proposed to identify and assess that concept explained on this chapter. It is again recalled that the main objective of this current research is to provide a methodological approach to adaptability, particularly applied to the current learning environments, rather than an extensive and chronological development on adaptable past schools.

Naturally, that for establishing the concept of adaptability considered to be the most adequate for this research, a widespread overview on this subject matter is needed, whose aim is to critically assess different takes on both the choice of the concept of adaptability and respective contexts, in order to acknowledge the one that can be most suitable and its definition for further use in this Thesis.

After the approach to the concept of adaptability, part 2.2 intended to focus on the state of the art of adaptable schools, in order to inform on how the concept has been translated onto design solutions and built spaces. The evolution of the learning practices has brought along spatial implications that represent moments of significance for rethinking the school building as a whole, its internal organisation, its envelope, structures and coating and also the learning potential it projects. Again, it is outlined that the overview provided by this chapter intends to be explanatory

of significant moments for rethinking how adaptability has been materialised within school buildings, rather than providing an in-depth outlook on the schools' state of the art, which might have been disruptive for the objective's attainment on a methodological and theoretical approach.

Finally, having considered the concept of adaptability on part 2.1.[355] and how has it been conceived for schools in part 2.2.[356], the present part 2.3.[357] aimed at tackling the contemporary learning practices, recognising that both space and experience, school and learning, hold an influential bond to one another in a dyadic relation that implies the reconsideration of space according to the current teaching-learning processes. Besides, this chapter also recognises that spaces can be an enabler and even an enhancer of these learning processes and that they hold a significant role for knowledge acquisition, creation and transmission. For this purpose, it has been relevant to identify what these learning practices are and what do they spatially imply. Finally, this chapter aimed at relating adaptability with learning environments as currently considered, approaching space to learning, to the users and to the effective needs, both in the present and in the future.

Having acknowledged the concept of adaptability and how can it be considered for schools and applied to the specificities of the contemporary context, the following chapter[358] may, at this point, reflect upon the possible methodologies to assess it, under this current approach defined for our Thesis.

[355] See chapter 2.1. Adaptability: definition and adjacent concepts.

[356] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

[357] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[358] See chapter 3. Construction of the methodology.

3. CONSTRUCTION OF THE METHODOLOGY

3.1. Space use assessment methodologies

> "If the validity of the form of a community is based on life patterns, the first principle should be an objective and permanent analysis of the human structure and its changes."[359] (Smithson, 1956, p.291)

After an early consideration of the reciprocity between space and use[360] that considered buildings not only as stages but also as enhancers of human behaviour, and their users both as spectators and creators of meaning by appropriating space, space use is acknowledged as relevant for the design when encountering life.

If Architecture and Life are no longer related alternatively or subsequently, but become an implication of one another[361], experience is hence an inexorable feature of architecture, as a *pre* and *post* contribution to the design process, in the form of participatory design processes and space use assessment methodologies, which will identify interactions and contributions, for a lived, whole and suitable built "life container" (Byrne, 2007, pp.23 -24).

Therefore, space assessment methodologies will be studied in this chapter in order to identify diverse practices from different study fields with regard to effective occupancy of the built space. Then, the last part of chapter 3 intends to depict the proposed methodology after a thorough literature review of possible space use assessment approaches and a subsequent focus on methods for identifying adaptability. Ultimately, this will support a more comprehensive outlook for assessing adaptable spaces, which will inform the proposed methodology under this research. Firstly, and considering the relevance of space use to this Thesis, an initial approach to users' possible contributions to the built space will be presented, both in design participation and effective spatial fruition.

[359] Free translation to English from the Spanish quote: "Si la validez de la forma de una comunidad se basa en las pautas de vida, el primer principio deberá ser consecuentemente un análisis objetivo y permanente de la estructura humana y de sus cambios." (Smithson, 1956, p.291)

[360] See chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[361] This justifies the main title of this current Thesis: Life within architecture from design process to space use.

. Design participation as users' contribution

Design participation is a concept often linked with *pre*-design process, where users are asked to contribute to the brief by explaining their needs. Fig. 76 illustrates areas of possible relevance for participation in architecture, according to Jenkins (2010), in which post-occupancy evaluation and facilities management[362] are considered to provide relevant input to the discipline of architecture[363].

In 1956 Alison Smithson, as a comment to the Team X's Doorn Manifest, two years prior, said it was up to architects to provide answers in the realm of reality, and for that, they would have to know it well[364]. She points outs, at this mentioned quote, the need for a "permanent analysis of the human structure and its changes[365]" as paramount, in order to better fulfil human needs by design.

Besides previous participatory experiences, the 1960s leads us back to the emergence of a bottom-up attitude of civic responsibility in shaping the physical environment. Architects came closer to the people, space embraced individual specificities, and people enjoyed the space they envisioned along with the architects. The voice of the people was becoming heard, experts worked along with "the foot people" (Jacobs, 1993, p.xii [366]), in order to fully fulfil their needs and comprise with individual specificities. As activist Jane Jacobs appealed: "Cities have the capability of providing something for everybody, only because, and only when, they are created for everybody." (p.312). This was a time where the practice sought alternatives to modern movement (with very different proposals as Archigram, Rudolp Paul's mega-structures, Yona Friedman, Groupe d'Architecture Mobile, Superstudio, or Christopher Alexander, among others), and where the space was claimed by people.

If the practice sought alternatives to the modern movement, theorists, particular study fields and respective publications were arising on the issues around man-environment relations, spatial perception, behavioural studies, environmental design, facility evaluation methods, evidence-based design, among others, all with their particular outlook on them.

Contemporary of these concerns, Edward T. Hall's *proxemic studies* (1990[367]) revolve around the relation between space and people and the relevance of the receptors such as: eyes, ears, nose (distance receptors) and touch from the skin, membranes

[362] These approaches will be dealt in detail further on this chapter.

[363] Despite being considered, by this author, a specific study field (see Fig. 76) it can also be a process within architectural research for assessing building performance that is not considered outside the discipline but as a part of it and providing a significant contribution to inform it.

[364] See the full quote in the beginning of this chapter.

[365] Note that Alison Smithson already refers to the "changes" on the human structure, which might imply a consideration on changing throughout the building's fruition.

[366] Original edition from 1961.

[367] Original edition from 1966.

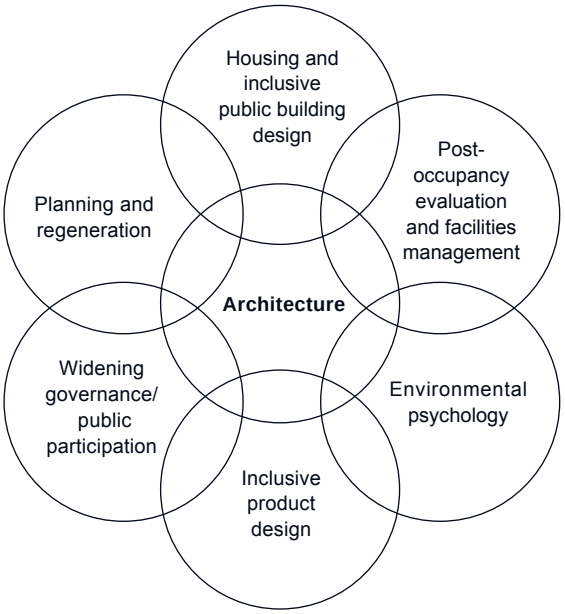


Fig. 76. "Areas of possible literatures of relevance"
Courtesy of Professor Paul Jenkins (Jenkins, 2010, p.10)

and muscles (immediate receptors) (p.41) guided by cultural identities, for the perception of space:

> "One of my objectives has been to communicate to architects that the spatial experience is not just visual, but *multisensory*. [...] No matter what happens in the world of human beings, it happens in a spatial setting, and the design of that setting has a deep and persisting influence on the people in that setting."[368] (Hall, 1990, p.xi)

Likewise, Barker's work on *Ecological Psychology* (1968) and his definition of "behaviour settings" situated human behaviour in context, and related perceiver and environment. Furthermore, Doxiadis with the studies on *Ekistics*[369] also revolved around human settlements and the interconnection between *man*, *society* and *networks* contained by *nature* and *shells*, considering them as a whole unit to be understood, precisely in their relation to each other. Its aim was to be *prescriptive* when conceiving, operating and primary enhancing human settlements (Doxiadis, 1964).

Associations like The Environmental Design Research Association (EDRA) were also founded in 1968[370]. Its first meeting's[371] proceedings, edited by Sanoff and

[368] Italics from the original quote.

[369] Besides the publication of his book under the same name, it is also a journal, has a world society and holds meetings and symposia.

[370] After the formal end of the Design Methods Group (DMG) in 1968.

[371] That took place in 1969 in union with the Design Methods Group and Man-Environment Systems (MES).

Cohn in 1970, already pointed out the need for thinking the human environment as a synthesis of contributions, whose issues continue until today, by holding regular meetings to discuss orbiting themes around Environmental Design. Also contemporary, is the *Environment and Behaviour*, whose first publication occurred in June 1969, as an academic journal, with a relevant impact factor on Environmental Studies, gathering natural and built environment and human action and behaviour, and embracing related themes throughout the years until today.

Whereas this legacy endures across close, but autonomous, disciplinary areas, often under the scope of social sciences, today design participation is a recognised subject within the realm of architectural studies themselves. In fact, the concept itself of design participation as a connection between *users* and *providers* is taken on by many authors and has multiple dimensions, in literature of reference, like *Architecture, Participation and Society* (Jenkins and Forsyth, 2010); *Place Identity, Participation and Planning* (Hague and Jenkins, 2005); *Architecture and Participation* (Jones et al., 2005); *User Participation in Building Design and Management* (Kernohan et al., 1996); and *Co-Design: A Process of Design Participation* (King et al., 1989).

In Portugal in the 1960s, Nuno Portas often mentioned the architect as the social technician and the architecture's responsibility to acknowledge the actual reality and to answer the needs and wants of the individuals[372]. During his work at the National Laboratory of Civil Engineering, from 1962 to 1974, he researched the *social incidences* (Portas, 1964) of the spatial organisation. At this time, he already considered architecture as being a work of synthesis of the context, all the stakeholders and the several subjects involved from brief to use, whose contributions would lead to a more complete spatial answer in time. The inquiries made at the National Laboratory of Civil Engineering were a way to know the people, to introduce the users' input in the design process and to reach a better and more informed response to the brief.

All in all, the mentioned authors and lines of thought, despite their differences in time, method and understanding, illustrate the prominence of this matter for both the academia and the practice. Often associated with the well-being of people, this has been, and continues to be addressed and valued today, as a relevant design concern. Recent literature on the theme shows that this remains a chronic sore point for architecture, that should be introduced to students from the beginning in the Design Studio, in terms of Universities' curriculum worldwide[373].

[372] Nuno Portas referred to these needs and wants as both *obligations* and *aspirations,* and hence architecture's accountability to answer them on different levels and dimensions of human life (Portas, 1969).

[373] This issue has been subject of debate, particularly on its relevance towards the Design Studio, in the communication "Space Use as an input to the Design Process", later published as: COELHO, C. (2013c). Space Use as an input to the Design Process. *Joelho #4. Ensinar pelo Projeto / Teaching through Design.* 47-50. Coimbra: Edarq.

. Space use assessment as an understanding of effective spatial fruition

By focusing on the actual living experience in real space and time, user research studies, as Fawcett (1995) entitled them[374], aim to describe and assess the space's potential for the inhabitants' appropriation and for fulfilling the functional, aesthetical and environmental needs and wants suggested in the initial brief[375]. Consequently, this current research acknowledges the relevance of user research studies to assess the depth of the bond between the space conceived by the architect and the spatial experience it holds, and its relevance as a post-design contribution for the practice.

Therefore, space use assessment methodologies are the ultimate validation to test the coincidence between what the architect envisioned in the design as *cosa mentale,* and how the built space is actually fulfilling this conception, ultimately understanding how the concept is translated into the practice, and whether expected and effective spatial experience overlap. As seen earlier, architecture, both as a design process and a built creation, is always imbued with social values and the user extends the work of the architect to define the space. Ultimately, space use assessment methodologies *help architecture report to architecture*[376], embracing Schön's (1983[377], 1987) "reflection in action", where a process is reassessed in each new phase according to the information detained in each of those phases[378], according to Schön: "In an *action-present* – a period of time, variable with the context, during which we can still make a difference to the situation at hand – our thinking serves to reshape what we are doing while we are doing it. I shall say, in cases like this, that we reflect-*in*-action."[379] (1987, p.26) Furthermore, Schön specifically addresses "the design process as reflection-in-action" as a chapter in his book *Educating the Reflective Practitioner* (1987, pp.44-79)[380].

[374] Despite their different terminologies according to authors of reference, space use assessment methodologies, usability studies, evidence-based design (Lippman, 2010) and user research studies (Fawcett, 1995), all regard space use and the study of individual(s)-environment interaction(s) in space.

[375] This ultimately could be related to the vitruvian *utilitas* and the albertian *commoditas*, as the most adequate answer to a specific functionality aimed by the architect, as it will mentioned further on this same chapter.

[376] Reflection from the quote from Sejima: "The idea is to help people report to architecture, to help architecture report to people, and to help people to report themselves." (Sejima, 2010)

[377] Consulted edition from 1998, original edition from 1993.

[378] According to Schön: "When someone reflects in action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. His inquiry is not limited to a deliberation about means which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry. Thus reflection-in-action can proceed, even in situations of uncertainty or uniqueness, because it is not bound by the dichotomies of Technical Rationality." (Schön 1998, pp.68-69).

[379] Italics from the original quote.

[380] Justified as follows: "I have chosen to focus on the architectural design studio […] because I have become convinced that architectural designing is a prototype of the kind of artistry that other professionals need most to acquire; and the design studio, with its characteristic pattern of learning by doing and coaching, exemplifies the predicaments inherent in any reflective practicum and the conditions and processes essential to its success" (p.18.)

Overall, experience goes beyond the built object translated onto plans, sections, or any particular drawing, and naturally the concepts of scale, dimension, materiality or function do not fully describe it. Particularly in the case of projects achieved by means of dynamic changing features, not easily nor fully translated onto plans and sections for its complete communication, these are naturally not fully assessed by the same traditional methods used in the discipline, guided by the concepts of scale, absolute dimension, measure, materiality, weight or function. So, the traditional methods for communicating and assessing the living experience can thus be widened, due to their materialization by new tools and by blurred design concepts, wavering between the natural and the virtual, the digital and the massive, or the conceptual and the real. Still, if solely plans and sections no longer define the spatial identity of a building, and if they are only fulfilled by the inhabitants' spatial fruition and, reciprocally, by the way space engages the inhabitants, then subjects within space use assessment methodologies will better report them. Therefore, the related design concepts, processes and assessment methodologies can be rethought in this sense, acknowledging a broader meaning for the spatial experience, its relevance for the design, and the ways to envision, communicate and assess it[381].

In fact, today, these methodologies are a valued area for architectural research, by implying the direct understanding and assessment of space use in real situations, whose results can be subsequently introduced into other design processes, as systematic knowledge transfer of relevant and accessible data for architects. Therefore, the design process should embrace these outputs as a way to acknowledge use and its changing conditions, adjusting expected and effective spatial fruition.

Each subject's different methodologies and outputs, within a common conceptual framework on the relevance of user research, act as contributions to be considered in the design process, informing professionals while conceiving space, for a more comprehensive solution, along space's lifecycle. Through these instruments, the project will result on a more thorough one, supported by user research outputs and the feedback of a broader stakeholders' community. This will bring closer the space thought by the architect during the design process and the space lived in by the individual(s) afterwards.

Jenkins (2010) represents in Fig. 77 a conceptual network that aggregates three variables - the participant: "client", "user" and "public"; the stages: "design", "construction" and "post completion"; and the form of participation: "inform", "consult" and "decide"; towards design participation. In short, this illustrates the possibility of the stakeholders to be included in all stages, from *pre* to *post* design, and to be empowered in each one (Jenkins, 2010, pp.13-14).

[381] The study on the relevance of the spatial experience for the design, as varied as it can be perceived, has been published in a peer review journal as: Coelho, C. (2015). The Living Experience as a design content: from concept to appropriation. *Ambiances Review, International Journal of Sensory Environment, Architecture and Urban Space [En ligne]. Experiential simulation.*

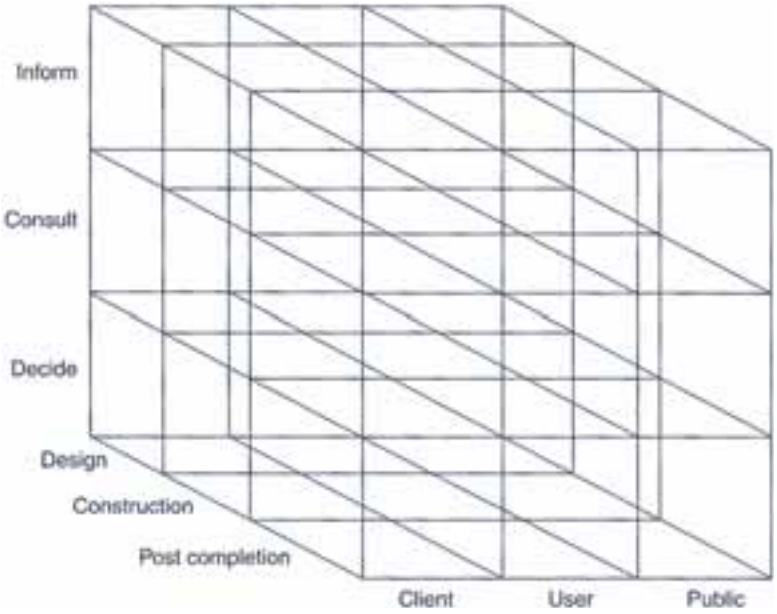


Fig. 77. "3D analytical framework"[382]
Courtesy of Professor Paul Jenkins (Jenkins, 2010, p.14)

Similarly, Bruno Latour's and Michael Callon's *Actor-Network Theory* (Latour, 2005) already assumes a connection between human and non-human "actors" both having "agency" and leading to the final result as a conjoint synthesis of the physical and conceptual relations between the network's elements.

Paralleling Jenkins's network of connections to user research overall, both can occur at several stages of the building's lifecycle, both resort to the stakeholders for informative feedback on the building's use, and both displace knowledge, in order to contribute to inform/consult and help making design/construction and post-completion decisions.

The process of user research, overall, aims at gathering data from the findings collected from previous space use assessment methodologies and from that particular case study, as well as theoretical results provided by literature and cutting-edge research, as a contribution to the professional's team, in a comprehensive approach to the design process, guided by aesthetic, but also functional and cultural goals when organising and creating space.

Voordt and Wegen's *Architecture in Use: An Introduction to the Programming, Design and Evaluation of Buildings* (2005) points out the intentions for evaluating a building benefiting both that or other buildings, the process and the product (p.143), the practice and the theory:

[382] Three-dimensional representation of the relationship between the various stages of the Design Process, stakeholders and tasks.

> "Evaluation allows lessons to be learnt which could lead to an improvement in the project under investigation and more generally improve the quality of programming, designing, building and management of the built environment. The reasons for the exercise can be both ideological and economic, e.g. the promotion of health and welfare or a reduction in the amount of property standing empty in an expanding market. Besides such practical goals, there can also be scientific goals, such as contributing to the formation of new theories or developing new tools, and there may be subsidiary goals derived from these main goals." (Voordt and Wegen, 2005, p.142)

Fig. 78 clarifies the fact that research and practice can be drawn closer together by "building bridges", through "approaches" and "information", from research - on people, design and buildings - towards the practitioner, and vice-versa, biunivocally exchanging operative information. This has been applied by Jenkins (2010) to design participation, but it could also be paralleled to space use assessment methodologies, because both design and research can be informative towards decision-making and provide knowledge transposable from one to the other[383].

Hence, this does not imply a questioning of the timeless design contents or even the professionals' decisions, but provides them with further information that eventually contributes to making more robust and comprehensive the final decisions.

Actually, if the search for a better building performance was one of the aims of the modern functionalism, the relevance of the inhabitants' well-being in space constituted one the revisions assumed by some of the modern architects, in search of a broader meaning to the concept, as Alvar Aalto (1940) sustained:

> "To make architecture more human means better architecture, and it means a functionalism much larger than the merely technical one. This goal can be accomplished only by architectural methods – by the creation and combination of different technical things in such a way that they will provide for the human being the most harmonious life." (Aalto, 1940, pp.102–103)

The fact that Aalto studied the individual and used that information to conceive the design solutions and the choice of materials, lighting, sound and heating conditions, for the Paimio's Sanatorium (Paimio, 1932), would better respond to the patients' mental and physical needs. By drawing together functional and emotional concerns, he acknowledged and valued the human condition and the effective spatial experience to essentially *humanize architecture*.

[383] Jenkins even refers specifically to post-occupancy as one of the approaches which is research-led on design, people and buildings, but that also informs the practice (2010, p.12) and that, with its methodological studies, "may have relevance for an improved understanding and/or practice of wider social participation in the architecture process" (*ibid.*).

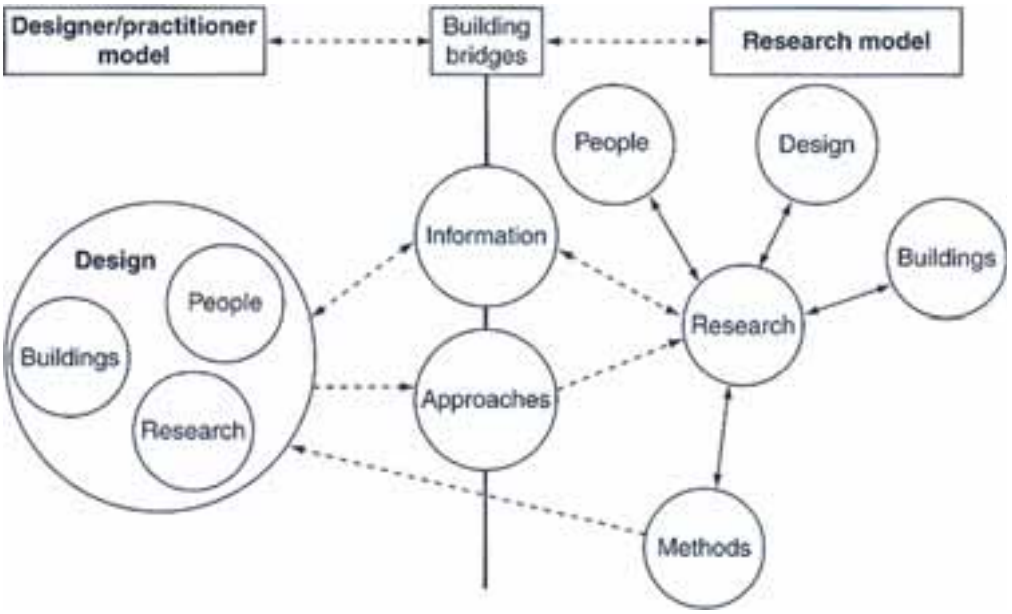


Fig. 78. "Models of knowledge of relevance"
(Jenkins, 2010, p.11)

The case study's output will then be expected to inform the practice on the actual spatial fruition the school promotes, proven by research in a real scenario, enclosing experienced users and creative professionals in a more whole, informed and participated design process, blending life and space, from brief to use, similarly to what Aalto already conceived in the Paimio's Sanatorium.

Since the 1960s this issue has become a central design concern, as mentioned in chapter 1.2.[384], resulting in the emergence of several user-oriented design methodologies.

Despite the wide realm of techniques included in these studies, their common outcome on how the space is responding to people and how people are engaged to space, can provide information to rethink that building in particular and its future rehabilitation interventions. But it can also, in more general terms, provide information for buildings with similar design briefs. This can be transferable as valid, verified and reliable information[385] (Voordt and Wegen, 2005, pp.158-159) from real life scenarios to the design as a feedforward technique. This is also a way to make users accountable and to introduce their contributions *post*-design process, to future interventions on that or other buildings, acknowledging use and change, and matching conceived and lived space, along the building's lifecycle.

In this way, appropriation and concept are linked in a cyclical process that gathers

[384] See chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[385] According to Voordt and Wegen (2005): "The accepted requirements for scientific research are objectivity, verifiability, validity and reliability" (pp.158-159).

inhabitants and professionals, research and the practice. As Evans (1997) puts it:

> "The point is that human action towards a goal cannot in any serious way be used as design criterion. But it is nevertheless useful, because it is always the vehicle of the intentions and purposes that underlie everyday existence. Action and intention are inextricably linked." (Evans, 1997, pp.16-17).

The design process that includes the creative assumptions of the architect, information collected from theoretical research and the study of space use in real life scenarios, is a more informed and supported one and should be able to better answer users' requirements[386]. Recalling Voordt and Wegen (2005): "Knowledge and understanding are essential preconditions for well-considered decisions" (p.146).

. Different approaches on space use assessment methodologies and concepts on literature

Space use assessment methodologies act as an operative tool for the design process, which recognises quantitative and qualitative variables and invariables of space use into a real life scenario, but also embraces the specificities of each context, suiting the project to its future uses and users, and acting as relevant output to transfer later on as input for any intervention throughout the building's lifecycle or future buildings made from scratch.

Accordingly, scholars at the Bartlett School of Architecture, along with Spacelab Architects, within the Effective Workplaces project, aim at defining a "Knowledge Transfer Partnership" that provides input on evidence-based design to the practice, both its process and product (Sailer et al., 2007a).

Its is noteworthy, at this point, Sailer's work on the connection between spatial configuration and behaviour from her Doctoral Thesis (2010) *The Space-Organisation Relationship. On the Shape of the Relationship between Spatial Configuration and Collective Organisational Behaviours*, but also other papers and publications like Sailer and Penn (2007) *The Performance of Space – Exploring Social and Spatial Phenomena of Interaction Patterns in an Organisation.*

With a particular focus on office buildings, Sailer intends a more thorough understanding of the connection between the design solutions and behaviour in the workplaces, which has been presented in multiple papers and conferences, like Sailer et. al. (2012) and Sailer et. al. (2007b). Specifically this has been tackled by

[386] This subject has already been addressed in the *Nexus 2012 Relationships Between Architecture and Mathematics*, in 11-14 June 2012, Milan, for testing and academic validation. It has also been published in the Conference's proceedings as: COELHO, C. (2012). From design process to space use: Adaptability in school buildings today. In M. Rossi (Ed.), *Proceedings of the Nexus 2012 Relationships Between Architecture and Mathematics.* (pp.23-28). Politecnico di Milano. Milano: McGraw-Hill.

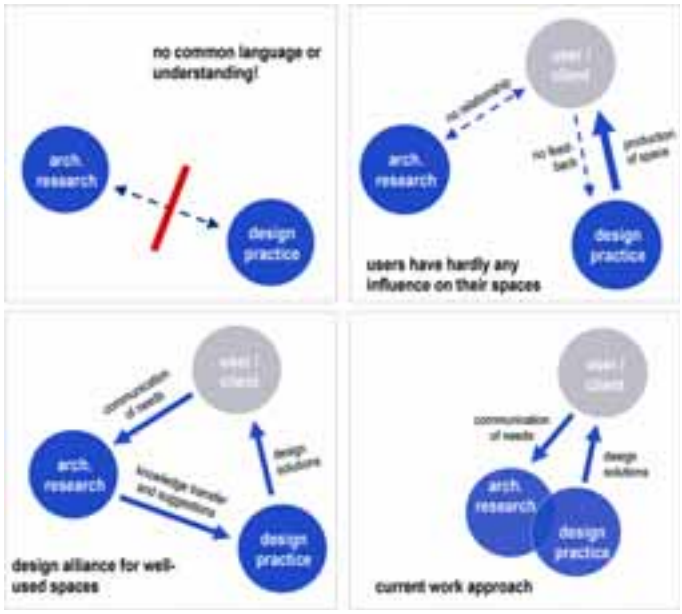


Fig. 79. "Re-defining the relationships between architectural research, the design practice and the user" Courtesy of Kerstin Sailer. (Sailer et al., 2007a, p.7)

means of her work also on space syntax (with frequent participations in the latest symposia) (Sailer, 2007; Sailer et. al., 2007b; Sailer and Penn, 2009; Sailer et. al., 2009; Sailer et. al., 2010; Sailer, 2014). But her work also revolves around evidence-based design in papers such as: *Changing the Architectural Profession - Evidence-Based Design, the New Role of the User and a Process-Based Approach* (Sailer et. al., 2007a) and *Evidence-Based Design: Theoretical and Practical Reflections of an Emerging Approach in Office Architecture* (Sailer et. al., 2008). This fact illustrates a common interest on both space syntax and evidence-based design, and on the connection between space and behaviour, and their potential proximity and relevance for this subject matter, in regard to research, the practice and the user (Fig. 79). Quoting Sailer et al.:

> "By integrating architectural research methods like Space Syntax, Social Network Analysis, ethnographic space observations, questionnaires etc. directly into the design practice and conducting case studies on life projects, a new evidence-based professional culture of architecture and design is formed and new relationships between the design practice and architectural research are created." (Sailer et al., 2007a, p.7).

Evidence-based design's purpose, according to Sailer, "is to take conscious and knowledgeable decisions in a balanced and considerate manner to the benefit of the ongoing work processes of the professional practice and thus also benefiting the user" (2007a, p.7). This can be paralleled with Lippman's (2010) perspective on *Evidence-Based Design of Elementary and Secondary Schools,* which he considers to foster a dialogic platform between professionals and inhabitants, extending the work of

the architect besides the mental design process to the realm of space use, answering more thoroughly to what is required of the space in each time, and lengthening the building's use value in a sustainable manner.

Thus, designing space acknowledging use and spatial experience will then imply considering the inhabitant(s) and the activities to be held in that space and the physical conditions that constitute that particular "milieu" that provide that experience. According to Norberg-Schulz (1996[387]):

> "The purpose of architecture is to give order to certain aspects of our environment. When we say 'give order to our environment', this implies that architecture controls or regulates the relations between man and his environment. It therefore participates in creating a 'milieu', that is, a meaningful frame for the activities of man." (Norberg-Schulz, 1996, p.109)

Indeed, and as already seen by the previous referred approaches, there are diverse methods to analyse, describe and assess (if needed), this relation between people and places, space and action, at different stages and with different procedures[388]. The choice in the type of knowledge and information collected will be constrained by the way experience is portrayed and materialized, whether collective and/or individual, intellectual and/or sensitive. If the inhabitant is engaged by a dynamic, visual, haptic, olfactory and/or hearing experience, so the physical features of the space will play a crucial role to process the devices that generate that experience. On the other hand, if it provides a more intellectual experience, then the analysis will focus on how space is perceived mentally and emotionally.

Collective data on a gathering of people will then present information on the most and least common uses and activities in space, whereas individual reports will inform on each person's relation to space and what are the features that better engage each one.

Likewise, information focused on the individual, will provide a detailed depiction on each one's actions, eventually space-oriented behaviour, and overall experience in space, assessing spatial fruition. This can be done by a neutral observer, whether or not supported by technological means, for quicker and accurate conclusions. Or else by "self-report methods" (Lippman and Allacci, 2010, p.45) - such as "interviews", "narrative techniques", "time sampling", "diaries" or any other way of individual expression - informing on a particular individual's engagement to space, translated into qualitative descriptions, regarding which senses does the space reach and by what means, and foremost acknowledging the uniqueness of each one's living experience.

Analytical methods provide collective data on how a group perceives a particular

[387] Consulted edition from 1996, original edition from 1963.

[388] For a systematic approach on several educational facilities performance evaluation methods, see Heitor and Silva (2009, pp.18-24).

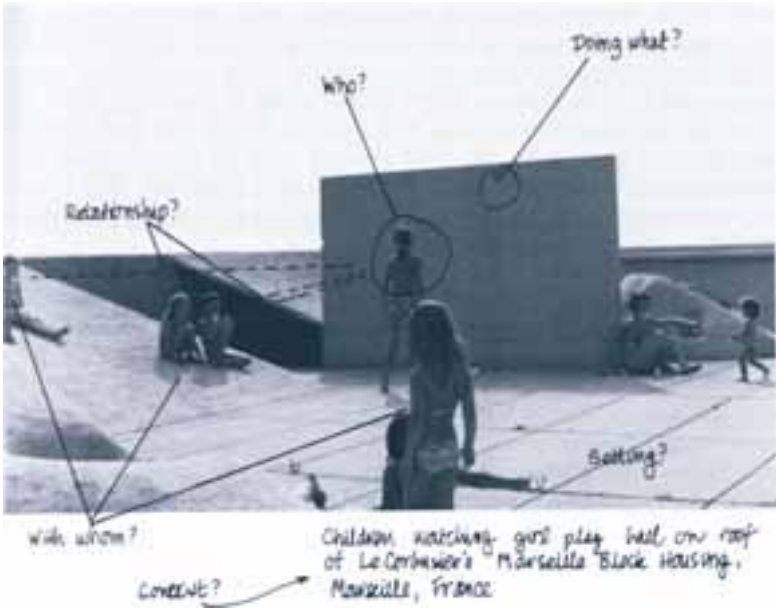


Fig. 80. Observing environmental behaviour
(Zeisel, 1984, p.125)

space, based on regularities and patterns of use. To such purposes, it can be resorted to charts and schedules of each activity and the analysis of people's flows and densities in space, and generally a broad range of quantitative outputs according to the methods applied. These will check for regularities and patterns on objective evidence related to uses, densities, performance, comfort, physical features, and several other variables, to be measurable by means of quantitative methods. These outcomes present generalised knowledge, often used to assess a functional purpose - the vitruvian *utilitas* – in order to test spatial efficiency and to compare the effective results with the perceived parameters envisioned in the design[389].

Current literature could be cited that centre on the incorporation of users' input and the human experience in the brief, to better match demand and supply, like *Inquiry by Design: Tools for Environment Behavior Research* (Zeisel, 1984[390]) that is mostly on Environment-Behaviour Research. It proposes as research methods: "observing physical traces" (pp.89-110), "observing environmental behaviour" (pp.111-136) (Fig. 80), "focused interviews" (pp.137-156), "standardized questionnaires" (pp.157-177), "asking questions" (pp.178-196), and "archives" (pp.197-225). This exposition of methods will impact on the proposed methodology in this current Thesis, because some of these methods will actually be used for identifying and

[389] Preiser and Vischer (2005) recall a "comparison between measured and perceived levels of performance" (p.11) that are amenable of analysis by a quantitative approach.

[390] First published in 1981.

assessing adaptability in the chosen case study[391]. Moreover, it is also stated that "although each method is presented separately, it yields its maximum potential when used conjointly with other methods" (p.87), whose outlook will be fundamental for the choice of the methods to undertake and the quantity and sequence in which to undertake them, detailed and justified in chapter 3.3.[392].

Post-occupancy evaluation (POE)[393] focuses on the building's use in the actual physical space and informs on how the space is fulfilling the needs for which it was built. According to Preiser (Preiser and Nasar, 2008, p.86) the first publication on POE was McLaughlin's studies on hospitals in Salt Lake City and southern California (1975) entitled *Post-Occupancy Evaluations of Hospitals*[394]. Already at this report POE is considered to provide information in order to, possibly, design "better buildings":

> "The architectural profession must begin to learn from its mistakes – and its accomplishments as well. The means of doing so is post-occupancy evaluation of buildings as an extension of the design process. […]
> The major questions they address are how well does the building work, and how well the building achieved the objectives initially established for its design. The answers to these questions, widely disseminated, could produce better buildings by putting a new data base under design." (McLaughlin, 1975, p.30)

But despite only being called POE by the mid-1970s, POE's first initiatives arose in the 1960s on university dormitories at the Universities of California by van der Rihn, and Utah by His, which was much in tune with the questions on the connexion between the built space and behaviour that arouse in this decade and were dealt by professionals of transdisciplinar study fields within organisations[395].

In 1966 *The Journal of the Royal Institute of British Architects* mentions a lack of feasible methods to "feed back into the design or production process information on the performance of past buildings" (Royal Institute of British Architects, 1966, p.103), but also the increasing attention to this subject. After a previous colloquium in 1965 at the York Institute, Markus's efforts to arrange a research programme "to study and develop measuring techniques for the human requirements aspects of building performance" (*ibid.*), are considered to be of particular significance for the profession, being appraised by the RIBA, which contributes and encourages its financing[396].

[391] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[392] The methodology proposed in chapter 3.3. is also a combination of methods that provide different data, whose aim is to include them in a final conclusion.

[393] Previously mentioned, regarding adjacent study fields.

[394] Although another study on hospitals has been undertaken in 1974 and published afterwards in 1975 by the Veterans Administration in San Diego (Preiser and Nasar, 2008, p.86).

[395] As seen in the beginning of this chapter.

[396] "The RIBA hopes that as many practices as possible will wish to invest in their own future and that of the profession by giving financial support." (*ibid.*)

This programme was intended to be accomplished in the University of Strathclyde for 5 years and to "provide building designers with a standard set of appraisal and measurement techniques suitable for adoption into design practice" (*ibid.*). In 1972 the *Building Performance* book is written by Markus and the research team[397] (Markus and Building Performance Research Unit, 1972), as a report on their work since 1967, acknowledging that "building performance is constantly related to people" (p.v)[398]. Already on this book, the appraisal is pondered both on the design preceding the built form, but also on the building itself, as a lasting and methodical process throughout:

> "The theme is appraisal of performance. Appraisal is a design activity. It is the continuous introspection by the designer whereby he monitors his *own* performance. Design is traditionally understood as taking place prior to the construction of a building, but it can also be seen as a continuous process lasting as long as the building itself, in which the designer is present directly or vicariously through a successor, nominee, design tool or even computer programme. In the former case appraisal has to be of design ideas; in the latter, of complete, working buildings. Hence design is a central theme; and the Unit's techniques apply to both interpretations of design." [399](Markus and Building Performance Research Unit, 1972, p.v)

This book was considered to be: "Perhaps the first attempt at systematic building evaluation" (Presier, Rabinowitz and White, 1988, p.11), by Preiser, Rabinowitz and White, in 1988, when reviewing the state of the art on POE.

In June 1969 Preiser presented the conclusions of his Master's Thesis in the *first Environmental Design Research Association Conference* (EDRA[400]) at Chapel Hill, with his paper: *Behavioral Design Criteria in Student Housing* (Preiser, 1970) (Fig. 81), which was followed by his Doctoral Thesis on building evaluation in 1974.

In the 1980s POE studies augmented, particularly on public buildings, and it also corresponded to a significant theoretical advancement on the field: "POE developed into a discipline of its own. Standardized terms are now being used in POE […], networks of practitioners and researchers have been formed, and significant large-scale multibuilding POEs are being carried out." (Preiser, Rabinowitz and White, 1988, p.13).

[397] As presented previously in chapter 2.1., the Building Performance Research Unit initiated its work in 1967 in the University of Strathclyde and had T. A. Markus as director, and P. Whyman, J. Morgan, D. Whitton, T. Maver, D. Canter and J. Flemming as members (Markus and Building Performance Research Unit, 1972).

[398] Full quote: "Building performance is an idea which assumes that we know what buildings are for. Since the simple answer is that they are for people, building permance is constantly related to people." (Markus and Building Performance Research Unit, 1972, p.v)

[399] Italics from the original quote.

[400] This conference was organised with the Design Methods Group (DMG) and Man-Environment Systems (MES) (Environmental Design Research Association, Sanoff and Cohn, 1970, p.iii).

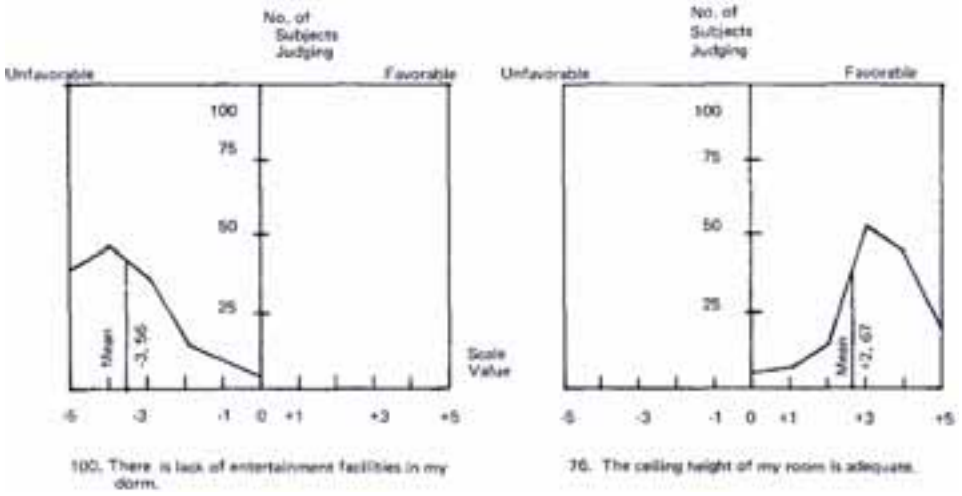


Fig. 81. "Frequency Distribution for Selected Statements"
(Preiser, 1970, p.257)

SHORT-TERM BENEFITS

- Identification of and solutions to problems in facilities
- Proactive facility management responsive to building user values
- Improved space utilization and feedback on building performance
- Improved attitude of building occupants through active involvement in the evaluation process
- Understanding of the performance implications of changes dictated by budget cuts
- Informed decision making and better understanding of consequences of design

MEDIUM-TERM BENEFITS

- Built-in capability for facility adaptation to organizational change and growth over time, including recycling of facilities into new uses
- Significant cost savings in the building process and throughout the building life cycle
- Accountability for building performance by design professionals and owners

LONG-TERM BENEFITS

- Long-term improvements in building performance
- Improvement of design databases, standards, criteria, and guidance literature
- Improved measurement of building performance through quantification

Fig. 82. "Post-occupancy evaluation uses and benefits"
(Preiser, Rabinowitz and White, 1988, p.5)

Fig. 83. Illustration of the benefits of POE
(Preiser, Rabinowitz and White, 1988, p.7)

In 1986 Eberhard was assigned to organise POE committees which Preiser led (Preiser and Nasar, 2008, pp.85-86). Two years later, Preiser, Rabinowitz and White produced a reference for POE, a book[401] with the homonym name (Preiser, Rabinowitz and White, 1988), that defines POE as "the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time" (p.3) and "is intended to provide architects, researchers, consultants, building owners, and facilities managers with useful guidance on the process and content of POEs. It is also designed to serve as a general, introductory text in teaching this subject" (p.x)[402]. Its benefits are also specified in the beginning of the book, separating them into "short", "medium" and "long-term" (Figs. 82 and 83).

The process of POE is wide-ranging according to the "level of effort", which could be: "indicative", "investigative" and "diagnostic"; varying in the techniques involved, consistent with the availability of "time, resources, personnel, the depth and breadth of evaluation, and, therefore, the implicit cost involved in carrying out POEs" (p.54). Nonetheless, all the levels imply three stages, which is: "planning", "conducting" and "applying" POE.

The indicative POE "provides an indication of major failures and successes of a building's performance" (p.54), resorting to: "archival and document evaluation", "performance issues", "walk-through evaluation" and "interviews" (pp.55-56). The investigative POE "can cover more topics in greater detail and with more reliability" (p.56), which involves more time for an in-depth analysis. The diagnostic POE takes longer, is achieved by means of: "questionnaires, surveys, observations, physical measurements" (p.57) and "its results and recommendations are long-term oriented" (*ibid.*). Interestingly, for the purposes of this current Thesis[403], it is highlighted that three case studies of POE are described in this book, being one of them a diagnostic POE of an elementary school in Indiana (pp.138-151).

In 2001 the book *Learning from our buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation*" (The Federal Facilities Council[404], 2001) was published as a report on works undertaken in three approaches: the presentation of papers by specialists, a survey of agencies with programs on POE, and a forum in March 2001, after an early study from 1986 and a subsequent one from 2000 required by the Federal Facilities Council (p.vi). The summary of findings is quite clear on the specificity of POE, starting precisely by mentioning that: "Post-occupancy evaluation is based on the idea that better living space can be designed by asking users about their needs" (p.2), to then apply the "lessons learned" (p.6) for management, planning and design.

[401] Eberhard signs this book's preface.

[402] According to Preiser and Nasar (2008) it is "the first POE textbook" (p.86).

[403] Whose focus lies on educational spaces. See chapter 1.5. The case study.

[404] "The Federal Facilities Council (FFC) is a cooperative association of 21 federal agencies with interests and responsibilities for large inventories of buildings" (The Federal Facilities Council, 2001, p.vi)

These studies have become more frequent and recognised through Post-Occupancy Evaluation: "a specialist architectural practice operating internationally" (https://postoccupancyevaluation.com), located in New Zealand and directed by Chris Watson; besides the work of other expert authors throughout. Even if, in its initial stages, POE has been applied to particular building briefs such as dormitories and hospitals[405], currently is has been widespread.

Schools have also become subject to POE. Watson and Ornstein, with previous works on this matter like *Post Occupancy Evaluation in Scotland* (Watson, 2004) *and Post-Occupancy Evaluation Performed in Elementary and High Schools of Greater São Paulo, Brazil: The Occupants and the Quality of the School Environment* (Ornstein, 1997), have been invited to Portugal for an experts meeting[406] (OECD, 2005) and presented their regard on POE on schools.

Besides an account on the methods of introducing POE to Scottish schools, also within a "school rebuilding programme", and on one evaluation of a primary school, Watson's analysis of the Portuguese case study of Galopim de Carvalho School in Lisbon, in which he was the main evaluator, was presented in *Pendão School in Lisbon: a POE in progress* (Watson, 2005):

> "The evaluation was to identify strengths and weaknesses of the new school facilities from the stakeholders' perspectives. Its fitness-for-purpose approach allows stakeholders to negotiate performance criteria that change during the service life of buildings and vary with region, budget, government policies, social trends, building type and use. By assessing buildings in terms of actual use, rather than predicted use or briefing issues, the fitness-for-purpose approach affords independence. It also allows stakeholders to negotiate use and design simultaneously, as well as to sort out specific issues and relationships between design parameters." (Watson, 2005, p.99)

This POE study was chosen for this school for the problems it demonstrated and provided specific and more general recommendations on "access to sports facilities, air quality, thermal comfort and safety" (p.100).

Similarly, Ornstein presented an outlook of POE in Brazil where it has been undertaken in schools of different levels since the 1990s (Ornstein, 2005)[407]. Presently, it is being done within a whole process where POE provides information that could be introduced in the following phases[408] (Fig. 84).

[405] As seen in the previous paragraphs on the state of the art of POE.

[406] This meeting's outcomes will be addressed in the last part of this chapter, focused on space use assessment methodologies on schools.

[407] POE in Brazil has also been undertaken by authors such as Rheingantz, Azevedo, Brasileiro, Alcantara and Queiroz (2009).

[408] Ornstein lists the following tools used under POE: "Observation and mapping of activities and behaviors",

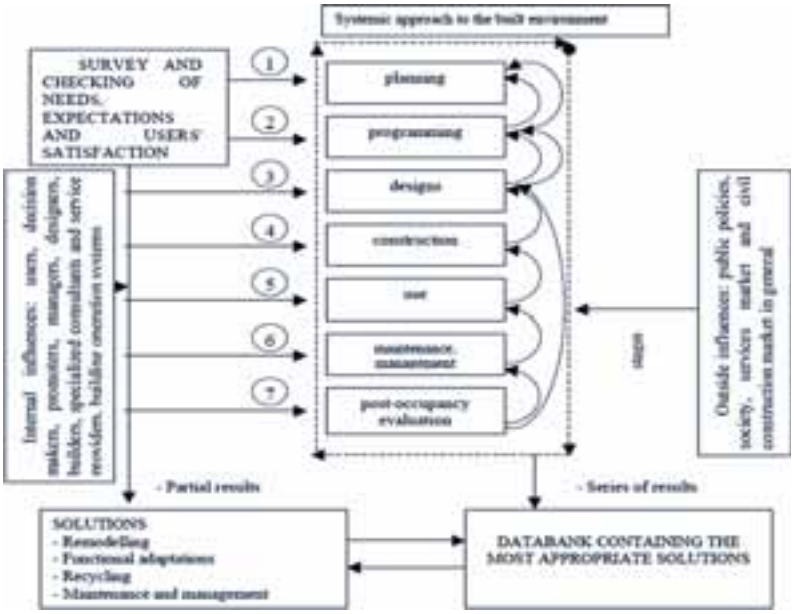


Fig. 84. "POE applied to school facilities: A systematic and integrated vision in a built environment" (Ornstein, 2005, p.137) (edited)

This already illustrates the use of POE not just at a later stage, but consecutively throughout the process. Hence, POE's representativeness and procedure became more frequent and decisive for the following decision-making. Vischer (2001) refers to "linking POE with Pre-Design Programming"[409] (p.26) and then advances to "POE in Strategic Space Planning" (p.27), sustaining that: "This latter use of POE has gained credibility in recent years as corporations are trying increasingly to provide functionally supportive workspace to their employees and simultaneously to reduce occupancy costs" (*ibid.*).

All in all, under these procedures there continues to be a wide range of potential designations, like the previously referred assessing building performance (Preiser and Vischer, 2005), or building evaluation techniques[410] (Baird et al., 1996), but also building performance evaluation (BPE)[411] (Preiser and Vischer, 2005, pp.1-26). This latter concerns the whole building's lifecycle, comprising six stages: ("strategic planning", "programming", "design", "construction", "occupancy" and "adaptive reuse/recycling") (Fig. 85), in which evaluation is assumed to take place,

"Interviews", "Questionnaires", "Focus groups", "Visual selection and perception" (Ornstein, 2005, p.139).

[409] "One of the most appealing reasons to perform POE is to be able to inform building decision-making in the early stages of a new project. POE studies target user evaluation of an existing space where users are destined to occupy a new space that is being planned. Their feedback is needed to ensure that the new design meets users' needs and solves problems in existing buildings." (Vischer, 2001, p.26)

[410] According to Baird et al. (1996, p.xxi): "Building evaluation is well established as a concept."

[411] Expression used in the first two chapters of the book edited also by Preiser and Vischer (2005) *Assessing Building Performance.*

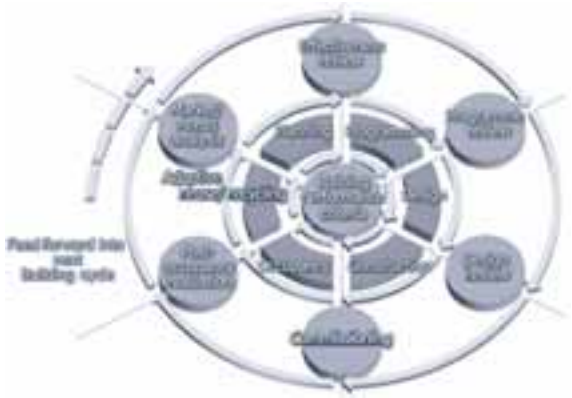


Fig. 85. "Building performance evaluation (BPE) process model"
Source: Wolfgang F.E. Preiser. (Preiser and Vischer, 2005, p.17)

Fig. 86. "Interrelationships between buildings, occupants and occupant needs"
Source: Wolfgang F.E. Preiser. (Preiser and Vischer, 2005, p.22) (edited)

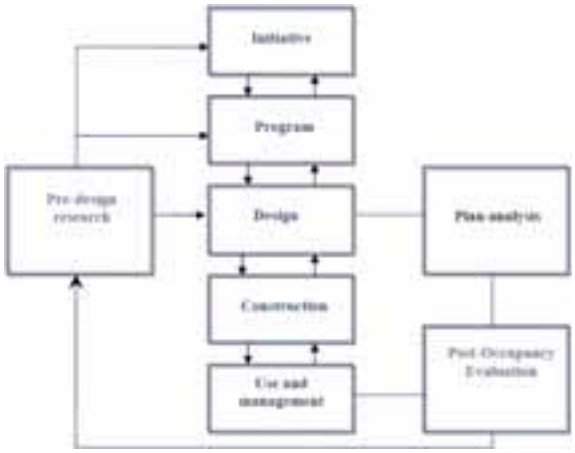


Fig. 87. "Feedback and feed forward of *ex ante* and *ex post* evaluation"
(Voordt and Maarleveld, 2006, p.10)

whose feedback can be introduced as knowledge, for an informed and "innovative approach" (p.1) to the design[412].

In fact, Preiser and Vischer (2005) argue that POE is a "sub-process of BPE" (p.8) that is more wide-ranging in its referred six stages. This enables the information achieved by POE to the included transversally along the building's lifespan:

> "The BPE framework was developed in order to broaden the basis for POE feedback to include a wider range of stakeholders and decision-makers who influence buildings. […] While POE focused primarily on users' experience of the performance of buildings, the most recent step in the evolution of POE towards building performance evaluation is one that emphasizes a holistic, process-oriented approach toward evaluation." (Preiser and Vischer, 2005, p.8)

The upper mentioned *Assessing Building Performance* (Preiser and Vischer, 2005) has a specific chapter on POE (Bordass and Leaman, 2005), but rather uses the concept of BPE that "systematically relates buildings and settings to users and their environmental needs" (Preiser and Vischer, 2005, p.7) (Fig. 86).

By perceiving evaluation through the whole process, as it has been in the overall building performance evaluation, it can be distinguished between *ex ante*[413] (before the event) and *ex post* (after the event, referred to as *ex post evaluation*) (Voordt and Maarleveld, 2006; Voordt and Wegen, 2005). Where the first will test potential solutions and contributions to achieve the purposes sought, and the latter the actual final product and the achievement of the aims for which the building has been built (*ibid.*) (Fig. 87). This distinction can also be made according to the process stage in which it is applied, or on the overall process.

Besides, another publication significantly relevant on this regard is *Building Evaluation Techniques*[414] (Baird et al., 1996), suggesting methods of globally assessing the facilities and how there are physically coping with the needs. In this book there is a chapter on user participation where POE is addressed under "evaluation practices" (pp.25-137) while tackling "user participation" (pp.77-128).

A more recent reference for POE is Mallory-Hill, Preiser and Watson[415] (2012) *Enhancing Building Performance*, with contributions from referred authors in this subject area and their studies on particular case studies throughout, which also

[412] This is confirmed by the authors: "A rational building design process using feedback from ongoing evaluation can be conceptualized as a loop, whereby information fed back through continuous evaluation leads to better informed design assumptions, and ultimately, to better solutions." (Preiser and Vischer, 2005, p.3).

[413] According to Voordt and Wegen's (2005) this could be referred as "pre-design research" and also "impact assessment" in American literature (p.142.)

[414] According to the authors: "Building evaluation is the systematic assessment of building performance relative to defined objectives and requirements. The assessment process is a means of getting buildings right for the people who own, manage, and occupy them." (Baird et. al.,1996, p.xxi).

[415] As described earlier, Watson is a prominent expert in POE and Preiser has been one of its earlier developers.

illustrates the widespread definitions for these procedures, besides the variety of possible techniques that had already been stated in *Learning from our buildings* (The Federal Facilities Council, 2001) as a conclusion[416]. It is also seen as a "sequel" (Mallory-Hill, Preiser and Watson, 2012, p.xxi) of *Assessing Building Performance* (Preiser and Vischer, 2005), which is here considered to be "the first book to illustrate the BPE conceptual framework through case studies from around the globe" (Mallory-Hill, Preiser and Watson, 2012, p.11). Mallory-Hill, Preiser and Watson designate the initial works that lead to POE: an early time period from 1975 to 1985 where POE methodologies started to arise along with its practice in case studies, subsequently from 1985 to 1995 POE was considered to be "a distinct discipline" (p.7), afterwards from 1995 to 2005 POE was integrated within a cumulative process of knowledge where POE went from "diagnostic tool to knowledge tool" (p.9), representing one of several evaluation stages[417], which led to "a new meta-level model" (p.11) which is BPE[418]. Today's stand is ongoing since 2005, as a widespread procedure and, in what regards the forthcoming situation of BPE, it is stated that "BPE generated future solutions will ensure that people and their needs will be critical criteria for improvements in the quality of our built environment" (p.14).

In any case, the results of these evaluations can enable adjustments and changes, in advance, for a better match between exigencies and spatial answers[419], which will generally: "increase the likelihood of successful decisions and a positive return on investment" (Voordt and Wegen, 2005, p.146).

All in all, the benefits assigned to these procedures are related to a closer analysis of a potential intersection between spatial demand and supply; higher productivity and user satisfaction; cost lessening; greater sureness in making decisions on both design and management; and overall better returns from the building (Baird et al., 1996, p.xxi).

The following references concern other publications and methods with particular significance on building assessment. Facilities performance evaluation (FPE) (Zimring, Rashid and Kampschroer, 2005) examines the building's performance

[416] "POE has been seen as one of a number of practices aimed at understanding design criteria, predicting the effectiveness of emerging designs, reviewing completed designs, supporting building activation and facilities management, and linking user response to the performance of buildings. […]
As a consequence, there is no industry-accepted definition for POE; nor is there a standardized method for conducting a POE. Even the term POE has come under scrutiny. Academics and others working in the field have proposed new terms, including environmental design evaluations, environmental audits, building- in-use assessments, building evaluation, facility assessment, post-construction evaluation, and building performance evaluations in an effort to better reflect the objectives and goals of POEs as they are practiced." (The Federal Facilities Council, 2001, p.2)

[417] The six phases are: "strategic planning", "programming", "design", "construction", "occupancy", "adaptive reuse/recycling" (pp.21-25); and have already been represented in Fig. 85.

[418] Systematically introduced in 2005 by *Assessing Building Performance* from Preiser and Vischer.

[419] Voordt and Wegen's (2005) suggest a four set criteria for the evaluation of buildings dividing it on: "functional", "aesthetic", "technical", and "economic and legal". (pp.151-152).

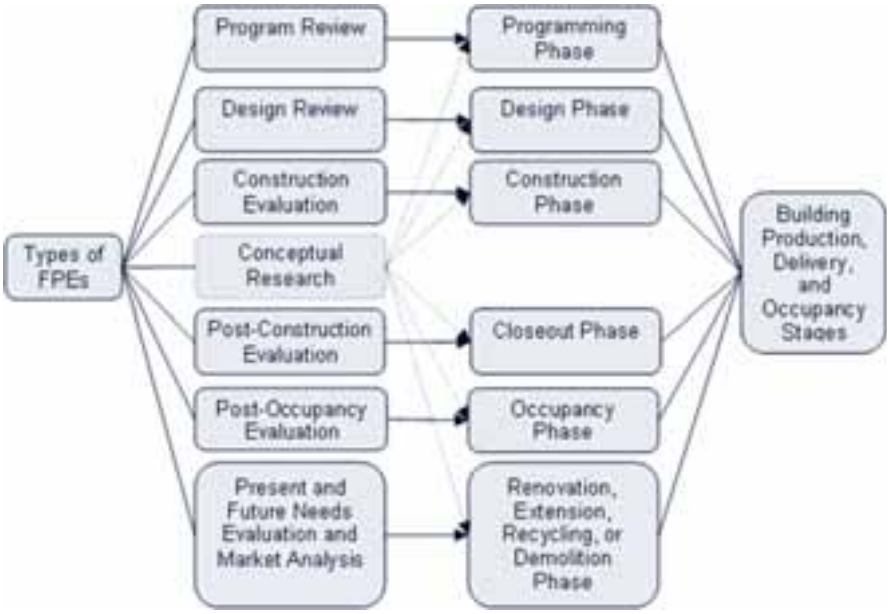


Fig. 88. "Types of FPEs and their relationships to the building production, delivery, and occupancy stages"
(Zimring, Rashid and Kampschroer, 2005, p.2)

according to the requirements found throughout its lifecycle and the response of its features. Even if the terms to define this methodology can be diverse, and post-occupancy evaluation could also be regarded as such and even the most prominent one, others can also be referred such as: "environmental design evaluations, environmental audits, building-in-use assessments, building evaluation, facility assessment, and building performance evaluations." (p.1). Nevertheless, and despite this diversity in definition, procedure or stage to be applied in, they all share common characteristics regarding: the search for the building's features that are working best and worst, their aim to "describe the setting" and they all are generally performed in a real life scenario (*ibid.*). They can adopt the form of a variety of methods, such as: interviews, cognitive maps, behavioural maps, diaries, direct observation, participant observation, time-lapse photography, video recording, questionnaires, psychological tests, adjective checklists, archival data and demographic data (pp.2-3). They can also be undertaken at several stages of the building's lifecycle, depending on the evaluation pursued, as Fig. 88 illustrates.

Usability studies pore over the building's effectiveness and ease of use and its compliance with the needs. They were initially related to Information and Communication Technology (Heitor and Silva, 2009, p.19) and the work of Keith Alexander (2008, 2010)[420]. All in all, the outcomes of these studies can be subject to

[420] Usability is here defined as follows: "Usability in the built environment is context dependent, a product of user experience related to the social relations amongst users and to the interaction between users and facilities." (Alexander, 2010, p.5).

cultural and social interpretation, when matching users, the built environment, its use and the work organisation (Alexander, 2010, p.5).

These methods often appear in close coordination with research centres at universities, as tools used on more advanced or post-graduate studies. This is the current case of the Center for Building Performance and Diagnostics, at the Carnegie Mellon University, which revolves around the connection between high performance building and user satisfaction (The Center for Building Performance and Diagnostics in http://www.nsf.gov/pubs/2002/nsf01168/nsf01168u.pdf)[421].

Also the Center for People and Buildings[422], in close relation with the TU Delft as one of the founding partners, and namely with Voordt's work[423] (Voordt and Maarleveld, 2006), orbit around the studies on "people, work and environment" and their potential resemblance (http://www.cfpb.nl/en/research/research-scope/)[424].

This brings closer academia and the practitioners and engages the students in these approaches, emphasising the disciplinary relevance of the methodologies and the significance of their outcomes for the design, for the theory and for the architectural knowledge as a whole.

Others could also be mentioned on programming and designing as a all-inclusive process of contributions and stakeholders, such as: *Managing the Brief for Better Design* (Blyth and Worthington, 2001); and *Excellence by design: transforming workplace and work practice* (Horgen et al, 1999) that is based on "process-architecture" (p.xiii) as an integrated way of considering the connections between space and stakeholders[425] under the specificity of each context. However, "process-architecture" is considered to differ from POE because:

> "Process architecture's emphasis on the active, collaborative involvement of stakeholders in workplace design leaves it open to discoveries of new purposes and priorities and to the invention of new methods for achieving them. This is unlike learning the methods of technical-rational expertise – such as POE or conventional approaches to spatial

[421] This close bond between research and lecturing holds great representativeness in this centre, according to its self account: "In order to share its findings with the world, the CBPD soon offered the very first non-history-related PhD in architecture—and has continued to offer it and other advanced degrees for thirty years." (The Center for Building Performance and Diagnostics in http://soa.cmu.edu/cbpd/)

[422] Considered to be a Foundation, established in 2001 (http://www.cfpb.nl/en/organisation/board/).

[423] Senior researcher.

[424] The relevance of space use assessment methodologies towards the Design Studio has been subject of presentation in the *Teaching through Design: International Colloquium on Design Studio Education*, between 27 - 29 September 2012, in the Department of Architecture Faculty of Sciences and Technology, University of Coimbra. It has also been published as: Coelho, C. (2013). Space Use as an input to the Design Process. *Joelho #4. Ensinar pelo Projeto / Teaching through Design.* 47-50. Coimbra: Edarq.

[425] "As an approach to workplace-making, process architecture engages a wide array of stakeholders in rethinking the dynamic relationship between work processes and the spatial, technological, financial, and organizational environments within which these processes occur." (p.xiii)

> programming – where one learns a fixed set of methods and tools. The process architect must continuously learn and adapt, applying certain tools when they make sense and inventing others as needed" (p.274)

At this point, it becomes paramount to underline, even from the titles of the referred books, the affirmed connection between the knowledge sought for an informative design and the assumption of an actual "better design" (Blyth and Worthington, 2001) that can even reach "excellence" (Horgen et. al, 1999). Additionally, Blyth and Worthington (2001) add that the built space provides tested and valid knowledge, able to be conveyed to other buildings' briefs[426] and informative to future deriving designs[427]:

> "Louis Kahn, the inspirational American architect, suggested that only when the building is completed, do you know what to build. The completed building for a perceptive client and designer becomes the 'sounding board' to learn what the next building should be." (Blyth and Worthington, 2001, p.xi)

The general systematisation from the upper contents presented, introducing study fields, methodologies and authors of reference is the shared possibility of assessing space use, either individual or collective, in order to understand a potential corresponding between the initial brief and the needs to which a space has been conceived, the actual design and the built space and its effective use or developments throughout its occupancy. This is also a manner of relating design and use, architect(s) and inhabitants(s), life and architecture, which has been a motivation from the start of this Doctoral Thesis. But specifically, it is of the utmost relevance when addressing adaptability, recognising it to be the ability of the built space to cope with changing needs and a multitude of uses and users, which it can still cater for.

Therefore, the mentioned methodologies, are several amongst many other, considered to be significant for the state of the art on assessing the built space after its completion and to acknowledge its continuing potential to cope with the changing and upcoming answers that are asked of it throughout its lifecycle. Its recognition is, thus, a part of the state of the art for a methodological approach to identify and assess adaptability, since it presents authors of reference and literature, in its respective locations and timeframes, that regard design and use. Acknowledging them as widespread as they are today, and they way in which they have evolved and been even specified by authors according to building briefs, it is possible to critically analyse these procedures and to assess their potential adequacy towards contemporaneity, adaptability and the school brief in particular, for both the research and the academia and also for the practical intervention on that or other buildings.

[426] "It is also about recognising that the briefing process is continuous and looks back on itself as feedback is generated, and looks forward as feedback is used to inform future decisions." (p.12)

[427] Hence, the focus of the book on "managing the brief" to be able to reach a "better design".

. Space syntax[428]

> "Space syntax is a method we have developed at the Bartlett Unit for Architectural Studies to describe and analyse patterns of architectural space-both at the building and urban level. The idea is that, with an objective and precise method of description, we can investigate how well environments work, rigorously relating social variables to architectural forms." (Hillier et al., 1983, p.49)

Another study field can also be mentioned that has conveyed established results, in a very distinctive approach to spatial analysis and the relation between space and behaviour, by resorting to morphology for analysing an urban space or a building. Space syntax is an understated study area with great representativeness to architecture and a becoming significance towards other disciplines. It aims to relate spatial configuration and morphology with behaviour, providing quantitative outputs, but also other representational results such as graphs, of subsequent cultural and social interpretation on related instances, such as spatial cognition, natural movement, wayfinding, patterns of co-presence …

Space syntax is considered to be very significant for the methodological approach proposed by this Doctoral Thesis, in which a morpho-syntactic analysis will be undertaken and overlapped with effective spatial fruition in order to conclude on a potential correlation between space and use and also between morphology and physical features of space and the potential adaptability they convey. Naturally that the study of the building's morphology through space syntax is paramount to understand its specificity and the way in which it supports activity allocation and also to considered a potential resemblance to behaviour, encounters, movement and co-presence according to the features under study[429].

The main literature references on space syntax are *The social logic of space* (Hillier and Hanson, 1984) and *Space is the machine* (Hillier, 2007[430]). From the following papers referred as representative of space syntax's state of the art and early development, it is also noteworthy the relevance Hillier, as other members of the Unit for Architectural Studies at the Bartlett in the 1970s, as founding authors of the principles that constitute it and the procedures to represent it. Formerly working at the RIBA Intelligence Unit, where he was considered "the RIBA's second youngest assistant secretary at 32, [as] the nearest thing we have to a long-haired intellectual"

[428] Space syntax holds a more in-depth development in this chapter because it will be used for the methodology proposed in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments. So, it becomes paramount to understand its origins, problematics, evolving development until today, its methods and outcomes.

[429] In this chapter it is intended to provide a state of the art on space syntax and foremost its outsets, methods and intentions in regard to space and society. In the following chapter 3.3. A methodology for identifying and assessing adaptability in learning environments, it will be explained in detail how and by what means is space syntax considered in the methodology proposed to identify and assess adaptability in school buildings today.

[430] Consulted edition from 2007, original edition from 1996.

Fig. 89. Bill Hillier, at 32 years old, as assistant secretary of the Royal Institute of British Architects. (Royal Institute of British Architects, 1969, p.426)

(RIBA, 1969) (Fig. 89). Ultimately, by leading the RIBA's Intelligence Unit, Hillier would share with Leaman the committed role of reflecting upon fundamental views, relating simultaneously research and theory, profession and practice, which was unusual until that moment within a professional organism as the RIBA.

In one of his initial papers *Psychology and the subject matter of architectural research*, from 1970, Hillier sustained the relevance to "Get involved in design so that hypotheses can be tested by that marvellous available instrument, the real building." (Hillier, 1970, p.29), which revealed the intrinsic fragilities of empiric research and induction. These early intentions will subsequently be addressed because they are considered to inform on the relevance of addressing space syntax for our current Thesis and to understand its grounding foundations and methodological developments that have brought us until today's widespread applications and informative approach to space and social relations[431].

In 1972 Hillier, Musgrove and O'Sullivan present the paper *Knowledge and Design* at the Third Environmental Design Research Association (EDRA)[432], regarding (environmental) research and its connection to the (design) practice. It is here

[431] The foundations of space syntax have been presented in the *11th International Space Syntax Symposium*, in 3-7 July 2017, Lisbon. It has also been published in the Conference's proceedings as: Gil, B.; Coelho, C. (2017). Laying the Fundamentals. Early methods and intentions from the outsets of space syntax. This also proves its peer validation, originality and relevance for the academia of space syntax.

[432] Section 5: Design Research and Education, of the proceedings (Environmental Design Research Association, Mitchell and AIA-Architect-Researchers' Conference, 1972).

pointed out very strongly the need to diminish the so-called "applicability gap" of research towards the design, but also the tasks to be achieved by research towards addressing its "credibility gap" (p.2). Under this contextual framework of the beginning of the 1970s, and according to these authors, architects developed design concerned with the practice, rather than knowledge for that practice, which was considered to be accorded to other realms of study[433] (*ibid.*).

Hence, this paper holds relevance on the state of the art of the linkage between research and knowledge, the practice and the design, in which the first set is proposed to inform and displace information and acknowledge "conjecture" (p.9), rather than systematise and generalise conclusions for particular "solution types" aiming at "fit" or "optimisation" purposes, as stated:

> "Design proceeds by conjecture-analysis rather than by analysis-synthesis. It is argued that if research is to make an impact on design it must influence designers at the pre-structuring and conjectural stages. The idea that research should produce knowledge in the form of packaged information, coupled to rationalised design procedures is therefore inadequate. The aim of research should be seen more in terms of providing designers with a stronger theoretical, operational and heuristic basis from which to conjecture, rather than in terms of knowledge to determine outcomes." (Hillier, Musgrove and O'Sullivan, 1972, p.1)

This paper elaborates on the societal connection of the physical environment to behaviour, which will be further suited by these authors, and considers the building as "a container of activities, and within this it both inhibits and facility[ates] activities, perhaps occasionally prompting them or determining them. It also locates behaviour, and in this sense can be seen as a modification of the total behaviour of society" [434] (p.12). Therefore, stating the research's contribution to the design to be to "reconstitute codes from a theoretical base concerned with the relations between physical environments and those who experience them" (p.13). The research will then provide theories on the "basic elements in design", namely: "ranges of activities, movements, perception motivated actions, social intercourse patterns, spaces and the environmental criteria" (p.13); which would be a based-informed knowledge for the designer to proceed according to his "basic cognitive capability"[435] (*ibid.*). Generally, by refusing a definite knowledge or a set of rules of

[433] "Because the education of architects was broad and shallow, and because they were concerned with action rather than knowledge, they could not be expected to generate new knowledge for themselves. This was the job of 'related' disciplines, whose concern was the advancement of knowledge. Architects, on the other hand, knew about design, and should make systematic design their research focus." (p.2)

[434] It also defines the building as a "climate modifier, a behaviour modifier, a cultural modifier and a resource modifier" (p.12.)

[435] Full quote: "[…] we can begin to build up theory-base descriptions of the basic elements in design. These basic elements include ranges of activities, movements, perception motivated actions, social intercourse

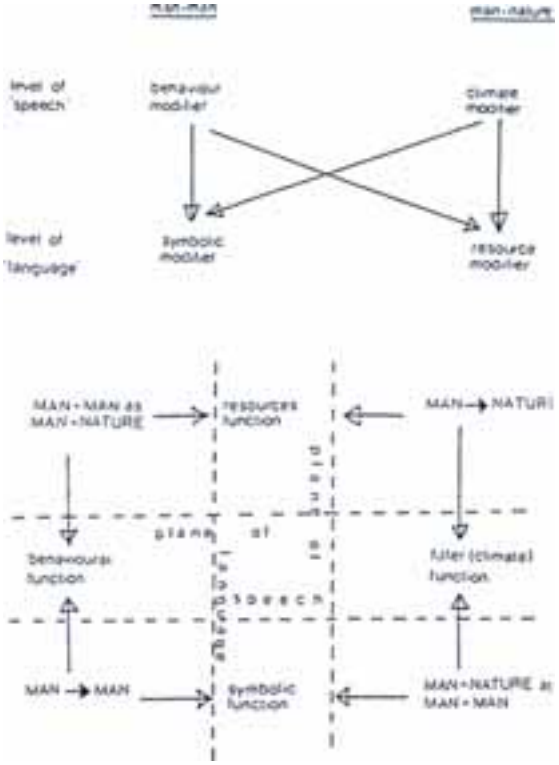


Fig. 90. "The four-function model as a structure (two versions)"
(Hillier and Leaman, 1974, p.8)

thumb, this approach draws near the design and the theory, the conjecture and the research, and strongly advances that: "Such theories are not pseudo-deterministic ways of telling the designer what will be the outcome of his design, but strong and cumulatively developing bases for conjecturing possible futures." (p.14).

Following this connection between the design and the environment, a subsequent paper by Hillier and Leaman (1974) (Fig. 90) states that "if design method is to be improved then it is more important to study the environment itself than how designers design" (p.4) and also to explore "how designers' internal models transform environmental reality". This recalls the previous 1972 (Hillier, Musgrove, O'Sullivan) idea of the building as a "climate", "behaviour", "cultural" and a

patterns, spaces and the environmental criteria that will satisfy a classified range of possible uses, coded and described in terms of the technologies which make them possible. Such a breakdown we might call a base component classification for environmental action, which would shift both in response to theoretical changes and also in response to changes in the environmental objectives of society. From the point of view of the designer such classifications and code formalisations would not be deterministic or constitute a set to be specified in relation to problem information, but would constitute an extension of the designer's basic cognitive capability, and provide him with - and this is really the point about science - a position of strength from which to make his conjectures. In other words he would be using theories operationalised and specified as far as possible in terms of externalized codes, linking instrumental sets to human usage, as a basis for proposing his own further modifications to the environmental field." (p.13)

"resource modifier" (p.12), even though this is deeper developed in this paper, in which the authors advance a more structured framework for these conditions, namely that the "man-man" relation regards the building as a "behaviour modifier", as the "man-nature" relation regards the building as a "climate modifier" (p.8).

Already at this paper Hillier and Leaman (1974) address "morphology" and "structure" (p.6) and refer to a:

> "[…] theoretical approach to space where the fixity of artificial space […] becomes a primary factor. Such a theory begins with the observation that the simplest structures in environmental action are already complex structures.
> Such elementary structures, given that they are identifiable, will contain within themselves rules for combination into the higher-order aggregations which give the spatial structure characteristics of urban and other higher-order spaces, as mappings of social processes" (Hillier and Leaman, 1974, p.10)

This latest remark on "mapping of social processes" could induce the future "social logic of space" (Hillier and Hanson, 1984), and also the identification of rules of combination of structures and the reference to morphology, could be understood as an anticipation of the *Space Syntax* paper (Hillier, Leaman, Stansall, Bedford, 1976) two years later.

But just one year afterwards, Hillier and Leaman publish *The architecture of architecture. Foundations of a mathematical theory of artificial space* (1975) that elaborates on "morphologies and codes" (pp.6-8), "spatial surfaces and aggregation modes" (pp.10-12) and presents an "elementary syntax of spatial structures" (pp.12-16).

So, as mentioned, in the following year, the paper *Space Syntax* by Hillier, Leaman, Stansall and Bedford (1976) that starts by questioning: "how and why different societies produce different spatial orders through building forms and settlement patterns" (p.147)[436], is paramount for the establishment of space syntax, as "a general syntactic theory of space organization" (*ibid.*).

Structurally, this paper first locates this theory as a "morphic language" that is "used to constitute rather than represent the social through their syntax (that is the systematic production of pattern)" (*ibid.*) and grounds it, between the mathematical and the natural language, from which it resembles, but also differs:

> "From mathematical languages, morphic languages take the *small lexicon*

[436] These authors, at this time, were a part of the Unit for Architectural Studies in the School of Environmental Studies, University College London. Having been published in *Environment and Planning B*, this paper is a reviewed version of an early report to the Science Research Council, on a research programme with a SRC Research Grant (p.185).

> (that is the homogeneity of its primary morphic units), the *primacy of syntactic structure* over semantic representation, the property of being built up from a *minimal initial system*, and the property of *not meaning anything except its own structure* (that is to say, it does not exist to represent other things, but to constitute patterns which are their own meaning). From natural languages, morphic languages take the property of being *realised in the experiential world*, of being *creatively used for social purposes* (or permitting a 'rule-governed creativity'), and of being *constitutive, rather than representative, of the social*."[437] (Hillier, Leaman, Stansall and Bedford, 1976, p.152)

In fact, the first part of the paper addresses the search for the recognition and representation of "inherent formal structures" (p.148) to understand spatial and social patterns (*ibid.*). For that purpose, the uncertainty on the use of mathematics overall, or of any particular work field, is reflected on affirmations such as: "We cannot know in advance whether the new combinatorial ideas we need will come from mathematics, or whether they will come from outside and challenge mathematics […]" (p.148). Under a yet emergent search on the methods, the "syntactic" choice is here justified, rather than a mathematical straightforward approach, as follows:

> "Perhaps a firmer argument for a 'syntactic' rather than properly mathematical strategy is that, even within the scope of a general belief in an inherent formal order giving rise to knowability in space patterns, we cannot know in advance which of the array of current branches of mathematics will be appropriate, or even if any branch will offer models for the level and type of approximation we require. The proper scientific strategy therefore seems to be to build a theory of patterns, with a close respect for the evidence but without too much regard for early justification in mathematical terms." (Hillier, Leaman, Stansall and Bedford, 1976, p.149)

Then, the paper explains the aim of the "theory of morphic languages" in "understanding how the morphology may be generated from a parsimonious set of elementary objects, relations and operations" (pp.149-150). Syntax here plays a prominent role, quoting the original words:

> "In effect the reduction of morphology to the elementary structure of a combinatorial system is argued to be its reduction to its principles of knowability. The set of combinatorial principles we call syntax. Syntax is the most important property of a morphic language. What is knowable about the morphological output of a morphic language is its syntax. Conversely, syntax permits the morphology to exhibit regularity in its similarities and differences.
> *Syntax* in a morphic language is defined as a set of related rule structures

[437] Italics from the original quote.

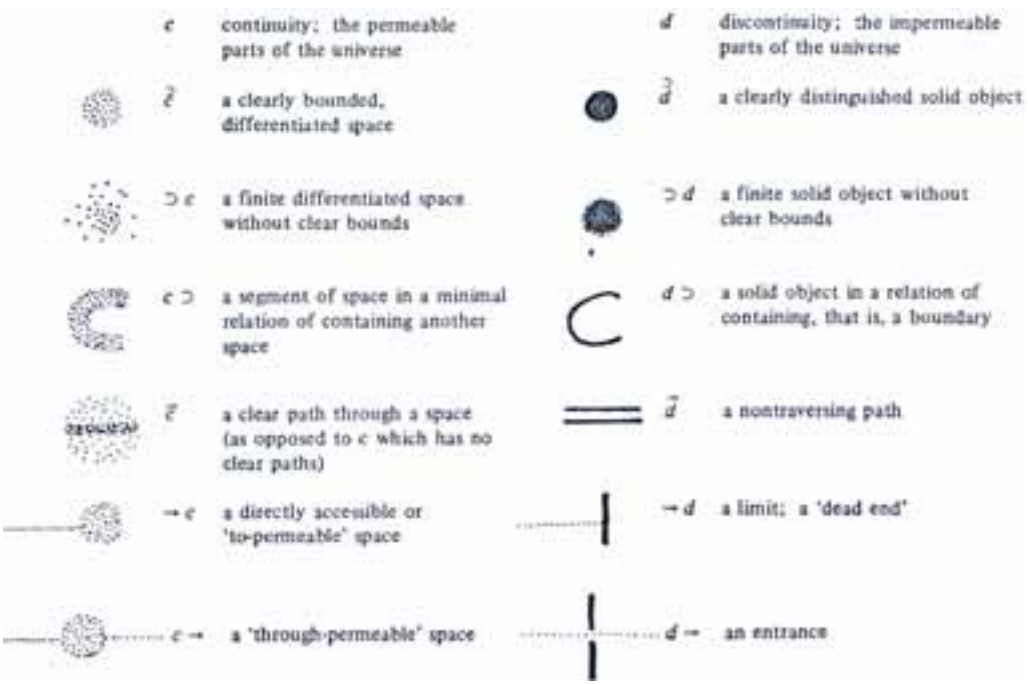


Fig. 91. "Elementary lexicon. The diagrams are illustrative rather than rigorous and are included as an aid to understanding the argument"
(Hillier, Leaman, Stansall and Bedford, 1976, p.155)

> formed out of elementary combinations of the elementary objects, relations, and operations. These can be introduced, independently or conjointly, in a *minimum setup* for the morphic language to produce recognisable patterns."[438] (Hillier, Leaman, Stansall and Bedford, 1976, p.150)

In this paper influential concepts of space syntax already appear, such as: "local" *vs* "global" (p.153), "retrieving a description of the collective pattern" (*ibid.*) and "description retrieval" (p.184), "a solid" *vs* "a vacant entity" (*ibid.*), "betweeness" (p.157) *vs* "insideness" (p.173),… Afterwards, it describes the postulates, the advantages and its lexicon (Fig. 91). Finally, it provides some reflection upon human settlements with examples.

Lastly, the paper stresses that at that time it presents an untested theory[439] (p.179),

[438] Italics from the original quote.

[439] "Furthermore, the theory as we developed it appeared to make sense and relate a significant proportion of the conclusions of other researchers, including architectural researchers, anthropologists, and even an economic anthropologist. Although it is in no sense a tested theory yet, having been developed and applied only retrospectively to the evidence collected by others, we are satisfied that the match between the formal structure of the theory and the distribution of evidence as currently known is sufficiently suggestive and exact to permit our giving an account of it at this premature stage. Unfortunately, in the time so far available, it has not been possible to give a thorough review and reference to the work of others on which we draw. This serious

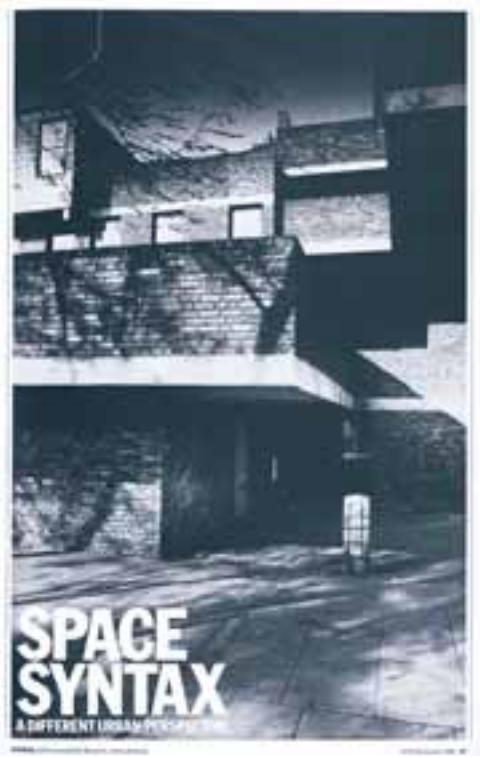


Fig. 92. Space Syntax, paper cover of the paper on the *Architect's Journal 30*
(Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.47)

which is not "causal" or a "reflection" (*ibid.*) of society and space[440], but that the theory here presented is the most exact one that engages syntax with social relationships[441], whose further developments would also lie in the clarification of this relation. This is the case of the paper *Creating life: or, does architecture determine anything?* by Hillier, Burdett, Peponis and Penn (1987), which exams in detail whether "architectural design create[s] a pattern of spatial life" (p.234), ending with the suggestion that "cities are not so much mechanisms for generating contact as mechanisms for generating a *potential field of probabilistic co-presence and encounter*"[442] (p.248) with a "definite and describable structure" (*ibid.*).

deficiency will of course be corrected in a later paper." (p.179)

[440] "This theory does not have a 'causal' form. It does not argue that particular forms of society 'cause' particular kinds of space patterns. Space is not a result of society as much as one of the means by which the social is constituted and made real. The theory is more in the form of pattern similarities or relationships between spatial and social syntax-social syntax being the patterns of encounters and relationships that hold among the members of a society. Nor is it correct to seek in such patterns and comparisons only a spatial reflection of social form." (*ibid.*)

[441] "In extending the concept of 'syntax' to social relationships and encounters, it must, of course, be stressed that no such syntactic theory yet exists on a level of exactness comparable to the syntax theory of space. […] At a broad level, we shall try to show that both the general shape of the syntax model as a whole, and the patterns implied by particular syntaxes, provide useful ways of talking about social relationships." (p.180)

[442] Italics from the original quote.

Fig. 93. Limehouse Basin – photo
(Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.60)

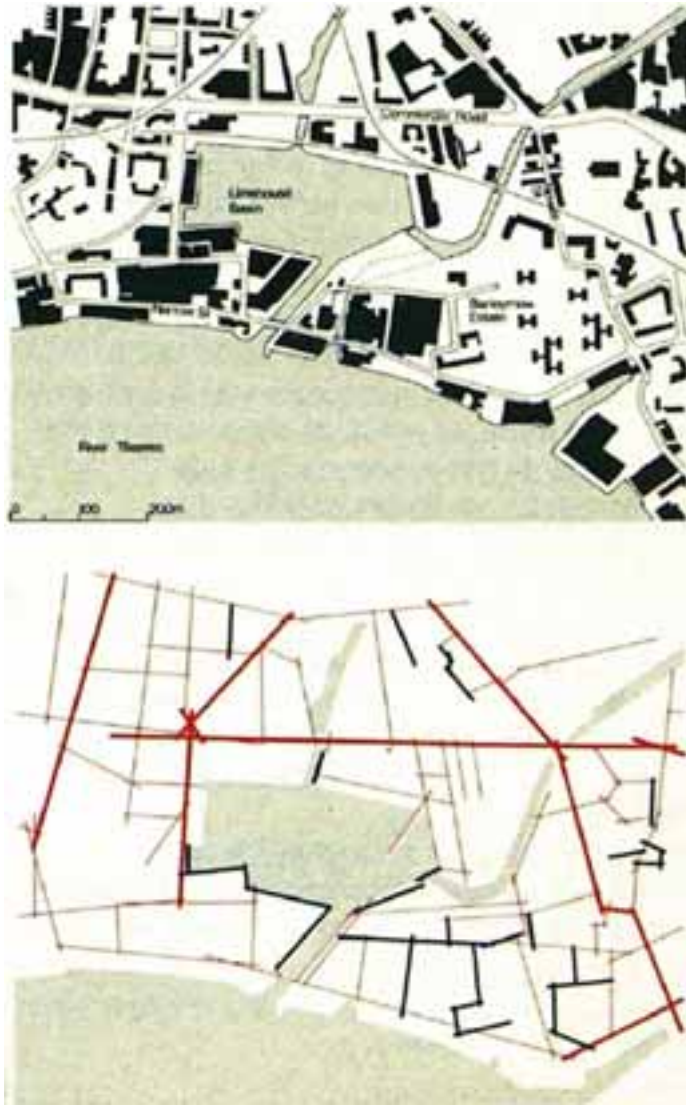


Fig. 94. Limehouse Basin – spatial analysis
(Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.60)

A subsequent paper under the same title *Space Syntax*, by Hillier, Hanson, Peponis, Hudson and Burdett[443], published in 1983 in *The Architects' Journal 30* (Fig. 92), developed this theory further and closer to what has been presented in the 1984 Hillier and Hanson's *The social logic of space*.

This paper explains very clearly the principles of space syntax:

> "Space syntax is a method we have developed at the Bartlett Unit for Architectural Studies to describe and analyse patterns of architectural space-both at the building and urban level. The idea is that, with an objective and precise method of description, we can investigate how well environments work, rigorously relating social variables to architectural forms." (Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.49)

This research has been taken up at the Bartlett and applied to "more than 100 towns, urban areas and design proposals, and the systematic observation of 15 examples" (*ibid.*). One of the focused examples is London's Limehouse Basin, for which four design proposals have been analysed, besides the existing urban tissue (Figs. 93 and 94). And despite the choice in the proposal, the research shows that the analyses of the existing structure tackle its respective problems and assets and also acknowledges the spatial requirements for bettering its movement and social interaction.

In addition to the fact that this paper presents a well-defined description of space syntax, it holds an appendix with the concepts that it takes up and it perceives its purposes and advancements very clearly. It also concludes on the relevance of spatial order towards cognition and behaviour (p.49):

> "Nevertheless our results show unequivocally that the spatial organisation of towns and urban areas affects patterns of movement and use according to well defined principles, which relate to intelligibility of space […]; the continuity of occupation […]; and the predictability of space […]" (Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.49)

Lastly, it strongly acknowledges space syntax as an advancement for urban design, by providing an understanding of the existing situation that can ultimately advise future designs:

> "Space syntax is therefore both a method and a message, and it would seem to open up new perspectives to urban design. It gives a rational way of approaching urban design 'top down', so that anyone can participate in the decision taking process from the 'bottom up'. Space syntax allows the structure of the area to suggest new possibilities. Above all, it is a way of looking at the oldest problem of all in urban

[443] Members of the Unit for Architectural Studies in the School of Environmental Studies at the Bartlett, with a grant by the SERC (p.48).

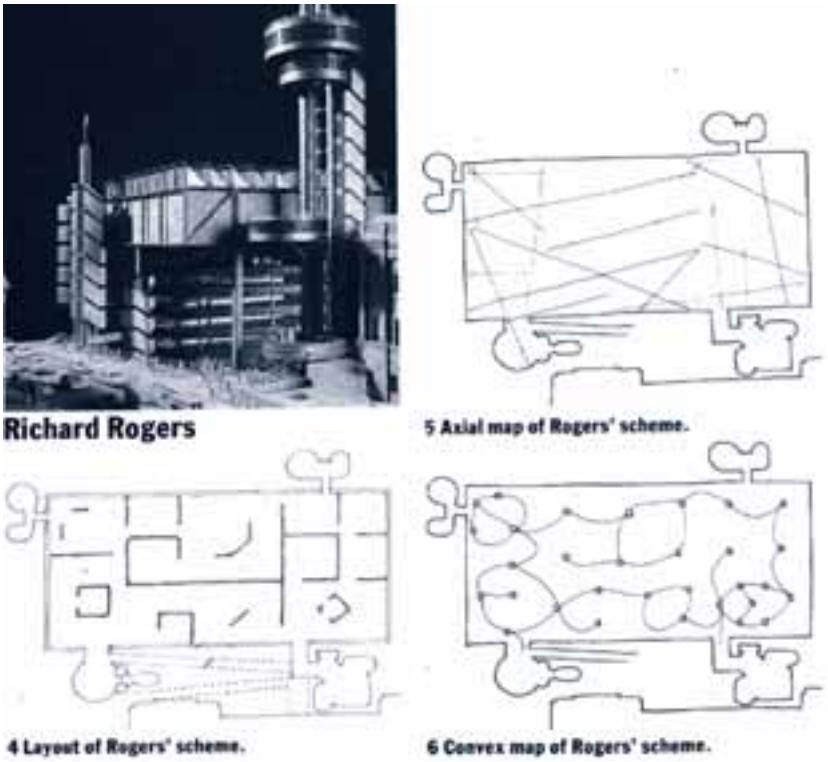


Fig. 95. Richard Rogers's proposal and analysis
(Hillier, Peponis and Simpson, 1982, p.38)

> design: how to add the new to the old." (Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.63)

This can be perceived in the analysis of the former example of Limehouse Basin. But, besides urban analysis, space syntax has also proven relevant on the analysis of design proposals for building interventions[444]. One year prior to the mentioned paper, another one is published on *The Architects' Journal,* regarding the National Gallery Hampton site proposals[445], already analysed by axial and convex maps (Hillier, Peponis and Simpson, 1982) (Fig. 95).

Remarkably, the headline of this paper states: "This approach to assessment, argue the authors, shifts the onus of selection from the subjective aesthetic onto more objective goals" (p.38). In this case Hillier, Peponis and Simpson do not evaluate any proposal but are constricted to their analyses in order to provide an insightful

[444] This is quite significant for the methodology proposed in this Thesis to identify and assess adaptability, because it is applied to a building, which also justifies its use in the proposed methodology and also the relevance of the development of space syntax in this chapter.

[445] Although this 1982 competition had 79 proposals, the one chosen has not been built. Instead, in 1991 the, currently known as the Sainsbury Wing, has been built by Venturi, Scott Brown & Associates.

Fig. 96. Mission Impossible?
(The Architects' Journal, 1983, pp.14-15)

outlook on how the spatial structure proposed would function[446].

This holds significance, because on the one hand, it demonstrates that space syntax is also possible to be transposed to buildings and not just urban areas, on the other hand, space syntax becomes a process able to provide information for a more supported decision-making, either for design competitions or for the designers themselves, and also during the design process and not just after completion.

However, the reception of the space syntax method by *The Architects' Journal's* readers expressed "major reservations" like Richard MacCormac (The Architects' Journal, 1983, p.14) who, even considering the "intelligibility of a locality" as relevant, argued that "space syntax describes formal characteristics of urban space and I do not feel that a measurable relationship between these and urban experience is established".

The only exception on this debate was Markus, who actually believed in its potentialities, rather than a "mission impossible" (Fig. 96). Hence, this could be

[446] "Our method of analysis of layouts with respect to strategic choices involves the representation of plans in ways that bring out their relevant spatial properties and allow their precise evaluation if this is whished. To keep the argument simple, no evaluation will be introduced here. Rather, the aim is to demonstrate the principles of analysis." (pp.38-39)

one of the early signs that revealed subsequent divergent approaches to the man-environment paradigm, foreseen by Hillier and Leaman ten years earlier (1973).

Then, the *First Space Syntax Symposium* occurs for an already established research community. Its opening lecture by Hillier and Hanson (1997) reflect upon the progressive development of space syntax, both as a method but foremost as a theory: "the analytical theory of architecture" (p.1). This recalled the early papers when Hillier was at the RIBA's Intelligence Unit while searching for the fundamentals of an architectural theory, which now holds specificities and mechanisms that structure and describe spatial configuration in regard to social relations.

According to Hillier and Hanson (1997) its development was instigated by the questioning of the spatial structures in the 1970s, which also engaged other researchers at that time, with different approaches to this subject:

> "Space syntax originated in the early seventies in an effort to understand why, from a spatial point of view, buildings and built environments were as they were, and occupied only a small corner of the theoretically vast field of architectural and urban possibility. From the earliest days we focussed on the study of real cases, and our efforts could be contrasted with the parallel efforts of others such as March and Steadman at Cambridge (and then at the Open University) to identify the formal and geometric limits of architectural possibility. They studied possibility, we studied actuality, and we compared notes in the friendly rivalry of a mobile joint seminar, which soon expanded to include George Stiny, Bill Mitchell and others. The earliest space syntax work took real environments, such as organic settlements, and vernacular buildings, and tried to identify the formal, spatial and functional forces that generated their characteristic spatial forms." (Hillier and Hanson, 1997, p.1)

As seen, their initial work lied along the study of urban settlements, which is confirmed by the referred 1983 paper from Hillier, Hanson, Peponis, Hudson and Burdett, recalling the study of more than 100 urban areas, at the Bartlett. This continued on in an effort for representing and analysing the found spatial patterns, that had already been established in 1984 with *The social logic of space* (Hillier and Hanson). This book's impact was then considered, by its authors, to be "methodological", which allowed other study fields and authors to acknowledge it in their own researches and enabled a wider research community to hold the symposium in which this lecture was given (Hillier and Hanson, 1997, p.1).

Anyway, Hillier and Hanson chose to underline at that particular moment, the analytical theory behind space syntax, rather than the method. According to them: "Without theory, method is nothing." (*ibid.*). And even though space syntax had already gained representativeness, both in the practice and also in the research,

in urban and building designs, at that point, it could gain a more crucial place in both[447], regarding it as a theory more than a set of techniques (*ibid.*), because:

> "Design is a matter of going from what we know to what we do not know. Techniques on their own cannot accomplish this. Only theory can. […] Architecture is about the exploration of possibility and so are space syntax techniques." (Hillier and Hanson, 1997, p.4)

Considering architecture as "the art of 'assemblage"' (p.2) of raw contents, and buildings as "essentially relational schemes" (*ibid.*), and being the "concrete elements" - "discursive", and the "relational schemes" - "nondiscursive", then:

> "Architecture and urbanism are the most omnipresent case of this duality, because buildings and cities are where we apply nondiscursive relational schemes to the real world in which we live, and so convert our milieu from materiality to culture." (Hillier and Hanson, 1997, p.3).

Hence, space syntax aims to provide an understating of these relational schemes: "Space syntax is a means to study architectural and urban phenomena directly and hope through this to identify the nondiscursive relational schemes that structure their characteristic forms." (Hillier and Hanson, 1997, p.3)

And if previous theories can be considered more normative, space syntax intends to be analytical, which "aided architectural understanding, but remained relatively uncommitted to any normative theory of design" (*ibid.*), being "aided architectural understanding" the crucial sore point, in this connection between the design and the analytical (and *not* normative) theory. Although it resorts to quantitative properties, it is supported by the nondiscursive relations, so it also informs on other representational properties:

> "Space syntax is about the configurational relation of part to whole, and aims to express these peculiar properties of configurations in a consistent, rigorous and quantitative way. But it is not simply about quantification. It also itself exploits nondiscursivity by using graphical representations of configurational properties, including quantitative properties, so that the intuitive eye and the analytic mind can work together in detecting the hidden patterns in architectural things." (Hillier and Hanson, 1997, p.3)

[447] From the lecture: "My purpose in this paper is to explain why it is not simply the methodology that is applied but the theory, and why space syntax should not be seen as some interesting techniques on the periphery of architecture and urban design, but as central to the development of the practice and theory in those subjects." (*ibid.*)

Fig. 97. Space syntax studies at the Bartlett, UCL
Courtesy of Professor Bill Hillier. (http://www.bartlett.ucl.ac.uk/graduate/programmes/postgraduate/mscdiploma-advanced-architectural-studies)

So, overall, Hillier and Hanson (1997) state that space syntax works along "design intuition" for the understanding of the possibilities:

> "Space syntax works with, not against, design intuition, and generates new generic possibilities for design intuition to explore rather than simply constraining design. It can do this precisely because it is a theory, and could not do this if it were not. […] Space syntax makes the deployment of nondiscursive intuition more rational and therefore more discursive. It aids design as what it is: the reasoned deployment of intuition. Architecture remains, as ever, the reasoning art." (Hillier and Hanson, 1997, pp.4-5)

This is picked up by Hanson (2001), in her paper *Morphology and Design. Reconciling intellect, intuition, and ethics in the reflective practice of architecture*, for the *Third Space Syntax Symposium*, where she recalls the engagement of morphology to design, but also, intuition and ethics to space syntax[448].

Furthermore, Hanson also highlights the relevance in studying morphology at an early stage of the briefing, which provides a significant contribution to architecture, both to the practice but also, within the university:

[448] "The creative interplay of intellect and intuition is considered in relation to how morphology can help to clarify strategic design choices early on in the design process." (Hanson, 2011, p.1)

Fig. 98. Space Syntax Laboratory
(Carolina Coelho, 2015)

> "[…] the potential for space syntax to guide the relation between morphology and design at the briefing stage, when the limits of architectural possibility need to be set against the constraints of the unique design context, may represent its most vital contribution yet to architectural knowledge and also to present its strongest claim to be a legitimate academic discipline within the modern university." (Hanson, 2001, p.17)

Pedagogically, the first space syntax course was originally conceived by Hillier in 1974 at the Bartlett, as the MSc Advanced Architectural Studies, and it continues to be taught today on the MRes/MSc and MPhil/PhD programmes (https://www.bartlett.ucl.ac.uk/space-syntax) (Fig. 97).

Also, within the Bartlett School of Architecture, the Space Syntax Laboratory (Fig. 98), created by Hillier in 1972, is the original and most representative research and educational unit, still currently active (The Bartlett Space Syntax Laboratory):

> "The Space Syntax Laboratory is the originator of the architectural research discipline of space syntax. Space syntax research has led to a fundamental understanding of the relationship between spatial design and the use of space as well as longer term social outcomes." (The Bartlett Space Syntax Laboratory)

Fig. 99. *Space Syntax Symposium*, London, 13th-17th July 2015
(http://www.sss10.bartlett.ucl.ac.uk)

Fig. 100. *Space Syntax Symposium*, Lisbon, 3rd-7th July 2017
(Heitor, 2017b, p.1)

Although, mostly applied to Graduate Studies Programs, pedagogically, space syntax subjects spread also worldwide. The current European Postgraduate Masters in Urbanism, a conjoint program conducted by: TU Delft, UPC Barcelona, KUL Leuven and Università IUAV di Venezia, had in the Autumn 2012 semester a ten-session course on space syntax, which is a clear example of the practical importance this approach has gained for notable universities and study fields.

Presently, this approach, linking spatial morphology to a "social logic of space" (Hillier and Hanson, 1984), provides information on a widespread number of study fields, from the urban scale to the dwelling. This is proven by the extensive themes addressed in the latest *Space Syntax Symposium* in Lisbon (3rd-7th July 2017) such as: buildings and respective "configuration-informed" knowledge for the design and the theory; "urban spatial-structural studies" for the design, movement, justice and mobility; "environmental and spatial cognition" and processes of wayfinding and perception of a particular spatial morphology towards movement, behaviour and interaction; "space-related environmental, social and economic sustainability issues" in a far-reaching understating of the environment beyond the built form for the analysis of study matters on behaviour, safety or gender; and "methodological and technical innovations" on this matter (http://www.11ssslisbon.pt). This largely demonstrates the wide framework of the current trends on space syntax research (*ibid.*) and the currently extensive community of researchers involved with this approach (Figs. 99 and 100), forty years after the breakthrough brought by the paper *Space Syntax* (Hillier, Leaman, Stansall and Bedford, 1976), setting its outsets.

So, overall the case studies and situations in which to apply space syntax have been gradually widened, its disciplinary scope has gained a broader extension, and a potential transdiciplinarity can be perceived, which is stated promptly in Hillier's (2007) *Space is the machine*:

> "The surprising success of configurational ideas in capturing the inner logic of at least some aspects of the form and functioning of built environments, suggests that it might in due course be useful to extend these ideas to other areas where similar problems of describing and quantifying configuration seem to be central, including some aspects of cognitive psychology, but also perhaps sociology itself. At present we are encouraged by the current interest in these ideas across a range of disciplines and, just as the last decade has been devoted to the development and testing of techniques of configurational analysis within architecture and urban design, so we hope that the coming decade will see collaborations amongst disciplines where configuration is identified as a significant problem, and where some development of the configurational methodology could conceivably play a useful role." (Hillier, 2007, p.2)

Hillier's reference to "collaborations amongst disciplines" (*ibid.*), may imply a way of surpassing the "paradoxes" on the "man-environment paradigm", foreseen in the early paper with Leaman (Hillier and Leaman, 1973[449]). These paradoxes have certainly contributed to the delimitation of the theoretical fundamentals of space syntax and its subsequent developments. Actually, in its outsets, by concentrating its methods in securing a rigorous and stable assessment of the structural logics that influence social relationships in space, the theory became intentionally biased by not taking into account subjects' sensorial experience and intentions and, thus, without aiming to resolve the holistic complexity of social encounters.

At the same time, this theoretical assertiveness brought some arguments from several critics, pointing out fragilities that were, from the beginning, outside the fundamentals proposed by the theory. The recent clarification of the field's limitations, by Netto (2015) when questioning "What space syntax is not", while systematically identifying the intrinsic goals of space syntax's theory, also underlines its abstraction when it reduces "social practice" and "the actors" to syntactic measurements.

From opposing epistemologies many of the controversies have grown towards space syntax, as we have seen in the publication *Mission Impossible* (The Architects' Journal, 1983). Hence, more than a permanent and unresolved fracture, questions can be placed on how far the confrontation between space syntax and divergent theories, might constitute a way of surpassing the above paradoxes, while respecting their mutual fundamentals.

From the three different possibilities pointed by Netto (2015, p.8) to this "epistemological dilemma" on the future of theory – "maintenance and reproduction"; "rupture"; or "adaptation and evolution" – we argue for the critical dialogue between theories, and a constructive triangulation of their original principles.

Hence, more than adapting and envisaging an expanded theory through its adaptation, its interaction with other theoretical contributes would comply with a critical and more complete sociospatial assessment, such as attempted in recent researches (Coelho and Krüger, 2015). This particular research associated space syntax with other approaches for assessing adaptability in educational spaces, in order to reach a more thorough conclusion on the relation between space and the learning experience, whose "[…] final outcome potentially provides a comprehensive outlook on spatial analysis and a methodological development on architectural research, to be applied to other design briefs." (p.2).

Ultimately, by acknowledging that the development of space syntax has been

[449] See paper *The man-environment paradigm and its paradoxes* (Hillier and Leaman, 1973).

instigated by the questioning of the spatial structures in the 1970s, which also engaged other researchers at that time with different approaches to this subject (Hillier and Hanson, 1997), a contemporary, renewed and entangled research culture might capture that ambiance for a more comprehensive study of the man-environment paradigm.

By understanding the theoretical fundamentals that ground space syntax research from its early outsets, along with its informed reassessment towards contemporaneity and the specificity of this current Thesis, it is possible to conclude on its relevance. Hence, space syntax may potentially be used as a procedure under the proposed methodology to identify and assess adaptability, since the information provided by the spatial morphology can be paralleled with behaviour, experience and movement in the complex building, which can be an indicator of its activities and users[450]. Foremost when it is understood and applied along, as it will be here proposed[451], with other study fields under Hillier's reference on a "collaborations amongst disciplines" (Hillier, 2007, p.2) it proves its "adaptation" and operative input for a more comprehensive approach to space and social relations.

Hillier's struggle for a "collaborations amongst disciplines" could still be recalled today and has been closed pointed out by Heitor (2017) in the *Opening Session* of the latest *11th Space Syntax Symposium* in Lisbon in 3rd July 2017, remembering Hillier's 1997 opening speech for the First Symposium 20 years prior, and the "challenges" space syntax currently faces:

> "[…] there is the inevitability that space syntax will allow itself to be inseminated by closely-related disciplines for which space is also a central concern, resulting in a process of cross-pollination that may lead to further developments and research achievements." (Heitor, 2017a, p.3)

This could support the continuous need for a closer contact with other study fields, the potential synergies that can result from this "cross-pollination" and the possibility of gathering research cultures for knowledge advancement, both with the academia and the practice. This methodology here proposed on this Doctoral Thesis holds that possibility and recognises its contemporaneity and relevance as a more comprehensive process for the acknowledgement of space that potentially might lead to also more all-inclusive results.

[450] For further development on this approach, please see chapter 3.3. A methodology for identifying and assessing adaptability in learning environments., since this is one of the procedures that the methodology presented in this Thesis proposes to apply.

[451] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

. Space use assessment methodologies focused on schools

Having aroused the issue of life within architecture, from a more general manner in chapter 1.2.[452], to the ways by which it can be assessed in this present chapter, it can be perceived that the living experience can be understood by numerous assertions, realms of study and authors. Therefore, the way of assessing that experience, will then vary according to its interpretation, but also, the purposes of that assessment, the nature of the design, and the features of the space, the way it engages people, and how its features are able to do it so.

Accordingly, this current research also aims at providing a broader insight on the possibilities of considering experience at the multiple stages, on both the design and the occupancy of space, assuming that enclosing distinct perspectives could also represent a thorough outlook on the subject and provide results derived from different fields in a more insightful report on that spatial experience.

As seen throughout this chapter, these studies provide a body of knowledge that can be redirected towards the systematic development of the design of today's school buildings, capable of informing on the actual space use and the outcome of a specific design solution and its impact on student achievement, the school community's well-being in space, and the potentiation of the learning process overall. In order to identify these experiences, the spaces in which they happen and the individuals to whom they are addressed, this current research resorts to space use assessment methodologies as the body of knowledge in which to support the proposed methodology to identify and assess adaptability in school buildings, as a broader way in which space use could be perceived.

At this point and having identified space use assessment methodologies in a more general and holistic manner, they will now be reapproached to the school brief, addressing the authors of reference, their studies and the specificities of assessment contemporary active learning environments in their relation to the pedagogical context and paradigm.

Specifically, authors like Lippman in *Evidence-Based Design of Elementary and Secondary Schools: A Responsive Approach to Creating Learning Environments* (2010), Ornstein in *Post-Occupancy Evaluation In Brazil* (2005) and *Post-Occupancy Evaluation Performed in Elementary and High Schools of Greater São Paulo, Brazil: The Occupants and the Quality of the School Environment* (1997) and Fawcett in *Architecture: functional approach or the case for user research* (1995), have applied methods of space use assessment methodologies to school buildings.

[452] See chapter 1.2. Motivation and background: Architecture and Life – conceiving forms of engagement.

Lippman (2010) defines this process as "evidence-based design"[453], a "responsive approach" (p.7[454]) that includes "actionable knowledge" (Elliott, 2001[455]) for the influence of the built environment on behaviour (Lippman, 2010, p.1), with the specificity that this particular approach implies the gathering of several methods (p.10). Lippman (2010) expresses the relevance of evidence-based design for the creation of a design solution that copes with the specific need of its occupants (p.7), and transposes this approach to school facilities by emphasising the relevance of knowledge acquisition on the influence of space on behaviour, applied to learning spaces:

> "And just as designers must understand that the physical environment evolves in relation to the people situated in it, educators and researchers must acknowledge that the physical learning environment assists them in providing opportunities for learning to take place." (Lippman, 2010, p.ix)

This goes along the bond between school space and the learning practice and student achievement already confirmed in chapter 2.3.[456], because it is here considered to be a "responsive approach" (pp.29-30) to the specific design of schools, "grounded in research on the social environment, learning, and the physical environment" (p.30), displacing information collected on the learning process, the space use and the social context towards the design practice[457].

Furthermore, a very relevant reference for this problematics on schools is Sanoff[458]. Professor in the areas of design participation, design research, methodology and programming, specially applied to school design. Sanoff was the developer of the *School Design Research* programme at the School of Architecture, North Carolina State University. In his books: *Integrating Programming, Evaluation and Participation in Design* (1992), *Community Based Design Learning: Democracy and Collective Decision Making* (2007), *Community Participation in School Planning: Case Studies of Engagement in School Facilities* (2010), and particularly in *School Building Assessment Methods* (2001), he actively introduces user contributions in the decision-making, managing and evaluation processes throughout, and particularly in school facilities.

[453] Initially applied to healthcare facilities (p.1).

[454] "An approach for the design of the physical environment grounded in research may be understood as responsive to the needs of learners and their social environment." (Lippman, 2010, p.7)

[455] "[...] the future of social and educational research can be redirected to generating actionable knowledge for both policy-makers and practitioners." (Elliott, 2001, p.557)

[456] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[457] "The responsive approach, which is the ideal, views each learning environment as unique and as raising a variety of issues that include, but are not limited to, the following: understanding the diverse ways in which people learn, how the learner and the social environment influence and shape learning, how pedagogy is used, how the physical environment may be designed to promote people's engagement in goal-oriented activities, the use of technology, and sustainability." (p.30)

[458] Foundation member of Environmental Design Research Association (EDRA) in 1969 and board member of the National Clearinghouse for Educational Facilities (NCEF).

Also others publications can be mentioned on criteria for assessing the quality of school space, like: *Assessing Secondary School Design Quality* (CABE, 2006) and *The State of Post-Occupancy Evaluation in the Practice of Educational Design* (Lackney, 2001).

Also, the *International Pilot Study on the Evaluation of Quality in Educational Spaces*[459] (Heitor and Silva, 2009) is also a tool of analysis and reflection upon the school space, and it "aims to support the education authorities, decision makers, school communities and other stakeholders in the teaching-learning process, to optimise the use of educational spaces and investments made in them."[460] (p.6). The selected Portuguese schools for this study are evaluated according to the CELE/OECD Model of Reference for the evaluation of the quality of educational spaces on: "the ability of the school space to improve the conditions of equal access to education" and "the ability of the school space to improve educational effectiveness and promote the acquisition of key skills"[461] (p.15).

Precisely in Portugal in 2005, and organised by the OECD Programme on Educational Building and the Ministry of Education in Portugal, 23 recognised experts such as Watson (Silva and Watson, 2005; Watson and Thomson, 2005), Fisher (2005), Ornstein (2005), Ponti (2005) and Portuguese representatives from the Ministry of Education and specialists on educational spaces (Heitor, 2005; Silva and Silva, 2005), have gathered together in Lisbon to analyse the issue on *Evaluating Quality in Educational Facilities* (OECD, 2005a). This meeting intended "to define a set of international principles and criteria for assessing quality in educational facilities", "to discuss methodologies used to measure these criteria in different countries", and "to consider options for an international methodology for assessing quality in educational facilities" (OECD, 2005b, p.1), whose conclusion were presented in the *Draft Report* (*ibid.*) that summarised the contributions, presented the methodologies considered and made recommendations. Seven quality principles were demarcated to be "concise, well-defined, measurable and not overly prescriptive" (p.4), even though caution was recommended in applying them, according to the contextual framework of each case study that sought understanding (p.2), explicitly: "fit for purpose"; "inspirational"; "stakeholder involvement and satisfaction", "environmentally sustainable"; "healthy, safe, secure and comfortable"; "cost-effective"; and "holistically planned and managed" (pp.4-5).

[459] From the Portuguese: "Estudo piloto internacional sobre avaliação qualitativa dos espaços educativos" (Heitor and Silva, 2009).

[460] Free translation of the original quote in Portuguese: "O estudo piloto pretende apoiar as autoridades educativas, os decisores, as comunidades escolares e outros intervenientes no processo de ensino-aprendizagem, a optimizar a utilização dos espaços educativos e dos investimentos que neles são efectuados." (p.6)

[461] Free translation of the original quote in Portuguese: "Capacidade do espaço escolar para aumentar as condições de acesso equitativo à educação [...] Capacidade do espaço escolar para melhorar a eficácia educativa e promover a aquisição de competências chave" (p.15).

Flexibility has also been addressed. Ponti (2005) clearly stated that: "Flexibility[462] in educational spaces is one of the most important challenges for today and tomorrow in all over the world" (p.85). But also Heitor (2005), at that meeting, focused on "spatial quality criteria in educational facilities and to explore how can they be combined into a single common framework for formulating and evaluating school physical conditions worldwide in order to bring school facilities up to higher standards including more flexibility for future change." (p.45), concluding that: "[…] schools' long lives require buildings that meet the demands of the future." (p.51), and that: "Being innovative in school design is risky but it is important in order to anticipate changes and rapidly respond to users needs." (Heitor, 2005, p.51)

In what regards the evaluation methods, several have been pointed out in the *Draft Report* of this meeting (OECD, 2005b), but the overall recommendation stood on a combination of methods subjective to the aims of the research and its resources:

> "Post-occupancy evaluation, inventories, performance measures, benchmarking, guidelines and regulations, best practice case studies… Presenters in this theme described a number of different studies that use one or several qualitative and quantitative methods: observation, interview, walkthrough, questionnaires (data analysis), focus groups and visual selection. The effectiveness of these methods is influenced by such factors as the scope of the study (i.e. local, regional or international context; one or multiple schools), type of research questions and desired outcomes of the study, policy and research interest, and availability of human and material resources. Experts agreed that any future study should combine research methods." (OECD, 2005b, p.11)

This conclusion holds particular relevance for this current Thesis. Because, even though it focuses explicitly on adaptability as a specific feature of space, and not on the school's overall quality, as did this meeting, the methodology proposed to identify and assess adaptable learning spaces[463] will also resort to a set of different methodologies, aiming to reach a more informed outcome and recognising that each approach concerns a specific procedure and data. The report has even produced a table that rates the research methods according to their nature and the input provided, as Fig. 101 shows.

[462] Ponti detached "the brief flexibility" from "the long flexibility", in which the first implied the "The possibility of daily and/or hourly changing of the space components" and the latter considered "modification adaptability with longer timings" (Ponti, 2005, p.85). This latter coincides with this Thesis's approach on adaptability, as defined in chapter 2.1. Adaptability: definition and adjacent concepts.

[463] Detailed in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

10=strong 1=weak	Ease of access intelligibility	Resource use cost/time	Comparability consistency	Applicability of results	Creative ideas	Interactive	Total
Observation	0	4	3	5	3	0	15
Interview	10	8	5	7	4	2	36
Walkthrough	10	7	4	10	6	4	41
Questionnaires	3	4	10	2	2	0	21
Focus groups	7	3	4	8	8	10	40
Visual selection	6	6	5	3	5	4	29

Fig. 101. "Rating of research methods for evaluating quality in educational facilities" (OECD, 2005b, p.12)

Having said that, and as seen throughout all this chapter, the wide range of methods mentioned to identify the building's performance, at its many stages and levels, whether on construction, physical attributes, work productivity or user satisfaction, amongst other variables amenable of study through this assessment methodologies; or even the observance of its occupancy and space use, through their diversity on the procedures and the features to be analysed; also indicate the complexity of the buildings and the wide scope of variables that regard the interactions on settings, people and activities. So, according to the objectives of the evaluation, the stage in which to be undertaken, the context of the building and its users and uses, can a methodology be found that best describes and assesses the building, its performance, its occupancy and its space use overall, or enhances it[464]. This is much in tune with the observations by Gray and Baird (1996):

> "We caution against the view that there is, or should be, a single formula for evaluation. This would be like saying that there is a single best way to cook a meal. […] Since we cannot know the specific circumstances and context in which you and your organization operate, we cannot nominate a best or most appropriate way to evaluate your buildings or facilities. Instead, we can be your partners in finding or developing and evaluation process that best serves your specific needs." (Gray and Baird, 1996, p.3)

Therefore, the choice amongst these studies will reflect the nature of the design and the features of that experience, and it also depends on how the experience is

[464] This is also supported by Voordt and Wegen's (2005) regarding the choice on the techniques used for evaluating buildings according to the factors to be assessed: "All these points need to be considered when preparing an evaluation. There must be as clear a picture as possible of what is to be evaluated, why, how, when, for whom and by whom." (p.141).

perceived by the user(s). It also depends on the kind of inputs this assessment will provide and the purpose of the research - whether to present generalised information on a particular brief, or a more insightful description on an individual report to space.

Assuming that each case study embodies specific features according to its design and the nature of the experience envisioned, also the choice in method(s) to identify and assess the living experience in space should reflect this specificity.

Therefore, according to the purposes of this current research[465], the gathering of different inputs as a whole, will potentially lead to a more insightful perspective on the experiences provided by the school under analysis, and will allow the identification of the degree of adaptability that each spatial feature has to enable different activities and respective experiences, as well as its ability to engage the overall school community.

As already presented[466], the main case study of this research, on which the mentioned methodology will be applied in, is Quinta das Flores School, built in 1968, and rehabilitated in 2008-2009 into a Basic, Secondary and Artistic School in Coimbra. Besides its wide educational provision that bonds transversally the subjects of regular and artistic teaching, and due to a naturally creative profile of the artistic students and the spatial features of the school, music is not only confined to the classroom, but is also played in the several informal and non pedagogical spaces the school has, conveying these sensitive and emotional experiences to the whole school community.

The specific case study of this school that blends artistic and regular curricula, enables particular circumstances where space actively engages the teaching and learning processes, peer interaction and ultimately life within architecture. In order to study this hybrid spatial set and broader range of inhabitants and actions, it is intended to assess the degree of adaptation of the space for a multi-layered living experience within a longer lifecycle[467] - because it will potentially continue to cope with the changing requirements for a longer time period, delaying obsolescence. Hence, this study will focus on the spatial features that potentiate and extend the living experience in schools, regarding their influence on the cognitive and social levels and respective interactions, and defining them as a main design concern, from the brief.

[465] See chapter 1.4. Research objectives.

[466] See chapter 1.5.3. The case study under this research.

[467] The methodological approach to be applied in the case study for this research has been presented in the *11th conference of the European Architectural Envisioning Association*, in 25-28 September 2013, Milan, for testing and academic validation. It has also been published in the Conference's proceedings as: COELHO, C. (2013). Designing and assessing the living experience from brief to use. In E. Morello; B. Piga (Eds.). *Envisioning Architecture: Design, Evaluation, Communication- Proceedings of the 11th conference of the European Architectural Envisioning Association.* Milano, 25-28 September 2013. (pp.183-191). Politecnico di Milano. Milano: Edizioni Nuova Cultura.

Particularly, in the case of the school building, the incorporation of space use assessment methodologies outputs in subsequent schools' design processes, aims at potentiating the learning process in each time, for a more full use, broader range of activities and inhabitants and a more endurable building for the future, that acts as a community's cultural and "social hub" (Department for Education[468], 2010, p.13).

Having acknowledged the potential of probabilistic and analytical methodologies to match spatial attributes with activities' needs that can generically be transposed to deriving case studies, because they focus on the most probable states and not on all the possible dimensions that architecture bears, it is also important to perceive that these approaches need not to obliterate cultural specificities and qualitative observations on the regarded results obtained. Indeed, if the research under development aims at transposing an abstract optimisation model to a methodology applied to a case study with a wide range of creative activities and users, it needs to be defined by other parameters for depicting space from an abstract model to a real life scenario.

By contrast, studies based on personal data and focused on individual fruition comprise a more singular perspective, and are not amenable of analysis only by space's efficiency or functional potential. Generally, this is a thorough way of understanding spatial experience based on its occupants, assuming that each one has a particular way of experiencing architecture.

As previously briefly introduced in a more general manner, the studies based on the individual feedback are entitled "self-report measures" such as "interviews"[469], "written reports"[470], "surveys"[471], "focus groups"[472], "narrative techniques", "time sampling"[473] and "diaries", as developed by Lippman and Allacci (2010, p.45), who specifically apply them to school buildings. These methods centre around each one's personal description of his relation to space, resulting on the subjects' own understanding and communication of the way space engaged him/her, by means of qualitative descriptions of his/her sensory and emotional individual experience.

[468] This quote is taken from a publication by the English Department for Education London.

[469] "Interviews entail preparing questions and asking individuals to verbally describe their experiences with a phenomenon […]. Interviewing is a self-reporting method for acquiring data, since individuals are providing an account of their cognitions, perceptions, beliefs, and thoughts. (Lippman and Allacci, 2010, p.45)

[470] "Participants may be asked to keep a diary, write a report, take a time sampling of classroom activities, or perform other actions that create data based upon their projective processes. Not only may participants be asked to write descriptions, but they may also be asked to create pictures to convey their feelings and thoughts about a phenomenon." (p.45)

[471] "A survey or questionnaire involves questions (typically closed-ended) formulated ahead of time." (p.47)

[472] "A focus group is a controlled group interview of a target audience demographic, often led by a facilitator. […] A focus group generally consists of 5 to 12 stakeholders and/or users of the facility. Although focus group interviews are informal, a list of questions should be prepared to direct the discussion. Questions are open-ended to encourage a flow of conversation." (p.45)

[473] "Time sampling often refers to a variety of methods for observing and recording behavior during intervals or at specific moments in time." (p.48)

Otherwise, these studies can also be carried out by a third party who observes and then provides reports based on behavioural descriptions[474], possibly recurring to digital techniques like photography, video or the recording of physical traces[475], for a faster and more precise analysis (p.47). Others can also be mentioned such as: "archival data[476], grounded theory[477], time sampling, and surveys of different types" (p.45).

By and large, the relevance in using each method will provide specific results according to the goals and the spatial and social context of each research process, and the acknowledgement of a combination of methods will provide broader outputs. Even in what regards the quantitative and qualitative assessment methods, Preiser and Vischer (2005) argue that: "the fact that the performance criteria at each stage are constituted of both quantitative and qualitative performance evaluation, it is necessary to utilize qualitative and quantitative research" (p.10). This is openly affirmed by Gray and Baird (1996) that support the association of both, also because of the blurred boundaries that quantitative and qualitative methods could adopt:

> "Qualitative information tends to be subjective, and quantitative information is commonly taken to be objective. But the distinction is never entirely clear-cut. For example, qualitative factors can be introduced into apparently rigorous measurements by both the choice of what is measured (and not measured) and how measurements are interpreted. Ideally, qualitative and subjective information should be complementary and in agreement with quantitative and objective information." (Gray and Baird, 1996, p.14)

Consequently, for this case study, and in order to develop a more comprehensive approach, it is intended to the use of a triangulation of methods, guided by different approaches, to provide a more informed and thorough output, on both: individual and group fruition, emotional and physical experience in space, collective and individual, as well as quantitative and qualitative research[478]. According to Lippman:

[474] "Behavioral mapping is a type of systematic observation that tracks behavior over space and time […] The tracking may focus on a particular place or may be based on an individual's movements. We term these two techniques place-centered and person- or individual-centered mapping." (p.47)

[475] "Physical traces that interest social science researchers include scratches, stains, and litter (by-products of use), furniture used to separate or connect spaces (adaptations), personalizations and labels (expressions of self), and signs (public messages)." (p.47)

[476] "Archival data consists of information collected by an agency or organization. These data may come from the school and may include, but are not limited to, where students live and their socioeconomic status, health records, attendance, teacher retention, and graduation rates. Archival data can be used to examine a program over time and can provide preliminary feedback on the success of a program in the LC." (p.50)

[477] "[...] grounded theory is developed deductively from specific data acquired by a participant observer. In this process the participant observer, who is immersed in the culture of the learning environment, develops a deeper knowledge of the phenomena in question through an iterative process of expanding and evolving questions about the data until the deepest possible level of information is revealed." (pp.49-50)

[478] The proposed methodology will be explained in detail in the next chapter 3.3. A methodology for identifying

> "This method, consisting of gathering different types of data from different sources and then looking at the findings across the data sources, is comparable to the triangulation approach, in which both quantitative and qualitative findings are analyzed to identify appropriate design guidelines for effective, usable results." (Lippman, 2010, p.10)

So, for choosing the approaches that better suit this case study, it is relevant to consider that this particular school has specific activities and both formal and informal usages[479], equally relevant for students' achievement. It holds academic and non-academic spaces, related either with the artistic or regular teaching, held in general and more specific classrooms, for internal and external users, which potentiate different ways of appropriating space by the school's broad community.

Moreover, it is also relevant to understand the need for updating the techniques for analysing space use in school buildings, according to the current pedagogical paradigm[480] and foremost the current school spaces, realising that today's informal adaptable school spaces will ask for specific space use assessment methodologies when studying space use.

Having presented space use assessment methodologies, and recognising their relevance and specificities, their translation onto this case study is guided by a critical consideration in order to reach a more robust, systematised and comprehensive methodology, but also a balanced approach between the cost and benefit of resorting to each particular method.

It also aims to be multidimensional since it is transposed from abstraction to reality, with the conjunctural constraints related to the human occupancy. Nevertheless, it lies irrefutably within the realm of architecture, because although it can resort to other study fields like social sciences or mathematics, it ultimately aims to answer an architectural brief and to provide deeper knowledge for future designs.

The references on the state of the art cited earlier, amongst different study fields, play a significant role when constructing this methodology, because they allow a more insightful understanding of the possible solutions for this problematic.

Recalling Tschumi's quote: "Architecture is defined by the actions it witnesses as much as by the enclosure of its walls" (Tschumi, 1994, p.100), this school is an example of a space enriched by the broad range of actions it witnesses and promotes. This is better described by specific methods directed towards each dimension of the living

and assessing adaptability in learning environments.

[479] The different formal and informal usages will be detailed and specified for the case study in particular in the chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[480] See chapter 2.3. Adaptability for contemporary learning practices and environments.

experience, from Holl's unanalysable or Kahn's unmeasurable architecture that engages each individual in a non-generalisable sensory phenomenon (Pallasmaa, 2005), to Hackings's definition of a collective and regular happening[481].

Aiming at analysing the activities and behaviour a particular school enables, the thoughts by Hillier hold great relevance at this point. According to Hillier (2007), architecture relates precisely the built space with the cultural framework. This is acknowledged in the design process and can be understood and analysed afterwards as a product, on how it relates to behaviour, interaction and the social context:

> "Architecture begins when the configurational aspects of form and space, through which buildings become cultural and social objects, are treated not as unconscious rules to be followed, but are raised to the level of conscious, comparative thought, and in this way made part of the object of creative attention. Architecture comes into existence, we may say, as a result of a kind of intellectual *prise de conscience*: we build, but not as cultural automata, reproducing the spatial and physical forms of our culture, but as conscious human beings critically aware of the cultural relativity of built forms and spatial forms. We build, that is, aware of intellectual choice, and we therefore build with reason, giving reasons for these choices."[482] (Hillier, 2007, p.32)

Thus, along with the architect's *techné* and e*pisteme*, the recognition of use, needs, change and people, reminding Alberti's *concinnitas* (1485) as a balance between distinctive but relevant inputs, will lead to a more informed and responsive design, participated by all the stakeholders and lasting throughout a longer period of time. To conclude, space use assessment methodologies, as varied as they can be, will provide information on these variables, an informed and evidence-oriented spatial input, and potentially, engage a closer link between the users and the activities, the requirements and the space, the research and the practice, overall.

Following the next chapter on previous approaches to adaptability assessment methodologies, the subsequent chapter will propose a methodology to identify and assess adaptability in contemporary school buildings, which will be afterwards applied to a specific Portuguese case study[483]. This is based on the body of knowledge presented until this chapter, namely the identification of the contemporary concept

[481] According to Hacking: "My use of the word "phenomenon" is like that of the physicists. It must be kept as separate as possible from the philosophers' phenomenalism, phenomenology and private, fleeting, sense-data. A phenomenon, for me, is something public, regular, possibly law-like, but perhaps exceptional." (Hacking, 1983, p.222)." For further development on these references see chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[482] Italics from the original quote.

[483] See chapter 4. Application of the methodology in the case study:

of adaptability studied in chapter 2[484], when applied to space and specifically to a school, and the possibilities of its assessment by means of some of the procedures from the detailed analysis of its extensiveness, studied in this current chapter. For the proposed methodology, the choice in practices will be rigorously justified and its sequence explained, acknowledging their adequacy for the purpose of this research, the local and time context and its objectives, regarding cost and benefit in undertaking each procedure and even the possibility of doing this under the context of a Doctoral research as an individual research, constrained by time, cost and resources availability.

[484] See chapter 2. State of the art and critical revision of the concept of adaptability.

3.2. Adaptability assessment methodologies: reviewing previous approaches

> "In this thesis, then, we set out to make a contribution to architectural research, and we feel that we have presented an approach to adaptability that advances the study of this important architectural issue. At the same time we have kept in mind that architectural research must ultimately contribute to architectural design. The general theoretical model may have relevance to designers in its conceptual form, but there is a need for further work before our mathematical elaborations could with confidence be proposed as working tools. This work must verify that real problems are being accurately modelled, and must find mathematical techniques to make models solvable. We believe that these advances could be undertaken on the foundations we have laid." (Fawcett, 1978, p.220)

Having presented the wide array of methodologies to assess space use in the previous chapter and having observed the also wide scope of approaches from different fields, this chapter aims to analyse the more specific methodologies to assess adaptability, so that the subsequent chapter can present our proposed methodology with the adequate backing and theoretical support.

The 1970s were paramount for the state of the art on the methodologies for assessing adaptability. It will therefore be a prime goal of this chapter to recognise their relevance on addressing this research question, on the methodologies to concretise it and also on the results achieved. Still, the assumption that these models have been produced at that time period will, naturally, have to be taken into account, and so, the following part will intend to contextualise them.

. Models' framework for architectural research

> "During the last decade, urban modelling has generated a momentum in Britain which has been unparalleled anywhere else in the world." (Batty, 1976, p.v)

Post-war times brought along an economic boom and higher investment and consumption urged the speed of urban development. According to Peter Hall

(1988): "The old planning system, geared to a static world, was overwhelmed." (Hall, 1988, p.327). Essentially, both higher demand and supply along with the advances on literature have led to the rapid development of planning in which "cities and regions were viewed as complex system […] while planning was seen as a continuous process of control an monitoring of those systems" (Hall, 1988, p.327).

Initial studies on urban modelling have been done in North America, particularly between 1959 and 1968, mostly by deriving models for "land-use-transportation studies" and particularly for "trend projection" (Batty, 1976, pp.7-11). Beyond North America, researchers in Britain have seen the ground for furthering the research resorting to a mathematical approach ("the best-developed language of science" (Batty, 1976, p.xx)), not solely in a descriptive approach but "as aids to conditional prediction" (p.5), and, moreover, within an educational context, models can even "help by demonstrating the limitations of theory and the potential of simulation" (Batty, 1976, p.xx). As Batty sustains:

> "[…] conditions in Britain have especially favoured urban modelling in recent years. Both the theory and practice of modelling have been stimulated by the development of an explicit 'Systems Approach' to urban research and land-use planning, and the presence of a highly developed institutional planning system has been of enormous significance in providing a natural focus for research efforts in this field." (Batty, 1976, p.v)

Kuhn (1962[485]) in *The structure of scientific revolutions* defines "scientific revolutions" as "those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one" (Kuhn, 1962, p.92) prompting "a new basis for the practice of science" (Kuhn, 1962, p.6). Accordingly, in 1976 Batty realises the conditions that can consider the previous two decades tending towards a "scientific revolution", for which technology has contributed (Batty, 1976, p.xix). Modelling, widely addressed in the 1970s after a "first generation" of studies (pp.7-11), is considered by Batty as "an integral part of this revolution in thought in which the boundaries between traditional disciplines are blurring in response to the need for interdisciplinary cooperation." (p.xx).

Batty's studies revolve around urban modelling, which he delineates as "designing, building and operating mathematical models of urban phenomena, typically cities and regions" (Batty, 1976, p.xx), particularly from his work at Urban Systems Research Unit at Reading University, with Peter Hall, since 1969. In his book *Urban Modelling: Algorithms, Calibrations, Predictions,* Batty (1976) intends to focus on "the process of modelling rather than the models *per se*" (Batty, 1976, p.v). And even though the understanding of the importance of urban modelling could only be assessed

[485] Consulted edition from 1996, original edition from 1962.

in the long term, Batty hopes his book could represent a contribution towards it.

Batty also ponders the implications both for urban modelling as for all the areas "where traditional boundaries are changing in response to new lines of inquiry", namely: the wide "body of 'new' knowledge" and foremost the fact that "new modes of thought are not built up from knowledge already acquired in that field" (Batty, 1976, p.xx). Furthermore, while "this new analytic tradition represents a breakthrough", Batty also accepts that "in some senses, it is less sensitive and less elegant, more ambitious and more straightforward". He also admits the criticism, particularly regarding the potential departure from reality and its "reliance on computation gives it a bias towards the 'number crunching'" [486], even if he acknowledges it as "part of the challenge that makes this field so exciting" (Batty, 1976, p.xxi).

Echenique's work (1972) is very significant for tackling models in architecture. His insightful definition of a model also assumes the simulation of "certain" aspects of reality significant to stand for that reality[487], as a simplification of the complexity of the system for its clearer comprehension:

> "A model is a representation of a reality in which the representation is made by the expression of certain relevant characteristics of the observed reality and where reality consists of the object or system that exist, have existed, or may exist." (Echenique, 1972, p.164).

The choice of the most insightful characteristics, whether "physical or conceptual" (Echenique, 1972, p.165), will also depend on the purpose of that representation ("the questions the model is designed to answer" (Echenique, 1972, p.165)), and the reasoning of the chooser[488]. And under this simplification it is possible to point out both the "similarities" and the "differences" between the model and reality (Echenique, 1972, p.165). Echenique provides a classification of models in their link to the reality they represent (Fig. 102).

Models could be regarded as an artificial construction that intends to depict a reality, recalling Simon's (1996[489]) *The sciences of the artificial*. Simon presents the reality as a set of products of the sciences of the artificial, produced by man as evidence of "our collective artifice" (Simon, 1996, p.3):

[486] In the 1960s "Going metric" had been a very thought theme, due to the metrification of measuring that would stand in for the imperial system. This implied a need for research on how it would affect the architectural profession.

[487] "The main purpose of a model is to provide a simplified and indelible picture of reality in order to understand it better." (Echenique, 1972, p.168)

[488] "This selective attitude, which depends on the intention of the observer, makes 'finite' the infinite number of characteristics." (Echenique, 1972, p.165)

[489] Consulted edition from 1996, original edition from 1969.

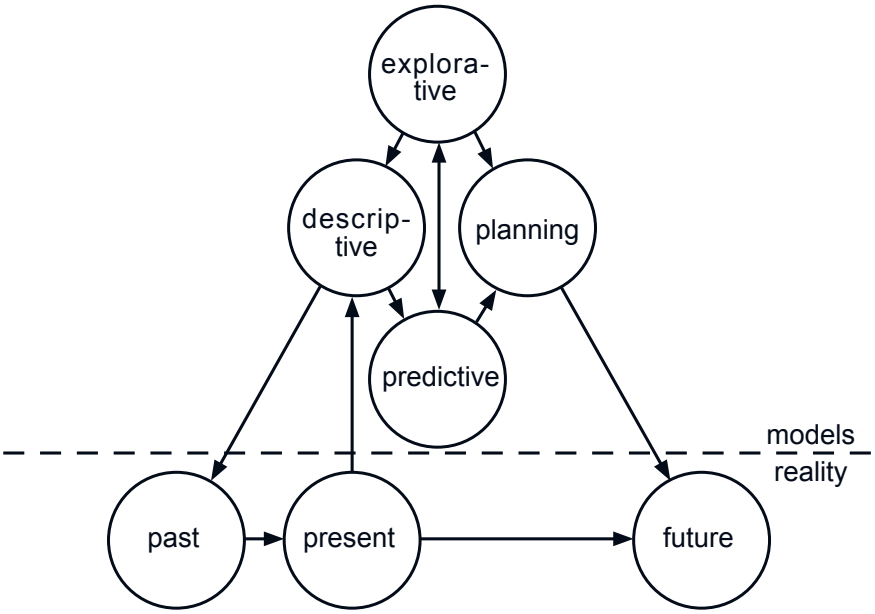


Fig. 102."Ideal process of model-making in relation to the reality"
(Echenique, 1972, p.172)

> "The world we live in today is much more a man-made, or artificial, world than it is a natural world. Almost every element in our environment shows evidence of human artifice." (Simon, 1996, p.2)

The sciences of the artificial such as engineering, economics, cognitive psychology, planning, medicine, commerce, painting, and even architecture, are subjects of synthesis (as opposed to the analytical disciplines of the natural sciences) and of projection into the future (as opposed to the description of the phenomena from the natural sciences), leading to the advancement of knowledge (and not the representation of a pattern that streamlines the phenomena) (Simon, 1996).

In fact, while the natural sciences deal with the analysis and explanation of natural phenomena in the present, social sciences deal with the explanation of human behaviour, and human sciences pore over the meanings of the human experiences in their social and historical context (Kagan, 2009); the sciences of the artificial have as their subject "man-made" artificial objects - the "artifice" (Simon, 1996). Quoting Simon on his definition of the artificial:

> "We have now identified four indicia that distinguish the artificial from the natural; hence we can set the boundaries for sciences of the artificial:
> 1. Artificial things are synthesized (though not always or usually with full forethought) by human beings.
> 2. Artificial things may imitate appearances in natural things while

> lacking, in one or many respects, the reality of the latter.
> 3. Artificial things can be characterized in terms of functions, goals, adaptation.
> 4. Artificial things are often discussed, particularly when they are being designed, in terms of imperatives as well as descriptives." (Simon, 1996, p.5)

In the specific case of architecture, as a science of the artificial, it develops objects through a design and presents itself as an open science projected onto the future, whose aim is also to develop a design optimised for a purpose.

The scope of the sciences of the artificial lies in the interstitial space between the internal and external environments. Hence, one of the primary features of the artifice is the adaptation of their internal structure ("internal environment") to the context ("external environment"), aiming at a goal ("purpose") defined by man ("the planner"):

> "The thesis is that certain phenomena are "artificial" in a very specific sense: they are as they are only because of a system's being moulded, by goals or purposes, to the environment in which it lives. If natural phenomena have an air of "necessity" about them in their subservience to natural law, artificial phenomena have an air of "contingency" in their malleability by environment." (Simon, 1996, p.xi, Preface to the second edition)

For architecture, the interaction between internal and external environments is also very relevant, because a building is always adaptive to the context, its use and its users, and throughout its lifecycle its adaptation changes along the changes both in the context and in the building. Consequently, the choices for solving each problem are manifold because there are also multiple contextual constraints and complexities, that condition our state of knowledge, as William Fawcett puts it:

> "For a given state of knowledge about activities we may wish to find the design that has the highest adaptability. It is the act of choosing possible designs that Simon (s.9) identifies as the essence of architecture as a science of the artificial." (Fawcett, 1978, p.68)

Simon admits that due to the complexity of the external environment, the adaptive capacity of the artifice may be limited. He adds that the design problems occur not due the diverse range of possibilities, but to the adaptive requirements. Thus, he indicates the possibility of working with abstract simplified models that simulate *some* (hence, the need for simplification) of the features of the external environment, which allows a partial analysis of the components.

An artifice should follow models aiming at the optimum, but, as these theoretical models are necessarily simplified and abstract, the result may differ with the

application in the real, specific (and non-optimum) environment. To fulfil its purpose, the artifice should take into account the historical and social local conditions. Thus, for the same purpose there may be different internal structures, due to the specificities of each external environment. In the case of architecture, as Fawcett (1978) puts forward, there may have to exist alternative designs that fulfil the brief, but that bear different features and attributes.

Each system belongs to a context and relates to the neighbouring systems of that same environment. The adaptation cannot be based on an overall maximum, but it has to take into account the place, its history and its method. It may even be better to adopt a specific system for that particular environment that is different from what is proven to be the best, in a general and abstract level. Thus, the method and the local history affect behaviour and the overall principles.

For architecture, which is an adaptive and situated discipline that meets the needs of users at a given place and social and historical context, the articulation between internal and external is very complex and involves a deep understanding of the context.

So, what was said about the sciences of the artificial generally applies here. Given the example of a design for a dwelling: for the same purpose (dwell), there may be different internal structures (different projects), according to historical and real external social environment. This is why, in the particular case study of this Thesis, it is acknowledge that a general and non-specific method for assessing adaptability may not involve and take into account all the significant features of a building that bear relevance for the analysis of adaptability in this particular building, context and brief.

When evaluating the elegance of the results, the criteria differ according to each science. The natural sciences are based on evidence findings produced by machines and capable of mathematical description; the social sciences provide theoretical conclusions about human behaviour, and the human sciences produce semantically correct arguments, translated into prose (Kagan, 2009).

As we have had occasion to state[490], one of the main objectives of the artifice produced by the sciences of the artificial is its adaptability, by establishing an interface between the external and internal environments. Hence, the accuracy and adequacy of the results obtained depend on the ability to meet this goal of articulation, before the demands of the purpose, independently of the complexity and specificity of the external environment.

Nevertheless, adaptation has its limitations and may lead to the acceptance of a satisfactory situation, because despite targeting the optimum result, it may only be satisfactory, due to the weaknesses of the internal structure of the artifice, or the

[490] See "Other concepts related to adaptability" on chapter 2.1. Adaptability: definition and adjacent concepts.

specificities of the actual external environment (not optimised and unrealistic). Here, Simon defines the concept of "satisficing" (Simon, 1996, p.119) to describe methods of achieving results that solve problems in a satisfactory manner, rather than optimal.

The result itself can also be assessed by criteria of elegance, but the procedures to achieve it - at the level of decision making ("procedural rationality" (Simon, 1996, p.25)) and such decisions ("substantive rationality" (Simon, 1996, p.25)) - are also marked by elegance. The results will be adapted and simplified, and they too can be elegant.

The models are, in themselves, techniques to achieve and to infer data, but we also consider them to be elegant procedures reflecting the elegance of the design process. The simplified models focus on the abstraction of only some features of the simulated object that meets the goals ("homeostasis" (Simon, 1996, p.169)) and through strategic simulation of progressive detail, they will add more complexity to the attributes of the simulated object[491].

For the evaluation of the results, the decomposition into components allows an isolated analysis of each part to pursuit the purpose that allows, by means of a simplified model, to assess the beauty, elegance and efficiency of every detail of the artifice.

Architecture embodies what has been said: there is great difficulty in finding the optimal result because, on the one hand, it responds to a very complex external environment and, on the other hand, because the requirements are also multi-purpose ones. The problem is so complex that during the process there is a need to simplify it, breaking it down into the needs to be resolved in every stage. Finally, there is also the difficulty in finding the criteria of beauty and elegance to analyse both the process and the final artifice, both qualitatively and quantitatively.

Even though Simon focuses on a culture of the sciences of the artificial, he also refers to a fragmentation of cultures, suggesting that cultures can be thought through common features that will bridge the understanding of each other:

> "Many of us have been unhappy about the fragmentation of our society into two cultures. Some of us even think there are not just two cultures but a large number of cultures. If we regret that fragmentation, then we must look for a common core of knowledge that can be shared by the members of all cultures a core that includes more significant topics than the weather, sports, automobiles, the care and feeding of children, or perhaps even politics. A common understanding of our relation to the inner and outer environments that define the space in which we live

[491] Simon gives the example of the computer as artifice whose analysis can only be done by simplifying and isolating each attribute.

> and choose can provide at least part of that significant core." (Simon, 1996, p.136)

In fact, the analytical approach on models can introduce this question on a polarization of cultures, which was eminently established by C. P. Snow. In 1959 Snow tosses the question of the divergence of cultures between "literary intellectuals" and "physical scientists", stating that these were different epistemological worlds, with different mental, personal and social dynamics. This fragmentation hindered the advancement of knowledge[492] and prevented the establishment of any kind of bridge between the two cultures limited by a "cultural box" (Snow, 1961[493], p.9) that defined and confined them.

The approach of Kagan (2009), fifty years later, to Snow's thesis reaffirms this fragmentation, but it adds a third culture that its predecessor did not anticipate: the "social scientists", whose study of human behaviour has gained great relevance to the posterior generations to Snow's *Rede Lecture*. Kagan structures a table with nine dimensions that illustrate very clearly and specifically the differences between the (now three) cultures (Kagan, 2009, pp.2-5). Interestingly, Kagan ends his book also appealing to the advancement of knowledge by the intersection of the cultures closed in themselves[494].

In our analysis of an issue within the disciplinary realm of architecture, we converge to the final appeal both by Snow (1961) and Kagan (2009). According to them, the knowledge would advance more dynamically by creating supra-disciplinary bridges, in each science would make its contribution for a common purpose in the interstitial space. The cultures would thus, be less confined by the "cultural box" (Snow, 1961, p.9) and more available for the solution of problems that could benefit from methods and contents of each project, producing a richer and broader result:

> "Closing the gap between our cultures is a necessity in the most abstract intellectual sense, as well as in the most practical. When those two senses have grown apart, then no society is going to be able to think with wisdom. For the sake of the intellectual life, for the sake of this country's special danger, for the sake of the western society living precariously rich among the poor, for the sake of the poor who needn't be poor if there is intelligence in the world, it is obligatory for us and the Americans and the whole West to look at our education with fresh eyes." (Snow, 1961, pp.53-54)

[492] "Closing the gap between our cultures is a necessity in the most abstract intellectual sense, as well as in the most practical. When those two senses have grown apart, then no society is going to be able to think with wisdom." (Snow, 1961, p.53)

[493] Consulted edition from 1961, original edition from 1959.

[494] "It is time for the members of the three cultures to adopt a posture of greater humility for, like tigers, sharks, and hawks, each group is potent in its own territory but impotent in the territory of the other." (Kagan, 2009, p.275)

The results from the referred analytical approaches will deal with general patterns, wide group sizing of populations and simplified models of the reality. The sensitivity of the process has then to be carefully construed, not to obliterate significant contextual variables when simplifying the complexity of the internal and external environments into a model.

And, in fact, while the models from the 1970s were open constructions that might discard information from specific programmes, the programme of the contemporary school, studied as the case study of this current Thesis here presented[495], as diverse as it could be, will constrain the variables and the potential simplifications of the process in order to report to that particular reality. Indeed, schools today do not all look alike, the inhabitants of these spaces also vary, the activities are specific of each case study, and this will naturally have to be considered when assessing adaptability in each school.

Besides, the fact that contemporary spaces of pedagogical potential relate not only to formal classroom but to a all variety of spaces, often not defined by physical boundaries, and that the all school building can be considered an active learning environment, as a whole and not a sum of parts, will have to be rethought when defining our own methodology that is intended to assess adaptability in contemporary school buildings.

Nonetheless, the methodologies taken on in this particular decade of the 1970s, despite recognising adaptability as an issue that was not new, often criticised the previous studies on how that issue had been addresses and the "intuitive" or "empirical" manner by which they had been tackled[496]. But they were also criticised for "walk[ing] a fine line between theoretical acceptability and practical feasibility" [497] (Batty, 1976, p.xxi).

The "general theory of adaptability" that Fawcett intended to accomplish with his Doctoral Thesis, presented in Cambridge in 1978 (Fawcett, 1978), will then become a very important document to be analysed at this chapter. Besides, all the research studies on this precise issue, contemporary of Fawcett's Thesis, have also been studied from their original primary sources, because they all embody a very significant part of the state of the art on assessing adaptability.

Finally, a critical overall review of these paramount references for the state of the art for assessing adaptability will be discussed towards the contemporary context of

[495] See chapter 1.5. The case study.

[496] Fawcett's Doctoral Thesis, for example, has a chapter on adaptability as "an empirical objective" (Fawcett, 1978, pp.31-50).

[497] "Many critics of urban modelling hold the view that model-builders are learning more and more about their models but less and less about the real world which they are attempting to model. Such a view will always provide food for thought but it illustrates that model-builders walk a fine line between theoretical acceptability and practical feasibility." (Batty, 1976, p.xxi).

active learning environments. For the purpose of proposing our own methodology, this will be supported by the previous references to adaptability, adaptable schools and specific use assessment methodologies overall.

Therefore, not only does this chapter aim to study these works, but naturally it also aims to critical assess them, in order to operatively provide support for the production of our own up-to-date methodology in the following chapter.

. William Fawcett's (1978) Doctoral Thesis at Cambridge

William Fawcett's Doctoral Thesis entitled *A Mathematical Approach to Adaptability in Buildings*, presented in 1978 at Cambridge and supervised by Lionel March, as well as all his extensive work derived from it[498] (Fawcett, 1979a, 1979b, 1995, 2010a, 2010b, 2011a, 2011b, 2012, 2015), represent a valuable approach on the state of the art of adaptability and foremost its methodological approach to combinatorial calculation, whose contribution is of the utmost relevance, particularly for this current Thesis.

Overcoming the lack in theoretical fundaments, it is also the aim of our current Thesis here presented, by recognising the state of the art on adaptability in which Fawcett's Thesis bears significant representativeness; to critically recall the studies on the topic from the 1970s; but naturally to go further and to analyse their scope, methodologies and relevance for today's contemporary school buildings, particularly to the learning environments more specifically addressed under this chosen case study[499] and their respective "real problems" that Fawcett acknowledges at his Thesis's conclusion (Fawcett, 1978, p.220). Ultimately, to make "advances" from the state of the art research on adaptability in school buildings, but acknowledging Fawcett for laying "the foundations" (*ibid.*) for this issue.

In fact, already at the beginning of his Thesis, Fawcett emphasises the lack of "sufficient theoretical backing" (Fawcett, 1978, p.i) that studies around the connection between "activities" and "spaces" reveal, as well as their general problem of being either too "deterministic" or too "empirical". He therefore reveals his goal to produce a "general theory of adaptability" that lacks in the existing studies that he considers to simply "consist of miscellaneous observations" (*ibid.*).

Fawcett focuses on adaptability as a "sounder focus of analysis"[500] (*ibid.*) between

[498] As well as the communications that were kindly and most insightfully established between us throughout the production of this Thesis.

[499] See chapter 1.5. The case study.

[500] "The relationship between activities and spaces may be analysed at many scales. [...] Adaptability is a sounder focus of analysis since it inherently takes account of the uncertainty and changeability of the relationship between activities and spaces." (*ibid.*)

"spaces" to "activities" whose study may represent an advancement for the knowledge in architectural research:

> "We argue that adaptability is a fruitful subject for research, and offer this thesis as a contribution to architectural research into the relationship between activities and spaces." (Fawcett, 1978, p.2)

Thus, he elaborates on this throughout his Thesis, by questioning: "What is the set or ensemble of possible activities?" and also by studying "all possible ways of allocating a set of activities to a set of rooms, taking into account of the compatibility or incompatibility of all rooms with all activities" (*ibid.*), which he clarifies, from the summary, to be the Thesis's goals, while producing a "theoretical basis for the study of adaptability in buildings", resorting to a mathematical approach (*ibid.*)[501].

According to Fawcett's definition of adaptability:

> "Adaptability is a probability - the probability that a building will not become obsolete." (Fawcett, 1978, p.i)

So, he then encompasses his methodology to revolve around adaptability as a "combinatorial ensemble", as he calls it, that responds to a "mathematical elaboration" (*ibid.*) on the probability of allocating activities to spaces.

Fawcett presents two scales in which to relate buildings and activities: the "urban scale", as the quantitative and enlarged scale that informs on general data disregarding information that differentiates activities and spaces (Fawcett, 1978, pp.2-3); and the "atomic scale" (Fawcett, 1978, p.3) connected to specificities of a particular set of activities and places. The issue of researching into different scales implies different methodologies and will also determine the outcomes achieved by those methods.

Fawcett relates the urban scale with "models", arguing their relevance for the information on the masses:

> "It appears urban models are extremely efficient: by ignoring masses of information which distinguish individual activities and spaces, and concentrating on simple quantifiable relationships, urban modelling establish general, aggregate properties of urban systems." (Fawcett, 1978, p.3)

Accordingly, these outcomes will be measurable in terms of quantities and general patterns of use and activities in spaces, but as Fawcett also acknowledges, it will also overlook individual behaviour, activities and fruition in space.

[501] "The thesis, therefore, offers a theoretical basis for the study of adaptability in buildings and begins to undertake its mathematical elaboration." (*ibid.*)

The remnant approach will deal with the "atomic" (or "micro") scale, that in our particular case, will be considered not as opposing but as complementary to the first, presenting the details and specificities of particular activities, inhabitants and spatial fruition, also relevant and clarifying for adaptability as a variable that enhances a variety of uses and users in each space.

But as Fawcett also underlines, this approach risks to achieve a result that is not as a "whole" but as a "sum of its parts"[502], of these specificities that have been remarked. Nevertheless, it also provides us with information on the potential of a specific activity to allocated to a space, but not of a whole "system of activities" or spaces in the form of "real organisations or buildings":

> "In effect, micro-scale research aims to enable us to say with confidence whether a given activity can be performed in a given space or how well it can be performed, but not how well an organisation can be accommodated in a building or how effectively" (Fawcett, 1978, p.4).

Having said that, for our current Thesis it could be argued that the particular case study of a school building embodies both scales, due to the variability of activities - each with its specificity and spatial needs; but also the weekly schedule of each class and student, which represents patterns of individual and collective use within the system. All in all, if these are considered to complement one another, this choice in approach will result on the weighing of several variables: from cost to benefit; the purposes of its pursuit; the potential outcomes provided; the scale of activities, spaces and users involved; and particularly its application onto the case study chosen. Hence, the scale of the so-called "system" and the data expected from the current research will be a balance between a detailed depiction of each activity, to the assumption of a more general use[503], in a way that our methodology can be quantitative and qualitatively representative.

Fawcett also recalls this needed balance in scale, particularly when applied to a secondary school, considering both the need for analysing it as a general set of activities and spaces, respectively an "organisation" and a "building", but also to differentiate their specificities:

> "The system we have set out to study in our research consists of an organisation and a building; typically, those constituting a secondary school, where the activities are numerous and interrelated, yet

[502] "The atomic approach, however, tends to assume the whole is merely the sum of its parts and does not directly analyse the system or activities or system of spaces that constitute real organisations or buildings." (Fawcett, 1978, p.4)

[503] "It is clear that the techniques appropriate for analysing the relationship between activities and spaces must vary greatly with the size of the system being analysed. The typical system in which we are interested is of an intermediate size: neither so large that aggregated statistical is possible, nor so small that endless detail can be considered." (*ibid.*)

> individually distinguishable, and the spaces have particular attributes which affect their suitability for different activities and patterns of activities." (Fawcett, 1978, p.5).

In fact, and assuming the complexity in choosing from these two referred work scales, Fawcett assumes another scale: the "architectural scale" whose approach to spaces and activities aims mostly at proving valuable knowledge to the architectural design:

> "The purpose of research at this architectural scale must be to acquire knowledge that will somehow be useful in achieving good architectural designs. [...] Our concern will be not only with techniques of analysis, but also with usefulness of the research for the ultimate purpose of contributing to architectural design." (Fawcett, 1978, p.5).

According to Fawcett, information on activities rather than on "existing buildings", is paramount when designing a new building, in order to know about the perceived activities and their properties, but also to be aware of each school's specificities and proneness to change, potentially unpredictable in the design but possible through its occupancy in time, enabling an open and not predetermined management and fruition:

> "What do surveys of existing buildings offer the designer? It is extremely questionable to use raw survey data as design data for a new building, but assumptions about expected activities are fundamental to any design. [...] We can make the following observations: 1) Some knowledge about expected activities is necessary for any design, and can only come from experience in existing institutions. 2) This knowledge can only be general - the precise pattern of use in any building is unpredictable and changeable. 3) The design should not aim solely for high efficiency with respect to the expected activities but should equally attempt to offer potential for managerial choice and activity change." (Fawcett, 1978, p.10)

Fawcett stresses that his "study of the relationship between activities and spaces" is placed at the "architectural scale" and intends to "help the architect design convenient buildings" (Fawcett, 1978, p.12). For such purposes, Fawcett points out three possible lines: "optimising, descriptive and probabilistic" (*ibid.*) to relate activities and spaces and to provide operative knowledge for the architectural design. While "optimising techniques" "place unique reliance on numerical data that is generally rather vague[504]", descriptive utilisation surveys provide "generalised information"

[504] The "optimal solution" (Fawcett, 1978, p.5) has the issue of the cost-effectiveness. It is costly to endow spaces with the attributes to activities of different nature, but as they naturally change in time, their conceptual basis and spatial needs may also change, ultimately not justifying the initial investment that fulfils all the activities' spatial properties. Fawcett goes further and points out that: "Not only is it extremely hard to establish precise data about the pattern of activities in any organisation, but activities, when considered in detail, are constantly changing. The optimality of results which rely on imprecise and unstable data is acutely ephemeral." (p.7)

that "do not in themselves lead directly to design data" (*ibid.*). However, in what regards the latter approach, Fawcett states that:

> "Probabilistic techniques go a long way to overcoming these objections by considering all possible states of the system and producing data that can be used in evaluation" (Fawcett, 1978, p.12).

So, "probabilistic models" offer the data on the most probable[505] (and hence more realistic (Fawcett, 1978, p.11)) and expected activities and uses, opposite to the deterministic models portraying an optimum situation, working as a tool to inform the architect during the design process, by displacing general knowledge on what is most likely to be expected in terms of uses and users, and on the most frequent spatial attributes common to a variety of activities[506].

So, adaptability arises in the design, when providing the spatial options of a variety of activities to occur in each space. Naturally, that the architect will have to be aware of the spatial layout and properties that will have to be considered in a space in order to decide whether it should or not be able to shelter that activity[507]. Ultimately, the choice in providing the space with the respective attributes may increase its cost, and will have to be balanced with the potential increase in its adaptability for allocating a variety of activities. Hence, the design options have to bear reasonability between "under" and "over" spatial provision (Fawcett, 2010), aiming at a high performance building and high levels of spatial usage, generated by a variety of activities that regularly occur.

In the case of a school, the number of possible allocation of activities to spaces is a significant constraint in the design and an invaluable asset throughout its occupancy:

> "[…] for the timetabler the ideal building is one which offers least constraint – to help him to achieve one workable timetable within a reasonable search time there must be many feasible solutions." (Fawcett, 1978, p.10)

So, the possible interchangeability of the classes and activities between the spaces that can allocate them, construe the weekly schedule and generate a net that will be more pliable according to the adaptability level of each space. The increase

[505] "In some ways, then, at the architectural scale the probabilistic model bridges the gap between the layout problem and empirical studies. It is realistic in a way that the layout problem is not, yet it offers more than just descriptive information. [...] they do begin to tackle the architect's problems of uncertainty about the relationships between activities and spaces." (Fawcett, 1978, p.11)

[506] But for Fawcett the concept of "the range of possible states" will be wider, more complete and "more valuable" (Fawcett, 1978, p.12) than the concept of "average" often used by these models.

[507] "The layout problem produces a single solution, and in elaborating this the architect would wish to know what important properties of this solution he should preserve (March & Steadman, 1971, p.333), but he is given nothing of the kind. What the architect needs is knowledge that enables him to match the general properties of an organization to the general properties of a design". (Fawcett, 1978, p.9)

in the number of feasible solutions for the allocation of activities to spaces will provide a wider range of options for spatial and pedagogical management, it will also potentially decrease circulation time from a classroom to the other and may escalate the utilisation levels of each space.

At the time of the brief, the architect comes to work with the data that he is provided with, the needs that the building is expected to overcome, and the activities it is expected to allocate, and it is with that particular data that he designs "convenient buildings" (Fawcett, 1978, p.12). However, and due to the natural process of change, these referred activities, and hence their spatial needs, will also evolve into other ones, possibly different from the ones originally specified in the initial brief. This process occurs throughout the building's lifecycle and during its occupancy stage, after its design:

> "Even if accurate data were available for the activities at the time of design, this data becomes obsolete during the life of building. Most buildings will, if well maintained, last for ever and when a building is erected a commitment is made which stretches far into the future, where human activities cannot be reliably foreseen." (Fawcett, 1978, p.12)

So, the "prudent architect" (Fawcett, 1978, p.12) as Fawcett calls him[508], will regard additional information related to the potential activities and uses the buildings might have in the future, in order to extend their ability to cope with both the needs and foremost the change they can undergo. To this process Fawcett implies the concept of dealing with the unforeseen at the moment of the design, to deal will the "uncertainty" of what will happen in the future, to provide the space with some resilience to change, and the spatial attributes to answer what will be asked of them in each time:

> "Buildings come to be used for purposes, which could not have been taken account of by their designers, and at any time only a small proportion of our building stock remains in its exact original use. These processes of change apply to all buildings, but a prudent architect may wish to anticipate some of the consequences and design adaptable buildings." (Fawcett, 1978, p.12)

Considering adaptability already at the design will acknowledge the possible variation in the activities and will anticipate the building's ability to cope with them in an early stage, both recognising that future change but not knowing in what it will eventually reside:

> "Now, adaptability is a rather poor operational criterion in design,

[508] The "prudent architect" has already been mentioned by Alberti (1485) in *Book IX* and studied by Krüger (2014) in *Comentários à Arte Edificatória de Leon Battista Alberti.*

A brief classification of research into adaptability may be useful, which we present in the diagram below. The distinctions upon which we base the classification should become clear in our reviews of the research. Our own aim is to further develop the designer's view, at the same time introducing methodological rigour.

	Designer's view	Historical view	Methodological view
Originated	Lynch (1958) (s.2)	Cowan (1963) (s.4)	Baird (1972) (s.7)
Developed	Aylward (1970)(s.3)	Nutt et al (1975)(5)	Rosenhead et al (1972) (s.8)

Fig. 103. "Classification of research into adaptability"
(Fawcett, 1978, p.16)

> for it is extremely difficult to know how adaptable a building is, or to compare the adaptabilities of different designs. If we do not know what will make a design perform well, it is merely playing with words to say that an adaptable design is one that will perform well despite this state of ignorance. Adaptability is a strategy for uncertainty, but we must be clear about where the uncertainty arises, and cause it to influence a design in some definite way." (Fawcett, 1978, pp.12-13)

. State of the art on adaptability - authors and approaches

When addressing the state of the art on this matter, Fawcett very clearly states that there is only the need to recall the work produced in the last twenty years, which is the most relevant for supporting "a sound and tractable theory of adaptability" able to induce "a workable tool for use by the architect"[509]. Fawcett also upholds his approach "to the theoretical field of architectural research" because he considers his aim in defining a model also to be a "theoretical task". So, for his review of adaptability (chapter 2 of Fawcett's Thesis) he presents a "review of theoretical writings" (Fawcett, 1978, p.16) (Fig. 103).

Lynch's paper from 1958 is the first to be mentioned by Fawcett in his review of adaptability, as a "conceptual" approach that is able to "cover great deal of

[509] "For this review, we have not tried to find amusing or telling anticipations of research into adaptability in the voluminous architectural writings of the past; not that we doubt they exist, but because they would not contribute to the precise analysis which we seek to bring to adaptability.
If adaptability is to be made a workable tool for use by the architect, there is less need for a mass of didactic anecdotes – useful though these are – than for a sound and tractable theory of adaptability. Our review, therefore, stretches back no more than twenty years." (Fawcett, 1978, p.15)

ground" (Fawcett, 1978, p.17). In fact, from the analysis of the original paper, we have observed that Lynch generally addresses the issues connected with adaptability and related concepts in their respective similarities and specificities, the ways in which adaptability could be dealt with, namely when applied to the urban scale, and the question of balancing between the initial investment and the design options under a contextual and specific decision.

After acknowledging that obsolescence can hinder our activities and limit our behaviour in space[510], Lynch sustains that change happens at different levels - from the house to the urban scale, and the eager to address it through flexibility is increasingly higher:

> "Moreover, we see that the tempo of change is increasing, and fear that what we are planning today will be tomorrow's incubus. Structures housing the activities in most rapid flux (laboratories or hospitals for example) are in a constant turmoil of destruction and change. In our cities we have launched on a desperate program of razing and rebuilding that gives promise of being endless. And so each day we murmur the magic word: "flexibility!"" (Lynch, 1958, p.16)

As also affirmed by Fawcett in his Thesis, Lynch also upholds that tackling adaptability is dealing with the unforeseen change and translating it to physical solutions that can eventually answer intangible future needs[511]:

> "Preparation for a known change to come may have its complications, but can be approached and solved in a straightforward manner. The more adequate our predictions of the future become, the more will our anxiety for flexibility be transmuted into such tangible problems.
> But as long as our environmental patterns outlive our original guesses, we face the rather harrowing problem of providing for *unspecified* future change, or providing generalized flexibility." (Lynch, 1958, p.16)[512]

Lynch then presents biological analogies between the body's "plasticity" as its ability to accommodate changes according to the contextual constraints, and the spatial "adaptability"[513] that aims to accommodate the changes of the body and the activities:

[510] "All of us are to one degree or another cramped by the survival of obsolete environmental forms: narrow streets, awkward rooms, vertical factories, crowded tenements. Elaborate constructions have been abandoned because of their inability to accommodate new activity. The structure erected to facilitate life has often become its strait jacket." (Lynch, 1958, p.16)

[511] Quoting Fawcett: "Lynch first distinguishes between preparation for known change, and providing for unspecified future change. The former is a well-defined problem that can be approached and solved in a straightforward manner; the latter calls for generalised flexibility. (Fawcett, 1978, p.17)

[512] Italics from the original quote.
"When it comes to an all-out showdown, present efficiency will always take the pot, but usually the problem is one of striking a reasonable balance, with many unknowns and much looseness of fit." (p.23)

[513] "Biological analogies are often referred to, with an inversion that Lynch acknowledges, for in the biological context adaptability generally refers to the ability of organisms to adapt to changes in their environment,

> "Among biological populations, the ability to adjust to new situations plays a vital role, both for the individual and for the species. The adaptable populations survive, and the inflexible succumb. This adaptability is often bought at a heavy price of constant destruction and renewal, both of individuals and of parts within the individual. Now we reverse the inquiry to discuss, not the adaptability of the organism to his environment, but that of the environment to the changing purposes of the organism." (Lynch, 1958, p.16)

Then, Lynch differentiates the concepts of "plasticity", present "flexibility" and "adaptability" and in a very graphic way:

> "[…] if your objective were wide choice, you would present your subject with a roomful of pottery, of all shapes and styles. If plasticity is the aim, give him the wet clay to make his own. For adaptability, give him a simple, average-sized pot, suitable for many uses. Or leave the day in the ground, for the disposition of future generations. If your problem is housing, build a great variety of dwelling types for the first objective; put everyone in low isolated dwellings for the second; but for adaptability put them in tents." (Lynch, 1958, p.16)

Hence, "present flexibility" can be considered in two approaches: to provide the maximum range of possibilities for activities to happen in a space, or to allow the space to foster individual and active participation when appropriating space (p.16).

Likewise, "adaptability" here is considered as: "the generalized adjustability of an environment or artifact, with minimum effort, to future changes of use. This might best be called adaptability." (p.16)[514]. And Lynch continues by saying that: "An adaptable environment is simply a highly permissive one, and this may be far from optimum for the stimulation of individual growth." (p.23). This goes along with Fawcett's argument further on his Thesis, stating that "the objective of adaptability being to encompass as many states as possible" (Fawcett, 1978, p.35).

Lynch also advances with physical solutions to provide space with more adaptable features, namely: the use of "unspecialized forms" - implying that spatial shapes with little differentiation and low structure would be more prone to change and development; "zoning and concentration of structure"; "additive structures" - either by modules or by lattices, that allow future more complex arrangements with relative easiness; "variety"; providing "over-capacity" - expectant spaces for future

whereas the question here is the ability of an environment to accommodate changes in the organisms using it." (Fawcett, 1978, p.17)

[514] "A flexible environment, Lynch continues, could mean three different things: 1) present-day choice in the environment, 2) freedom for the user to develop the environment to his own requirements, 3) ability to cope with unspecified future change. The third alone is defined as environmental adaptability, and Lynch specifically states that present-day choice is quite independent of future change." (Fawcett, 1978, p.17)

activities or extra dimensioned spaces, that "leaves room for growth and change" (Lynch, 1958, p.19):

> "It should also be made clear that adaptability is not the same as growth or development, but simply is a permissive quality which *allows* growth or development. [...] We are only interested that, when it is desirable that life patterns should change, they can do so with minimum effort, and, were it possible, with no environmental change whatsoever."[515] (Lynch, 1958, p.23)

His notion of "flexibility" and "multipurpose" or "unspecified" space does not imply overly vague[516], but whose structural design allows spatial change without major layout arrangements. But to clear out his definition of specialisation, Lynch also defends that a space has to be provided with attributes that allow a wider allocation of activities, but cannot be overly specialised in the sense of being specifically created for the particular needs of a client that would produce a costly and narrowly directed spatial outcome (Lynch, 1958, p.17). This will imply a balanced choice, contextual as it is[517], between the "too narrow" options and the "sufficiently broad" solution. On the one hand: "Complexity of organization does not entail inflexibility: perhaps even the reverse, if the complexity has a purpose. A complexity like an arterial highway network may release potentialities of function that markedly enhance the adaptability of the whole." (*ibid.*). On the other hand: "Chaos, or lack of structure, is not flexible per se." (*ibid.*).

All in all, by pointing out some possible physical attributes of an adaptable space that potentiates and provides for change, Lynch calls out the need for a balanced outcome between the concepts defined and the referred design options, in the specific context of that space:

> "There seems to be a continuous conflict between future adaptability and present efficiency. Low intensity, over-capacity, highly temporary structure, intense concentration of structure, modular standardization, separation of centers, avoidance of specialization: all are likely to exact a price in terms of immediate function of first cost." (Lynch, 1958, p.23)

Consequently, a balance is also needed when reflecting on the concepts of "likelihood of change" to happen (and the nature of that change) and the concept of "easiness of change" (according to the effort implied in altering the initial spatial

[515] Italics from the original quote.

[516] "By failing to define structure or allocation, he is simply shifting the responsibility for decision to other individuals, or to the play of circumstance." (Lynch, 1958, p.17)

[517] "This study has discussed it primarily as an end in itself, and entirely in relation to the physical means of attaining it. Certainly, in any real situation, adaptability must be considered only in context with many other objectives." (Lynch, 1958, p.24)

layout). Likewise, there needs to be balance between "cost-effectiveness" and "over-provision". Quoting Lynch:

> "Unfortunately, these advantages of adaptability must usually be paid for by present loss. Over-capacity usually means the waste of scarce resources, or at least a denial of present use. More concrete or steel is consumed, or costly land may be required. Equally as important as the increased first cost, are the enlarged operating costs incurred by extra capacity. There may be more rooms to dust, more miles to travel to work (as in Canberra), more square feet of siding to paint." (Lynch, 1958, p.20)

Thus a balance must continually be struck between increased present costs, and decreased future adaptability. This is a conflict that a designer frequently mediates, as he decides on his "factor of safety," or ponders how to give a shopping centre room to grow in, without surrounding it with large tracts of unused land." (Lynch, 1958, p.20)[518]

Lynch concludes on the complexity of addressing adaptability, in what regards its goals, the means to achieve them and its connection to other "human needs". Before these specificities, the approach to adaptability must be placed "in context", but, all in all, "it appears that adaptability to future change unspecified is a significant goal in city planning […]" (Lynch, 1958, p.24)

Subsequent to Lynch's paper, Fawcett recalls Aylward's (1970) paper *Towards a theory for describing and designing adaptability in the built environment.* In recognising the "increasing rate and magnitude of change"[519] (Aylward, 1970, p.130), Aylward points out two possible effects on "the needs of an adaptable environment":

> "One is that individual activities need to be able to minimise the stress and costs of alteration and adjustment to new operations and requirements; and second, because of various technological innovations, activities will have increasingly greater freedom to locate independently of functional/geographic ties."[520] (Aylward, 1970, p.130)

Therefore, Aylward explains the aim of his paper:

> "There is an obvious gap in our theoretical and operational knowledge;

[518] "Any wise designer leaves some extra capacity in his design, for the sake of future stress and change. He leaves as much as he can, but must strike a balance with present cost. Where unused capacity is expensive, either in first or running cost, a society can hardly be expected to allow very generously for the future." (Lynch, 1958, p.20)

[519] Aylward defines five "aspects of change": "rate", "magnitude", "frequency", "duration" and "continuity" (p.138) and considers both space and activity to be "instigators of change" (Aylward, 1970, pp.138-139).

[520] "Using alternative, and maybe changeable, location criteria, there is an increased likelihood that more 'footloose' activities will bring greater demands on space (assuming that activity change rate is greater than space obsolescence), simply because one space may have to serve many alternative inhabitants in its lifetime." (Aylward, 1970, p.130)

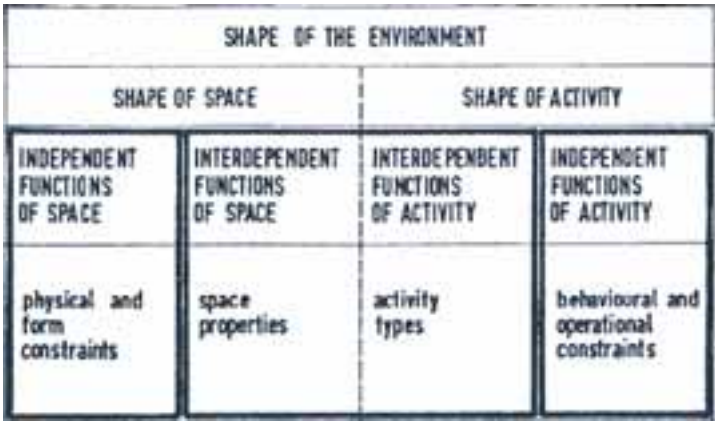


Fig. 104. "Relationships between the functional parts describing the environment" (Aylward, 1970, p.131)

> we are not able to translate how we use the man-made space of our environment into terms that can be understood and manipulated to minimise the stress of change. The purpose of this paper is to start to fill this gap by defining and analysing the component parts of the problem, and assembling them into workable procedures to design an adaptable environment." (Aylward, 1970, p.130)

Aylward presents advancements from Lynch's 1958 paper, which he gets to quote as "an important source for several of these ideas (Aylward, 1970, p.139), connecting activities to spaces in a straightforward manner, as "the two essential components of environment" (Aylward, 1970, p.130), and pointing out the "interdependent" and "independent functions" within these two (Fig. 104), which he defines as:

> "(a) *Interdependent functions* - categories of activity and space shapes that are directly and clearly cross-related and are, for the most part, quantifiable. For example, 'group teaching' (activity) demands a certain type of enclosure, floor loading, etc. (space).
> (b) *Independent functions* - categories that do not directly cross-relate activity and space but are more self-contained descriptions. For example, the material description of space, or the standards of personnel performance of activity. It is not to be inferred that these functions are completely independent, but only they are predominantly idiosyncratic." (Aylward, 1970, pp.130-131)

Aylward them presents a matrix with the correspondence of "fit"[521] between "activity types" and "space properties", which he calls "Notional order of need and interdependence between activity and space properties" (Fig. 105), which is widely

[521] Aylward defines two concepts: "fit" and "interfit", in which the first means "matching, of compatible activity and space" and the latter regards "what range of varied activities fit one space quality" (Aylward, 1970, p.131).

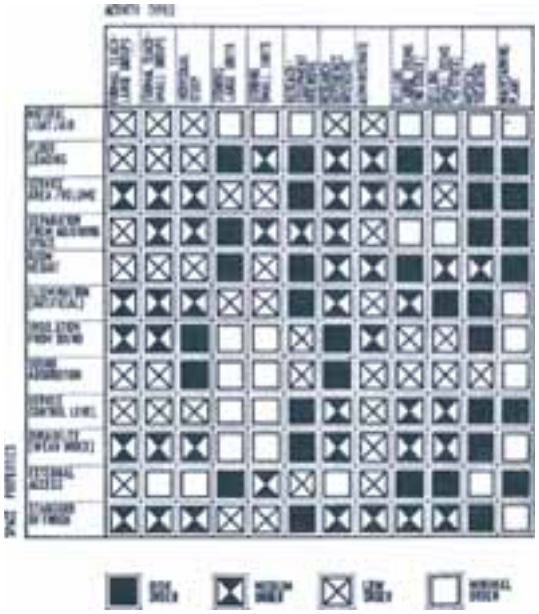


Fig. 105. "Notional order of need and interdependence between activity and space properties" (Aylward, 1970, p.132)

significant for Fawcett's feasibility matrices for "event-space pairings" presented in his Doctoral Thesis (Fawcett, 1978, pp.168-181)[522].

All in all, Aylward realises the relevance of defining activities and spaces for a better fit between them both:

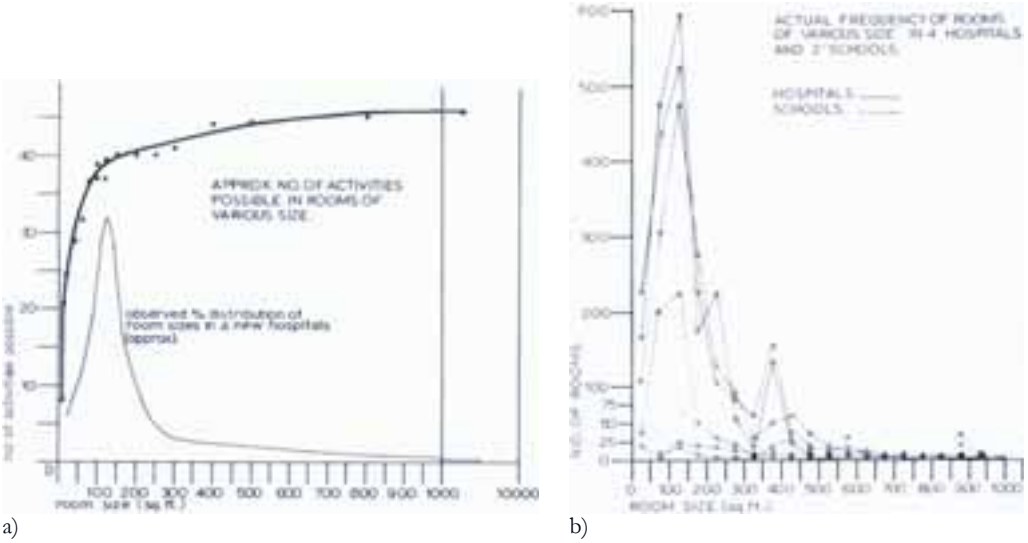
> "The initial split of the analysis into 'activity' and 'space' is an important first step to prevent blurred boundaries of definition in what is changing the shape of the environment. As a result it can be more clearly seen what needs to be changed to obtain better 'fits'. (Aylward, 1970, p.146)

By matching activities' needs to spaces' attributes, it is possible to conclude on the potential allocation of each activity to a space and hence, the space's capacity of adaptability to multiple activities. Fawcett advances that Aylward's concepts of "fit" and "interfit" provided by the matrix are "a preliminary step in our "loose-fit measure of adaptability"", the object of his study in chapters 9 and 10 of his Doctoral Thesis, although in Aylward's paper there is no explanation on how to accomplish it (Fawcett, 1978, p.20).

Fawcett then refers to Cowan's[523] (1963) paper *Studies in the growth, change and ageing of*

[522] Aylward notes that the wider the detail on the matrix, the more abundant the differences, this will be clear when producing and defining the degree of detail to introduce in our own feasibility matrix in chapter 3.3. for the purposes of this present Doctoral Thesis. See chapter 3.3 A methodology for identifying and assessing adaptability in learning environments.

[523] Peter Cowan was a member of the Research and Development Group of the ministry of Health and in 1960



a) b)

Fig. 106. a) Distribution of activities per room size;
b) Frequency of room in hospitals and schools per room size
(Cowan, 1963, pp.57,58)

buildings. According to Fawcett, the relevance of Cowan's 1963 article is that:

> "He provokes a design response from architects, or the attempt at such a thing, and permits the need for adaptability in buildings to be considered axiomatic, as we consider it in this thesis." (Fawcett, 1978, p.20).

In fact, Cowan addresses the issues of "growth", "change" and "ageing" of building in connection with "size", "shape" and "function", and in a very supported and graphic manner, "in the hope of describing patterns which might aid future planning" (Cowan, 1963, p.55), recognising that there were not yet answers for the practice.

Having acknowledged change from within the organisations, Cowan sustains its relation to the "design of the structures which house them". But, yet, he places the question:

> "But how far will it be worthwhile to make the insides of buildings adjustable to these changes? For human activities are adjustable to many different physical situations; and a single unit of space will often accommodate a wide variety of human activities." (Cowan, 1963, p.57)

Cowan's diagrams are very illustrative of the need for the buildings to cope with change. For the question posed by Cowan, Fig. 106 shows that from a certain point

he was associated with the Hospital Research Project (Cowan, 1963, p.54). So, the examples given in this paper, although with other and briefer references, mostly refer to the hospital brief for clarification.

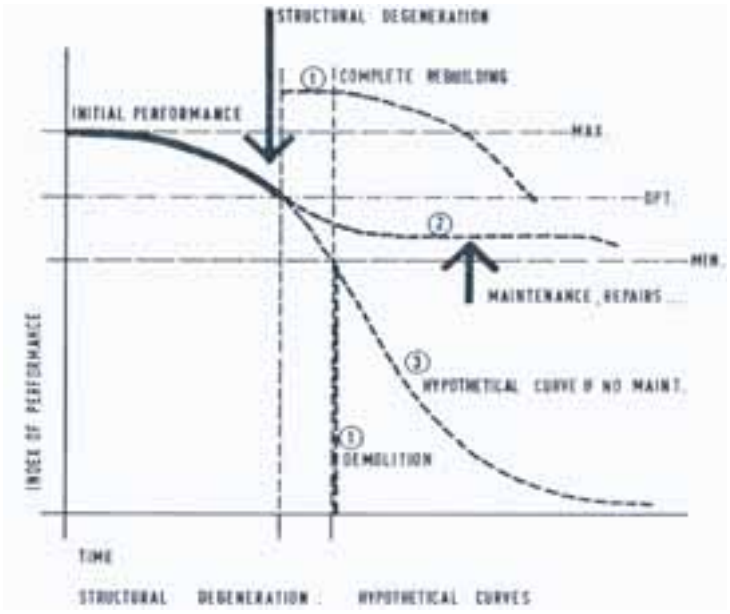


Fig. 107. Structural degeneration
(Cowan, 1963, p.68)

on the number of activities possible within a room tends to stabilise and that, both in schools and in hospitals, the room size is below 200 square feet[524]. This will imply that within that room size, most activities can take place[525]. Reminding of Weeks's (1960) "duffle coat"[526], as opposed to a "tailor-made" garment (Weeks, 1960, p.20), Cowan states that most needs can be held in a space of "normal office size" and that because alterations are costly, then they must be thoughtfully considered according to the "frequency of change" in that building:

> "If we provide a series of regular rectangular spaces of about normal office size, many different purposes can be adequately accommodated, without structural alteration.
> Alterations to the insides of buildings are very expensive, and it is necessary to discover the frequency of change within a building before

[524] "From these data we may draw a curve which starts at a minimum value of about four square feet, when about ten basic activities are possible, and then rises very rapidly to about 200 square feet, at which point the curve levels off abruptly. After this even large increments of floor space make possible relatively few additional activities." (Cowan, 1963, p.58)

[525] Cowan states that: "In addition, it is quite reasonable to suppose that rooms of 150 sq. ft. will serve a very large proportion of human needs." (Cowan, 1963, p.59)

[526] According to Weeks: "In order to get maximum flexibility within a department it is necessary to provide rooms which fit around the activities which are to be carried on in them like a duffle coat. The duffle coat, provide by the Navy for its officers, was not a tailor-made garment. A few sizes were made and these were related to the known range of sizes of sailors so that it was usually possible to find one that would fit very reasonably, and keep the sailor quite snug." (Weeks, 1960, p.20)
The approach to Weeks's "duffle coat" has already been dealt in detail. See chapter 2.1. Adaptability: definition and adjacent concepts.

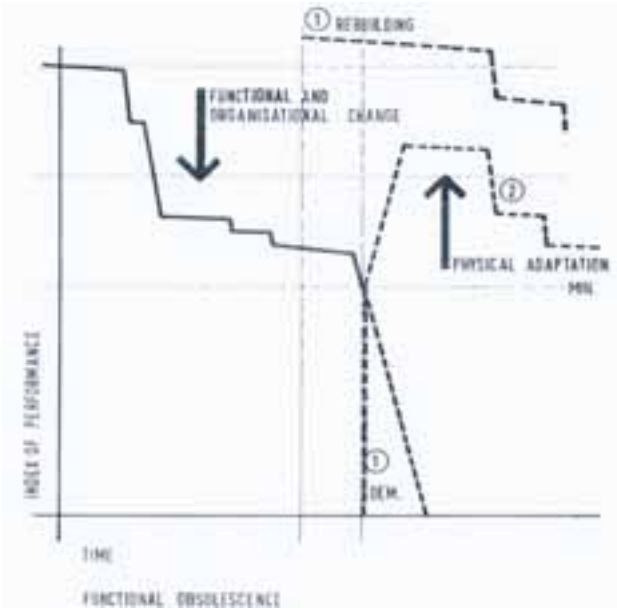


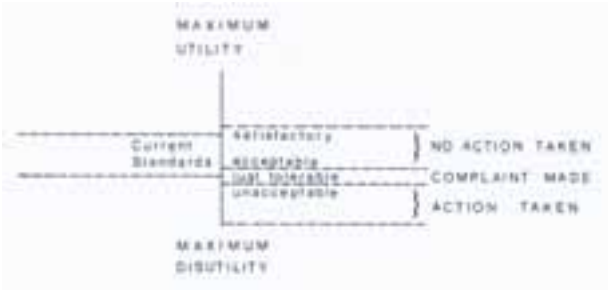
Fig. 108. Functional obsolescence
(Cowan, 1963, p.69)

> we are sure it is worth making special provision. It is surprising how little internal rearrangement has occurred in buildings, even those built some time ago." (Cowan, 1963, p.59)

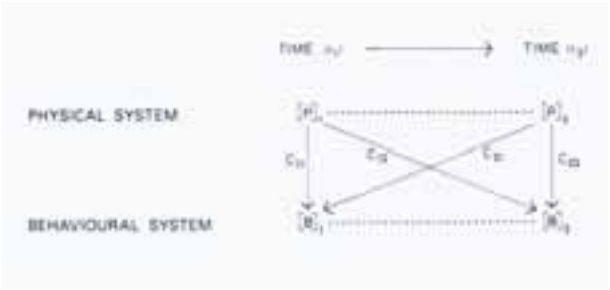
Two other images in this paper also bear significant representativeness for the state of the art on change, as conceptual diagrams which relate to structural degeneration (Fig. 107) and functional obsolescence (Fig. 108) related with life span, considered by Fawcett as "the essence of Cowan's analysis" (Fawcett, 1978, p.21). The first is represented by a smooth gradual curve from the initial performance to a complete lack of performance:

> "The curve starts at a high point of maximum structural performance and falls away smoothly to nothing. At some time during the life of the building this curve will approach the minimum satisfactory level of structural performance. If the structure is rebuilt, it will begin again at a higher level of performance due to improvements in construction methods. But if the building is repaired and maintained above minimum structural performance level, structural performance will never be raised to its original level." (Cowan, 1963, p.68).

While, the second figure illustrating functional obsolescence in time: "the curve showing functional obsolescence also falls from left to right, but in a series of steps, each indicating the introduction of a new procedure or technique which suddenly lowers the functional effectiveness of the plan" (Cowan, 1963, p.69).



a)



b)

Fig. 109. a) "Disutility scale"; b) "A schematic view of constraints through time" (Nutt et al., 1976, pp.64,40)

Cowan then realises that structural degeneration and functional obsolescence do not necessarily go along and that seldom at that time and contrarily to the past, "almost every building becomes obsolete long before it is ready to fall down" (Cowan, 1963, p.72). Having presented a wide span of topics on this behalf, many as Cowan implies, ranging other disciplinary fields, Cowan's paper elaborates on buildings "as part of the general system of human affairs which is constantly changing, and have tried to indicate the way in which buildings affect and are affected by the larger systems of human development" (Cowan, 1963, p.82). Hence, Cowan concludes by highlighting "homeostasis", "which describes the shifting balance between an organism and its environment, is a condition which we should seek to achieve in our buildings", but leaving the topic open to "make our own way on this research with no ready-made tools to help us" (Cowan, 1963, p.82).

After tackling Cowan's work, Fawcett focuses on obsolescence as describes it as such:

> "A building is obsolete when it can no longer be used for its intended purpose, and obsolescence is the process by which buildings reach this condition. Consider Lynch's unspecified future change: an adaptable environment can cope with change and does not become obsolete, whereas an unadaptable environment is more likely to become obsolete." (Fawcett, 1978, p.22)

Fawcett comments on Nutt et al.'s work and confirms it to be relevant to his individual work on "the features of buildings that resist obsolescence" (Fawcett, 1978, p.22).

Nutt et al. (1976) address obsolescence in dwellings, under the context of a "full-scale study of obsolescence in the housing sector"[527], regarding obsolescence in the housing sector as: "the relative degree of uselessness or disutility as assessed by the occupants themselves, or by the landlord, the property market or the planner, as the case may be." (Nutt el al., 1976, p.53) (Fig. 109a).

By addressing "the circumstances that give rise to high levels of disutility, disbenefit and dissatisfaction" (*ibid.*), they point out obsolescence to be "physical", "financial", "functional", "locational", "environmental", "style" (from "stylistic qualities") and of "control" (from "regulating mechanisms") (Nutt el al., 1976, p.6). Nonetheless, the authors conclude that a more complete framework on obsolescence should enclose all previous aspects and not consider them *per se* but rather as a "process" (Nutt el al., 1976, p.33):

> "Obsolescence in buildings is a phenomenon in which no single facet is always dominant. Any theory about the process of obsolescence in buildings must be capable of accounting for a variety of human actions that may accentuate or alleviate obsolescence and of the mechanics of regulation and control. The theory should integrate these disparate but related factors within a cohesive framework." (Nutt el al., 1976, p.29)

The concept of "constraint" as perceived by mathematics as: "anything that restricts the number of variables or the values that variables may take" (Nutt el al., 1976, p.36), is therefore quite relevant for this whole theoretical perspective, which in this case could be perceived as being of different types i.e.: "spatial", "facility and condition", "financial", "locational", "market" and "legislative" constraints, on "different levels of aggregation" (Nutt el al., 1976, p.38). These constraints condition the allocation of a "physical system" (understood as spaces) to a "behavioural system" (taken as activities) (Fig. 109b).

The study then focuses on modelling the "areas of constraint" and "areas of response" (Nutt el al., 1976, p.49) in order to perceive the trends and address them, preventing obsolescence[528]. A binary diagram can then be modelled with the possible actions and the constraining factors for each action that may hinder the possibility of that action to occur in that space or to consider it satisfactory to shelter that activity (Fig. 110a). This is put by Fawcett as:

> [...] the essence of the models to compare an array of possible

[527] An initial study on "patterns of growth and change, of both staff and accommodation, in a number of institutions," by the Joint Unit for Planning Research funded by the Ministry of Public Buildings and Works in 1964; followed by a "pilot-study of obsolescence in buildings" from 1970, led to the funding in 1972 of the research to "develop techniques for assessing, simulating and alleviating obsolescence of housing" that are presented in the book by Nutt et al. (1976) *Obsolescence in housing: Theory and applications* (Nutt et al., 1976, p.x).

[528] "So, by focusing on two critical aspects of obsolescence – areas of constraint, areas of response – and modelling them, we are able to examine and describe the possible courses of obsolescence for single items of building stock and for urban areas as a whole, and warn of trends that need watching." (Nutt el al, 1976, p.49)

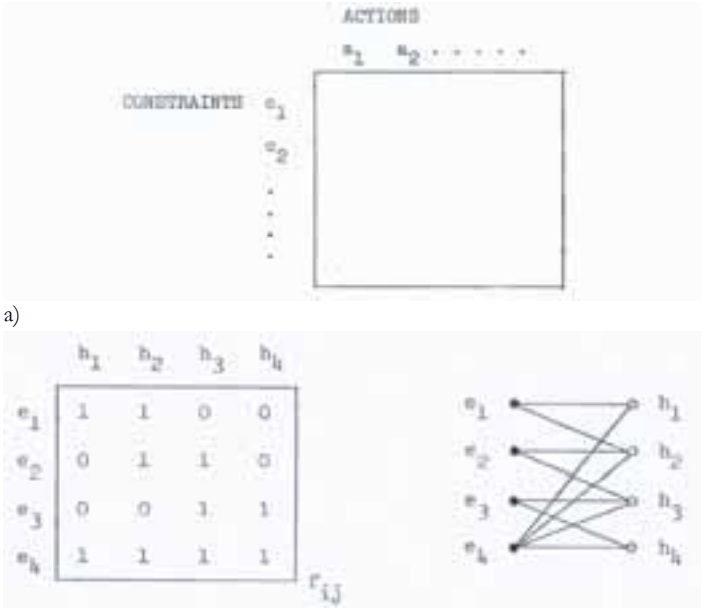


Fig. 110. a) Matrix of correlation of actions to constraints; b) Zero-one matrix and bipartite graph as in which feasible event-space pairs are linked by an edge

(Fawcett, 1978, p.23)

> actions with an array of constraining factors, for a given household and dwelling. [...] The constraining factors of the dwelling are those physical characteristics, which might, if inadequate, cause the dwelling to be unsuitable for the activities. (Fawcett, 1978, p.23)

This is later tackled by Fawcett in the combinatory models for measuring adaptability, as we see further on his Thesis, as the connection between spaces and events, whose pairing is constrained by factors that enable and/or hinder their allocation[529] (Fig. 110b).

All things considered and after having focused on the previous works mentioned, Fawcett supports that adaptability is a question of providing the possibility of choice in the future and to be able to answer the uncertainty of future change. The relevance of identifying the boundaries between performance and obsolescence is relative, as the most significant issue in providing for adaptability is the potential choice for coping with the changing needs (what he later calls of "loose-fit" potential):

> "Following Lynch, we suggest that an adaptable environment is one that offers choice, in the present and in the future, and to make any estimate of the extent of choice offered by an environment it is necessary to be able to identify thresholds of satisfactory performance, or obsolescence. But we do not see this as the central task in the study

[529] Nutt et al. also use zero-one matrices (see Nutt el at, 1976, p.74).

> of adaptability - which should build on such knowledge, and erect a superstructure that deals directly with the breadth and type of choice that is offered. The essence is the choice available, not the thresholds themselves." (Fawcett, 1978, p.24)

He also mentions Baird (1972), who connects the degree of flexibility of a system to the options made by the planner in the design, ultimately defining the degree of flexibility by the respective the degree of "choice":

> "The degree of choice is, in effect, the flexibility of the system. As soon as the planner decides that one facility should definitely go on a particular site, some choice is lost. Long-term plans are always affected by unexpected new circumstances that arise, so it is implied that planners should be aware of the effect on flexibility of their decisions, and should try to retain flexibility." (Fawcett, 1978, p.26)

For Fawcett the relevance of this paper lies on the use of the concept of "flexibility" that Fawcett translates to his Thesis as "loose-fit adaptability" of entropy "as the index of adaptability" (Fawcett, 1978, p.27) [530].

Fawcett recalls Markov simulations taken by a SRC-funded research project at Bristol for modelling patterns of students' activities, but concludes by favouring the model for maximising entropy, as Tomlinson et al. described it in 1973, as "more economical, stable, and comprehensible for the problem in hand" (Fawcett, 1978, p.25)[531].

This particular model from Tomlinson et al. (1973) for simulating patterns of student population to activities and space in time, identifies the time for each activity and the restrictions regarding available time and location to take up every activity:

> "A model is described whose purpose is to predict the distribution of students in different activities and locations during the course of a typical day, depending on the effective restrictions imposed by the spatial distribution of buildings and sites, and by administrative and social constraints on the timing of activities. The model is of an entropy-maximising type; the data against which it is tested are drawn from time budget surveys made in two universities, using diary methods." (Tomlinson et al., 1973, p.231)

Fig. 111 allows a clear understanding of the three variables: activities, location and time and their possible arrangement, along with the distribution of the student population. This models does not intend to perceive individual decisions but rather

[530] Baird's (1972) paper *Applications of information theory to man-environment systems* will be analysed in-depth in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[531] We here recall another crucial paper on this model by Batty and March (1976) and the overall book in which it has been published as a compilation of papers on the subject of the analysis of spatial systems.

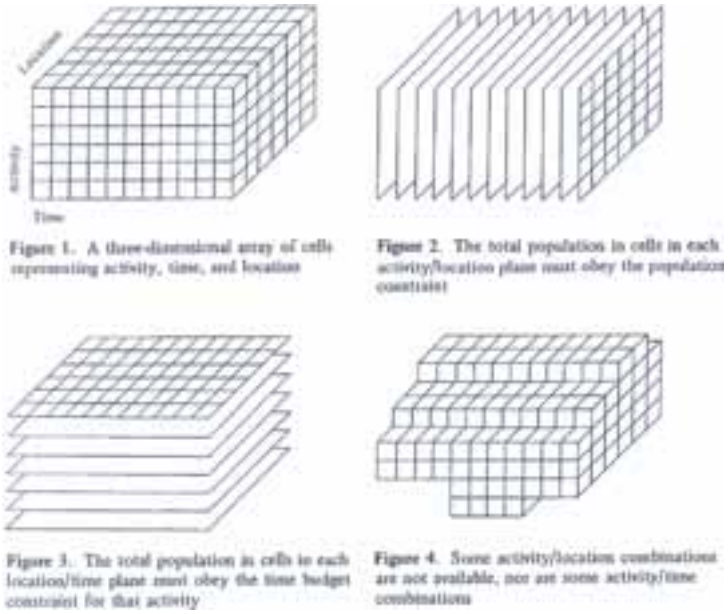


Figure 1. A three-dimensional array of cells representing activity, time, and location

Figure 2. The total population in cells in each activity/location plane must obey the population constraint

Figure 3. The total population in cells in each location/time plane must obey the time budget constraint for that activity

Figure 4. Some activity/location combinations are not available, nor are some activity/time combinations

Fig. 111. "Restrictions and constraints shown diagrammatically" (Tomlison et al., 1973, p.234)

"the most probable distribution of the population in time and space"[532]:

> "[…] the most probable distribution of the population in time and space can be derived, subject to the population and time budget constraints[533] and the restrictions on the availability of time and space for activities, by using the entropy-maximising technique. The resulting distribution gives the number of people engaged in each activity in each time period in each location over the day." (Tomlinson et al., 1973, p.234)

Conclusively, as future developments on this model the paper points out the study on possible variations on "alternative population groupings", "activity classifications" and "time budget variations", which could potentially inform on the "level of detail at which further surveys need to be conducted". This is particular relevant and could still be considered today. In fact, it could be argued that contemporary university buildings, or in a more general outlook, educations facilities, are provided with spaces that in the 1970s were not necessarily considered, particularly in regard

[532] Surveys for data collection and testing of this approach have been undertaken at Reading University, Leicester University and Leicester Polytechnic.

[533] Time budget constraints for this model imply that: "for a given group of people, over some repeated period (such as a week), the proportion of time spent in various activities will remain the same, although the sequence of activities and the locations would, of course, differ. This overall division of time between activities, the *time budget*, is expected to vary for different groups of people." And for the purpose of the model: "the proportion of time spent in different activities by the population as a whole is similar to the time budgets" (Tomlinson et al., 1973, p.233). (Italics from the original quote.)

to time budgets and information technology[534] in what concerns the activities for knowledge acquisition, communication and evaluation, and the needs for the placement of those more recent learning activities in space and time. This will be further considered, when our proposed methodology will be explained in the following chapter[535], along with the definition of the detail on activities and spaces to be introduced in the application of the methodology in the case study of our present Thesis, but, naturally, that the recognition of the relevance of this paper, along with all the references on the state of the art presented beforehand support the robustness of this original methodology.

To contextualise this paper and to highlight the relevance of this issue during the 1970s, it becomes relevant to mention that the referred authors: Tomlinson, Bullock, Dickens, Steadman and Taylor (1973) present a model produced under a wider array of themes within university planning, taken on a research project entitled University Study, in the Centre for Land Use and Built Form Studies[536]. This centre's first report is on this particular study (Bullock, Dickens, and Steadman, 1969[537]), where it is explained the wide scope of this project:

> "What we feel is needed is a theoretical model of the physical planning of universities – 'model' in the sense in which it is used in economics or operations research: such models are now being developed, particularly in America, for use in the field of urban planning. The essential feature of such a model would be the establishment of a comprehensive series of mathematical or semi-mathematical relationships between the different parameters which affect the physical aspects of university planning." (Bullock, Dickens, and Steadman, 1969, p.1)

Under the mentioned inclusive study on university planning by the Centre for Land Use and Built Form Studies, on both activities and organisation of the university's spatial layout, Bullock, Dickens and Steadman (1970) have also related activities to spaces for student population.

Fig. 112 presents student distribution and movement, identifying its location per facility and per time period. The convergence (or divergence) of students in particular facilities could support the presentation of the sought alternative layouts for universities, also regarding the time spend on those activities and the more frequent movements between locations.

[534] Note that the paper actually points out on the last conclusions, the potential incidence of "technological innovations" (p.265) to be considered in future surveys, and even in comparison with previous ones.

[535] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[536] According to Leslie Martins' preface on this report (who was the centre's first director), this study started by a Grant from Calouste Gulbenkian Foundation in 1965-66 and continued on by funding from the Department of Education and Science. Then, when the Centre for Land Use and Built Form Studies was created, later in 1967, it carried out this Project (Bullock, Dickens, Steadman, 1969, preface).

[537] Consulted edition from 1969, first edition from 1968.

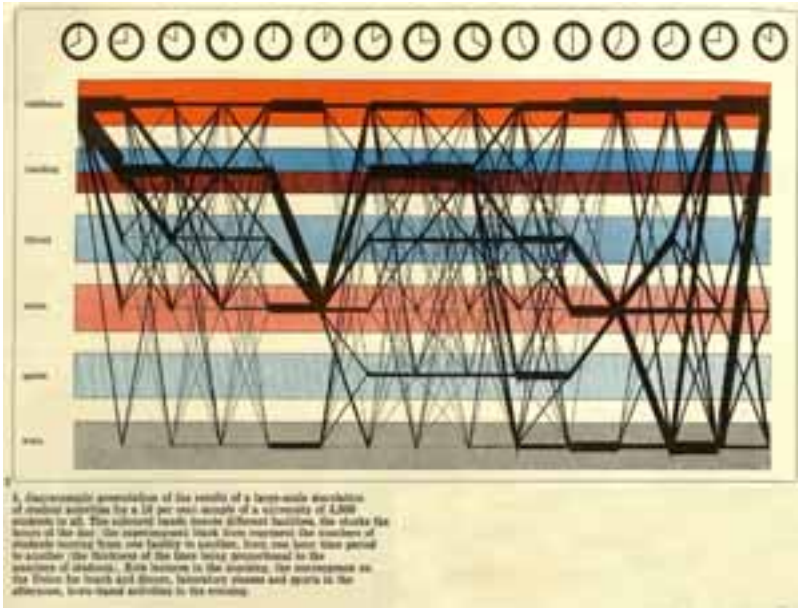


Fig. 112. "Diagrammatic presentation of the results of a large-scale simulation of student activities for a 10 per cent sample of a university of 3,000 students in all"
(Bullock, Dickens, Steadman, 1970, p.304)

Models are therefore used extensively under the University Study in the Centre for Land Use and Built Form Studies in an "exploratory", rather that purely "descriptive", approach on alternative patterns that can also be evaluated, and whose results may cyclically introduce improvements in the initial models (Bullock, Dickens, and Steadman, 1970, p.299)[538].

"Robustness" is presented by Fawcett at this point, as another concept of relevance. For introducing it Fawcett refers to Gupta and Rosenhead's (1968) *Robustness in sequential investment decisions*, where the concept is applied to "long-range investment plans" (Gupta and Rosenhead, 1968, p.B-18), and particularly to the case study of a plant location, which they define as such:

> "In the context of our discussion, "robustness" (or flexibility) of a decision or decisions must be measured in terms of the numbers of the "good" end-states for expected external conditions which remain as open options. If a formal definition is required, then the robustness of a decision can be defined simply as the ratio of that number to the number of good end-states considered." (Gupta and Rosenhead, 1968, p.B-21)

These authors have adopted the concept of "robustness" linked to "stability" and the unforeseen change, leaving decisions open to future choices when "more up-

[538] The subject of models, deeply sought in the 1970s, has been previously analysed when addressing Echenique's (1972) classification of models, even though this original paper dates back from 1968, when written in the working paper #6 from the Centre for Land Use and Built form Studies.

to-date information is available" (p.B-28) and estimates on those variations bear natural subjectivity[539]. This "robust-stability[540] approach" (p.B-29) is presented as an alternative perspective different from an early optimum solution (or "the best end-state" (p.B-21)) taken right from the beginning when not all the information on future circumstances and potential variations is available:

> "The alternative approach described in this paper is, where there are a number of end-states whose outcomes (on the basis of current information) are not much inferior to that of the "best" end-state, to make initial decisions which permit the achievement of as many as possible of these end-states. We have called such initial decisions "robust."" (Gupta and Rosenhead, 1968, p.B-28)

Hence, "robustness" caries advantages on "the reduction of the need for subjective estimation—only a range of likely variation in outcome, rather than a set of subjective probability distributions; and in the formal abandonment of the search for an unknowable future optimality in favour of the more modest and practical goal of future flexibility" (*ibid.*). This could be related to Fawcett's "lifecycle options approach" (Fawcett, 2010) undertaken later in his subsequent work.

It could here introduced the reading from a more recent work by Kincaid (2003) *Adapting buildings for changing uses: Guidelines for change of use refurbishment*, which revolves around this concept of "robust buildings for changing uses" (Kincaid, 2003, p.93). He also mentions that the viable development options[541] of both new buildings and research-adaptive ones should be based on the "systematic comparison of options in relation to": the "risk", the "robustness", the "value", the "utility", the "benefit" and the "cost" of options (Kincaid, 2003, p.104). At the end: "Robust decisions to protect future options" (p.80). "Supply" and "demand characteristics", "performance requirements" and "decision procedures" (p.21) need to be thought and evaluated to produce a viable approach to "changing use demands and existing supplies" (p.6).

A decade later from Gupta and Rosenhead's paper, Pye (1978) also addresses the concept of robustness linked with flexibility. In the paper *A Formal, Decision-Theoretic Approach to Flexibility and Robustness* Pye explains robustness as an approach to problem-solving that implies decision-making and future uncertainty:

[539] "A major problem in assessing the flexibility to changed circumstances of a planned sequence of investment decisions is the identification of just what circumstances are likely to change and by how much. Estimates of this variability are often and necessarily made, but rarely without a large element of subjectivity and therefore controversiality. In this section a measure of flexibility, called "robustness," is developed which does not depend directly on such estimates." (Gupta and Rosenhead, 1968, p.B-20)

[540] "Where there are several robust decisions, an appropriate discriminatory factor is "stability"—that is, the ability of the system (as amended by the Initial decision or decisions) to perform well should the subsequent stages of the investment plan be delayed or cancelled." (Gupta and Rosenhead, 1968, p.B-28)

[541] He mentions the criteria for viability as "cost", "value", "risk" and "robustness" (p.15).

> "Robustness is a criterion formulated to be appropriate to problems involving a finite sequence of decisions taken by a single decision-maker (d.m.). At each stage, the d.m. must choose between a finite number of alternative moves (using standard game theoretic terminology) which will, in general, restrict choice of later moves. Between each pair of decisions, the d.m. can be informed of the state of an informational variable, called a state or move by nature, which will also restrict future moves and affect the value the sequence of moves selected." (Pye, 1978, p.215)[542]

Flexibility will allow that an initial choice does not entirely hinder future possibilities and Pye relates flexibility to entropy, understanding flexibility "as the entropy of that uncertainty" (*ibid.*) as an alternative method for "the solutions sequential problem"[543] (p.216), because:

> "It will be argued that the traditional approach can deal only with a limited amount of uncertainty and that, rather than attempt to increase the range of unknown factors explicitly considered, it is better to introduce an additional criterion, flexibility, in order to ensure that initial moves do not preclude too many later ones. Flexibility will be defined to be the amount of uncertainty which the d.m. [decision-maker] retains concerning the future choices he will make. Under simple circumstances it may be interpreted as the number of future alternatives from which choice may be made. Robustness is a method of trading off flexibility against expected value." (Pye, 1978, p.215)

Deriving flexibility by the use of entropy is then placed by Pye, being *U* the entropy of that distribution[544]:

> "One measure of the uncertainty in a probability distribution is the entropy of that distribution. The entropy of the distribution $\{p_i\}_{i=}^{M}$ is the function
>
> $$U(\{p_i\}_{i=1}^{M}) = \sum_{i=1}^{M} p_i \log(p_i)$$
>
> where the logarithm, like all others in this paper, is to base 2. Let

[542] "Unforeseeable uncertainty can only be dealt with if the decision-maker's response to nature's moves is not fixed in advance but is itself uncertain. Flexibility is then defined as the entropy or that uncertainty. It is a measure of both the number of alternative sequences of moves which are open to the decision-maker and his attitude to them. Robustness is a way of trading off flexibility against expected value as estimated under foreseeable uncertainty. The cost of flexibility may be estimated and controlled." (Pye, 1978. p.215)

[543] "Unforeseeable uncertainty cannot, by its very nature, be incorporated in nature's moves. As a result, it cannot be accommodated by the traditional approach. A different basis for planning is needed - one which does not involve the specification and retention of a detailed plan based on initial estimates of value and probabilities. The new method should retain flexibility for dealing with unforeseeable uncertainty." (Pye, 1978. p.217)

[544] The explanation of this formulation, within the scope of our Thesis and acknowledging the relevance towards architecture more than the mathematics to derive it, will be analysed in the subsequent chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

> flexibility be defined to be the entropy of the distribution of probabilities concerning the d.m.'s [decision-maker] future decision." (Pye, 1978, p.218)

Therefore, the proposition for the definition of flexibility as "uncertainty concerning the d.m.'s own future moves" is established to be "the most fundamental of the formal constructions used on this paper" and this uncertainty is here proposed to be assessed by entropy (Pye, 1978. p.225). Pye even mentions Baird (1972), whose significant work on entropy will be analysed in the following chapter of our Thesis, in closer detail with entropy maximising. Pye assumes the originality of his research on the use of entropy to measure flexibility and to support decisions based on that evaluation (*ibid.*)[545]. Fawcett, recognising Pye's work underlines its scope on decision-making, which differs from the architectural specificities (Fawcett, 1978, p.29).

After focusing on the mentioned authors and approaches, Fawcett concludes that Lynch (1958) and Aylward (1970) tackle the issue but do not present strategies "of immediate interest" (Fawcett, 1978, p.29), because Fawcett aims at an analytical approach. Cowan (1963) and Nutt et al. (1975) provide a more theoretical approach to the subject that already provide "more substancial analytical tools" (*ibid.*). While Baird (1972) and Gupta and Rosenhead (1968) point out potential methods to address it. Lastly and after explaining the previous authors relevance for backing Fawcett's "general theory of adaptability" (Fawcett, 1978, p.i), Fawcett clearly states what his own approach intends to:

> "We are interested in adaptability that allows buildings to cope with activity change." (Fawcett, 1978, p.29)

Chapter 3 of Fawcett's Doctoral Thesis relies on "Adaptability as an empirical objective" (Fawcett, 1978, pp.31-50), sustaining that adaptability has already been put into practice even though its definition is still rather blurred and its strategies still "intuitive", which is also proven by the previous works on the state of the art formerly presented. As he puts it:

> "It is fair to say that the theory of adaptability has not broken the barrier of practicality. Concepts are often carefully, indeed subtly, discussed, but no solid principles have emerged that can stand alongside other criteria in the design process. This does not mean that adaptability has not been influential in design: it has been, and was before any of the theoretical studies we reviewed in Ch.2. Intuitive strategies to maximise adaptability abound, and an ambition of this work is to make possible to distinguish between myths and strategies of adaptability." (Fawcett, 1978, p.31)

Moreover, for embedding adaptability in the design, decisions must be made not solely

[545] "Although earlier studies have used entropy of future behaviour as a measure of flexibility, none have attempted to either evaluate flexibility or to base a decision-making criterion on it." (*ibid.*)

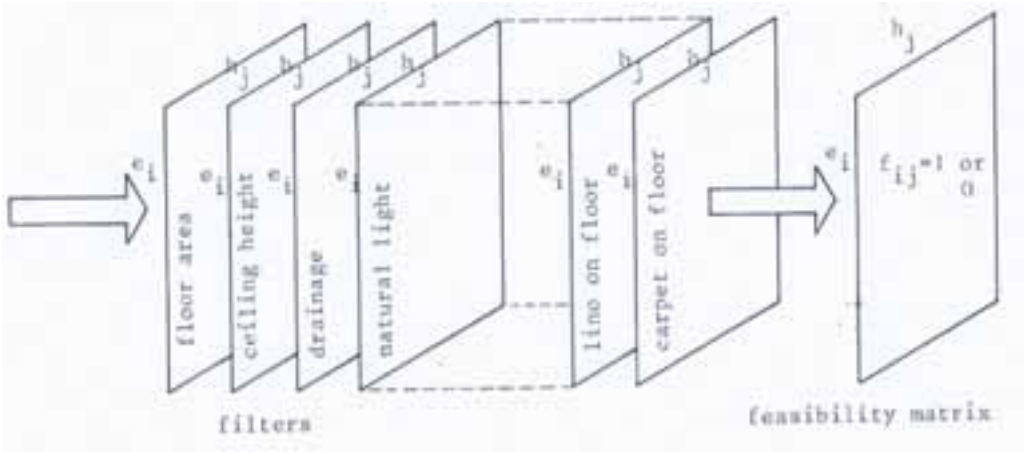


Fig. 113. Filters that constrain the feasibility matrix
(Fawcett, 1976b, p.28)

on its "maximum" degree, but also on the adequate choice[546], which corroborates the latter reference to the need for a thorough and contextual balance between the design options, the gain conveyed and the cost implied, in order to provide "robustness" in the future, rather than either costly "over-provision" or potential obsolescence. In each particular case, specific design solutions should be conceived according to the brief, the referred balance of variables and the expectancy of change:

> "Adaptable designs are strategies with which to face uncertainty - uncertainty about the relationship between activities and spaces, either now or especially in the future. The actual types of activity change that designers guard against tell us implicitly what they believe to be variable aspects of the relationship, and will guide our search for a relevant and useful theory of adaptability." (Fawcett, 1978, p.31)

At this point, in 1978, Fawcett advances that adaptability is connected with the buildings' "attributes" (Fawcett, 1978, p.32)[547], from the more permanent and large scale, to the more variable and small scale ones (*ibid.)* and in which "the succeeding characteristics tend to be constrained by those before" (*ibid.*). Thus, Fawcett puts forward the concepts of:

structure --------- spaces --------- services --------- fittings

(Fawcett, 1978, p.32)

[546] "Needless to say, the designer's task is not solely to generate maximum adaptability in his designs, but rather the degree of adaptability which is appropriate to the problem in hand." (*ibid.*)

[547] "Any characteristic of buildings that affects the ability to accommodate activities will affect adaptability. We have proposed (Fawcett, 1976a), that in a general way the characteristics of spaces that determine the ability to accommodate activities can be ordered, beginning with coarse and permanent ones and moving on to detailed and changeable ones, in the following sequence" (Fawcett, 1978, p.32).

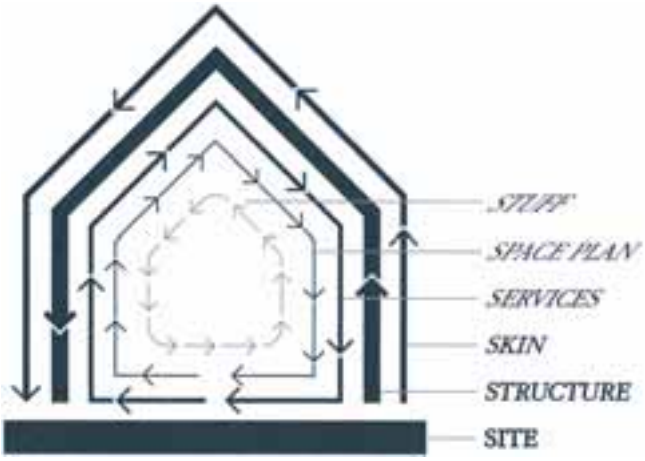


Fig. 114. Brand's "shearing layers of change"
(Brand, 1994, p.13)

This had already been advanced in his paper from 1976 *Measuring Adaptability* (Fawcett, 1976b), where Fawcett refers to "filters" (Fig. 113[548]) that constrained the allocation of activities to spaces and establish the "feasibility potential" of a particular space (Fawcett, 1976b, p.28). This would be accomplished according to the compatibility between "attributes of activities' demands and spaces' supplies":

> "Each attribute can be considered as a 'filter' with which an activity-to-space match (e_i,h_j) must be tested. […] the overall feasibility matrix is the result of passing every possible activity-space pair through every filter." (Fawcett, 1976b, pp.27-28)

The approach on "attributes" much recalls Duffy's (1990) later work on *Measuring Building Performance*, where he recognises "shell", "services", "scenery" and "set"; and later developed by Brand (1994) with his "shearing layers of change": "site", "structure", "skin", "services", "space plan" and "stuff"[549] (Fig. 114).

But according to Fawcett it is the "spatial level" that is most determinant to the remaining decisions and to overall adaptability[550]. He recalls the concept of the "multi-use box" as "the purest strategy of adaptable architecture" with its "long-span, deep-plan, fully-services, single-storey box", due to the variability of uses it can accommodate, which can "be interpreted in terms of our four-level hierarchy" (Fawcett, 1978, p.33).

[548] This has already been referred in chapter 2.1. Adaptability: definition and adjacent concepts, considered relevant for the concept of adaptability and is referred again here in the context of Fawcett's specific work.

[549] This has been previous dealt in deeper detail, while also comparing the concepts' meanings according to the respective authors in chapter 2.1. Adaptability: definition and adjacent concepts.

[550] "The level that is most important, that exerts most leverage over the convenience of buildings, is the one concerning spaces. [… It is at the spatial level that we shall mostly concentrate, as we believe it to be the primary characteristic of building which determines what activities can be accommodated, and which therefore determines adaptability. " (Fawcett, 1978, p.32).

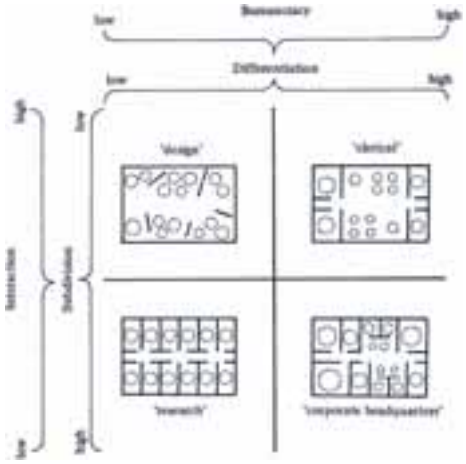


Fig. 115. "Office layouts of differing degrees of sub division and differentiation are thought likely to relate to the organisational dimensions of interaction and bureaucracy"
(Duffy and Worthington, 1976, p.602)

But Fawcett also points out single measures that enhance adaptability *per se*, as options in the design, such as "long-span frames", "simple rectangular plans" instead of "highly articulated" ones, "movable walls" or even "no walls at all", "all-over servicing from a continuous ceiling void" and "making all furniture and fittings mobile" (Fawcett, 1978, pp.33-34).

However, Fawcett underlines once more the need for a balance between high provision and redundancy and its respective "cost penalty", that in the "multi-use box" is recurrent (Fawcett, 1978, p.34) [551]. Furthermore, the model of the "multi-purpose box" is not a potential standardised design solution, because adaptability lies under specific options and its adequacy depends on specific circumstances and so, it is shaped, structured and fitted accordingly:

> "The fact that adaptability is not a simple property that is maximized in the multi-purpose box is easily demonstrated. The building type, though, redundant, is not universally applicable, and we compare two office designs by the same architects that are very different but adaptable in different ways." (Fawcett, 1978, p.37)

Assuming that "no one pattern of subdivision and arrangement of spaces can cater for all needs" (Fawcett, 1978, p.34) and that adaptability does not carry a standard solution and takes different forms, Fawcett recalls Duffy and Worthington's *Organisational design and space* (1976) where four possible plans are presented implying different organisational interfaces (Fig. 115), which had already been addressed on Duffy's (1974) former paper *Office design and organizations: 2. The testing of a hypothetical model* for

[551] "However, whilst it may with reservations be accepted that a building cannot be too highly serviced or too well equipped, it is not so obvious that ever larger structural bays and ever deeper plans are always desirable." (Fawcett, 1978, p.34)

Environment & Planning B. To comment on that image Duffy and Worthington state that "Building form may be used to confirm an organisational strategy […]" (Duffy and Worthington, 1976, p.602) And so, the purpose of adaptability in the particular case of office buildings would be "to encompass as many states as possible" (Fawcett, 1978, p.35) according to the grouping of workers and their activities.

All in all, adaptability implies little material change to provide maximum states, quoting Fawcett: "Adaptability derives from being able to rearrange activities in many ways with minimal environmental change" (Fawcett, 1978, p.40).

This may bear different meanings according to several and diverse contextual constraints and may even differ according to the brief at hand. Even though Weeks (1964) proposed an "indeterminate architecture" he had looked at hospitals in particular within his previous research at the Nuffield Foundation. While Rabeneck, Sheppard and Town (1973) studied this issue applied to dwellings and present different ways of interpreting flexibility in projects in several countries in Europe (Rabeneck, Sheppard and Town, 1973, p.698).

But Fawcett specifically focuses on the school building, that has a particular need for interchangeability of spaces (Fawcett, 1978, p.46). He starts by mentioning a pamphlet by the Ministry of Education (1957) on post-war school buildings, which raises a proposition that could be applied today:

> "[…] these spaces [the schools we should build] must be adaptable not only to a present variety of uses, but also to the changes which the future is bound to bring, sometimes suddenly, sometimes imperceptibly". (Ministry of Education, 1957, p.15)

Besides proposing more adaptable spaces, the pamphlet also concludes on a number of other requirements for post-war school buildings, namely: the need for "more room in total", "more individual spaces", "individual spaces will not be of uniform size", "different physical conditions in different spaces" and spaces "designed for children" with the appropriate scale (*ibid.*).

By consulting the original publication, we could also add that in the same publication the Ministry of Education assumes "a growing diversity of the forms taken on by the old subjects and a greater variety of ways in which they are combined on the timetable" (Ministry of Education, 1957 p.12). Fawcett is also in agreement with this assumption, assuming the changeability in subjects and teaching processes throughout the school buildings' lifecycle: "During the life of a school there will be educational change in the subjects taught and the manner of their teaching". (Fawcett, 1978, p.43)

Change is therefore certain to happen in a school building, not only because of a potential enlargement or reduction, but also due to the variation in group sizing and specificities, in teaching practices and the subjects provided and, overall, in

timetabling changes (when allocating activities to spaces), habits and routines, and life within the building at large. But Fawcett assumes that: "The changes that do concern us are those affecting the patterns of grouping and the system of timetabling." (Fawcett, 1978, p.43)

So adaptability becomes an invaluable design goal, enhanced by "interchangeable" and "multiusable" spaces that can allocate "activity states that consist of different patterns of grouping within a fairly static building" (Fawcett, 1978, p.47), which more easily provide "workable timetables" (Fawcett, 1978, p.46).

But assuming the differences in activity states for specific school briefs, Fawcett recognises the diversity in adaptability solutions for a primary and a secondary school:

> "The adaptability requirements for primary schools and higher education seem relatively well defined, but secondary schools are more complex, and demand the balancing of different factors." (Fawcett, 1978, p.48)

This is fairly relevant for our current research, since our main case study is a secondary and music school, which adds further variables and complexity to our study with regard to the states and spaces, their specificities, spatial features, group variety and sizing, and overall their respective distribution of activities to spaces.

At the end of this chapter Fawcett acknowledges that change can be coped with "activity change, or by changing the matching of activities to spaces: either by organisational or allocational change" rather than physical alterations undertaken in static buildings[552]. Hence, Fawcett introduces the following chapter on "a new theory of adaptability in buildings".

So far, Fawcett analyses adaptability from an abstract and open perspective and "with some degree of generality", admitting that "adaptability has been used in diffuse ways" (Fawcett, 1978, p.51). In fact, Fawcett relates adaptability to a general outlook on matching spaces and activities, and its references to the state of the art reflect that perspective. He points out specific authors and their respective outlooks on adaptability in a critical, but very systematised reference to lines of thought, breakthroughs on this issue, or that have contributed to his own model explained further on his Thesis. This is assumed by Fawcett, when he initiates chapter 4 entitled "A new theory of adaptability in buildings" (Fawcett, 1978, pp.51-74), by saying:

> "We have shown that adaptability has been used in diffuse ways, but we have tried to analyse it with some degree of generality, and abstracted the essence from the circumstances of each instance." (Fawcett, 1978, p.51)

[552] We remind here that adaptability is understood for the purposes of our current Thesis as "the ability of the built form to maintain compatibility between activities and spaces, as those vary" (Krüger, 1981a, p.1169). See chapter 2.1. Adaptability: definition and adjacent concepts.

From this quote two issues have to be highlighted: the fact that Fawcett deals with adaptability in a general perspective and that he has "abstracted the essence from the circumstances of each instance". This confirms his first postulate on aiming for a "general theory of adaptability" (Fawcett, 1978, p.i) and that its "mathematical approach to adaptability in buildings" is detracted from the context and the specificities. Note that, not even in the title, does Fawcett recall his case study, but rather leaves it open, so that the school is here chosen as an adequate case study whose timetable recurrently needs adaptability from the space, but his methodology could also be tested on other building typologies because of its generality and abstraction.

Right at this point Fawcett states his outlook on adaptability and points out the way in which to assess it, by relating activities and spaces and their respective attributes to accommodate those activities:

> "We find we are dealing with some of the fundamental properties of buildings which determine the relationship between activities and spaces. What, then, is the specific property adaptability?
> It is not based on new attributes, over and above those that determine the ability of spaces to accommodate activities, but is a reflection on those attributes themselves." (Fawcett, 1978, p.51)

Having said that, adaptability for Fawcett is clearly associated with probability, which could ultimately be overlapped, in the sense that:

> "A statement about adaptability is a statement about a probability: namely, probability that the proposition "this building will not become obsolete in the future" is true." (Fawcett, 1978, p.52).

This is of course very relevant for defining the adaptability approach, recognising first that it is a "mathematical" one, but also understanding it to be probabilistic. So, Fawcett states that in this chapter on "a new theory of adaptability in buildings" lies "the probabilistic basis for adaptability" from which to explain his interpretation and methodology and "how it can be given a formal language and quantified" on this perspective (Fawcett, 1978, p.51).

Fawcett refers to Keynes, who in 1921 introduced the *Treatise on Probability*, assuming that a probability can be considered certain or probable, and hence subjective, according to the knowledge we have of the specific circumstances. But, according to Keynes, in logical terms, a probability describes the "degrees of rational belief" that objectively results from the propositions placed from our "*corpus* of knowledge" (Keynes, 1921, p.2)[553]:

[553] Italics from the original quote.
"Let our premisses consist of any set of propositions *h*, and our conclusion consist of any set of propositions *a*, then, if a knowledge of *h* justifies a rational belief in *a* of degree α, we say that there is a *probability-relation* of degree α between *a* and *h*." Like so: $a/h = \alpha$ (Keynes, 1921, p.3)

> "Given the body of direct knowledge which constitutes our ultimate premisses, this theory tells us what further rational beliefs, certain or probable, can be derived by valid argument from our direct knowledge. This involves purely logical relations between the propositions which embody our direct knowledge and the propositions about which we seek indirect knowledge. What particular propositions we select as the premisses of *our* argument naturally depends on subjective factors peculiar to ourselves; but the relations, in which other propositions stand to these, and which entitle us to probable beliefs, are objective and logical."[554] (Keynes, 1921, p.3)

Under a "frequencist theory" (Fawcett, 1978, p.52), understanding the likelihood of a future situation is connected to past events and implies that the past will be repeated in the future and does not incorporate the possibility of change[555]. However, the concept itself of adaptability implies the assumption of change and the uncertainty of what change might mean, when and how often it might occur, and what will it imply:

> "But a fundamental assumption which motivates the search for adaptability is that things will change in the future, and in particular activities will be different in the future from what they are now. [...] When our state of knowledge of future activities is incomplete we must attempt to establish the corresponding probability of the statement's truth, and this will be a measure of adaptability." (Fawcett, 1978, p.53)

To "measure" the degree of adaptability of a particular building involves dealing with the body of knowledge we currently hold on the potential incidence of change. Therefore, adaptability becomes particular relevant when dealing with a high "incidence of change" regarding future activities and a building is considered as adaptable for "not being liable to obsolescence caused by activity change" as it is still fit to continue to perform (Fawcett, 1978, p.54):

> "We define adaptability as the probability that a building will not become obsolete in the future, subject in our state of knowledge of future activities." (Fawcett, 1978, p.54)

So, adaptability is linked with change and hence to the current knowledge or uncertainty about future change, where the widest the array of possible states, the

[554] Italics from the original quote.

[555] "It is difficult to borrow from the frequencist theory of probability, which says that the probability of an event occurring in a trial is given by the frequency with which the event occurs in a long series of trials, as when studying what may happen to a particular building we are concerned with a single event in the future. [...] Such information could be used to estimate the likely present response by the occupants of an unsurveyed house with the same attribute, but it says little about the future, unless we assume the future will repeat the past." (Fawcett, 1978, p.52)

more uncertain we are of future situations. Ultimately, when a building continues to answer what is asked of it, is continuous to perform at several levels, and so it continues to be adaptable to the situation. On the contrary, if it no longer performs or complies with the changeable circumstances and needs it becomes obsolete:

> "Adaptability, then, is a subjective measure dependent on our knowledge or ignorance of future activities. The extent of our ignorance is reflected in the range of possibilities that we believe might come about (Fawcett, 1978, p.53)

Within its mathematical approach to adaptability, Fawcett develops the concept of adaptability with regard to a "quantified measurement" (Fawcett, 1978, p.54). In his adaptability model, he intends to reach a "precise numerical value" for which he "can state the formulation algebraically" (Fawcett, 1978, p.55).

As said before, the estimate of the degree of change will be based on the knowledge currently held, because to forecast potential activity changes would incur into speculative scenarios. So, Fawcett poses that precise question:

> "But how, when our knowledge of future activities is uncertain, can our subjectively held estimate of a building's adaptability be established? We cannot test whether a building will become obsolete by reference to what actually happens to it in the future since we do not know: a workable measure must rely wholly on information available in the present." (Fawcett, 1978, pp.54-55)

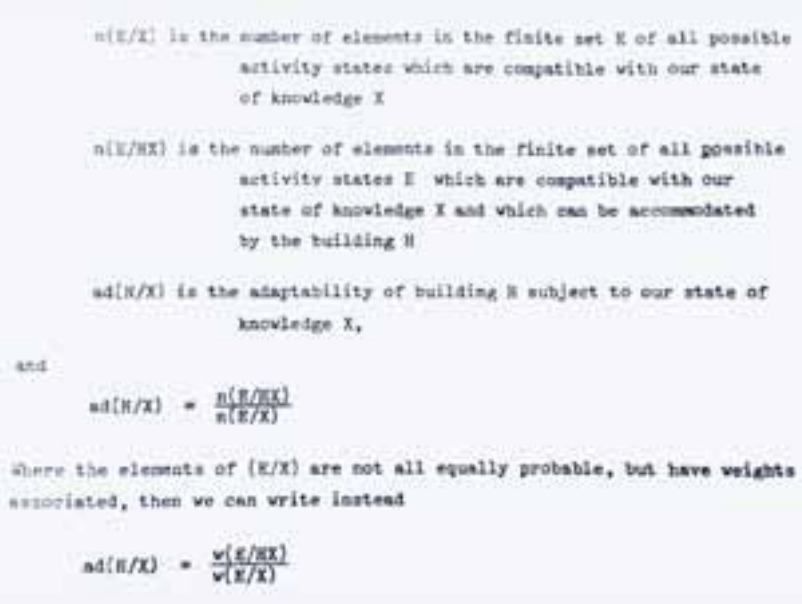
Shannon and Weaver's (1949) outlook on information theory, present in *The mathematical theory of communication*[556], is then recalled, admitting that the number of possible activity states allocated to a space is a determinate number from the overall number of all possible activities, where the allocation can be equally probable, to which Fawcett would add the option of having "weight associated", when the probabilities are not all alike[557]. According to Shannon and Weaver:

> "If the number of messages in the set is finite then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices being equally likely. As was pointed out by Hartley the most natural choice is the logarithmic function." (Shannon and Weaver, 1949, p.32)

Wittgenstein's (1922) *Tractatus logico-philosophicus* is also quoted by Fawcett (1978, p.55):

[556] Shannon and Weaver's (1949) work will be detailed in the next chapter, due its representativeness towards our proposed methodology. See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[557] "Where all activity states are not equally likely, the weights associated with states must be used instead of their number." (Fawcett, 1978, p.55) .



n(E/X) is the number of elements in the finite set E of all possible activity states which are compatible with our state of knowledge X

n(E/HX) is the number of elements in the finite set of all possible activity states E which are compatible with our state of knowledge X and which can be accommodated by the building H

ad(H/X) is the adaptability of building H subject to our state of knowledge X,

and

$$ad(H/X) = \frac{n(E/HX)}{n(E/X)}$$

Where the elements of (E/X) are not all equally probable, but have weights associated, then we can write instead

$$ad(H/X) = \frac{w(E/HX)}{w(E/X)}$$

Fig. 116. Fawcett's adaptability formulation
(Fawcett, 1978, p.56)

> "If all objects are given, then thereby are all *possible* atomic facts also given." (Wittgenstein, 1922, p.26)[558]

Fawcett appraises this reasoning because it allows to further his notion of adaptability in a probabilistic outlook for assessing adaptability, revealing that:

> "This is: precisely the way in which we wish to analyse the adaptability of buildings; despite its simplicity it has not, so far as I am aware, been developed before in this context. It offers a way of looking at activities and spaces that is inherently probabilistic, and is explicitly based on a state of knowledge represented by the set of possible activity states." (Fawcett, 1978, p.55)

A model of adaptability is pursued that is based on the state of knowledge that is held at the current moment and that depends on the possible set of activities, which provides a value by means of an algebraic formulation[559]. This formulation results in a value that considers adaptability of a building *H* according to the state of knowledge *X,* as the ratio between the set of all possible activity states and the one that can be allocated in that building (also according to the state of knowledge *X*). In Fawcett's

[558] Italics from the original quote. Original German edition from 1921.

[559] "It enables us to give a precise numerical value to the subjective probability that a building will not became obsolete, that is, the building's adaptability, so long as we can answer two questions that immediately arise: 1) what is the set, or ensemble, of possible activity states that corresponds to our state of knowledge, and 2) how is it possible to determine which activity states can be accommodated by the building." (Fawcett, 1978, p.55)

words he defines his model and Fig. 116 also presents the formulation:

> "Thus, in our model, adaptability is a ratio of two numbers, representing a probability. This ratio, based as it is on subjective estimates about possible activities, stands, we propose, as a meaningful measure of a building's adaptability." (Fawcett, 1978, p.56)

Finally, we would add that the weight is also contextual and would depend on the circumstances of usage and management that will ultimately constrain the incidence of change and the allocation of spaces to activities. And if Fawcett quoted Wittgenstein earlier, we would add another quote from his same work that endorses this assumption:

> "Just as we cannot think of spatial objects at all apart from space, or temporal objects apart from time, so we cannot think of any object apart from the possibility of its connexion with other things." (Wittgenstein, 1922, p.26)

Fawcett considers "adaptability" for architecture as being "analogous" to the concept of "reliability" applied to engineering (Fawcett, 1978, p.56). Here he quotes Tribus (1969) on *Rational Descriptions, Decisions and Designs*[560] and parallels Tribus's notion of "reliability engineering" to his own concept of adaptability, assuming that they are both identifiable as a probability, a "contingent measure" (Fawcett, 1978, p.61) subject to our "state of knowledge, not a state of things" (Tribus, 1969, p.421).

Fig. 117a summarises this comparison, in which reliability and adaptability are placed under the probability column. For reliability strength is an attribute of the beam, and for adaptability the number, types and size of spaces are attributes that enable the allocation of activities to spaces in the building, and which constrain adaptability.

This referred knowledge implies both the "environment" and the properties of the "device" itself (Fawcett, 1978, p.57). For adaptability, the mentioned knowledge will lie on data of both the "possible activity states" of the "environment" and "which activity states can the building accommodate", considering the building as the "device". Fawcett assumes that "a substantial part of this thesis consists of setting up precise combinatorial arrays of possible activity states" (Fawcett, 1978, p.58).

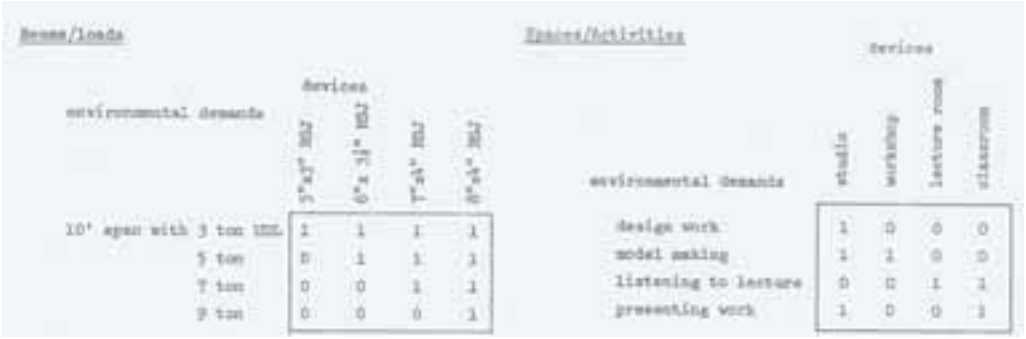
Although considering the relation between the "environment" and the "device" to be undetachable and difficult to separate the two[561], Fawcett defends the

[560] Tribus (1969) Chapter 10: *Reliability Engineering.* (pp.421-471).

[561] "The distinction between the device and its environment is rather an arbitrary one - is the beam's bearing part of the environment or the beam itself? - just as it is difficult to draw boundaries around any system. The load that the engineer's beam is designed to withstand would not actually exist unless there were a beam to withstand it, and nor can activity states exist without physical accommodation. The range of demands that people actually make on a building is affected in reality by the building upon which they are made." (Fawcett, 1978, p.58)

Device	Environmental demand	Property of device	Probability of satisfactory operation
Beam	load	strength	reliability
Building	expected activities	number, type and size of spaces	adaptability

a)



b)

Fig. 117. a) Analogy between adaptability and reliability, illustrated from a beam and a building; b) Comparison between beams and spaces in the same feasibility matrix

(Fawcett, 1978, pp.59-60)

reasonability of the study of all possible activity states of a general and unspecific environment detached from any particular building, context or typology[562] (Fawcett, 1978, p.58). This complies with his aims for a "general theory of adaptability" whose mathematical approach is open and abstract, as already stated.

He continues by stressing this potential comparison between engineering reliability and architecture adaptability, by using the examples of particular devices for each realm, respectively beams and spaces, in the same feasibility matrix. In the matrix: one (1) means the "device" (beams and spaces – studio, workshop, lecture room and classroom) will cope with the "environmental demands" (loads and activities – design work, model making, listening to lecture and presenting work), and zero (0) that it is not fit to perform those demands (Fig. 117b).

Fawcett acknowledges that, if for reliability, strength is the one attribute that potentiates the activity states of a particular beam (which means the loads each beam can support), for adaptability an environment has multiple attributes that condition the environmental demands (which in this case means the activity states that can be accommodated there)[563] and the environmental demands also imply specific

[562] "We hope that it is nevertheless reasonable to enumerate all possible activity states that might exist if there were no particular building in existence to impose limitations one way or another, and to treat this as an environment that is independent of the particular design being analysed." (Fawcett, 1978, p.58)

[563] "In the case of beams both the devices and demands can be ranked, as in the matrix, with respect to their severity, and successful operation depends solely on the device being stronger than the load. But in the case of spaces we cannot rank devices and demands with respect to an attribute X such that successful operation falls into a simple pattern. In the example, the studio can accommodate more of the demands than any other space,

adaptability attributes. Hence, it might be implied, even though Fawcett does not affirm it, that there is a distinction between the two concepts, and a higher complexity in the analysis of the probability of success of a device in an environment, and putting it into a clear perspective, the degree of adaptability of a building.

It is advanced that when assessing adaptability, it could be understood that to be adaptable may mean to possess certain attributes with regard to the environment, the environmental demands and the devices of any specific building typology. This will lead to different adaptability settings and shapes, and hence different types of adaptability. Nonetheless, Fawcett finds this "dangerous" and upholds his open perspective, not bounded by any particular building typology, but primarily with regard to the array of activity states under consideration[564].

In order to address the issue of adaptability in architecture, the two questions have to be attended, regarding both the activity states possible on that "environment" and the attribute of the "device" for activity allocation. As Fawcett puts it:

> "l) What is the ensemble of activity states compatible with our state of knowledge - this is the environment of the problem; and 2) which of these activity states can be accommodated by the building under examination - this relates to intrinsic properties of the building." (Fawcett, 1978, p.61)

In what concerns this latter question, Fawcett stresses that its answer must be yes/no[565], and done "mechanically", "with reference to a set of precise rules", which will imply the need for an "algorithm" (Fawcett, 1978, p.62). Hence, Fawcett determines that the matching of activities to spaces should be "a binary yes/no answer", not admitting to "use a fraction representing the likelihood that an activity can be accommodated, or the degree of satisfaction that could result".

Nevertheless, the introduction of behavioural research would broaden the range of answers and would constrain the limits for spatial obsolescence or, as Fawcett defines

but it does not possess more of some attribute X than, say, the workshop. The studio has many attributes and so does the workshop, but the studio is more adaptable in this example because of the range of environmental demands. (Fawcett, 1978, p.60)

[564] "It is futile to suggest that there are many different versions of this attribute X, corresponding to different types of adaptability, for we find there are as many versions as there are environments. When a particular range of activity states often recurs, perhaps for a given organisational type, it may be convenient, although dangerous, to say that buildings which are especially likely to perform well for those demands possess adaptability of the particular type. Thus one might be led to talk about domestic adaptability, or hospital adaptability. This shorthand is unconvincing, because the environment in any given design problem usually contains some unique features to reduce comparability: it is best to state the environment in question; that is, to explicitly state what range of activity states is being used as the basis for a statement about adaptability. A limited typology of adaptability might also be introduced with respect to different ways of describing the ensemble of possible activities, and this is what we attempt later." (Fawcett, 1978, pp.60-61)

[565] "We have, as we said, to be able to give a yes/no answer to the question "can these activities take place in these places?", for all elements of the ensemble of activity states and the building under consideration." (Fawcett, 1978, p.62)

them: "the thresholds of feasibility" (Fawcett, 1978, p.63), since the compatibility of activities to spaces can vary according to each inhabitant and its particular response towards the environment. As already put by the previously mention work by Nutt et al. (1976): "Any theory about the process of obsolescence in buildings must be capable of accounting for the variety of human actions that may accentuate or alleviate obsolescence and of mechanisms of regulation and control". (Nutt et al., 1976, p.29). After pointing out the factors that enable obsolescence, Nutt et al. claim that some constraining factors of obsolescence may be perceived as individual, varying accordingly, which may cause an exponential number of variables to model and hinder the process, stating that:

> "The perception of constraint, levels of discrimination and tolerance will probably vary with the age and type of perceiver. This subjective aspect gives rise to a number of well-known difficulties." (Nutt et al., 1976, p.63)

Hence, if for someone an activity is possible to happen in a particular space, for someone else this same activity can occur elsewhere, whether for behavioural or sensorial reasons, rather than for simple functional arguments (Fawcett, 1978, p.61). However, Fawcett concludes that he will focus on disclosing the extensive ensemble of possible activities, all similarly likely[566], and not the degree of compatibility between spaces and uses individually variable:

> "Whereas [...] we argued that the ensemble of possible activities is a legitimate problem for the architectural researcher into adaptability, we feel that the problem of assessing the compatibility of given activities and spaces is peripheral to the question of adaptability [...]". (Fawcett, 1978, p.63)

Under this perspective, to define the possible activities according to our current state of knowledge in an extensive and precise way, Fawcett defines a model based on a "precise combinatorial structure" that aims to associate a comprehensive array of activity states to spatial attributes with "discrete values"[567].

[566] Assuming that: "all activity states in the relevant ensemble are equally probable, or weighted for their probability of occurrence." (Fawcett, 1978, p.62)

[567] "Our present state of knowledge defines the range of possible activities against which we test a design's adaptability. To formalise this principle in a workable model it is a primary requirement that our knowledge of future events can be expressed as a finite number of distinct activity states. This set, or ensemble, of distinct activity states must be exhaustive, subject to our state of knowledge. In order to create this manageable ensemble a great deal of radical simplification is necessary, for our knowledge of possible future activities, which might intuitively take the form of a continuous spectrum from one possible extreme to another, must be formulated as a precise combinatorial structure. This transformation, and simplification, corresponds to the development of an ill-defined model into a well-defined model (Ch.2, s.1).
The process of simplification can be achieved by putting activity states into equivalence classes, defined with respect to a small number of relevant attributes which themselves have discrete values. It is then possible to catalogue all possible combinations of attribute values, and establish the exhaustive ensemble of all possible activity states defined with respect to the chosen attributes. All real activities have numerous characteristics, and every activity is individually distinct from all others; in putting activities into equivalence classes information

Yet, besides assuming the need to a simplified answer of yes or no to the feasible activities in each space, and not introducing individual and behavioural variability, Fawcett also underlines that this model has a "high degree of generality" and does not approach any particular built form of specific type of adaptability[568] (that he had already assumed to exist if the issue of adaptability would be dealt in a more contextual approach) (Fawcett, 1978, p.65).

On the contrary, in our Thesis, we aim to inform on a specific case study and typology, its environmental features and particular attributes of that "device", which potentiate a certain degree of adaptability. Hence, in our approach behavioural data and individual information will also be added in order to increase the state of knowledge about the building and its possible, current and future activity states. This will deepen Fawcett's approach to a more specific building, and will broaden the output of the information given by a general model based on a combinatorial structure, with further data from other methodologies[569].

In 1950 Wiener[570] referred to Gibbs "revolution" [571], for his "introduction of probability into physics" that "occurred well before there was an adequate theory of the sort of probability he needed"[572](Wiener, 1989, p.10). And Fawcett assumes his shared conception with Gibbs for his "process of coming to terms, both conceptually and mathematically, with uncertainty and a contingent universe" (Fawcett, 1978, p.65). Within this parallel, both Fawcett and Gibbs specify their relation to entropy and information theory embedded in the concept of probability. Wiener refers to the novelty of Gibbs's work:

> "Gibbs' innovation was to consider not one world, but all the worlds which are possible answers to a limited set of questions concerning our environment. His central notion concerned the extent to which answers that we may give to questions about one set of worlds are probable

about many characteristics is thrown away and individuality is lost." (Fawcett, 1978, pp.63-64)

[568] "The activity ensembles that we elaborate later in the thesis are ones which, we hope, possess a high degree of generality, and therefore refer to rather general properties of built form. [...]..] Our general approach does not, of course, preclude the existence of highly specified ensembles that apply to particular cases, defined by arbitrary equivalence classes or a priori explicit enumeration. [...] The substance of our approach to adaptability, though it relies on the ensemble of possible activity states, does not consist in any particular form of the ensemble." (Fawcett, 1978, p.65)

[569] Our proposed methodology will be described in the next chapter. See chapter 3.3 A methodology for identifying and assessing adaptability in learning environments.

[570] Consulted edition from 1989, original edition from 1950.

[571] "But for all these gaps it is, I am convinced, Gibbs rather than Einstein or Heisenberg or Planck to whom we must attribute the first great revolution of twentieth century physics." (Wiener, 1989, p.10)

[572] "No physical measurements are ever precise; and what we have to say about a machine or other dynamic system really concerns not what we must expect when the initial positions and momenta are given with perfect accuracy (which never occurs), but what we are to expect when they are given with attainable accuracy. This merely means that we know, not the complete initial conditions, but something about their distribution. The functional part of physics, in other words, cannot escape considering uncertainty and the contingency of events. It was the merit of Gibbs to show for the first time a clean-cut scientific method for taking this contingency into consideration." (Wiener, 1989, p.8)

> among a larger set of worlds. Beyond this, Gibbs had a theory that this probability tended naturally to increase as the universe grows older. The measure of this probability is called entropy, and the characteristic tendency of entropy is to increase.
> As entropy increases, the universe, and all closed systems in the universe, tend naturally to deteriorate and lose their distinctiveness, to move from the least to the most probable state, from a state of organization and differentiation in which distinctions and forms exist, to a state of chaos and sameness." (Wiener, 1989, p.12)

Yet, if Fawcett assumes their proximity in regard to the definition of a set of activity states according to the actual state of knowledge at that time, he also differentiates his approach to Gibbs because he does not "attempt to apply the more specialised mathematics of statistical mechanics or information theory" (Fawcett, 1978, p.66). It could also be added at this point that our current methodology proposed under the Doctoral Thesis here presented also agrees with Fawcett in this sense. And if the concept of entropy and its connection to probability could be borrowed from information theory, our present Thesis is on architecture and so is its scope and relevance for the advancement of knowledge. Therefore, our methodology that will be presented in full detail in the next chapter, will resort to multiple approaches for a more informed outcome on adaptability, but will use an architectural methodology and aims to inform both the theory and the practice of architectural research, which naturally do not encompass "specialised mathematics".

Fawcett also assumes the possibility of comparing designs according to their adaptability under the same state of knowledge, but when proceeding with comparisons it is important to compare alternative designs whose attributes bear relevance for the ranking of adaptability. Hence, paralleling designs is based on the attributes of their spaces and their significance towards adaptability, and this is what will be most relevant when assessing adaptability under Fawcett's approach:

> "Whilst it is wasteful to consider redundant attributes of building when analysing their adaptability, it is altogether impossible to arrive at a measure of adaptability unless we are able to describe buildings with respect to the attributes that do determine which activity states can be accommodated. The selection of attributes used to describe activities and spaces is therefore of very great importance, and must be made jointly, for the sake of economy and efficiency." (Fawcett, 1978, p.69)

As stated earlier, Fawcett aims at a model that measures adaptability applied to a general design and that could be used for any building form or typology (Fawcett, 1978, p.69). Hence, as other models, simplifications had to be assumed in order to focus on the more general principles of adaptability in architecture. The first one revolves around the assumption of each space and activity state separately,

disregarding "interconnections between activities" and spatial "connectivity":

> "A major simplification in our descriptions of activity states and building designs, affecting the ensembles of possible activity states and possible plans, is that we have not considered interconnections between activities, nor connectivity between spaces. Thus we describe an activity state as set of distinct activities, each one by implication requiring a separate space, without specifying which activities interact either positively or negatively." (Fawcett, 1978, pp.69-70)

Fawcett justifies this simplification by assuming that it is the space itself that, above all, determines the possibility of accommodating activities, whereas the layout of the building, although relevant, is considered secondary[573].

To understand this option it is important to acknowledge that Fawcett intended a well-defined model, potentially applicable to diverse buildings despite their layout. But for the purposes of our current Thesis, the potential links between spaces are considered essential for the choice of a space for accommodating any particular activity. The fact that a space is closer, or closely connected to another, bears relevance when choosing one from a variety of spaces. Hence, spatial connectivity may potentiate adaptability by weighing on the probability of choosing that space, either for behavioural, functional or even management decisions. That is why, topology and space syntax are considered here to be relevant, complying with a more generalized and simplified model that does not take this into consideration. By gathering other approaches, such as this, the simplifications taken on by each one are tackled by the others, into a more complete outlook on adaptability and a more supported outcome. This assumption will lay the foundations for constructing our methodology[574].

Fawcett's second simplification is the analysis of the building as it is, and to overlook its potential changes. By considering it to be "static" throughout its lifecycle, Fawcett narrows its adaptability potential to what it currently is[575] and not what it has the potential to be in the future if activity alteration may occur:

> "A second important restriction is that we have decided to apply to the description of buildings an assumption that spaces are static. We do not, therefore, take account of physical alterations to buildings. Some workers have treated physical alteration as the heart of adaptability, but physical alteration is only required to accommodate activity changes,

[573] "This is a radical simplification, but we think that it is reasonable to consider that the component spaces of a building are the primary determinant of the activities that can use it, and that the form of the building, whilst very important, is generally a subsidiary factor." (Fawcett, 1978, p.70)

[574] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[575] "Thus our definition of adaptability does not have to be tied to chronology. It is more fundamentally a reflection of a state of uncertainty at a particular point in time, and the main component of this uncertainty normally arises from the unpredictability of future change." (Fawcett, p.72)

> and it is therefore more satisfactory to measure adaptability against activity change. " (Fawcett, 1978, p.70)

This is an issue that Fawcett deals with later on, after his Doctoral Thesis, when he addresses "under" and "over-provision", in his paper: *Investing in flexibility: the lifecycle options synthesis* (Fawcett, 2010b, 2011b). Here he implies that a building may have the possibility of change in the future after being built, in order to cope with the changes that may also occur, within a "lifecycle options approach" (Fawcett, 2010b). So it is a design choice to provide the building with the possibility of change according to our state of knowledge then, and not to the current uncertainty of our state of knowledge about the future. Instead, this approach chooses not to provide all the attributes at an early stage if they are not initially needed, which avoids over-provision and economic squandering:

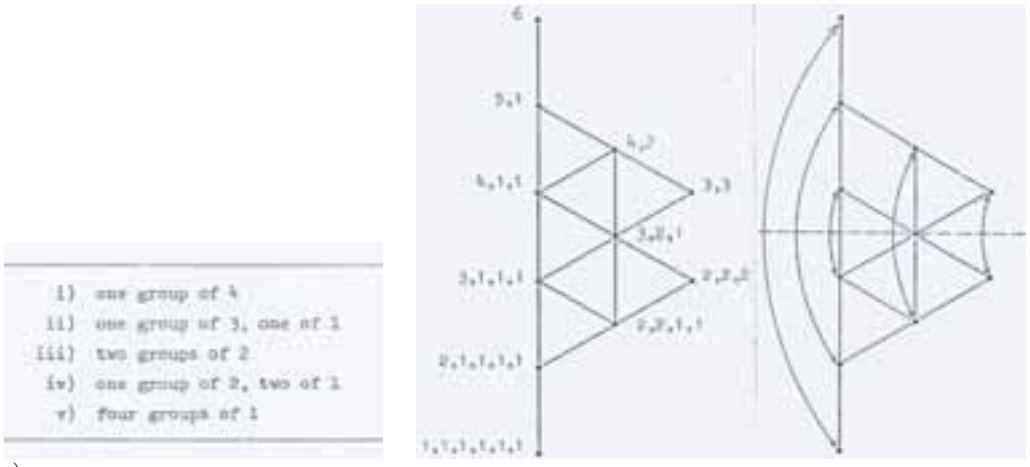
> "In this approach, a lifecycle option is a feature of a design or plan that makes it possible for new decisions to be made in the future. […] Lifecycle options transfer decision-making from people in the present to people in the future who will know more about the changing state of the world." (Fawcett, 2010b, p.2)

Still, in his Doctoral Thesis, Fawcett already mentions the consequence of comprehending time in his methodology, assuming that both time and scale are two variables that might condition adaptability and that delineate different methodologies to address it. Fawcett mentions "long" and "short-term adaptability" (Fawcett, 1978, p.71), but he chooses a model that simplifies these concerns by valuing change rather than growth:

> "We often find the two topics of growth and change coupled together, but in our own work we have limited our concern to change, and ignored growth. This is partly a consequence of our decision to ignore physical change in buildings - for any significant growth results in the expansion of physical facilities. And on the other hand the omission acts as a further simplification, enabling us to arrive at well-defined and solvable models of adaptability, limited though their resulting range of application is." (Fawcett, 1978, p.73)

At the end of this chapter, and after explaining the concepts at hand and the approaches that laid the foundations to Fawcett's approach, it is stated that an adaptability model has been accomplished, considered original and "well-defined":

> "We believe we now have a well-defined model of adaptability, or at least the specification for constructing well-defined models. […] Our model of adaptability allows every application to be freshly defined, in accordance with the prevailing ensemble of activities. (Fawcett, 1978, p.73)



a) b)

Fig. 118. a) "Five possible schedules of a population of 4"; b) Diagram of the set of schedules, in which adjacent schedules are joined, for a population of six and "rotational symmetry" from the lattice (Fawcett, 1978, pp.76,81)

From this point on, and having explained his approach on adaptability as "a probability, measured by comparing a building with an ensemble of activity states" (Fawcett, 1978, p.75), its theoretical backing and its methodology, it is possible to put it in action through a "mathematical elaboration of this postulate" (*ibid.*) along the following chapters of Fawcett's Doctoral Thesis.

Fawcett starts by determining a set of activity states, defined by "the number of people involved": "a fixed finite population […] divided into groups" which are "the only structure in the population" (*ibid.*). Furthermore, and in order to reach the "simplified representation" of "all possible organisations" (*ibid.*), Fawcett also states other postulates: the fact that "all individuals are indistinguishable" (Fawcett, 1978, p.76) within a group to which the number of individuals that it complies is its "only property". In addition, "there is no prior information about a group", which implies that "any individual is equally likely to be in a group with any other individual", dismissing behaviour from the analysis (*ibid.*).

Having defined the population, each set can be depicted into "component groups", which are the "finite number of different schedules" potentially assumed by each population. As an example, Fawcett demonstrates the possibilities of grouping a population on four in "lexicographic order" (*ibid.*) (Fig. 118a).

Afterwards, Fawcett illustrates this arrangement in "adjacent schedules" (Fawcett, 1978, p.78) "which clarifies the properties we are interested in", namely its "structure". Here adjacent schedules are defined as such:

> "A schedule is transformed into an adjacent schedule by one individual changing groups, and this includes the possibility that the individual forms a new singleton group; or that individual formerly in a singleton group

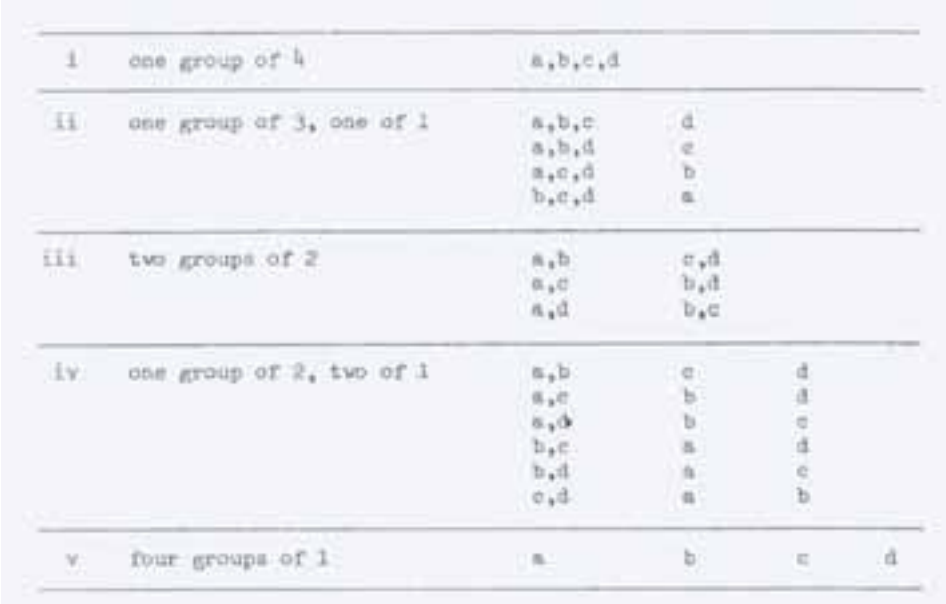
> joins another group. In the former case the number of groups in the schedule is increased, and in the latter decreased." (Fawcett, 1978, p.78)

Then, groups can be represented in a diagram with regard to their "adjacency", in which the highest number of population in a group is placed at the upper top and the lowest, the singleton groups, are located at the lower end of the diagram (Fawcett, 1978, pp.78-79). Fig. 118b demonstrates the diagram for a population of six, in which a "rotational symmetry" in the lattice can be noted (Fawcett, 1978, p.81). The horizontal "axis of rotation" is represented, and we can realise that the "two conjugate parts", above and below the axis, have "identical structure" (Fawcett, 1978, p.80).

Immediately we can reflect on Fawcett's assumptions conveyed by the postulates for simplified organisations. Here, activity states are identified by this approach according to the number of population within. This implies that each grouping of activities is indistinguishable, as Fawcett initially states. However, for our current Thesis, the activities cannot be random and have to be accounted as distinguishable at their nature, the pedagogical potential they comply and the kind of (in)formality they involve. This will provide more thorough and detailed answers on the nature of the pedagogical activities and how can they be accommodated in spaces in the school building. We are expected to inform whether formal activities can be accommodated in informal spaces and vice-versa, in order to understand what is the degree of adaptability of spaces to shelter diverse activities of different nature but enabling knowledge acquisition, and respectively what are their spatial demands for being accommodated in space and which spaces can better provide it.

Besides, Fawcett has also another postulate: the indistinguishable population in the groups. But for the purposes of our Thesis, the people that undertake those activities matter to be understood as individuals with prior information on each one, as opposed to Fawcett's assumptions. These people are placed in different groups according to the nature of their position and work in the organisation of the school. So, it becomes relevant to understand first, the different populations of the school which undertake specific activities, like: students, teachers, staff and external community. But secondly, it is important for us to understand the individual behaviour and spatial fruition at a school, where informality and spontaneous artistic displays bear particular relevance for the analysis of space use, besides the more common pre-determined schedules for formal classes and activities overall.

Though, after demonstrating that "a given population can adopt a number of different schedules" (Fawcett, 1978, p.83), Fawcett turns towards the analysis of the possible variability for the same schedule, because "a population of distinct individuals can adopt the same schedule in many different ways" (*ibid.*). So, Fawcett addresses the concept of "microstates of the population", which are "the ways that the individuals can form the schedules", but note this time the individuals are considered to be "distinct" according to the upper quote. So, as opposed to the



i	one group of 4	a,b,c,d			
ii	one group of 3, one of 1	a,b,c	d		
		a,b,d	c		
		a,c,d	b		
		b,c,d	a		
iii	two groups of 2	a,b	c,d		
		a,c	b,d		
		a,d	b,c		
iv	one group of 2, two of 1	a,b	c	d	
		a,c	b	d	
		a,d	b	c	
		b,c	a	d	
		b,d	a	c	
		c,d	a	b	
v	four groups of 1	a	b	c	d

Fig. 119. Ensemble of possible states for a population of 4
(Fawcett, 1978, p.85)

analysis above, this concept that encompasses "distinct individuals" plays a vital role for our methodology. Fawcett also expresses their relevance:

> "It is therefore the microstates of the population that are of fundamental importance, and constitute the elements of the ensemble of possible activity states that are defined by the assumption. The schedules are simply convenient ways of grouping activity states with the same structure of group sizes." (Fawcett, 1978, p.85)

Fig. 119 demonstrates the ensemble of 15 possible states for a population of 4 and Fig. 120 shows the association of microstates according to the same schedule applied for 6 individuals.

As realised from the upper figures, this application becomes more and more complex as the population grows and "excessively cumbersome in large problems" (Fawcett, 1978, p.997) for which Fawcett considers probabilistic analysis, introducing mathematical formulae, in order to proceed with his approach. All in all, and considering a probabilistic methodology, Fawcett associates probability to the number of microstates:

> "We suggest that, for a known population and in the absence of any other knowledge, the probability of a schedule occurring is proportional to its number of associated microstates. To predict the most probable schedule we have to find the schedule with the highest number of

	Schedule	Number of associated microstates
i	6	1
ii	5,1	6
iii	4,2	15
iv	4,1,1	15
v	3,3	10
vi	3,2,1	60
vii	3,1,1,1	20
viii	2,2,2	15
ix	2,2,1,1	45
x	2,1,1,1,1	15
xi	1,1,1,1,1,1	1
Total	11	203

Fig. 120. "Schedules and associated microstates of a population of 6 individuals" (Fawcett, 1978, p.87)

> associated microstates, and this will be the schedule (or schedules) at the "summit" of the lattice. The schedules in the region around this summit will constitute the most probable region, which is of interest for more generalised predictions." (Fawcett, 1978, p.90)

From the analysis of Fig. 121 it is quite evident that the extremes of the distribution bearing either the largest or the singleton groups are the less likely, while the central core, with "a mixture of medium-sized groups" are the most probable and hence the ones with more microstates associated (Fawcett, 1978, p.87). This is indeed a relevant outlook on adaptability, and the process to achieve it is also considered of relevance for our present Thesis, even if some constraints will have to be considered with regard to activities and individuals, and also to encounter a less complex and mathematically specific methodology to proceed with it under an individually focused analysis and within a comprehensive architectural research, to be pondered in the next chapter.

So far Fawcett presents a scenario where the activity states are equally probable and not associated with weights for depicting a particular bias on the probability of any state. This embodies the "Poisson-shaped distribution" (Fawcett, 1978, p.113). Yet, has Fawcett had already explored in his paper two years prior: *School Management and School Design* (Fawcett, 1976a), the environment observed in a school does not necessarily match the "non-spatial ensemble" (Fawcett, 1978, p.127) studied in the previous chapters of his Thesis, which would be "of Poisson form"[576] (Fawcett,

[576] "The general distribution of group sizes in the most probable unweighted schedules are of Poisson form,

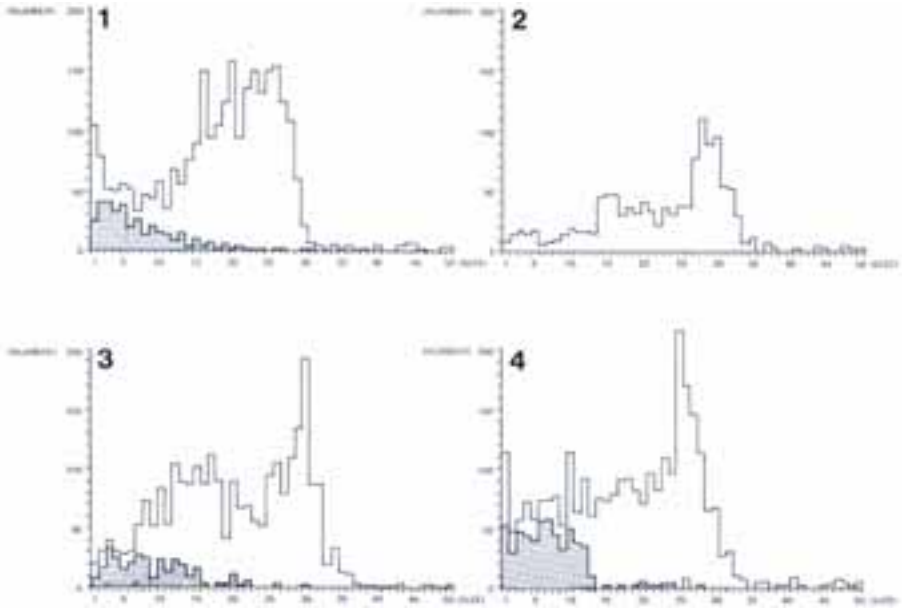


Fig. 121. "Number of occurrences of groups according to size (=number of pupils present) in the observed weeks. Subsidiary segment represents sixth form groups"
(Fawcett, 1976a, p.12)

1978, p.117) whilst these are not, as Fig. 121 illustrates.

Fawcett understands that a real environment has constraints of individual or group demands and partialities or management decisions, and picking up on the paper from 1976, for a particular school this is quite relevant:

> "It is self-evident that in a school the individuals making up the population are constrained by rules, conventions, preferences and also constraints of accommodation, so as to fall into the grouping patterns in which they are observed. The constraints do not precisely determine what groups occur and how large they are; in general they act as an environment within which a residue of random behaviour can still be expected insofar as individuals retain some degree of independence." (Fawcett, 1978, p.114)

This will influence the state of knowledge for modelling adaptability for that system. So, Fawcett presents the possibility of introducing "fixed a priori knowledge into the probabilistic models" (Fawcett, 1978, p.115) with "strong and carefully-placed weights" (Fawcett, 1978, p.118), so to that it "may be possible to model realistic systems" (Fawcett, 1978, p.115). Nonetheless, "it has been hard to find the set of weights that will achieve this, as no procedure has been found except trial and error" (Fawcett, 1978, p.120). However, even if this "system of weightings" contributes

that is single-peaked and, except for very small populations or average group sizes, fairly symmetrical." (Fawcett, 1978, p.117)

to overcome the "purely probabilistic" into a "stable environment", which could similarly "be applied to represent prior information about the same institution at, perhaps, a different time, or another similar institution" (*ibid.*); Fawcett alerts that it "may be highly ephemeral and not transferable to other situations" (*ibid.*).

Overall, it could be argued that the system modelled by Fawcett until this point was non-spatial and did not depict a real situation where the probable state is not necessarily the result of a probabilistic distribution, but of other information that constrained the results. So, in this chapter Fawcett addresses this argument and assumes the difference between the probabilistic distribution, which would be in the Poisson form, and the observed distributions on real school systems. He then discusses the possibility of introducing weights that depicted more closely this system, but also assumed that they would be difficult to model and could be rather specific and not necessarily conveyable to a general building type or endure in time.

Having said that, we could transfer this attempt to model a real situation to our current methodology, and consider the possibility of modelling the system also resorting to information achieved by other study fields, which could, in fact, bring further data for coming closer to a real environment. Consequently, having portrayed the probabilistic model, it could be critically assessed in regard to the specificity of the case study. This will be further analysed in the next chapter, but the fact that Fawcett's model already assumes this need, reinforces the attempt to focus on the specificity of the case study chosen for our Thesis.

For the purposes of his own methodology, Fawcett advances that the ensemble of activity states should remain the same, in order to compare the designs and understanding which accommodates the widest range and, therefore, which is the most adaptable. So, he concludes at the end of that chapter that the ensemble of activities should not be subjective, but the identification of that ensemble so it encompasses the constraints is still "open":

> "Our definition of adaptability (Ch.4) requires an ensemble of activity states against which alternative building designs can be compared. The ensemble, therefore, should be independent of the physical characteristics of any particular design, and should not be biased by spatial information. […] The questions of how to establish the purely managerial constraints on activities when all empirical data is observed in a spatial context, and of how to model such activity constraints whilst retaining a well-behaved and tractable ensemble, remain open." (Fawcett, 1978, p.128)

Although Fawcett assumes the need for a non-subjective ensemble of activities, we differ from this postulate. In our Thesis we argue that in the present pedagogical context, all schools differ in their pedagogical curricula and so, the activities held in each school building will naturally differ. Unsurprisingly, the schools where

more activities are held will be perceived as the most adaptable ones and under this assumption, the chosen case study of a school where regular and artistic teaching both occur will gather a wider ensemble of activities. If that same ensemble would be applied to other school that just have the regular teaching, naturally that our chosen school would be more adaptable[577].

Nevertheless, spaces on this particular school were also designed for complying with the spatial requirements of each of these specific activities. So, even empirically, we could assume that these activities would not take place in other school that had not been envisaged to have these spaces, because it would be over-providing in respect to the original brief.

Consequently, we argue that the ensemble of activities could also be identified according to the case study in which the adaptability model will be applied, even if the sensitivity for the choice of the activities could be more deeply studied in regard to each building type or, in the case of the schools, to each curriculum. This would potentially lead to a comprehensive analysis of the buildings and a fine-grained outlook on the ensemble of activities with regard to other schools, but also enclosing a balance between the cost and benefit of providing spaces according to our state of knowledge.

Overall, the postulate for Fawcett's "general theory of adaptability" lies under two issues - the ensemble of possible activity states and the buildings to accommodate them:

> "Our definition of adaptability is applied by 1) establishing the exhaustive set of possible activity states that are compatible with our state of knowledge, and there should be a finite number of states, and 2) for a given building ascertaining with activity states can and which cannot be accommodated. The number that can be accommodated represents the subjective probability relative to the state of knowledge that the building will not become obsolete." (Fawcett, 1978, p.129)

So, after pondering the question of the activities states, Fawcett will address the building to accommodate those activities, for which he also presents some assumptions, as previously done for activity states:

> "1) A building has a fixed total size. The total size is divided into distinct rooms, each room of a definite size.
> 2) No account is taken of links or connections between rooms – the layout and form of the building is ignored.
> 3) All attributes of buildings and of rooms are ignored: the only property of a room is its size." (Fawcett, 1978, p.129)

[577] This school's wide pedagogical curriculum has also been one of the reasons for choosing it for assessing its adaptability. See chapter 1.5 The case study, and more particularly, the text on 1.5.2. Artistic schools as a specific case study.

If in the previous analysis of activity states we could argue with some particular aspects already mentioned and justified, at this stage we will argue with all these three assumptions, which differ from our own when addressing adaptability in buildings.

Due to the current learning paradigm, learning can occur in the whole school, which alters our way of considering spatial boundaries, regarding the school overall as an active learning environment. This prevents us from considering the rooms apart but as a pedagogical ensemble that enables the learning process, either through formal and informal activities and held in formal and informal spaces. This hypothesis will then differ from Fawcett's assumption of separate rooms, each with an adaptability outlook. Moreover, the relation between rooms also bears representativeness, because in moving from our room to another there could be an activity held that enables the learning process, like a conversation with the peers where pedagogical contents are provided, for example. This is in close line with Hertzberger's "learning street", whose Montessori School in Delft leads back from 1960-2010. This fact will add another issue into this question: besides formal and informal spaces, also pathways of movements as well as static spaces can accommodate pedagogical activities and will therefore have to be accounted for when considering the ensemble of spaces in the school that hold the ensemble of activities with pedagogical potential. This approach, as contemporary to the learning process and deeply focused on schools will naturally differ from Fawcett's general approaches on an adaptability model.

Furthermore, for the purposes of the learning process it is relevant to acknowledge spatial differentiation, because learning occurs in many different ways, and the spaces to accommodate all those ways will also bear different spatial features which cannot be ignored. Moreover, this differentiation does not care only for the room size but for other spatial features that have to be taken into account and which will be identified in the next chapter, whose variability will also constrain the activities held in each space.

Accordingly, and considering the relevance of spatial topology that Fawcett dismisses, as well as spatial differentiation, our methodology that focuses on contemporary schools will resort to other study fields in order to complement the information given by an analytical model that this model disregards.

So, overall, before the assumption presented by Fawcett with respect to spaces to accommodate the ensemble of possible activity states, we would argue that for our approach on adaptability in contemporary school buildings we admit the following assumptions:

1. A building has a finite number of rooms but some spaces with pedagogical potential cannot be defined as a closed boundary but rather as an active learning environment that exceeds the fixed determination of a formal classroom.

2. The layout of the school building conditions the natural movement of its inhabitants and so the adjacency of the rooms bears relevance when choosing the space for allocating an activity and this bias that choice. Besides, the space in which that movement occurs also has pedagogical potential and should therefore be considered for the analysis as a representative space.

3. The spatial attributes of each room in the school constrain the allocation of activities and, so, play a relevant role for providing spatial adaptability for that school. These have to be known so that the analysis can provide operative information for future designs and spatial interventions in educational environments and generally for the architectural research.

After depiction of the spatial schedules, Fawcett determines the assumptions for the activity allocation, in which: "a group of individuals can be accommodated in any room with an equal number of or more space-units" and "each group of individuals must be in a different room: a group may not be split between rooms nor may one room be shared by more than one group." (Fawcett, 1978, p.130).

Subsequently, Fawcett defines that generally his approach on adaptability signifies the "number of activity microstates out of the ensemble of possible activity microstates that can be accommodated; and, in the state of knowledge and subject to the assumptions made in the calculations" (Fawcett, 1978, p.131).

From this relationship, increasing adaptability can imply increasing the spatial microstates, which imply increasing the space budget. So, Fawcett illustrates that relationship in the following graph in a conceptual diagram (Fig. 122).

This graph introduces information in respect to the cost and benefit of increasing adaptability in a building, assuming that adaptability increases quite fast until it reaches an optimum, and from that point on the costs of accommodating a higher number of activity microstates tends to be increasing higher (*ibid.*).

Anyway, Fawcett at the end of this chapter realises that the assumptions and simplifications made earlier differ from a realistic system where compatibility between spaces and activity states have to be thought. This would potentially change the increasing adaptability mentioned before, because adaptability would increase with that compatibility, and not just due to the increase on the spatial budget:

> "[…] a realistic model of activities and buildings would have to take account of both activity to space compatibility and relationship between activities and between spaces. This would also, we anticipate, undermine the possibility of interpreting adaptability as an increasing property of buildings." (Fawcett, 1978, p.164)

Other simplifications dealing with overlooking spatial attributes imply that for Fawcett's Thesis "only a single activity and space type is encountered", and while

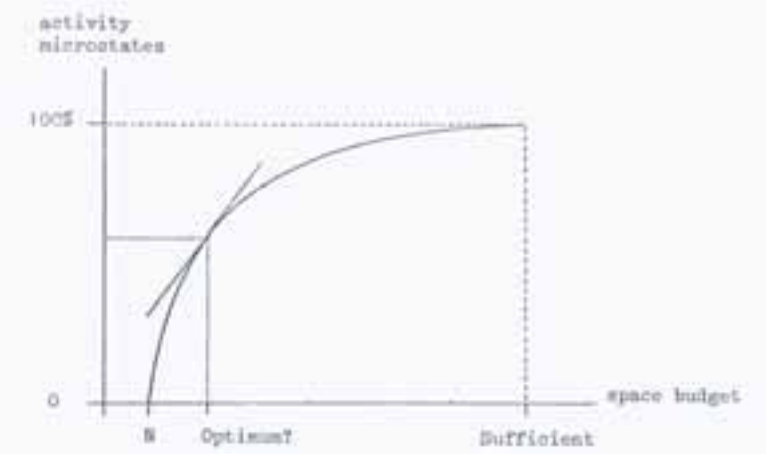


Fig. 122. "Plotting activity states against space budget"
(Fawcett, 1978, p.138)

office buildings "offer the best potential of applications", for the school building that will not be straightforward. In fact, even according to Fawcett, this is "untenable in school design, where the different attributes of activities are enshrined in the floor area table" (Fawcett 1978, p.150). This mentioned table from the Department of Education and Science shows "four different space standards which could be applied" in schools, in which there are different areas of square feet according to the activity involved, either: "reading, writing, discussion, explosion"; "light practical"; "heavy practical"; "movement, large projects" (Fawcett 1978, p.149). This is very relevant because it assumes that in a school this dismissal of spatial attributes cannot occur and also that activities are not all alike as well, largely acknowledging that activities and spaces differ amongst themselves and should be regarded as such for the purposes of adaptability. Fawcett addresses this matter in his following chapter, even assuming that it is done "without considerable extension" and that his Thesis has that restriction on activities and space types.

We could argue that the fact that Fawcett had already assumed this contingency and addressed it in the subsequent part of his Thesis, acknowledges that his simplifications can restrict the model to an abstract or non-spatial system. When Fawcett lays that issue towards school buildings he immediately understands that specificities need to be accounted for, even if he does not develop them in full extent as he recognises. For our current Thesis this could be regarded as a future development of Fawcett's model, recognising the relevance of the foundations he has laid, but complementing them with approaches that will potentially bring further information particularly relevant for the school building, and even more so according to the contemporary learning paradigm with regard to activities and learning spaces, that naturally have evolved in the nearly forty years that have passed after Fawcett's Thesis.

All things considered, Fawcett assumes the constraints of his model, but considers

them to provide a more straightforward and clear question that is possible to address without over-complexity, and that still preserves the core of this issue:

> "We have chosen to work within the limitations we have outlined (Ch.5, s.1 and Ch.8, s.1), feeling that they define a more manageable problem, and perhaps a more fundamental one upon which extensions can potentially be made." (Fawcett, 1978, p.164)

So far, Fawcett deals with accommodating an organisation with regard to its grouping of individuals, matching it to spaces in no specific building or design. On the contrary, the chapter on "all possible allocations" (Fawcett, 1978, pp.165-184) revolves around "a single given set of activities and a given design and ignoring the variety of other possible organisations" (Fawcett, 1978, p.166), which is of the highest relevance for our current Thesis. For this purpose Fawcett uses the concept of "possible allocations" meaning the "activities as a set of events constituting a function", differently from his previous "use of the term organisation to describe the elements of the exhaustive ensemble of states of grouping" (Fawcett, 1978, p.166). Accordingly, the assumptions on spaces remain then unaltered, whereas this alteration on the concept of allocation implies a rearrangement of the assumptions:

> "1) A function consists of a fixed number of distinct events.
> 2) There are no associations or relations between events – the list of events is the only structure of a function.
> 3) An event can be described in as much detail and with respect to as many attributes as is desired." (Fawcett, 1978, p.167)

Fawcett then proceeds with the "allocational measure of adaptability" in which "the ensemble of all possible allocations is specific for a given function and a given building", as opposed to his previous "organisational measure" possible to be applied to "all possible organisations […] against which many different building designs can be measured". While the first is considered to be "narrower than the organisational measure" Fawcett assumes that "it does allow a more detailed analysis", so that he establishes then to be "complementary" because they address this issue "at different levels of specificity" (Fawcett, 1978, p.173).

In order to accomplish this Fawcett resorts to a feasibility matrix (Fig. 123):

> "A feasible allocation is a set of event-space pairs, typically (e_i, h_j) where event e_i is allocated to space h_j. Every event has to be in one event-space pair and no space may be in more than one. All event-space pairs must be feasible, $f_{ij}=1$." (Fawcett, 1978, p.168)

For this pairing to be feasible all events must be allocated to feasible spaces that are provided with attributes to accommodate those activities (Fawcett, 1978, p.169). The spatial requirements needed for an activity to be allocated involve "capacity

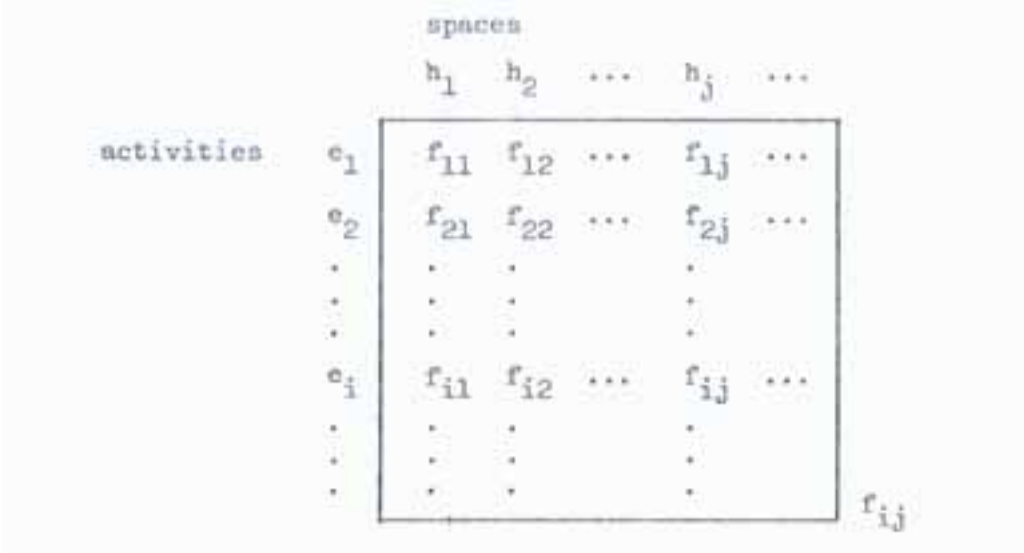


Fig. 123. Feasibility matrix
(Fawcett, 1978, p.168)

constraints", furthermore also the "allocational constraints" would affect the overall allocations, even if Fawcett assumes not to consider them in his theory (Fawcett, 1978, 172)[578].

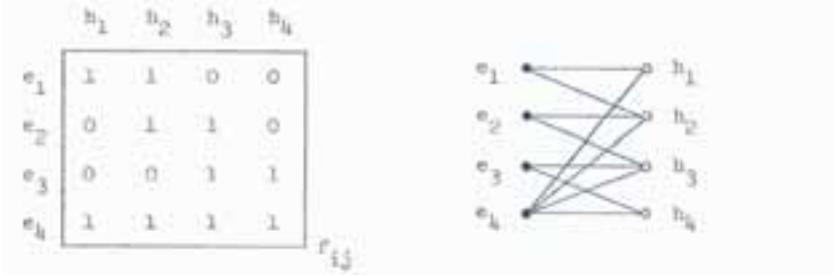
Naturally that the allocation of particular activities to spaces implies a specialisation of those spaces with detailed spatial features. The specialisation of the spaces does not involve only an increased provision of one attribute (Fawcett, 1978, p.174), but rather a "very high level of servicing and equipment to increase the range of events it can cater for" (Fawcett, 1978, p.175), that has to be acknowledged in regard to the spatial budget available for that design.

To represent this possible pairings of activities to spaces, Fawcett presents two representations: the "spanning zero-one matrices" (Fawcett, 1978, p.178) and the "bipartite graph, as in which feasible event-space pairs are linked by an edge" (Fawcett, 1978, p.179) (Fig. 124a).

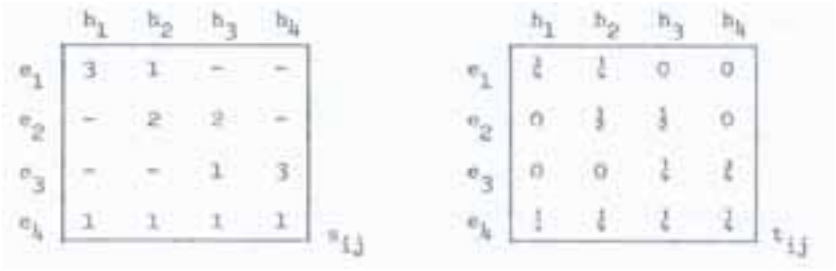
After modelling the feasibility matrix, all feasible allocations have to be analysed and added up into a "matrix $\{s_{ij}\}$, of all allocations" with "integer entities". This matrix can then be converted into a "stochastic matrix[579], $\{t_{ij}\}$, by deriving all entries by the total number of allocations, S" (Fawcett, 1978, p.181) (Fig. 124b). This will be of essential relevance for our current methodology, explained in the

[578] "The choice of allocations will in practice be substantially affected by connections between activities and links between spaces, but in the present study we do not take account of this, but they do add to our ignorance of allocational constraints." (Fawcett, 1978, p.172)

[579] Also know as Markov matrix.



a)



b)

Fig. 124. a) Two representations of feasible event-space pairs
b) Matrix of all allocations and stochastic matrix
(Fawcett, 1978, pp.179,181)

next chapter of our Thesis.

Afterwards, Fawcett refers to entropy, paralleling Baird's approach (1972) to his research question because it: "corresponds to our problem of allocating events to spaces at the architectural scale" (Fawcett, 1978, p.182).

Picking up on his "loose-fit" approach[580], Fawcett corresponds it to adaptability, so that this variety of possible allocations can be measured by Shannon's entropy (1949)[581]:

> "If an element had many alternatives and all were equally probable, then the activity would be at its loosest; if an activity could only use one space it would have a probability of 1, and then there would be no looseness. […] The measure of this looseness across the probability distribution is Shannon's entropy
>
> $$k.\sum_{j} p_{ij} \ln p_{ij}$$
>
> for activity i across spaces j. $k.\sum_{j} p_{i}$=1. The looseness of the system is the sum of the loosenesses of its elements." (Fawcett, 1978, p.182)

[580] "An adaptable design is one which allows the activities to take up a variety of states and which is minimally specific to a particular activity state. In this context the term activity state refers to a state of allocation, and the variety, or number, of ways of allocating the activities to spaces of a building can be considered as a measure of its loose-fit adaptability." (Fawcett, 1978, p.166)

[581] The fact that we will also regard this hypothesis will provide a more in-depth analysis of Shannon's work and on the overall concept of entropy in the next chapter.

Through this approach adaptability is measured by means of "a single index" that already takes into account prior information (Fawcett, 1978, pp.182). Resorting to "computational efficiency" instead of "the exact count of feasible allocations" (Fawcett, 1978, p.183), this enables its use in more complex systems.

After explaining the feasibly matrices and the take on entropy measurement, at his final chapter Fawcett presents the possibility of using the rock polynomial for allocation of events to spaces. Considering its relevance but also its mathematical specificity, particularly in regard to the use of detailed formulae on "combinatorial mathematics" (Fawcett, 1978, p.215), this approach is considered to surpass our architectural methodology and scope and will not be considered for our current Thesis. Instead, we realise that the concept of entropy is an asset for enclosing an ensemble of information into a figure that could be later compared to others, after an intervention on the same building or in other buildings. Besides, the use of feasibility matrices, also assists this understanding, linking, in a very graphical manner, identified activities to a list of spaces on that building. This will be crucial for modelling our own methodology to identify and assess adaptability.

In what concerns his rapport with mathematics, Fawcett advances that, although he aimed at quantifying adaptability in his theory, it "has intrinsic value", outside mathematics and besides his probabilistic approach:

> "Reliable data about the compatibility of activities and space is a prerequisite for, but is not the essence of, our approach to adaptability. This lies in the probabilistic statement of adaptability, and its representation by exhaustive combinatorial ensembles. This offers a structure for the quantification of adaptability, but also, I think, has intrinsic value. It gives a unified framework which accommodates diverse applications – a relationship implicit in the fact that designers propose quite different strategies for different problems, whilst all of them are called adaptable." (Fawcett, 1978, p.218)

Fawcett also recognises that the professional may not entirely embrace his approach due to its mathematical core, instead, he admits that most practitioners aim at "simple rules, even rules of thumb". Anyhow, he advances the relevance of his theory by the relevance of its subject and the defined way of addressing it, even despite its formulations:

> "[…] our general approach to the problem of adaptability has value in itself without mathematical elaboration, and by increasing conceptual clarity could help the architects give adaptability its appropriate weight in the design process." (Fawcett, 1978, p.219)

Lastly in his Thesis, Fawcett envisions further work on this approach, acknowledging

that it could be taken further, namely because of its scale and simplifications, and also due to the potentiality of tackling other issues based in this thought, like: "the possibilities of growth, the possibilities of physical change to buildings, and the effect of associations between activities and connections between spaces." (Fawcett, 1978, p.220).

All in all, and picking up Fawcett's first quote on this critical analysis of his theory[582], he hoped to have set the fundamentals for future developments. Hence, after careful analysis and critical understating of his theory, we hope to proceed with the aimed developments, based on our own intentions and research questions, and particularly applied to the chosen case study and the contemporary context, which impacts both the activities and the spaces to match. Some assumptions that guided Fawcett's approach are considered to have changed in regard to activities and spaces, and the need to associate activities and spaces will occur, as well as the validation of the methodology in a real system. Nevertheless, the definition of adaptability, its parallel to a probability, the modelling of matrices and foremost his rapprochement to entropy, certainly take a primary role in our own research.

. Simplification and over-complexity: between models and reality

As stated from the beginning of this chapter, Fawcett's work, along with the other researches that have also been considered, demonstrate that the question of identifying and measuring adaptability has been addressed in the 1970s, under the context of an analytical framework.

From the beginning of his Thesis, Fawcett expressed his wish for creating a "general theory of adaptability" that used mathematical methods, in which generalised activity states were addressed, and where the least knowledge on individual specificities was accounted for. He hoped to stand between the "deterministic" and the "empirical" (Fawcett, 1978, p.i) as a "contribution to architectural research" (Fawcett, 1978, p.2). The papers that he considers as relevant works on the state of the art for addressing the framework he speaks of, also represent previous approaches on the issue, in which mostly were also from the 1970s.

In addition, Fawcett anticipates a potential critical take on his work and determines his Thesis to be between the "urban" and the "atomic" scale, within the "architectural scale", that ultimately could be regarded as a "working tool" contributing for the architectural design (Fawcett, 1978, p.220).

The probabilistic approach derives the most probable states and, so, enlightens on the lack of uncertainty on space uses. The model has to be carefully derived, because

[582] "We believe to that theses advances could be undertaken on the foundations we have laid." (Fawcett, 1978, p.220)

it should not be too overly specific that it considers all individual possibilities, but it should not also be overly general that it overlooks relevant information, when grouping activities and users.

Consequently, the binary matrices that univocally match the activities to the possible spaces of allocation could still be understood as highly relevant methods for identifying adaptability in each school, but modelling those matrices will imply the identification of the current pedagogical activities and active learning environments relevant for today's education, which comprises informal activities and informal spaces, raising an original issue. To this it is added the difficulty of pairing activities and spaces in the matrix that also carries subjectivity when associating informal learning activities with spaces and, reciprocally, identifying which learning activities can be sheltered in informal spaces.

For this purposes, it is recognised the relevance of models for achieving conclusive outcomes and establishing a simplification of the reality, so that effective results can be attained. But if the context, and even the brief, did not determine the model in the 1970s (see the fact that not even in the title does Fawcett mention schools), our proposed methodology is bounded by the context and ultimately helps to test it, to validate it and to make it more robust.

The current Thesis here presented is also envisioned to assess the adaptability in a whole building ensemble and not in each space of the building. Secondly, it is believed that the application onto a particular case study will provide more detailed information on the attributes that enhanced a higher degree of adaptability for the school brief in particular. It is also believed that the specificities of each case study may influence its respective adaptability, and that a methodology that is less general and simplified, but rather closer to the buildings, to the context, to life within it, may depict its adaptability outcome in a fine-grained analysis.

For that reason, it is assumed that models represent a very important part of the outcomes of the Thesis by providing us with a consistent way in which to examine and compare designs. But it is also acknowledged that, for being simplified models of the reality, some aspects will be edited, that might influence the degree of adaptability of each case study. It will then be relevant to choose a model (or several complementary models), which features the attributes considered most relevant for assessing adaptability for that particular brief and context, without the over-complexity of the system, but also regarding the significant contents for the analysis.

Hence, it is also the aim of this Thesis to resort to other relevant tools and approaches on morphological and functional analysis, and closer to C. P. Snow's "two cultures" (1961[583]), and possibly also embodying behavioural studies, individual and sensorial/phenomenological research, for a broader output, a more realistic portrait of how

[583] Consulted edition from 1961, original edition from 1959.

adaptability can be assessed and how it potentiates activity states in the building.

This chapter intended to identify previous approaches on adaptability assessment methodologies, particularly focused on schools because this study aims to act as a theoretical support to the proposed methodology for this current Thesis and therefore, to be informed by previous methodologies, namely the most similar ones in terms of case studies and approaches considered. Thus, this chapter aimed at debriefing Fawcett's 1978 Doctoral Thesis and understanding it in detail because it is considered to be paramount for the very specific state of the art on this subject matter. Only after a more in-depth knowledge on this Thesis, can our current Thesis assess conceivable advances from Fawcett's 1978 "mathematical approach", its possible contemporaneity and relevance in terms of methods undertaken and results achieved towards our proposed methodology.

Nevertheless, not only has this chapter focused on Fawcett's Thesis, but it has also focused on relevant works from other authors that played a relevant role for the state of the art and that have also been a direct support for Fawcett's proposition. Still, the review undertaken here aimed to be critical and resort to the primary sources, which in this case are the direct works from the referred authors, and analyse them not just by Fawcett's lenses but straight from their direct study. This is considered to be significant because is develops a critical eye towards these approaches and potential synergies for our proposed methodology, that may coincide or not with the inputs Fawcett has taken from his own reading.

It is recognised that this chapter holds a very analytical framework, because relevant studies on school adaptability have been approached under that scope, deep-rooted in the 1970s and in Anglo-Saxon architectural research. It should also be highlighted that even the most relevant definitions of adaptability for this current Thesis date back from this decade as well, namely the OECD's from 1976 and Krüger's definition from 1981 (Krüger, 1981a) supported by his thorough previous studies from his stay in Cambridge in the 1970s. Naturally that the study of this sources implies a critical perspective not only on their contents, methods and outputs, but foremost on the possibilities of translating them onto the current pedagogical reality. For that purpose, this will imply understanding whether these models can portray the contemporaneity of the educational paradigm in terms of activities and also of the current educational environments, and their contextual, cultural, social and management constrains that these models do not fully comprise.

Fawcett's wide work on adaptability has continued on to more recent ones to date, which have been subject to closer detail in chapter 2.1[584]. His doctoral Thesis has been here analysed more closely as the basis of a full and cohesive academic research that has layed the foundations for more recent thoughts. Along with its state of the art

[584] See chapter 2.1. Adaptability: definition and adjacent concepts.

for assessing adaptability, this Thesis will be central for our proposed methodology.

Consequently, it is assumed that these studies are paramount for assessing adaptability, in terms of their straightforward outlook on this subject and the comprehensiveness of their procedures that tackle all possibilities. Capacity constraints can possible be introduced in future models so weights can be associated with each space or each activity for a less-uniform distribution of activities to spaces, which is considered to more closely depict the current reality.

Moreover, these results and the methods to achieve them can also be complemented by others that add information on the previously referred informality, appropriation and contextual framework[585] that guide this case study, considered these to be central for the learning environments and practices.

Hence, other methods and fields of research analysis addressed in the previous chapter[586] and used for space use assessment overall without the specificity of assessing adaptability in schools, can provide relevant information for this specific approach. That will bear significance for the proposition of our current methodology, comprising an analytical approach to adaptability that has proven its relevance, even more when applied to schools, but it also relies on others methods that complement both these results and the variables that they engage. Overall, assuming that other variables could impact adaptability today when applied to school environments, the proposed methodology tackles different study fields and methods to assess how and by what means do they weigh on the final results achieved.

Therefore, the following proposed methodology for identifying and assessing adaptability in learning environments will resort to an analytical approach closer to Fawcett's Thesis and the references on the state of the art that comprise this research context, but it will also resort to space use assessment methodologies that have already been applied to schools to describe the spatial sample and to understand the reality in which adaptability is needed and to which it will respond. Only by understanding the specificities of the context, can the research overlap expected and effective use in order to identify adaptability as the ability to continue to accommodate changing activities, both in space in the present and in the future.

The methodology to identify and assess adaptability under the case study proposed and aiming at enclosing this wide array of lines of thought will be explained in closer detail in the following chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[585] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[586] See chapter 3.1. Space use assessment methodologies.

3.3. A methodology for identifying and assessing adaptability in learning environments

> "Describing change from within can be a considerable challenge.
> Still, change is a fascinating topic and has brought forth a plethora of concepts and theories across different academic disciplines." (Sailer, 2014, p.xx)

This quote in *The Journal of Space Syntax*, Vol 5, No 2, entitled *Changing building typologies,* corroborates change as a contemporary and relevant issue in the design of buildings. Particularly, when applied to case studies, current research on this problematic may provide "actionable knowledge" (Elliot, 2001, p.555) towards future designs.

Consequently, and as already explained in detail[587], this research presents a comprehensive methodology to identify and assess adaptability within educational spaces, with a critical review based on previous advancements, particularly from the approaches carried out since the 1970s[588] and the crossing of distinct spatial assessment processes, aiming to describe how adaptability is portrayed and what are its key variables to assess it.

In order to assess the adaptability level of each space of the school building and ultimately of the overall system, the methodology is here presented at its theoretical foundations, followed by its experimental application on a Portuguese school chosen as case study[589]. This has been originally created from scratch under the context of this current Doctoral Thesis here presented and is considered as potential input for architectural research, informing both the academia and the practice.

As previously suggested[590], if the learning experience takes place in distinct spaces, this methodology is also applied to distinctive learner-centred environments, in order to conclude on potential adaptability discrepancies between them. It also considers a crossing of methods, in order to deliver quantitative and qualitative results on both formal and informal spaces and regular and spontaneous activities,

[587] See chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

[588] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[589] See chapter 4. Application of the methodology in the case study.

[590] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

and their potential mutual correspondence.

Windelband in his *Rectorial Address* (1894) introduces the concepts of *nomothetic* and *idiographic*, in which the first relates to general laws and regularities, and the latter to the events and singularities. In his own words:

> "In their quest for knowledge of reality, the empirical sciences either seek the general in the form of the law of nature or the particular in the form of the historically defined structure. On the one hand, they are concerned with the form which invariably remains constant. On the other hand, they are concerned with the unique, immanently defined content of the real event. The former disciplines are nomological sciences. The latter disciplines are sciences of process or sciences of the event. The nomological sciences are concerned with what is invariably the case. The sciences of process are concerned with what was once the case. If I may be permitted to introduce some new technical terms, scientific thought is *nomothetic* in the former case and *idiographic* in the latter case."[591] (Windelband, 1894, p.175)

As Windelband continues, he stresses that this dichotomy can be introduced in a methodology, as "modes of investigation" (*ibid.*), and potentially brings conclusions from both epistemological provinces:

> "It is possible - and it is in fact the case - that the same subjects can be the object of both a nomothetic and an idiographic investigation. This is related to the fact that, in a certain respect, the distinction between the invariable and the unique is relative. Consider an entity which undergoes no immediately perceptible change within a very large span of time. For this reason, its unchangeable forms can be investigated nomothetically. From a more comprehensive perspective, however, the same entity may prove valid for a more limited time-span only, i.e. it may qualify as a unique phenomenon." (Windelband, 1894, pp.175-176)

Consequently, both concepts can potentially be brought to this methodology. If the nomothetic assessment relates to the ideal uses and fullest spatial allocation that can be foreseen, the idiographic relates to the effective events that occur in the school environment, not necessarily foreseeable from the brief, or even the most frequent, but the singular activities and the uniqueness of the individual experience in space and all that it implies in relation to space and activities. The latter can bring further knowledge *per se* and can also be absorbed within the collective framework.

Hence, a more comprehensive assessment of adaptability in this case study can be reached. Assuming the "nomological regularities" (p.178) of a weekly schedule of formal activity allocations to space, naming all possible uses that can be previously

[591] Italics from the original quote.

defined or described; and also considering the individual(s) frameworks, events and dynamics, like the informal activities undertaken by students from different teaching regimes or non-programmed events of different sort; ultimately to support the conclusions this research aims to achieve.

Furthermore, after the account on chapter 1.2[592] on the existing differences of interpretation on the concept of *living experience,* the methodology to assess it will also differ according to the authors of reference. Therefore, this chapter advances from the previous 3.1.[593] and 3.2.[594] that examined the methodologies to assess space use and adaptability from a general outlook to a particularly spot on schools, and admitting the broad range of procedures, it points out and justifies the ones considered to be more representative to report on adaptability in this case. So, having described and recognised different conceptions to identify experience before a phenomenological approach particularly introduced on chapter 1.2, and also the collective and analytical methods to assess occupation and movement by spatial morphology, like space syntax, that has also been dealt in detail in chapter 3.1; this methodology aims at including outcomes from different assessment procedures, in order to report on the activities amenable to occur in (an adaptable) space, from a more formal and/or informal usage, collective and/or individual perspective, and also from a more social and/or analytical approach. This search for a more complete conclusion on the activities that a space can allocate, and their nature and respective spatial requirements, justifies the use of different methods from distinct study fields, such as space syntax for the description of the spatial sample, along with individual methodologies to identify experience in space, which will be described subsequently.

Therefore, this methodology converges outputs from proven, yet distinctive, methods of spatial assessment into an original and contemporary approach, which provide in-depth data by a broader range of approaches. For this purpose, this chapter presents an overall description of the methodology, by briefly introducing each of the approaches and respective inputs towards a more supported definition of an adaptable learning space[595].

As a combined process, the methodology is composed of three stages, considered as milestones, in which the subsequent complements the previous, in order to reach a fourth stage corresponding to the achievement of potential conclusions.

Each of these stages is descriptive of a case study in a real life scenario that is

[592] See chapter 1.2. Motivation and background: Architecture and Life – conceiving forms of engagement.

[593] See chapter 3.1. Space use assessment methodologies.

[594] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[595] This methodology, as an overall procedure to address this research question, has been presented in the *3rd International Symposium Formal Methods in Architecture*, in 30 November – 2 December 2015, Porto, for testing and academic validation. It will also be published as: Coelho, C. (in publication). A Gathered Methodology Towards Enhancing Adaptable Learning Spaces. In D. Viana, F. Morais, J. Vaz (Eds.). *Formal Methods in Architecture and Urbanism*. Cambridge: Cambridge Scholars Publishing.

analysed by different approaches, providing specific information of a localised space-time reality. Particularly, for this methodology, the first implies the description of the spatial sample as was defined from the design envisioned by the architect from that brief, and actually built as a space-time system with social potential.

Then, the following analysis focuses on a description of *all* potential allocations of activities to the spatial configuration in question, considering the respective spatial demands each activity implies with regard to the spatial potential of the building.

Thirdly, a description of *effective* events and experience in space displays information on the individuals of the society[596] and the possible ways in which space is occupied by "situated practices" (Hillier and Netto, 2001, p.4) in time.

Each of the referred stages will conclude on patterns of the analysed variables from specific analysis, translating space-time reality to abstract patterns and overall conclusions. These conclusions, when analysed in a gathered way, will describe potential correlations amongst the results and, overall, amongst the approaches used to pursue these results.

Finally, the outputs from individual patterns and correlations amongst the three stages and approaches will aim to conclude on the adaptability potential of the space analysed, bounded by its space and time frame and context.

This recalls Hillier and Hanson's mechanism of "description retrieval", described in *The Social Logic of Space* (1984) and interpreted by literature. This evokes the concept of "arrangement" as a reality enclosed in space and time, which can be related by "transpatial" patterns into the system and subsequently reproduced:

> "An arrangement can be defined as some set of initial randomly distributed discrete entities, which enter into different kinds of relations in space-time and, by retrieving descriptions of the ordering principles of these relations, are able to reproduce them. An arrangement is essentially the extension of spatial integration into the realm of transpatial integration: that is, it creates the appearance- and in a more limited sense, the reality of spatially integrated complexes which, properly speaking, retain their discrete identity as individual objects. A class, or transpatial integration of objects is an unarranged set. Arrangement of these sets gives each object a new relational identity; and out of the accumulation of these relational identities in space-time global patterns can arise which, by description retrieval, can also become built into the system." (Hillier and Hanson, 1984, pp.50-51)

Hillier and Hanson apply this mechanism for space syntax as a potential mechanism of linkage between reality and abstraction: "The syntax theory shows how such

[596] Hillier and Netto refer to the individuals of the society as such: "The individuals who make up a society are clearly well-defined space-time "things" in the sense of being bounded and occupying a well-defined and continuous region of space time." (Hillier and Netto, 2001, p.5)

descriptions can be abstract, and can be retrieved from complex realities." (p.204). But for this to happen, the latter is a consequence of the first, cyclically:

> "For syntax to appear requires not that the rule precedes the event, but that an initial description is retrieved from spatio-temporal reality and then applied consistently in the succeeding events in the process. Syntax is a consistency in description retrieval and re-embodiment from one moment to the next." (Hillier and Hanson, 1984, p.205)

Peponis (2001) includes "description retrieval" within an enlarged process that goes from the creation of a pattern to its generalization for future definition of "generative rules"[597]. Psarra (2003) highlights the concept of "invariance" (p.2) as inherent to the generation of patterns and abstraction. This author presents a clear definition of this process:

> "Description retrieval is a process by which abstract laws are derived from real space-time events and are subsequently embedded into further actions. In the beady ring settlement it is possible to retrieve a description from a local rule that is recurrently applied governing the position of blocks, their relations to other blocks and to the open space. It was proposed that abstract laws and space-time events are in a 'sandwich' like relation establishing the primacy of reality over abstraction and of the phenotype over the genotype (reality 1 – description – reality 2)." (Psarra, 2003, p.2)

This concept also appears in Hillier and Netto's paper *Society Seen Through the Prism of Space. Outline of a theory of society and space* (2001), which aims to highlight the contingency between space and society by specifically focusing on both the "constructive" and the "receptive" role of spatial configuration towards co-presence, movement and social action (p.3)[598], in contrast with what Hillier considers the approaches which "typically look at society and try to detect its output in space" (*ibid.*).

This outlook is also shared by the current methodology presented here, when describing space and aiming to describe the spatiality of the school community, which corresponds to this society's case study, and establish a link between its activities and individuals with the configuration of the space in question.

A final outlook on this paper points out that, according to Hillier and Netto (2001) (when referring to the city rather than to a particular building), the rapid change in

[597] "To use the earlier terminology that serves rather well for the purpose, we have to understand: 1) the creation of pattern based on relatively simple generative rules; 2) the emergence of pattern properties which arise as these rules interact with the laws of formal possibility and constraint, essentially with mathematical necessity; 3) a process of description retrieval whereby the emergent regularities are recognized; and 4) an application of new generative rules informed by description retrieval. In short, we are looking for a theory of how complex structures can emerge through distributed processes associated with growth." (Peponis, 2001, p.xx)

[598] "However, it was only by extracting space from its embedding and treating it as a thing in itself that we are able to bring to light its configurational properties, and it turns out to be these that link space back to society, both as a receptor of social forces but also an an active constructive agent in society." (Hillier and Netto, 2001, p.6)

the activities is effectively a constant. Still, the authors then conclude, that despite this rapid change in the activities, if their needs continue to be fulfilled by space, it does not necessarily have to change at that same pace:

> "This is why in general - and with important exceptions - during the life of a city space changes only slowly while activity changes rapidly. We do not find that new phenotypical patterns of activity *per se* generate new patterns of space, but that new patterns of activity have a certain distribution of demands on co-presence, and that to the degree that the new distribution approximates the old, the new pattern will be absorbed into the existing urban framework with comparatively little change." (Hillier and Netto, 2001, p.2)

This, ultimately, implies OECD's (1976[599]) definition of an adaptable space, able to cope with activity change without frequent physical change[600].

All in all, "description retrieval" embodies the ability to translate situated events to generalisable patterns in order to reach for conclusions, much recalling the early definitions presented:

> "This process would depend on the mechanism of description retrieval discussed earlier, that is the ability of human being to retrieve an abstract description of spatiotemporal events and use it as a template for further action. Retrieved descriptions from practices which had the effect of reproducing the emergent system would in effect become normative to the degree to which the system was reproduced." (Hillier and Netto, 2001, p.13)

For this methodology it was assumed not to use Hillier's full expression "description retrieval" in stage four, but rather to deconstruct this expression into two components. In which the first constitutes a "description" *per se* of each layer of the case study to be analysed amongst the three previous approaches, both by its data as well as by its nature.

As a culmination point of this hybrid and extensive process, conclusions can be drawn on the space's adaptability potential, according to both individual results and correlations. It is then that a generalised conclusion will be "retrieved" for generalised data on the attributes that promote adaptability in school buildings today, or specific forthcoming design interventions.

The following chart (Fig. 125) represents as a schematic synthesis of the methodology, which will be sequentially depicted according to each of the milestones displayed in this chart:

[599] There is no defined author in this publication, only the OECD's authorship overall.

[600] "[…] adaptability, the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition in respect of either the constructional elements, services or the finishes of the building - essentially large magnitude/low frequency change" (OECD, 1976, p.10)

SCHEMATIC SYNTHESIS OF THE METHODOLOGY

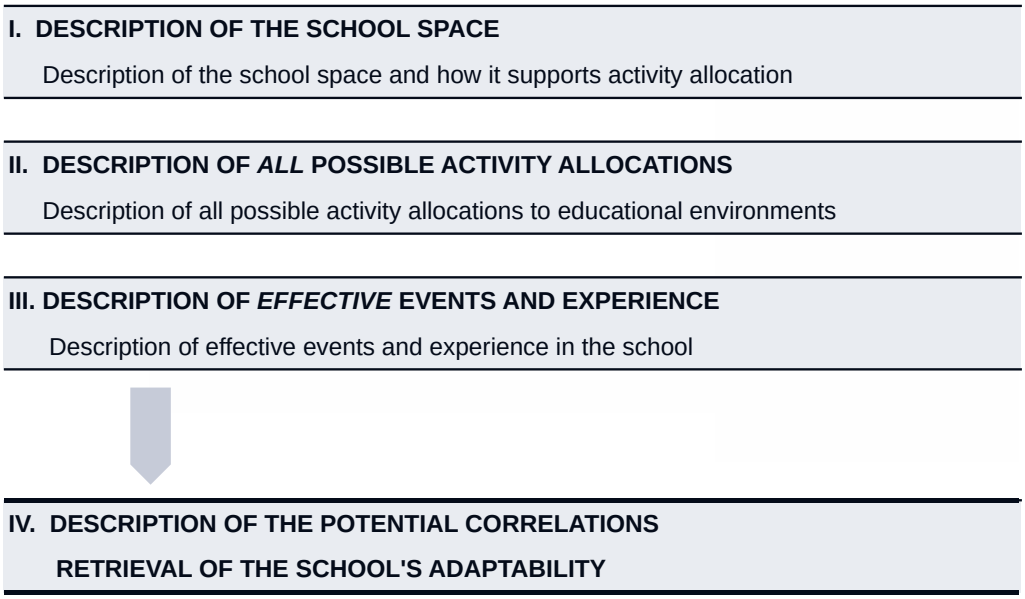


Fig. 125. Schematic synthesis of the methodology
(Carolina Coelho)

I. Description of the school space and how it supports activity allocation

The first milestone of this methodology is the description of the spatial sample, which is in this case the school space, on which adaptability will be assessed.

For an insightful understanding of the school environment, it becomes relevant to analyse it from a functional perspective, namely by its spaces, activities and spatial attributes, that allow activity allocation to each of the spaces identified. This will be based on the characterisation of each of the above items, with its full and extended description.

Within this analysis, the school's morphology will also be portrayed, in order to better understand the connection between spaces and, consequently, between activities and users. So, assuming the specificity of today's active learning environments, whose configuration can widely vary according to the diverse range of activities – formal and informal, group or individual – that contribute to the learning process, it becomes relevant to analyse the school building not only in its convex spaces and respective physical features, or even in the spatial morphology of the whole building, but also to consider the moving paths as possibilities for learning while informally interacting with other members of the school community.

Thus, this study will focus on both convex spaces and axial lines, assuming that both moving and static activities bear potential on knowledge spread, whether on formal scheduled classes or on spontaneous activities held in "spatial units" (Hertzberger, 2009, p.11), "articulated classrooms" (Hertzberger, 2008, p.24) and "learning streets" (p.113) because "corridors do not belong in schools" (Hertzberger, 2009, p.9). Consequently, the methodology will consider two initial methods of analysis: space syntax on stage one and entropy approach on stage two, in order to provide input on the potential correlation amongst the two approaches, for the same variables from the sample.

Therefore, a space syntax analysis focused mainly on the attributes of integration, depth and connectivity, based on both the axial lines and convex spaces, informs on how a space is being used and whether spaces with analogous entropy levels, allocate different uses. An analysis on the isovists will also bring further information on space's configuration, as well as an intelligibility assessment of the system.

In fact, intelligibility, as a second order measure that can be achieved by correlating global integration and local connectivity, can better clarify which floor's layout is best comprehended and less "labyrinthian" (Hillier, 2007[601], p.94). The correlation in a scattergram with these two variables presents a regression line and a determination coefficient that inform on the degree of intelligibility of the system. If the scattergram indicates low intelligibility: "This means that connectivity is no longer a good guide to integration and therefore as we move around the system we will get very poor information about the layout as a whole from what we see locally." (*ibid.*), closer to a more "labyrinthian" (*ibid.*) layout then a clear and understandable system to move around.

Therefore, as it relates a global with a local measure, it provides information on the whole structure and how it can be perceived, by the understanding of its parts (Heitor, 1995, pp.54-55). This is set clearly by Hillier:

> "The property of 'intelligibility' in a deformed grid means the degree to which what we can see from the spaces that make up the system - that is, how many other spaces are connected to - is a good guide to what we cannot see, that is, the integration of each space into the system as a whole. An intelligible system is one in which well-connected spaces also tend to be well-integrated spaces. An unintelligible system is one where well-connected spaces are not well integrated, so that what we

[601] Consulted edition from 2007, original edition from 1996.

> can see of their connections misleads us about the status of that space in the system as a whole." (Hillier, 2007, p.94).

These findings display information on whether spatial morphology bears relevance for the school's occupancy, namely to activity schedules and spatial density of natural movement[602].

II. Description of all possible activity allocations to educational environments

The following stage of the methodology aims to define all possible activities that can be allocated to each of the spaces already identified in the first stage. This corresponds to the ideal scenario, which lists and assesses all possible linkages of activities to spaces according to their spatial attributes, and the nature and spatial requirements of the referred activities that enable or hinder a potential allocation.

Overall, it will inform on the regularities of the programmed schedule for activity allocation, in the form of a nomothetic assessment.

This first step consists on a critical analysis of the outcomes provided by milestone one, which enables to draw the potential correspondences of attributes to spaces, of activities to spaces, and ultimately to conclude on the link between spatial attributes to activity allocation that enables them to happen in each of the spaces identified, in the form of a feasibility matrix[603]. Then, conclusions may also be drawn on the primary activities of each space, how the pedagogical curriculum is played in the school's spaces and provide a depiction of its uses and users overall.

After producing the feasibility matrix on the correspondence of spaces to activities, the entropy[604] of each space will be determined by mathematical approaches, which will ultimately provide a quantitative measure of adaptability.

In order to achieve this description, this stage will undertake an entropy approach,

[602] The correlation between entropy and space syntax, as a part of the presented methodology to identify and assess adaptability has been presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London, for validation of the procedure and of the potential correlation. This communication was published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

[603] This matrix and its procedure will be explained in detail in the subsequent chapter 3.3.2. Description of all possible activity allocations to educational environments. See also Fig. 134.

[604] The concept of entropy will also be explained in detail in the referred chapter 3.3.2. Description of all possible activity allocations to educational environments.

by resorting to probabilistic and combinatorial models, following Fawcett's studies (1976b), that focus on maximising entropy, considering the most adaptable one, to be the most probable macrostate amongst all the microstates (Krüger, 1984).

III. Description of effective events and experience in the school

Overall, the previous data, when associated with qualitative methods such as: walkthroughs, focus groups and observation matrices, depict individual experience and spontaneous appropriation, by adding information on the adaptability potential of spaces for non-scheduled learning activities, and translating Windelband's idiographic perspective of specificities and individual events. This will be the main focus of milestone three of the methodology.

IV. Description of the potential correlations and retrieval of the school's adaptability

The final milestone comprehends a systematisation of the results, concluding on whether potential spatial feasibility and effective spatial occupancy overlap, and providing an outlook on the relevance of spatial morphology, towards entropy and finally adaptability. It also informs on adaptability variations between formal and informal, productive and supportive spaces (Krüger, 1992).

By and large, this hybrid methodology[605] aims to assess the adaptability of the learning environments by means of the three distinct approaches, within the milestones mentioned above: description of the school space, description of all possible activity allocations to educational environments and description of effective events and experience in the school. The means to achieve each of these descriptions resort to different academic provinces, respectively: a space syntax analysis focused on the building's morphology, entropy calculations by means of a mathematical formulation and, lastly, the use of qualitative methods

[605] Shibley and Schneekloth (1996) also discuss "hybrid evaluation processes" stating their several benefits namely: their "capacity to redefine issues internal to organizations while they concurrently identify the limits of external methods" and foremost the fact that "hybrid methods tend to focus on relationships and context rather than on single issues" (p.20). This is in close coordination with the methodology proposed in this chapter that aims at constituting knowledge on the school and its community and Portuguese context, but also on a general procedure to assess the adaptability of a school.

such as observation matrices, walkthroughs and focus groups[606] for a better understanding of spatial experience and appropriation. The methodology will, then, display conclusions based on the outcomes of each procedure, either quantitative and qualitative, nomothetic and idiographic, and finally on their potential overlapping. Resorting once more to the words of Windelband: "both forms of knowledge are equally justifiable" (p.180), both "independent and juxtaposed" (p.183)[607].

Furthermore, by introducing a triangulation approach of different methods, their respective results will also lead to a more complete, supported and informed assessment of the learning environments and their respective spatial adaptability, by introducing data brought from distinctive, yet academically acknowledged, fields under the context of this research.

After proceeding with this methodology, by fulfilling each of the four milestones, educational spaces can be analysed, assessed and even ranked according to the possibility of allocating learning activities of distinct nature and undertaken by different users, ultimately concluding on each space's adaptability potential.

This chapter will provide an overall theoretical description of the full methodology, yet to be applied, and how it potentially reaches a robust conclusion by gathering distinct academic established areas, in order to answer a defined research question for both the theory and the practice. After the overall depiction, the following chapter[608] will proceed with its application into the case study, for a more concrete explanation of a methodology that is admittedly complex by its several stages and its hybrid approach.

The following chart (Fig. 126) illustrates, in a schematic manner, a more detailed description of the methodology, according to all the variables mentioned above and the representativeness in including and assessing them individually and sequentially for an end conclusion.

[606] These procedures will be explained in detail in the subsequent chapter 3.3.3. Description of effective events and experience in the school.

[607] For a broader contextualisation of this quote, this is the full quote: "The question is: from the perspective of our total cognitive purposes, which is more valuable, knowledge of laws or knowledge of events? Is it more important to understand the general, atemporal nature of things or to understand individual, temporal phenomena? From the outset, it is clear that this question can only be resolved on the basis of reflections concerning the ultimate aims of scientific research.
At this point, I shall only touch superficially on the extraneous resolution of this question from the standpoint of utility. From this standpoint, both forms of knowledge are equally justifiable." (Windelband, 1894, p.180)

[608] See chapter 4. Application of the methodology in the case study.

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 126. Synthesis of the methodology
(Carolina Coelho)

3.3.1. Description of the school space and how it supports activity allocation

> "[…] in talking about buildings, we need not only to talk about objects, but also about systems of spatial relations." (Hillier and Hanson, 1984, p.2)

This quote refers to the bond between society and space explored by Hillier and Hanson in *The Social Logic of Space* (1984). In fact, according to its spatial properties, the school enables a particular system of social relations (Coelho, 2013b), by stimulating encounters, patterns of movement and co-presence, considering it to be an "educational tool" (Heitor, 2005)[609]. Hence, the need for describing the school space in the sample, namely through spaces, activities and attributes, rests in the analysis of how and by what means does the space support, promote or even hamper activity allocation.

In a more detailed depiction of this process, the initial step consists on listing the existing spaces and identifying them in the final plans, which are considered to be the ones that more accurately report the built space. A functional analysis will be undertaken by assigning coloured hatches to each space represented in the plans, complemented by their respective captions, for these specific responses:

a) Whether each space is an active learning environment or a supportive environment.

b) Its potential either as a social and informal space and/or as a formal and curricular space.

c) Whether each space is a pathway for circulation or a space for standing, or both. This holds particular relevance for the methodology when correlating spaces and lines.

d) If each space is either exterior or interior.

e) Which teaching regimes each space holds.

f) Whether the space has a particular functionality or a specialised use.

g) The primary activity the space is expected to accommodate.

The following chart (Fig. 127) systematises these considerations in a tree-shaped scheme, to be used when listing the spaces and identifying them in the drawings[610]:

[609] As seen in chapter 2.3. Adaptability for contemporary learning practices and environments.

[610] The spaces considered in this chart (Fig. 127) are all considered productive, either: social, formal and both.

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. SPACES	. Social and informal spaces	. For staying / clusters	. interior . exterior
			. For circulation / pathways	. interior . exterior
		. Formal and curricular spaces	. Classrooms	. Regular teaching . Artistic teaching . Both teaching regimes
			. Others	
		. With both formal and informal potential for both teaching regimes	. Library . Auditorium . Dance studio . Music studio . Orchestra room	

Fig. 127. Description of the spaces of the school
(Carolina Coelho)

For a deeper analysis of the school's activities, as in the preceding one, a list will also be produced, considering them in general terms: programmed/formal, non-programmed/informal and for circulation purposes, in which the first can be considered according to the teaching regime and the second according to the nature of the activity, such as: social, artistic, pedagogical overall,… The chart of Fig. 128 resumes those possibilities.

This consideration can also be translated onto the school plans, by assigning coloured hatches to each space according to its main activity. Nevertheless, this initial connection between spaces and its main activity has to be addressed as an introductory approach to the functional analysis of the school, which admittedly limits the range of activity allocation to each space, by a single univocal connection between a space to one main activity. In a deeper subsequent analysis each space will be analysed according to the other possible activities it can hold, and so, a potential overlapping of the referred activities described in Fig. 128 can occur in the same space.

Since assessing adaptability implies the ability to hold several and distinct uses, this research lies in an indisputable acknowledgement that spaces have the possibility of holding diverse activities and that those activities can be diverse in nature and even mutually inclusive of the above classification. E.g. activities that can be both programmed and informal, moving and pedagogically representative[611].

[611] This potential overlapping of the classifications is more extensively studied further in this chapter, when addressing the entropy approach, particularly for validating the production of the activities sample (Fig. 133). It is also based on Krüger, M. J. (1992). *Caracterização e Programação de Edifícios Complexos*. Departamento de Engenharia Civil. Instituto Superior Técnico. Universidade Técnica de Lisboa. Abril de 1992 (Publicação N° 78).

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation			
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. ACTIVITIES	. Programmed / formal	. Regular teaching . Artistic teaching . Both teaching regimes . Administration
		. Non-Programmed / informal	. Social nature . Artistic nature . Pedagogical nature for the regular teaching
		. Circulation / fluxes	

Fig. 128. Description of the activities of the school
(Carolina Coelho)

Therefore, after this first approach on each spaces' main brief and what they have been designed to pursue, according to the information in the plans, on milestone two of this methodology an in-depth matrix of all potential allocations will be undertaken through the production of an extensive activity sample (Fig. 133). Then, the identified spaces in milestone one will be matched with these possible activities from that extended scheme, producing a feasibility matrix (Fig. 134). This process will then provide a more insightful interpretation of the possible activities that may occur in that educational environment and the spaces' ability to cope with them all.

This first milestone also implies a study on spatial attributes for future conclusions on their compliance with activity allocation and, ultimately, with the adaptability of each space, recalling Brand's (1994) and Duffy's (1990) previous approaches to layers.

Therefore, spatial attributes for this particular methodology have also been listed, according to six properties: *dimension* (high, length, width), *configuration* (openness, partitioning), *coating* (floors, ceilings), *networks* (power access, connectivity), *environmental conditions* (temperature, acoustics) and *accessibility* (direct, by means of a lift, staircases or ramp); which may constrain or enable activity allocation to a space (Fig. 129).

It also becomes quite significant to highlight that this methodology concerns adaptability as the ability to allocate a wider range of activities to spaces, so the internal attributes of each space will determine their inner activity potential and ability to cope with each specific use. Hence, the attributes referred for this methodology will necessarily focus on interior and built-in features that can potentially be applied to each space.

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation			
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. ATTRIBUTES	. Dimension	. Height . Length . Width
		. Configuration	. Openness . Partitioning
		. Coating	. Floors . Ceilings
		. Networks	. Power access . Connectivity
		. Environmental conditions	. Temperature . Acoustics
		. Accessibility	. Direct . By lift . By staircase . By ramp

Fig. 129. Description of the spatial attributes of the school
(Carolina Coelho)

Nevertheless, the attributes considered for this particular methodology and the literature references previously explained can be compared on definition, duration and potential overlapping of their meanings and scope of each concept according to the authors of reference mentioned above. This will be addressed in these following explanations.

As these attributes were chosen, by considering them representative to activity allocation in a school building, especially when it has undergone a process of adaptive re-use, so, large scale layers have not been moved or changed. So, Brand's "site" can be considered an attribute that can possibly condition adaptability in a building, but for this case study it cannot be assessed, since the original site of the school has not been changed during the adaptive re-use process.

It becomes relevant to underline that this chapter focus on the overall methodology and its general application and not on the specific application on the case study, in which the following chapter 4 will focus on[612]. Nevertheless, at this point, it could be recalled that this particular case study in which the methodology will be applied to, having be adapted to a new pedagogical curriculum, has also had a new building built that aims to resolve some precedent and current issues, such as: providing the school with a representative street façade, coping with spatial needs brought both by the enlarged school curriculum and also by the need for updating spatial features for a more lasting and responsive school space overall, besides potentially

[612] See chapter 4. Application of the methodology in the case study.

structuring the pavilion layout from the original brief by the pathways and exterior and interior spaces that this new building connects. In this case, this could be considered a change in both the implementation in the "site", although it was a part of the original school, and also on the "structure", which is specifically different from of the original pavilions[613].

. Dimension, such as height, length or width, is both defined by structure, when concerning height and length defined by the load-bearing walls or structural elements that define a possible grid or layout. But it could be also associated with interior partitioning, when it is concerned with the width or length of the interior divisions and rooms, hence related to Duffy's "shell" and Brand's "structure", but also to Duffy's "scenery" and Brand's "space plan".

Even though Duffy's "shell" or Brand's "structure" have not been changed on the original pavilions, which is confirmed by both authors of reference who believe this layer (whatever its name according to the author) to be lasting throughout the building's lifecycle, structure conditions interior dimension and partitioning of the individual spaces, prone for activity allocation. Hence, this is an attribute already recognised by both Duffy and Brand, which is here referred to as *dimension*.

. Configuration of each space will also be determined by Duffy's "shell" or Brand's "structure", when it defines the possibilities of openness and partitioning of the building. But, once more, it also relates to Duffy's "scenery" and Brand's "space plan", when it is concerned with the interior layout of the system overall.

These first two attributes comprehend a larger scale, hence being naturally connected with larger scale layers mentioned by the referred authors. The following will look into a more detailed choice in features for each specific space.

. Interior **coating** of floors and ceilings recall's Brand's "skin", although he then mentioned it for exterior surfaces rather than interior ones. Nevertheless, coating plays an important role for activity allocation particularly in an artistic school, namely for acoustics and environmental comfort.

. Networks are quite relevant in today's learning model, where virtual accessibility and power access to multiple electronic devices are crucial for knowledge transmission and independent research. This is embedded in both Duffy and Brand's "services".

[613] As mentioned, this matter will be subject to further analysis in the following chapter, when applying this general methodology to the case study, and particularly when analysing the spatial sample as milestone one of this methodology.

SCHEMATIC SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. SPACES**	**. Social and informal spaces**	. For staying / clusters	. interior . exterior
			. For circulation / pathways	. interior . exterior
		. Formal and curricular spaces	. Classrooms	. Regular teaching . Artistic teaching . Both teaching regimes
			. Others	
		. With both formal and informal potential for both teaching regimes	. Library . Auditorium . Dance studio . Music studio . Orchestra room	
I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. ACTIVITIES**	**. Programmed / formal**	. Regular teaching . Artistic teaching . Both teaching regimes . Administration	
		. Non-Programmed / informal	. Social nature . Artistic nature . Pedagogical nature for the regular teaching	
		. Circulation / fluxes		
I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. ATTRIBUTES**	**. Dimension**	. Height . Length . Width	
		. Configuration	. Openness . Partitioning	
		. Coating	. Floors . Ceilings	
		. Networks	. Power access . Connectivity	
		. Environmental conditions	. Temperature . Acoustics	
		. Accessibility	. Direct . By lift . By staircase . By ramp	
I.II SPACE SYNTAX morphological analysis	**. CONVEX SPACES** **. AXIAL LINES** **. ISOVISTS**			

Fig. 130. Detailed systematisation of the first step of the methodology (Carolina Coelho)

. Accessibility is also mentioned by Duffy within his "services" definition when he mentions elevators, which it is here taken further by adding other accessibility conditions, like the need for a ramp or staircase.

. In the same manner, also **environmental conditions** can be understood amongst Duffy's "services" definition, by his reference to air conditioning. Once more, this could be further developed into more general terms, such as temperature and acoustics, also particular relevant for the case study as a school of music, dancing, sporting and regular teaching. Overall, when Brand refers to "services" he refers to the overall "working guts of a building" (Brand, 1994, p.13), where these latter attributes can be embodied as well in more general terms.

Finally, a reference to Duffy's "set" and Brand's "stuff" that are not mentioned by these attributes, considering the approach to adaptability rather than flexibility. In fact, the possibility of movable furniture of frequent interior small scale changes is not believed to be fundamental to activity allocation. This much recall's OECD's quote in 1975:

> "Adaptability is the ability to physically change, by moving, replacing and removing components, or by subsequent addition of other components. Flexibility is the quality of the building as it exists at any time, which makes it possible to modify the type of activities that it can accommodate, without the need to perform a material adjustment. As a result, the greater the flexibility, the later the need for adaptation."[614] (Oddie, 1975, p.37)

This overall process of describing the school space as the first step towards assessing a school building's adaptability, is resumed in the chart (Fig. 130).

This corresponds to a detailed description of both the items to be assessed and their respective variables introduced in this first milestone, for an extensive description of the sample, which is the school environment, with its respective spaces, activities and spatial attributes.

Subsequently, a space syntax analysis plays a critical role, as it focuses on spatial morphology and the concepts of integration, depth, connectivity, visibility and,

[614] Free translation from the quote in French: "L'adaptabilité est la capacité de changement matériel, par déplacement, remplacement et suppression des composants, ou par addition ultérieure d'autres composants. La flexibilité est la qualité du bâtiment tel qu'il existe à n'importe quel moment, qui permet de modifier le type d'activités qu'il peut accueillir, sans qu'il faille procéder à une adaptation matérielle. En conséquence, plus la flexibilité est grande, plus loin dans le temps peut être repoussé le moment où l'adaptation sera nécessaire." (Oddie, 1975, p.37)

ultimately, intelligibility. This will provide conclusions on the implications of spatial placement towards patterns of natural movement and activity and users' clusters.

The fact that this methodology is applied to the school brief endorses it with specificities that have to be particularly taken into account. Ultimately, Bernstein (1971) states that "Educational knowledge is a major regulator of the structure of experience." (p.202), implying that it might be a reflection of society at large and the power holding structures (*ibid.*)[615].

Pedagogically, as the contemporary learning paradigm is not confined to formal classrooms, but yet to all the spaces in the school, knowledge is not transmitted only by a content provider but by peer interaction and individual discovery, and because learning occurs in several environments, the needs of the wide range of activities that comprise it will also have to be specifically contemplated. This emphasises what Bernstein (1999) defines as "vertical and horizontal" discourse acquisition and circulation, and also his approach to the "changes in the structure of cultural transmission" (1971, p.202) and his considerations on "valid knowledge", "valid transmission of knowledge" and its "valid realisation" (*ibid.*)[616].

Spatially, when considering that learning occurs both in individual spaces as well as amongst pathways where both formal and informal spaces are displaced, the sequence or the *promenade* through those spaces is also a means towards communication, interaction and learning between all the school community. Hillier points out the dichotomy between convex spaces and axial lines, respectively related to standing and moving in space:

> "The space structure is admittedly highly broken up into 'convex' spaces — but there are always lines which link the convex spaces together, usually several at a time. […] But because people move in lines, and need to understand lines in order to know where they can go, this means that the space structure is easily intelligible from the point of view of movement." (Hillier, 2007, p.116)

Thus, axial lines are particular significant for the school brief, because their acknowledgement envisions the learning experience to happen on the whole spatial layout. In fact, as axial lines cross several spaces, their analysis brings further data to this research, because they refer to several activities in sequences of natural

[615] Full quote from Bernstein on this matter: "How a society selects, classifies, distributes, transmits and evaluates the educational knowledge it considers to be public, reflects both the distribution of power and the principles of social control." (*ibid.*).

[616] See a more detailed analysis of Bernstein's work on chapter 2.3. Adaptability for contemporary learning practices and environments.

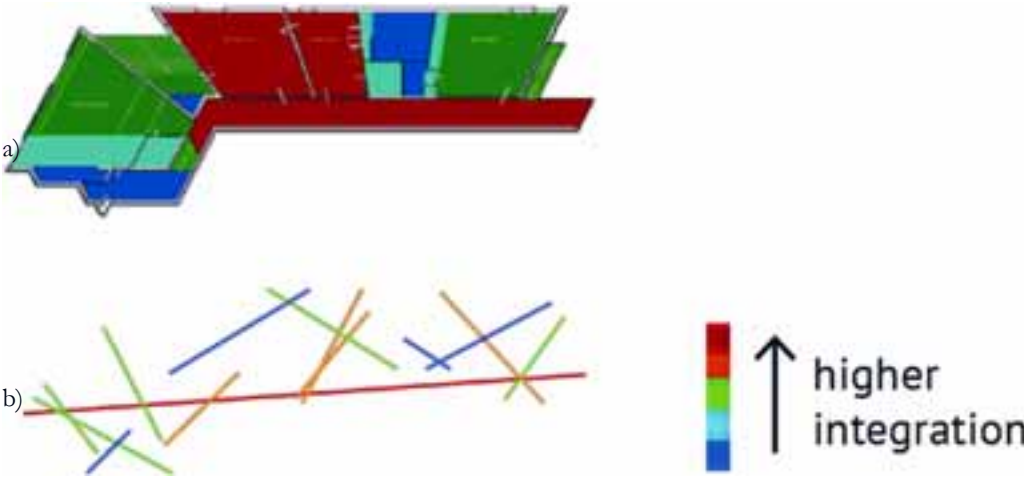


Fig. 131. "An example of how convex and axial representations are mapped on House at Creek Vean, Team 4." "a) An analyse convex map," "b) An analyse axial map"
(MSc AAS student work 2007 @UCL in Al_Sayed, Turner, Hillier, and Iida, 2014, p.12)

movement, thus gathering formal and informal activities and analysing them as a spatial and pedagogical whole. Besides, axial lines also provide data on "shapeless", informal and indeterminate spaces, rather than the formal and defined classrooms, which also hold pedagogical potential, but whose adaptability analysis was not in other ways as deepened.

For such purpose, the space syntax analysis will be primarily undertaken on convex spaces as individual entities and, subsequently, on a topological relation of spaces by axial lines that cross the group of the spaces previously analysed solely. The paralleling of both results will conclude on the relevance of the values encountered in the adjacent spaces towards the actual use of a particular space (Fig. 131).

For a convex space analysis the contours of the spaces will be drawn in Autocad and then imported to DepthmapX (Varoudis, 2012) and linked together, constructing a convex space map whose attributes can be assessed by means of extended charts imported then to Excel software or by means of the maps' coloured schemes, assuming the traditional colour range from warm to cold colours, respectively as the highest to the lowest figures.

For the axial line analysis the same process will be undertaken, although it starts by designing the outlines of the whole space in Autocad and then importing this file to DepthmapX and reduce it to the fewest lines, creating an axial line map,

with subsequent production of the respective charts and coloured maps for the same attributes.

For the purposes of this research, as already referred, the attribute considered most insightful for the description of the school space is global integration, which represents the most significant spaces/lines in the systems. This coincides with literature indications: "The general form of this measure is called integration, and can be applied to any space in any configuration: the less depth from the complex as a whole, the more integrating the space, and vice versa." (Hillier, 2007, p.25).

Local measures will also be assessed, namely connectivity that indicates which spaces are the ones with the highest number of connections towards other adjacent spaces, and mean depth, which refers to the changes in direction from one space to another.

Subsequently, isovists will be analysed, in the form of a VGA analysis, for further information on the visual properties of the system, the features of each "visibility field" (Al_Sayed, et al., p.27) and the "inter-visibility between each pair of points in a layout" (*ibid.*). By gathering these outcomes with the intelligibility assessment it may also bring additional information on the morphological, visual and comprehensible relation between the spaces and the overall spatial system.

All in all, the crossing of the entire results will provide a broader outlook on the patterns of co-presence, both in moving and static activities, and more fully describe the relation between morphology, function(s) and behaviour.

This overall process depicted above, referred to as milestone one, will provide a deeper understanding of the school's brief and layout, the identification of its features and the topological relations between the spaces within the overall spatial system. It will also provide a detailed description of each space's functions(s) and potential activity overlapping, which is quite significant for the entropy approach within the methodology, as the second milestone.

3.3.2. Description of all possible activity allocations to educational environments

> "The pursuit of adaptability can be seen as maximising the looseness of the fit of the known activity schedule into the first-build physical schedule […] Thus the concept of entropy seems likely to be a very helpful tool." (Fawcett, 1976b, p.7)

Milestone two of this methodology is based on an entropy approach to adaptability. It follows Fawcett's assumption that adaptability can be measured in a "precise numerical value" (1978, p.55) provided by an adaptability model (*ibid.*).

This value will represent a figure related to the potential of activity allocation to a space in an ideal scenario, where no other contextual, individual or management constraints bear significance for this allocation. Therefore, this approach embodies the nomothetic perspective within this methodology, informing on the regular and potentially quantifiable activities and allocations by the referred "numerical value".

In fact, Fawcett's studies represent a benchmark on the state of the art for this approach, namely his Doctoral Thesis *A Mathematical Approach to Adaptability in Buildings* (1978) on calculating adaptability and matching adaptability and entropy.

Jaynes considers entropy and uncertainty as "synonymous" (1957, p.622), which can be transferable to the case study as the uncertainty of an activity allocation to a space. This, ultimately, implies that a higher entropy space has a wider range of potential activity allocations, whereas a space where the uncertainty/unpredictability about which activity is currently happening is lower will mean that it has a smaller number of potential allocations. Ultimately, a space with a single function has a very low or non-meaningful value of entropy, because of the full certainty about which activity it is holding. This definition can be paired with Tribus's interpretation of entropy as "a measure of the uncertainty of the knowledge about the answer to a well defined question." (1969, p.119).

Consequently, a high entropy space will be more adaptable, in condition *ceteris paribus* (meaning that we assume that all other variables besides entropy are constant), because its allocation potential is also higher. From these studies entropy becomes close to an adaptability index.

For the current research, this can be translated into spaces' "loose-fit adaptability"[617] (Fawcett, 1978, p.27), which Fawcett paired with Baird's "index for the amount of flexibility" for "the measurement of the link between physical environments and the

[617] "Its measure of flexibility is basically what we term loose-fit adaptability in this thesis." (Fawcett, 1978, p.27)

manmade items which might be placed in those environments at some future date" (1972, p.254), resorting to information theory to achieve the quantitative measures.

Thus, Baird's outlook on flexibility, when applying information theory to the man-environment systems, is similar to the one explained above:

> "If there are many reasonable ways to place the different items in the *PE* [Physical Environment], great flexibility exists, and consequently, a unique match need not occur between the items of the *ME* [Manmade (built) Environment], and the locations of the *PE*. For example, it may be decided that a home, school, and recreation area could be placed equally well in one of many alternative locations. In this case, an information analysis would indicate that little information had been transmitted between the *PE* and the *ME*. That is, knowing a certain location in the *PE* would not assist us in predicting the item placed there because there are many equally likely candidates. At the other extreme, a *PE* may be so unique that only *one* reasonable mapping (reasonable from the planner's standpoint) could exist between its locations and the items of the *ME*. Such a plan has minimum flexibility, and in this situation, the information analysis would indicate that a maximum *amount* (not type) of information was transmitted by the planner."[618] (Baird, 1972, pp.254-255)

This could also be interpreted towards adaptability as a potential adaptability index for estimating the possible allocations between spaces and activities in educational spaces. But it is relevant to understand that, nor Baird, nor this current research, aim at proposing a level appropriateness of the activity allocation to a space by means of the information theory[619], rather than an outlook on the range of them all and their potential variability as operative data for the planner.

For this research, entropy will be calculated by means of the mathematical formulation defined by Shannon (Shannon and Weaver, 1949) under the context of information theory, which was later studied by Jaynes (1957) and Tribus (1969):

$$S = -\Sigma_i \, p_i \ln p_i$$

The relevance of this formulation lies in the results provided towards space and the relation between entropy and adaptability. Even though the mathematics involved on this formulation are not derived or further explained, the original quote by Weaver (1949) is set to clear the meaning of the variables involved:

[618] Italics from the original quote.

[619] "Information transmission is a measure of the uniqueness or flexibility of a man-environment interaction, but it is not a measure of its ultimate "goodness." Such a measure must be based on other criteria." (Baird, 1972, p.256).

> "Although it is not at all the purpose of this paper to be concerned with mathematical details, it nevertheless seems essential to have as good an understanding as possible of the entropy-like expression which measures information. If one is concerned, as in a simple case, with a set of n independent symbols, or a set of n independent complete messages for that matter, whose probabilities of choice are $p_1, p_2 \ldots p_n$, then the actual expression for the information is
>
> $$H = -\left[p_1 \log p_1 + p_2 \log p_2 + \ldots + p_n \log p_n\right],$$
>
> $$H = -\Sigma p_i \log p_i .$$
>
> Where the symbol Σ indicates, as is usual in mathematics, that one is to sum all terms like the typical one, $p_i \log p_i$, written as a defining sample." (Weaver, 1949, pp.14-15)

Following Krüger's studies (1981a), maximising adaptability will mean determining the feasibility matrix that corresponds to the highest "number of biunivocal corresponding matches" between spaces and activity allocations (pp.1171-1172), which can be provided by maximising entropy by means of a mathematical expression, as proceeded in this methodology. Similarly, according to Hillier: "Entropy is maximal in a system when the system is in one of the macrostates for which there are the largest number of microstates" (2007, p.57).

For that purpose, a sample of spaces will be analysed according to their features and respective potential for activity allocation. This can be measured as the entropy of that probability distribution (Fawcett, 1976b, p.7) and as "a unique, unambiguous criterion for the "amount of uncertainty" represented by a discrete probability distribution" (Jaynes, 1957, p.622).

By producing a feasibility matrix, which displays activity allocation per space, it is possible to calculate the entropy of each space. The application of the formulation will present a figure linked to each space. These results can be crossed with the actual occupancy of that space, concluding on whether it is holding an effective and full usage, under or over the initial brief.

It is also relevant to underline that Hillier also pointed out the possibility of analysing entropy by means of a mathematical formulation:

> "In other words, entropy relates the notions of order and chaos into a single concept, but at the same time gives it a much more precise and limited reference to the world. […] It permits the concept to be captured in a formal mathematical expression as well as through words." (Hillier, 2007, p.57).

In fact, DepthmapX (Varoudis, 2012) provides "point depth entropy", by using Shannon's formulation (1949) of uncertainty, hence portraying "how orderly a spatial system is structured from a certain location" (El-Khouly and Penn, 2012, p.5). Thus, DepthmapX provides a measure of entropy, calculated according to the distribution introduced in the software. Entropy is here understood according to Hillier's definition (2007) and "corresponds to how easy it is to traverse to a certain depth within the system (low disorder is easy, high disorder is hard) […]" (Turner, 2001, p.7-8).

However, while DepthmapX's "point depth entropy" indicates the degree of disorder from a particular point in the system analysed by its spatial morphology[620], for this research the distribution is another. Here, entropy is not only conditioned by topology but by functional use caused by the design options and physical features of each space, which introduces constraints in the activity allocation, and thus, a diversity in the spatial sample. So, this calculation does not only indicate a pattern of movement but rather relates also to activities, informing further on the effective use of space towards the learning process[621].

Having said that, it becomes clear that the concept of entropy has a wide scope in definitions, approaches and authors of reference. From a more subjective approach from Shannon (later studied by Jaynes and Tribus) to a more objective one from Wilson, this Thesis will have to first define what is the definition used and why is it considered to be the most adequate for this methodology. Overall, it *measures entropy* rather than *predicting* a degree of uncertainty. This is because the subjective approach introduces more information in the entropy measurement rather than using a more objective and isotropic distribution. The capacity constraints that are applied to allocate only a set of activities to spaces that are physically able to cope with them, makes the distribution closer to the actual scenario, to the spaces and to the activities of that school and hence, the uncertainty degree is lower and closer to that real activity/space allocation. This is much different than Wilson's parameter estimates of an objective approach like coin-tossing, because not all microstates have the same likelihood of happening in this school[622].

Accordingly, the process of calculating the entropy of the system will be done by a sequential production of specific matrices (Coelho and Krüger, 2015) from the data collected from milestone one, as follows in Fig. 132:

[620] "Calculating point depth entropy can give an insight into how ordered the system is from a location" (Turner, 2001, p.7)

[621] Overall, it informs on the degree of disorder introduced according to the spatial features of each space and axial line and respective activity allocation potential.

[622] This matter has also been discussed in an email exchange with William Fawcett in December 2015.

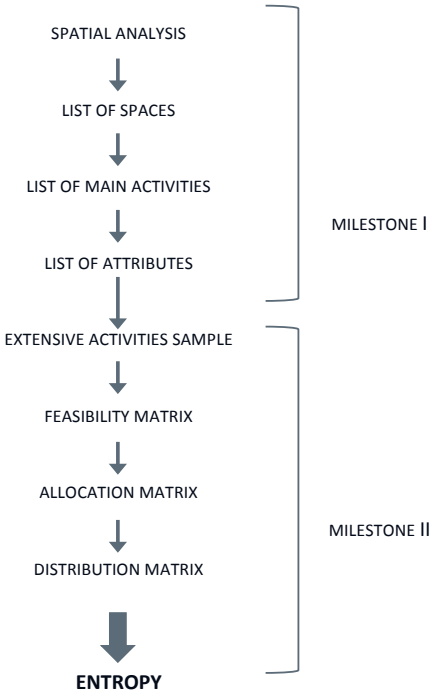


Fig. 132. Sequential procedure for measuring the entropy of the system
(Carolina Coelho)

After the initial spatial identification of the school, understood as part of milestone one, it is possible to list the potential activities that can occur in those spaces. This will be specifically applied in the case study, in an original way, considering all possible activities in a tree-shaped scheme that starts with the most general domains to the most detailed ones, like so:

. Domain I) Corresponds to types of spaces in relation to the learning process. They could either be: active learning environments or supportive environments, in which the first hold effective learning activities whatever their nature, considered to be the "end-activities" of the school, and the latter support the activities held in the first, identified as the "means-activities" (Krüger, 1992, p.7)[623].

. Domain II) Corresponds to the nature of the uses: curricular or extra-curricular. Curricular activities are the ones acknowledged within the pedagogical curriculum of the school, whereas extra-curricular activities are activities that could also bear pedagogical potential but are not included in the school's curriculum.

. Domain III) Corresponds to types of activities: programmed or non-programmed. According to Krüger (1992) programmed activities are related to a

[623] Translation from the Portuguese respectively by: "actividades-fim" and "actividades-meio".

functional schedule and a work routine (usually a weekly schedule), whereas non-programmed activities are related to spontaneous or non-repetitive activities and present an "irregular usage of the space" (Krüger, 1992, p.7).

It is of the utmost importance to underline that non-programmed activities today may be academic and comprehended in the school's pedagogical curriculum, due to the relevance of informality for the current learning model. Therefore, active learning environments can accommodate curricular and extra-curricular activities, which can be considered both programmed and non-programmed, according to their specificity, the users involved, the frequency of those activities and whether they are contemplated in the school's curriculum or not.

Specifically, programmed academic activities are related to classes, in the shape of lectures, evaluation classes, group work formal activities or any specific class included in the school's curriculum. Whereas non-programmed curricular activities can also be classes that do not happen weekly, but rather sporadically, or occur due to a specific need or any curriculum's schedule constraint or specificity.

Also, extra-curricular activities can happen both in supportive learning environments like the activities related to the Administration, or can also be held in active learning environments. In this case, these can be: learning activities, social interactions amongst all users, peer interaction only or, more specifically, they can take the form of external displays. All the former activities create moments for learning, whether programmed or non-programmed. The non-programmed, extra-curricular activities like circulation can also be considered prone on learning, because although patterns of movement are not programmed, the learning process can also occur amongst pathways, by means of peer socialisation or spontaneous encounters with anyone from the school community that enables communication and knowledge exchange.

Nevertheless, some of these activities are mutually exclusive, which is the case of learning activities in supportive environments, or circulation as programmed activities, which have been disregarded. So, supportive learning environments accommodate programmed and non-programmed activities, but deployed of a pedagogical nature, like general interaction amongst the school community, formal activities supportive of the learning process, such as the work from the Administration and circulation, specifically as a non-programmed activity.

. Domain IV) Corresponds to teaching regimes held by the pedagogical curriculum of the school in which the methodology will be applied. This could vary from the regular teaching alone, to others like the artistic teaching or the external teaching, done by the school's educators or by associations that use the spaces outside the school schedule.

. Domain V) Corresponds to activities in each identified teaching regime, detailed according to the subdivisions and previous domains.

ACTIVITIES - SAMPLE

DOMAIN I	DOMAIN II	DOMAIN III	DOMAIN IV	DOMAIN V
EDUCATIONAL DOMAIN	**TYPES OF USES**	**TYPES OF ACTIVITIES**	**TEACHING TYPES**	**DETAIL OF THE ACTIVITIES**
Active learning	Curricular	Programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
		Non-programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
	Extra-curricular	Programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
		Non-programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
Supportive	Curricular	Programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
		Non-programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
	Extra-curricular	Programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5
		Non-programmed	Type 1	A 1, A2, A3, A4, A5
			Type 2	A 1, A2, A3, A4, A5

Fig. 133. Activities sample of an abstract scenario
(Carolina Coelho)

The matrix (Fig. 133) corresponds to a blank activities sample, with the referred domains, to be filled in with further detail, according to the case study's specificities.

In order to produce the methodology, several procedures have been studied. From Fawcett's 1976 approach on the "loose-fit" method on his paper *Measuring Adaptability*, a feasibility matrix will be done that links the spaces identified in the school (not space-types, but actual spaces located in the plans), with the activities that happen there. From the spatial attributes it is possible to match activities to spaces and produce this matrix. This approach does not consider a particular time period, because it would imply combinatorial models for the possible allocations for each time period.

So, a feasibility matrix will be produced, by matching all the previous identified spaces with the activities in the sample (Fig. 134). This matrix points out the activity allocation potential of each space in an abstract scenario, ideally identifying all the activities that all spaces are physically prepared to shelter.

FEASIBILITY MATRIX

ACTIVITIES SAMPLE					SPACES																				
DOMAIN I	DOMAIN II	DOMAIN III	DOMAIN IV	DOMAIN V	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Active learning	Curricular	Programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
		Non programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
	Extra-curricular	Programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
		Non programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
Supportive	Curricular	Programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
		Non programmed	Type 1	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
			Type 2	A1																									
				A2																									
				A3																									
				A4																									
				A5																									
	Extra-curricular	Programmed	Type 1	A1																									
				Total																									
				activity allocations per space																									
				ai/ Σai	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Fig. 134. Feasibility matrix of an abstract scenario to be filled in (Carolina Coelho)

Then, it will also be possible to cross the number of activities that each space is potentially able to allocate with the range of all activities accounted for in this study and listed in the activities sample produced from scratch for the methodology. From that feasibility matrix of spaces to activities, conclusions can be drawn on the most relevant spatial features towards adaptability and the ones that, when provided to a space, potentiate a higher range of uses.

By determining which are the spaces with the highest and lowest range of activity allocations and studying their respective spatial attributes pointed out in Fig. 129 - according to their respective dimension, configuration, coating, networks, environmental conditions and accessibility - this will inform which features are present in the analysed spaces and, ultimately, which attributes enable higher activity allocation, because they provide the space with the ability to hold further uses. From then, professionals can be informed on the cost/benefit of introducing a particular design solution and which spatial features have stronger and lower influence on the building's adaptability.

Afterwards, an allocation matrix will be developed that joins activity allocations per domains of activities. This is what Fawcett entitles "matrix $\{s_{ij}\}$, of all allocations", holding "integer entries" (Fawcett, 1978, p.181). At this point the procedure implies a choice on the distribution to be analysed, whether a more or a less disaggregated one. A more disaggregated distribution is one that holds deeper complexity, because it has a wider range of items to be accounted for, and the less disaggregated has less groups of activities to estimate partial calculations. In this case, if the distribution is chosen for domain III it will be less disaggregated than for domain IV, because the one for domain IV has additional detail and items (Fig. 135).

For this research, and in order to provide a more complete outlook on the methodology to be validated and in the case study in which the methodology will be applied, it is considered to be significant to consider two distributions: a more and a less disaggregated. This will inform whether the degree of aggregation of the probabilistic distribution analysed bears significance for the analysis, if it provides different entropy results and which distribution proves to have higher correlation with the other parameters, namely with integration, connectivity and mean depth. All in all, the final results will potentially establish new data for the methodology itself and also for the correlation analysis between entropy and integration, which aims to be innovative and to bring the architectural knowledge forward in this matter.

Next, a distribution matrix will be produced by dividing the number of grouped activities for each space by the overall number of potential activities for that space

ALLOCATION MATRIX _ DOMAIN III

ACTIVITIES SAMPLE			SPACES																								
I	II	III	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
I a)	II a)	III a)																									
		III b)																									
	II b)	III c)																									
		III d)																									
I b)	II c)	III e)																									
		III f)																									
	II d)																										
allocations per space			0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	14	0	9	0	0	0	0	0	0	0

ALLOCATION MATRIX_DOMAIN IV

ACTIVITIES SAMPLE				SPACES																								
I	II	III	IV	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
I a)	II a)	III a)	IV a)																									
			IV b)																									
			IV c)																									
		III b)	IV d)																									
			IV e)																									
			IV f)																									
	II b)	III c)	IV g)																									
			IV h)																									
			IV i)																									
		III d)	IV j)																									
			IV k)																									
			IV l)																									
I b)	II c)	III e)	IV m)																									
			IV n)																									
			IV o)																									
		III f)	IV p)																									
			IV q)																									
			IV r)																									
	II d)																											
allocations per space				0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	3	0	0	0	0	0	0	0
			pi e1 /	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Fig. 135. Allocation matrix of an abstract scenario to be filled in
Domain III _ less disaggregated
Domain IV_ more disaggregated
(Carolina Coelho)

DISTRIBUTION MATRIX_DOMAIN III

ACTIVITIES SAMPLE			SPACES																								
I	II	III	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
I a)	II a)	III a)																									
		III b)																									
	II b)	III c)																									
		III d)																									
I b)	II c)	III e)																									
		III f)																									
	II d)																										
allocations per space			0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	14	0	9	0	0	0	0	0	0	0
S = ENTROPY																											

Fig. 136. Distribution matrix of an abstract scenario to be filled in for Domain III
(Carolina Coelho)

(Fig. 136). This is what Fawcett entitles "stochastic matrix, $\{t_{ij}\}$, by diving all entries by the total number of allocations, S" (Fawcett, 1978, p.181). Finally, Shannon's entropy formulation: $S = -\Sigma_i pi \ln pi$, will be applied to all these spaces, presenting an entropy figure for each space, that can be ranked and analysed.

From this final matrix it is possible to derive the entropy of each space by using Shannon's formulation on the values from each column on the matrix. This will provide a value of entropy for that space. At this point, this methodology diverges from Fawcett's approach, because this does not considerer activity-schedules and also introduces Shannon's formulation to derive the entropy for subsequent critical analysis.

This process overall studies "the property of many-statedness"[624] rather than states, activity-schedules and space-types per time unit. As realised by the previous explanation of the methodology and the expected results, the final outcome introduces a figure linked to each space overall, not regarded to any schedule. So, this process aims to measure the possibility of allocating an activity to a space, according to each space's physical attributes like: dimension (high, length, width), configuration (openness, partitioning), coating (floors, ceilings), networks (power access, connectivity), environmental conditions (temperature, acoustics) and accessibility (direct, by means of a lift, staircases or ramp); which may constrain or enable activity allocation to a space[625].

Conclusively, if the spaces with the highest entropy have common spatial features, it is possible to identify which ones are more significant for a higher adaptability. Ultimately, this will potentially provide guidelines to choose the attributes for a more adaptable space and the cost/benefit of introducing each one.

All in all, this methodology is supported by the studies on building adaptability representative of the state of the art, but critically projects them to the current paradigm of the learning process and learning spaces. So, following Hertzberger's concept of the "learning street" (2008, p.113), another novelty introduced by the research is the analysis of the adaptability potential of the learning environments, within a broader definition, already considered in the previous procedure.

Accordingly, after the analysis of convex spaces and axial lines through space syntax, entropy will be calculated not only for all the convex spaces, but it will also provide an entropy value to the axial lines recognised in milestone one of the methodology.

[624] Expression used by William Fawcett in December 2015, in one of many emails exchanged during the research process.

[625] This matter has also been discussed in an email exchange with William Fawcett in December 2015.

For this purpose, this research introduces two original concepts on calculating entropy for axial lines: ""axial line entropy" […] calculated as the sum of the entropy of all convex spaces intersected by this axial line" and ""average axial line entropy" […] calculated, by dividing the axial line entropy by the number of convex spaces intersected" (Coelho and Krüger, 2015, pp.17:11[626]), as follows:

AXIAL LINE ENTROPY: $S_i = \Sigma_k S_{ik}$

S_i entropy of axial line i

S_{ik} entropy of convex space k intersected by axial line i

AVERAGE AXIAL LINE ENTROPY: $AS_i = \Sigma_k S_{ik}/NK$

AS_i average entropy of axial line i

NK number of convex spaces intersected by axial line i

After measuring the entropy of each individual space, the grouped spaces taken into consideration in the sample will also had their total entropy calculated. By the formulation presented, the values estimated will, logically, be a product of the individual spaces' entropy that each axial line intersects, varying accordingly. Naturally, it will increase as the axial line intersects more spaces and also if the spaces intersected hold themselves higher entropy values.

The "average axial line entropy" will also be defined by the number of spaces intersected by that axial line. Therefore, if it intersects a high entropy space but also numerous others spaces with low entropy, the final figure will diminish because of the low entropy of the remaining spaces. So, it increases with the increase of the average entropy of each space and decreases with the number of convex spaces for the same number of average entropy of that axial line.

In Fig. 137 a representative axial line is highlighted in red that crosses an extensive range of convex spaces in Quinta das Flores School, therefore if the entropy of the spaces it crosses is high so will its axial line entropy and average axial line entropy be, but if it is low and because it crosses so many convex spaces, these values will naturally diminish[627].

[626] These concepts have been presented for the first time in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London, for peer validation. This communication was published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

[627] This study and the analysis of each of the axial lines from the spatial sample chosen from Quinta das Flores,

Fig. 137. Floor plan of Quinta das Flores School with its several convex spaces and a representative axial line (in red)
(Carolina Coelho)

3.3.3. Description of effective events and experience in the school

> "Users are continuously making design decisions as they move scenery around on a day-to-day basis to match changing demands." (Worthington, 2007, p.17)

After assessing the full and expected activity allocation potential of the spaces, the following procedure, milestone three of the methodology, focuses on describing their effective occupancy, adding further information on spontaneous and non-programmed activities, not referred in the activity sample used for the entropy measuring.

Such a qualitative approach focuses on behaviour, actions and the way by each people interpret their experience in the world. Subjectivity is here acknowledged as a part of individual spatial fruition and a filter between the actual built environment and the way people experience and appropriate space (Minayo, Souza and Santos, 2005, p.85).

So, for the assessment of space, after portraying the sample in its physical features, it will also be significant to conceive space in regard to the experience it provides, beyond the physical objects *per se*, and exploring what it implies to the individuals' experience, embodying Hill's words: "[…] architecture is not just a building. It is, primarily, a particular relation between a subject and an object, in which the former occupies the latter [...]" (1998, p.7).

Assuming that each method will provide different conclusions, this methodology resorts to observation matrices, walkthroughs and focus groups[628], for depicting individual experience and spontaneous appropriation, adding information on the

will be dealt in detail in chapter 4. Application of the methodology in the case study.

[628] These procedures will be developed in the following pages of this chapter.

Fig. 138. Illustration of observation practices.
a) "An example of snapshot at observation at Belén Library Park"
b) "An example of tracing observation at Belén Library Park"
c) "Aggregating all snapshots and tracings in a single GIS file"
(Capillé and Psarra, 2015, p.8)

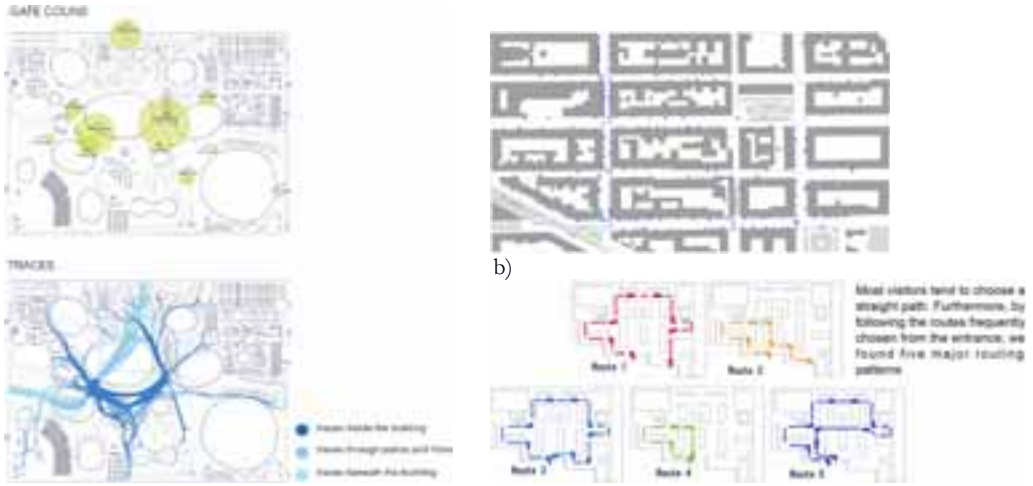
adaptability potential of spaces for non-scheduled learning activities.

Observation matrices aim to recognise patterns of movement and use and to identify invariables and fluctuations in those patterns. They comprise a report on the nature and density of the activities acknowledged in a specific time period and repeatedly in several intervals during a whole day.

Particularly for the analysis of a school by observation matrices it is relevant to choose the most representative time periods like: the morning arrival, the lunch break and the evening exit; as well as specific observation dates, such as: a regular school day, the examinations' phase, or a community event day. These are considered to be the schedules in which more users converge to the common spaces and, hence, with a higher and more dense patterns of natural movement and activities. It is also done in the spatial clusters acknowledged as the most significant for spatial occupancy, such as: the main hall, the cafeteria and the main corridors.

This procedure also recognises the specific diversity of meaningful time periods for observations, due to the numerous extra-curricular activities a contemporary school holds, even after school hours, which also acknowledges a wider community of users within each spatial cluster performing activities of different nature. This validates the school's potential to be more often and intensively used.

Iconographic representations can be considered a straight way to illustrate those observations of spatial experience, whether by free-hand drawing or drawing over the school's plans, in order to depict the activities occurring in the spaces analysed.



a) b) c)

Fig. 139. a) "Observation analysis"
(Aragüez and Psarra, 2015, p.16)
b) "Snapshot data from the study areas showing the amount of pedestrians: […] SoFo"
(Choi and Koch, 2015, p.6)
c) "Five major routing patterns at the Keio Techno Mall."
(Naya, Yamada, Kishimoto, 2015)

This process has already been undertaken by authors of reference, as useful and straightforward means to illustrate observation matrices, considering it a proven tool for retrieving information and to systematise the uncovered results. This is proven by the figures 138 and 139, which illustrate the wide variety of potential layouts that the iconographic representations can take, the variables that can be analysed under the scope of spatial experience, and also on a wide range of working scales (either on the city, the building or a single space) by various authors.

It is also used by pointing out densities of users within convex spaces or pathways, by means of a density of dots on the plans (Fig. 139b) or by other types of representations where effective quantitative amounts are displaced or represented by the width or density of the routes identified, for actionable knowledge on effective spatial occupancy per cluster (Fig. 139a).

According to each of the authors of reference, even in the examples shown (chosen due to the representativeness and clarity of the iconographic representations and the information that they can hold), they are generally a product of observations whose results can be retrieved either manually of by digital means (see the differences in Fig. 138 a), b) and c) and their respective captions).

But also for the current theoretical presentation of the methodology in this chapter, the schemes, models and plans are representative, and their actual and effective application in the case study will be described on the following chapter 4[629].

[629] See chapter 4. Application of the methodology in the case study.

Walkthroughs are another procedure to assess experience. Logically, that several sampling criteria could be proposed for the selection of the population under study, which vary according to the references and study fields, from social research (Neuman, 1996; Bryman, 2008) to a more mathematical nature of the sample (Hansen, Hurwitz and Madow, 1953a and 1953b; Levy and Lemeshow, 1999; Jessen, 1978). This could be either as a "probability" or a "non-probability or non-random sampling method", according to a possible bias on the selection of the population or not (Bryman, 2008, pp.168-169). The most relevant criteria should be the representativeness of the population, in which there is "a sample that reflects the population accurately", ultimately, "to be able to generalize your findings from your sample to the population from which it was selected" (Bryman, 2008, p.168).

For the purpose of assessing effective spatial fruition in active learning environments in the school, it is considered to resort to assorted focus groups of the internal school community, each with a common denominator, such as: students and educators from each specific teaching. This procedure aims to recognise how the school community moves and acts in space and what are the main pathways each focus group choose. Hence, the need for a thorough identification, a "sampling method by clusters" (Hill and Hill, 1998, p.29) composed by representative groups of people within the school community.

Naturally, the wider the variety of users and uses in the school, the greater the complexity of this procedure and the number of walkthroughs necessary to better describe the school's experience and appropriation. Likewise, the diversity of informal or non-programmed activities in a variety of school spaces, increasingly broadens the range and nature of the activities into consideration.

All in all, it provides information on the possible routes taken by the school community and their representativeness and density within the defined pathways (Fig. 139c).

Afterwards, within a last procedure for assessing spatial experience, each person from each previous focus group identified is asked detailed questions, adding information on specific situations recognised in the previous walkthroughs. Focus groups, overall, aim to provide qualitative information of spatial experience, rather than inquiries.

In fact, in inquiries the questions placed are limited and often resort to multiple answers, restricting the possibilities of experiencing space to the answers considered, and providing mostly a quantitative outcome. By contrast, in focus groups, the detail of the questions is chosen according to the purposes of the research and is done in the form of recorded interviews on individual experience and personal opinion (Minayo, Souza and Santos, 2005, pp.96-97), with subsequent critical analysis. For analysing school facilities, the focus groups consist mostly of a set of students and a set of educators.

3.3.4. Description of the potential correlations and retrieval of the school's adaptability

> "Strategic decisions made at the beginning of all design processes (typically, when little information is available) always have great influence on initial performance and on long-term consequences […] In the subsequent life cycle phases (e.g. in a refurbishment) design also assumes a long term impact; it must ensure or recreate the adaptability of the building to meet future needs." (König, Kohler, Kreißig and Lützkendorf, 2010, p.19)

After having produced a critical analysis of the data gathered on the individual approaches from specific academic fields, the fourth and final milestone of this methodology aims to display an insightful outlook on the possibility of analysing an educational space by these several procedures, but foremost to demonstrate its relevance and originality when used within a hybrid methodology. This sustains the possibility of a transversal gathering of approaches to be prolific for both the practice and the academia:

> "[…] the practical relationships between the sciences have been successful in producing a richer and more vital interaction between the various provinces of scientific research than perhaps would have been the case had they been interrelated on the basis of the more abstract criteria employed in the scientific academies." (Windelband, 1894, p.172)

The data gathered in each sequential milestone will be transferred to the next as Schön's (1983) "reflection in action" process, ultimately to provide a general conclusion on the case study's adaptability and the respective prominence of the partial results.

The significance of the methodology resides firstly in the fact that, because it is applied to contemporary educational spaces prone on both formal and informal learning environments, as vehicles for peer collaboration and communication, it also takes that into consideration while assessing both formal and informal spaces. Furthermore, within the first two milestones, an analysis will be undertaken of the formal spaces by themselves, followed by the same analysis on grouped spaces as a whole and significant space in which learning occurs.

Therefore, assuming the specificity of today's active learning environments, whose configuration can widely vary according to the diverse range of activities that contribute to the learning process[630], it has been considered relevant to analyse the school building not only by its convex spaces but also to assume the pathways as possibilities for learning.

[630] See chapter 2.3. Adaptability for contemporary learning practices and environments.

As previously seen, on milestone one, charts and graphs will be produced on the axial lines and convex spaces of the sample, for local and global syntactic properties, as a means to further understand part-whole spatial relationships and space's individual representativeness towards to whole system. Then, the entropy of each convex space and axial line will be measured and charts will be made with the end results.

Hence, one of the expected outcomes of this research is to demonstrate whether the entropy levels achieved by means of the mathematical expression are correlated with spatial morphology assessed by space syntax, in order to identify the degree of adaptability of a building and its ability to physically cope with a vaster range of activities.

Consequently, the relevance of this methodology also lies in the correlation between convex spaces and axial lines within a space syntax and an entropy approach, followed by a comprehensive analysis of the potential correlation between the individual results. Overall, the methodology identifies the spaces whose individual values and overall correspondence between all approaches are higher, in order to inform on the most significant adaptable environments.

In fact, when the space syntax analysis is paired with mathematical entropy calculations for each space, conclusions can be achieved on its quantitative allocation potential, assuming that higher entropy implies a more adaptable space. Furthermore, the paralleling of both approaches may also conclude on the relevance of these variables towards the actual use of a particular space. E.g. space *x* and *y*, sharing the same spatial features, and hence the same entropy levels, can present different values of integration, depth and connectivity and hence, despite their similar potential to allocate activities, their actual use may differ, because of their spatial morphology within the school system. Besides, the fact that space *x* is closer to space *z*, which has the highest value of integration, when grouped within the same axial line, will naturally interfere with the end value of these parameters, and thus, with its adaptability as the end conclusion.

Besides, the importance of this methodology is also supported by the originality of the analysis of the two differently aggregated distributions analysed for the same variables, concluding on their potential correspondence towards adaptability.

Thus, scattergrams will be produced that correlate space syntax's integration with entropy calculations for both convex spaces and axial lines. The correlation will be analysed for both distributions, in order to understand which one proves to have higher determination coefficients and hence, to be stronger. If the most integrated axial lines intersect the spaces with the most significant values of entropy, this will support a noticeable correlation between syntactic integration and entropy.

Should this correlation between axial line integration and entropy be the strongest,

this will bear significance at a pedagogical perspective as explained earlier, by recognising the then proved potential of informal and open spaces towards knowledge transmission, and corridors or sequences of spaces to act pedagogically.

It will also confirm a higher possibility of spaces with high entropy to be experienced by users in various ways and highlight the significance of informality and non-programmed activities, particularly for this school's curricula and students.

Syntactic intelligibility will also be considered in order to demonstrate a potential correspondence between the most intelligible distribution (whether by convex spaces or axial lines) and the stronger entropy/integration correlation.

Additionally, this research also intends to conclude on the relevance of the potential correspondence between spatial morphology and high entropy levels towards building performance, its actual spatial usage and the learning process within both formal and informal strands. Therefore, another possible conclusion is the analysis of a possible overlapping of effective and full activity allocation, by crossing the feasibility matrix of all activity allocations to the effective allocations for a specific time period. The outcomes will describe the school's current scenario, regarding its overall functional potential and may also point out external variables, such as management decisions to influence activity allocation or the school's agenda overall.

Furthermore, from this methodology it is also possible to conclude not only on the representativeness of morphology, but also of spatial features, towards adaptability, by cross-referencing the acknowledged high and low adaptable spaces with their respective attributes, like: dimension, configuration, coating, networks, environmental conditions and accessibility. Its final outcome potentially provides a comprehensive outlook on spatial analysis and a methodological development on architectural research, to be applied to other schools or other design briefs.

Finally, the procedures for understanding experience and appropriation by qualitative methods will potentially imply that a space can be used for a specific purpose but could also, before management decisions or informal spontaneous appropriation by the users, hold other activities rather than the original ones from the brief. This will vary according to the profile of the community analysed, which in this case is particularly relevant, because it introduces a wider range of activities to be considered.

Besides, these methods will also promote a reflection upon the degree of appropriation the school enables. If this proves to be significant, following Hertzberger's outlook that: "[…] architecture should offer an incentive to its users to influence it wherever possible, not merely to reinforce its identity, but more especially to enhance and affirm the identity of its users." (1991, p.148). This will be admittedly recognised if the

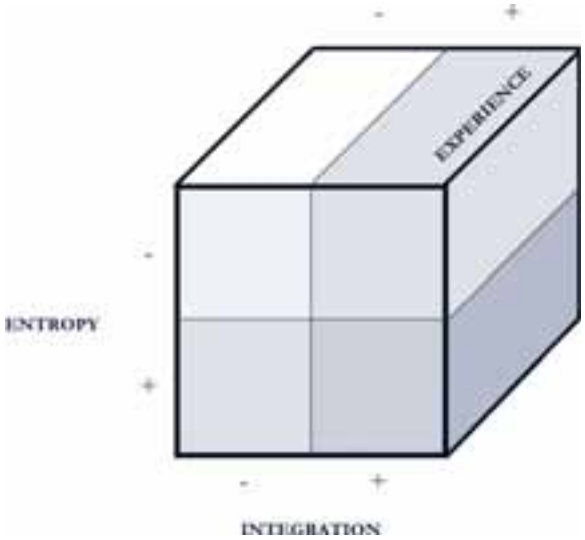


Fig. 140. Analysis of the potential correlations between
Integration, Entropy and Experience from the milestones of the methodology
(Carolina Coelho)

school community proves to be creative and spontaneous when experiencing space through non-programmed and informal activities, perceived in the walkthroughs and by means of observation matrices and focus groups.

All in all, the multi-stage procedure this methodology implies, will introduce a reflection upon the potential correlations expected to be found. Firstly, results will be analysed amongst each stage: regarding the analysis of the school space, namely with the global and local syntactic measures studied; regarding convex and axial entropy; and lastly on experience and appropriation. Then, it will be possible to point out which spaces have the highest and lowest values on each of these stages. Subsequently, the retrieved results will be correlated amongst the several stages of the methodology, in order to understand a potential correspondence mostly between integration, entropy and experience.

Conclusively, if spaces with recognisable values of entropy also represent some of the most integrated and connected ones and the most significant for users when experiencing space, this will also indicate a potential correlation between activity allocation, integration and appropriation, and ultimately towards adaptability (Fig. 140). So, a more thorough study on their spatial attributes (indicated on milestone one), will provide information on which features potentate adaptability and the cost and benefit of introducing each one in a particular space, its relevance for enhancing the adaptability of that space and increasing their allocation potential.

Ultimately, and recognising the importance of the educational spaces towards learning, this methodology will conclude on the potential correspondence between

spatial morphology and high entropy levels towards actual spatial usage and building performance. These outcomes provide in-depth data on the potential overlapping of attributes, spaces and activities towards adaptability, whose input can inform future projects on the design strategies that will affect the building's occupancy, ability to cope with change and overall lifecycle extent.

It could be argued that the Thesis is evaluating a possible methodology or rather the school where it is applied in. It is therefore believed that the originality of this Thesis lies first on the methodology, the fact that it is a hybrid methodology that recurs to different approaches to a more supported conclusion, and also the fact that it is applied to active learning environments today, which are broader in shape, size and definition from the traditional classroom. And by measuring "axial line entropy", corridors and sequences of spaces, generally informal, but that also hold pedagogical potential today, can also be considered and evaluated by this methodology. Naturally, because this is applied to a case study, it is also being evaluated and its degree of adaptability is, then, an ultimate conclusion. But, as future developments, subsequently to this Doctoral Thesis, it could be of interest to test it in other schools, whose outcomes may possibly differ.

As a final remark, it is also relevant to underline the prominence of the iconographic representation, in its so many diverse possibilities, visual layouts, nature and variables under analysis. The iconographic representation by means of a functional analysis of the plans will play a relevant role on the early depiction of the overall space, by placing coloured hatches in each of the spaces according to an analytical study of the brief and how it is translated onto the built spaces. The drawings produced in Autocad to be introduced in DepthmapX software are also a means to reach to charts and graphs that use colour and figures to best illustrate conclusions and differences in the syntactic variables analysed. Then, entropy calculations produced also with Excel software provide charts that rank the results encountered and also tables and scattergrams for conclusions on compared results. Finally, and as explained earlier, iconographic representations also play a relevant role in describing spatial experience, in a less analytical manner than the latter procedures referred, but as an immediate way to depict information under observation.

All in all, drawings, pictures, models and schemes, illustrate immediate observations, systematise results, rank the figures on a particular variable, and lead to conclusions under potential comparisons and respective interpretations. Hence, iconographic representations will be a significant tool within this methodology, whether by plans, free-hand drawings, annotations over the plans, tables, charts, graphs, scattergrams, or photo or video recordings, each on its particular milestone of this methodology, because they all introduce data to reach a comprehensive and more robust conclusion on the problematics.

4. APPLICATION OF THE METHODOLOGY IN THE CASE STUDY

Quinta das Flores School in Coimbra, Portugal

4.1. Presentation and justification of the chosen case study

> "The differences and uncertainties regarding the brief advised that the proposed project had the intrinsic quality of future metamorphosis capacity."[631] (Santos, 2013)

The case study where the methodology will be applied is Quinta das Flores School in Coimbra, a Basic and Secondary regular teaching school existing in a 1968 building with a scattered pavilion layout, that was joint with the Artistic School of the Music Conservatory of Coimbra[632], by the rehabilitation made in 2008-2009, under the Secondary School Modernisation Programme (Figs. 141, 142 and 143).

For the purposes of this Doctoral Research the methodology to be applied will be done considering the regular teaching school and the artistic school as a whole school[633]. Even though, for administration purposes, the schools are considered separately, which is proven by the external evaluations and internal regulations (Escola Básica e Secundária Quinta das Flores, 2015a; 20015b; 2014; Escola Artística do Conservatório de Música de Coimbra, 2015; Delegação Regional do Centro da Inspecção-Geral da Educação, 2010; 2011; Inspecção-Geral da Educação e Ciência, 2014b, 201c) that are done separately, but for the aims of this research, under a disciplinary scope on architecture, it is the shared space which is the focal point, rather than its independent administrative management. And so, considering that the new central building is shared by both the artistic and the regular schools, it will be considered as one compound with a wide range of activities, a broad curriculum and an extensive community. For future reference, and although they are individually named "Quinta das Flores Basic and Secondary School" and "Artistic School of the Music Conservatory of Coimbra", the space under assessment will be entitled Quinta das Flores School, acknowledging both teaching regimes and understanding that their administrative boards work in a shared space.

In addition, for the purposes of the Secondary School Modernisation Programme,

[631] Free translation of the original quote in Portuguese: "As diferenças e indefinições do programa aconselharam ao proposto projecto a qualidade intrínseca de futura capacidade de metamorfose." (Santos, 2013).

[632] The conservatory will be mentioned without capital letters as well as the school, its name in capitals will only be done when a quote uses it originally or when the full names are recalled; Music Conservatory of Coimbra or Quinta das Flores School.

[633] After an initial brief presentation of the case study in chapter 1.5., this current chapter 4.1. intends to study the building more fully and specifically focused on the application of the proposed methodology.

Fig. 141. Quinta das Flores School _ Location in Portugal identified with a red dot (Google Earth)

Fig. 142. Quinta das Flores School _ Location in Coimbra identified with a red dot (Google Earth)

Fig. 143. Quinta das Flores School _ Bird's eye view of the all school (Google Earth)

as the space to be modernised is assigned to both regular and artistic schools, it is considered as only one equipment called "Escola Básica e Secundária Quinta das Flores / Conservatório de Música de Coimbra" (Parque Escolar, n.d. b).

According to the latest External Evaluation of Quinta das Flores School *per se,* the modernisation process on this school offered "modern"[634] and "adequate facilities" namely "the library, labs, teachers' rooms and sporting facilities" (Inspecção-Geral da Educação e Ciência, 2014b, p.2)[635]. This complies with the previous report that admitted that the facilities "provided the users with good working conditions and comfort"[636] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.3)

Specifically, the Music Conservatory of Coimbra, dates from 5th September 1985, legislated by the law "Portaria nº 656/85" as a public equipment for the specialised teaching of Music (Escola Artística do Conservatório de Música de Coimbra, 2013, p.4). Since its creation, it has been placed in several buildings since its creation. In February of the following year it started working in a palace[637] from the City Hall located in Cerca de São Bernardo in Ladeira do Carmo. Then, in October of the next year it has been displaced for the rehabilitated building of the old maternity in Sé Velha, provided by the District Council of Coimbra[638]. Meanwhile, in the academic years of 1996/1997 and 2002/2003 it has also been sited, at the same time, in the Institute of Coimbra in Rua da Ilha, due to a protocol with the University of Coimbra and this Institute. From the academic year of 2003/2004 to 2010 the conservatory has been placed in a part of D. Dinis Secondary School's facilities in Rua Adriano Lucas (Escola Artística do Conservatório de Música de Coimbra, 2013, p.4; Delegação Regional do Centro da Inspecção-Geral da Educação, 2010).

So, only twenty-five years after its institution, in 2010, has the Music School gained a home specifically built for its purpose, in Rua Pedro Nunes, a space also shared by Quinta das Flores Basic and Secondary School. In the following year its designation has been altered to "Artistic School of the Music Conservatory of Coimbra" because all Music Schools have had that title included in their names (Escola Artística do Conservatório de Música de Coimbra, 2013, p.4).

The Music School has its facilities in the new building (Fig. 144), distributed in

[634] According to the full quote, modern in this context will imply a contemporary, and even future-forward, design solution.

[635] Free translation of the original quote in Portuguese: "A Escola Básica e Secundária Quinta das Flores situa-se no Vale das Flores da cidade de Coimbra, ocupa uma área extensa, dispõe de novas e modernas instalações e de equipamentos adequados, destacando-se a biblioteca, os espaços laboratoriais, os gabinetes de trabalho para docentes e as instalações desportivas. Este campus escolar acolhe também a Escola Artística de Música do Conservatório de Coimbra com quem partilha espaços específicos apropriados (auditório, salas de dança, sala de professores, secretaria, entre outros)." (p.2)

[636] Free translation of the original quote in Portuguese: "Dispõe de novas e modernas instalações e de equipamentos adequados, resultantes da intervenção recente da Parque Escolar, E.P.E, proporcionando a todos os seus utentes boas condições de trabalho e conforto." (p.3).

[637] In Portuguese "palacete" (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010).

[638] In Portuguese "Junta Distrital de Coimbra".

Fig. 144. Quinta das Flores School _ New building in its street façade
(Carolina Coelho)

three curricular floors, with very diverse spaces for the also very diverse activities that there take place, like: classrooms for the teaching of instruments, orchestra, choir, electro-acoustic laboratory and composition rooms, besides individual training rooms and administrative board rooms (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.3).

Besides, and according to the artistic school's Educational Project (Escola Artística do Conservatório de Música de Coimbra, 2013) their specific facilities are also composed by a small auditorium, a 400 places auditorium shared by both teaching regimes and a dance studio, all placed in the main building. Not initially foreseen and only for specific purposes, for the Department of Musical Sciences and for the subject of Group Classes[639], the school uses classrooms in the pavilions B and D (*ibid.*).

As mentioned above, this building has shared spaces with both the regular and the artistic teachings, namely: the auditorium, locker rooms, dressing rooms and restrooms; rooms that support the students' activities, like the photocopy room, the students' shop and the psychologist's office; the library; teachers' offices; the staff room, pathways and administration areas (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.3). The sharing of the space with both teaching regimes is considered to enhance the relation between the community and the institutions: the regular teaching school and the artistic school (Delegação

[639] From the Portuguese "Classes de Conjunto".

Regional do Centro da Inspecção-Geral da Educação, 2011, p.4).

In fact, for the regular teaching school this new building has also been considered "an asset in terms of access and use by the school students, of equipment and installations concerning the arts […]"[640] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.3)

Also from the External Evaluation Report of the conservatory, from 2010 (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010), the facilities, that had been just opened at that time, were considered suitable in what concerns the generic and specific equipment and parents had been informed of the new functioning of the space[641] and all students have been granted access to all school assets and artistic events [642](p.5). Additionally also acoustics, accessibility, safety and spatial dimension have also been valued positively, besides the existence of signs and safety measures [643](p.11).

This particular school has already been presented overall in chapter 1.5.[644], after the presentation of the educational brief, the Portuguese context and the specificity of the artistic schools joint with the regular teaching. Already at that point, this school had been justified as a valid choice as the case study. This chapter aims to introduce a deeper detail on this school and to present and support the chosen spatial sample in which to apply the methodology explained in abstract in the last chapter[645].

[640] Free translation of the original quote in Portuguese: "Acresce que o novo edifício foi projectado para acolher, também, o Conservatório de Música de Coimbra, o que constitui uma mais-valia em termos de acesso e utilização, pelos alunos da Escola, de instalações e equipamentos específicos ligados às artes (p. ex., salas de dança, orquestra e música)." (p.3)

[641] As considered in Chapter 1.8. Viability and feasibility, the lack of information on the functioning of a new space and the persistence of old habits and routines might hinder the full usage of the rehabilitated buildings, whose actions such as these might prevent.

[642] Full quote in English: "The school facilities recently opened, are adequately equipped in terms of generic and specific furniture [...] The guardians are informed of crucial aspects of the school functioning and many initiatives are promoted to attract families by engaging them, by standard, in the dynamics of the organization. [...] The leaders have a general policy of fairness and justice, allowing access of all students to educational goods and diverse artistic experiences." (p.5)
Free translation of the original document in Portuguese: "As instalações escolares, recentemente inauguradas, estão adequadamente equipadas a nível de mobiliário genérico e específico, […] Os encarregados de educação são informados de aspectos cruciais do funcionamento escolar e são promovidas múltiplas iniciativas para atrair as famílias, envolvendo-se estas, por norma, na dinâmica da organização. […] Os responsáveis têm uma política generalizada de equidade e justiça, permitindo o acesso de todos os alunos aos bens educativos e a experiências artísticas diversificadas." (p.5)

[643] Full quote in English: "The Conservatory building, established in contiguous spaces to Quinta das Flores Secondary School with 3rd cycle, was specifically designed for the teaching of music and dance. Its opening is very recent (December 2010), with facilities in good conditions in what concerns soundproofing (especially in the auditorium, shared by both schools), accessibility, security and space size." (p.11)
Free translation of the original document in Portuguese: "O edifício do Conservatório, implantado em espaços contíguos da Escola Secundária com 3.º Ciclo da Quinta das Flores, foi especificamente concebido para o ensino da Música e da Dança. A sua inauguração é muito recente (Dezembro de 2010), apresentando as instalações boas condições de insonorização (especialmente no auditório, partilhado por ambas as escolas), de acessibilidades, segurança e dimensionamento de espaços." (p.11)

[644] See Chapter 1.5. and particularly chapter 1.5.3. The case study under this research.

[645] See Chapter 3. Construction of the methodology.

As previously explained, before the current shift in the pedagogical process and consequently in the learning environments where it takes place, Portuguese school buildings were not able to fully answering the spatial, pedagogical, technical or digital needs. Hence, Portugal has undergone a secondary school modernisation programme since 2007 by Parque Escolar, whose aim was "To renovate and modernise the school buildings […], Opening the schools up to the community […], Creating an efficient and effective school building management system" (Parque Escolar, n.d. a). Furthermore, "New standards for state-of-the-art infrastructure have been developed for the programme, providing a benchmark to ensure adequacy and equity across the school system and parity within the EU. The aim is to develop innovative responses to the new educational and environmental paradigms, taking into account the curriculum, functionality, motivation, replicability and sustainability." (Heitor, 2008, p.2). Renewed school buildings were guided by flexibility, multifunctionality, safety, accessibility, inclusiveness, durability and environmentally efficiency and spatial attractiveness for users' well-being in space (*ibid.*), in order to update, promote, and enhance school environments.

So, this school now holds a very particular teaching curriculum, where regular and artistic teaching share the common spaces of the school, despite having separate administrative boards. Thus, besides the general aims from the programme that guided all the schools' interventions, for this school the spatial modernisation had the specificity of widening the curricula options. Hence, it ultimately corroborates its need to provide the community with adaptable spatial solutions that answer today's spatial, pedagogical and social requirements of both teaching regimes and respective specificities, which are clearly more extensive for this particular case study.

In fact, the adaptive re-use process in this school demanded more extensive requirements in terms of modernising the educational spaces for the current pedagogical and environmental legislation, but also to provide them with spatial and technical features that the artistic school demanded for its teaching, according to the architect José Paulo dos Santos:

> "The existing property was recovered and adjusted to the new requirements - with recurring materials and of local use - in which an environmental comfort law caused quite constructive discomfort." [646] (Santos, 2013)

Besides, it also bestow on the school a new openness to the city that was also one of the goals of the programme, as seen in an upper quote, and that had a particular representativeness in this school, due to is performative and cultural activities for the most different and broad audiences. Naturally, that this implied a more demanding intervention, as also stated by the architect José Paulo dos Santos:

[646] Free translation of the original quote in Portuguese: "O património existente foi recuperado e ajustado às novas exigências – com materiais recorrentes e de uso local – em que uma lei de conforto ambiental causou bastante desconforto construtivo." (Santos, 2013)

Fig. 145. Quinta das Flores School _ New building and its accesses from the street (Carolina Coelho)

> "The brief provided for the Music Conservatory is naturally complex, demanding in the environmental quality of the different educational spaces and their relationship with the surroundings."[647] (Santos, 2013)

Specifically, this change in the pedagogical curriculum of this school also implied the construction of a new building that introduces a new school front (Fig. 145), which underlines the motivation for a current urban relevance, from which the school was previously deployed, as the architect mentions:

> "The plot where the Music Conservatory has been implemented in conjunction with Quinta das Flores Secondary School is simultaneously too exposed, unprotected and adjacent to a road punctuated by careless rear housing blocks, supermarkets and structures that together qualify these "weak-places" as near suburban."[648] (Santos, 2013)

Not to overlook the existing legacy, this new construction is also linked to the existing buildings that were naturally modernised, by means of pathways[649]. The

[647] Free translation of the original quote in Portuguese: "O programa previsto para o CMC é igual e naturalmente complexo, exigente na qualidade ambiental dos diferentes espaços de ensino e no seu relacionamento com a envolvente." (Santos, 2013)

[648] Free translation of the original quote in Portuguese: "O lote onde se implantou o CMC em conjunto com a Escola Secundária da Quinta das Flores está simultaneamente demasiado exposto, desprotegido e adossado a uma estrada pontuada por traseiras descuidadas de blocos de habitação, supermercados e estruturas que, juntas, qualificam estes "fracos-lugares" quase suburbanos." (Santos, 2013)

[649] According to the architect these were designed for accessibility purposes (Santos, 2017) but that could also be interpreted as pathways between the new and the existing built space.

urban cohesion is, thus, attempted by spatial connotation of this school's new façade in this plot, but also by the educational brief and the style of management.

In fact, the leadership and management are very appreciated in the latest External Evaluation Report (Inspecção-Geral da Educação e Ciência, 2014c) that considers it to be engaging, to students and parents and sharing responsibilities with educators, to be motivated and approachable, within what is called in the document "a culture of shared management"[650] (p.6), and ranked as "Good" (p.8).

Clearly, in this school the heritage of the regular teaching went along with the present pedagogical agenda, that also brought an emphasised openness towards the school, the cultural community and the city overall.

Hence, this is a school that embodies the need for adaptable space in a deeper sense, due to the broad range of users and activities throughout the all day, and repeatedly in a weekly base. So, spaces have to be able to cope with different requirements from both teaching regimes as well as external uses, and also have to welcome and answer the school's internal and external community needs, acting as a pedagogical, cultural, social and territorial core.

The relevance of the role of the school towards the community represents one of the aims of the Secondary School Modernisation Programme[651] and effectively holds particular significance in this school, whose conservatory's Educational Project (Escola Artística do Conservatório de Música de Coimbra, 2013) starts precisely by expressing the desire for supporting the educational training of a widespread community, assuming a relevant role on the arts as a part and parcel of a broad and comprehensive learning framework[652] (p.2).

Additionally, the conservatory has guiding principles that consider, amongst others, the artistic teaching to promote creativity, critical assessment and contemplative capabilities, to understand and value the current cultural multiplicity, to enhance the significance of the artistic teaching within the overall learning process, and to regard student's individuality, as well as the capacity of sharing and group-working, which becomes quite significant for the joint regular and artistic regimes as a whole, and for all youngsters in general (pp.11-13).

[650] Free translation of the original quote in Portuguese: "Cultura de "gestão partilhada"" (p.6).

[651] "Opening the schools up to the community" (Parque Escolar, n.d. a).

[652] Full quote in English: "[…] specialised music education is now seen as an integral part of the training of children and young people, a perspective that does not exclude but rather equates, adherence to professional options related to Music, Dance and other artistic expressions. Thus, in nearly three and a half decades of existence, the Artistic School of the Music Conservatory of Coimbra (AS of MCC), as an artistic school, it has been playing a unique role in the educational formation of its geographical area of influence." (p.2)
Free translation of the original document in Portuguese: "[...] a educação musical especializada é hoje encarada como parte integrante da formação das crianças e jovens, numa perspetiva que não exclui, antes equaciona, a adesão a opções profissionais relacionadas com a Música, a Dança e demais expressões artísticas. Assim, em quase três décadas e meia de existência, a Escola Artística do Conservatório de Música de Coimbra (EA do CMC), enquanto escola artística, tem vindo a desempenhar um papel único no panorama educativo da sua área geográfica de influência." (p.2)

This document also states that, currently, the artistic learning can be perceived with particular interest due to the "profound reformations" on the requalification of the teaching regimes, on the spaces, which have either been modernised or constructed *ex nuovo*, and also on the regularisation of the employment status of teachers[653] (*ibid.*).

Picking up in the positive context of the institution of the artistic teaching today, the conservatory considers to have contributed to the growth of the artistic education within the community, to the promotion of the space by its open and wide-ranging offer of activities, to pedagogically approaching Quinta das Flores Basic and Secondary School and also to the establishment of both Dance and professional teaching courses[654] (*ibid.*). Thus, this proves this school to be relevant to the context of the artistic teaching, and also that the construction of its new and permanent space has enabled the educational project and the expansion of its activities and users towards the city and the community, culturally, socially and pedagogically.

Actually, its widespread school community includes students from the regular teaching, from the artistic teaching, from both, all teachers, staff and parents. Moreover, this school plays an active role in the community, enhanced by its artistic nature, which leads to frequent performances and public exhibitions from the students, as well as a special openness to external organisations of different kinds.

The music school has several possibilities of teaching, from the articulated[655]

[653] Full quote in English: "There are reasons to face the educational role of artistic education with enthusiasm. After a long period of stagnation in the various areas of this subsystem witnessed in the last decade, the deep reforms ranging from the overhaul of the frequency regimes, to the rehabilitation/construction of equipment and the regularisation of the educators' professional situation." (p.2)
Free translation of the original document in Portuguese: "Existem motivos para encarar o papel educativo do ensino artístico especializado com entusiasmo. Após um longo período de estagnação nas diversas áreas deste subsistema assistiu-se, na última década, a profundas reformas que vão desde a reformulação dos regimes de frequência à requalificação/edificação de equipamentos e regularização da situação profissional dos docentes." (p.2)

[654] Full quote in English: "Continuing the consolidation of the educational role of effort of the AS of the MCC [Artistic School of the Music Conservatory of Coimbra] in the region to which it belongs, it is noteworthy the progress made by the school in the recent past, namely:
. in boosting the equipment on which it is now definitely located, producing a permanent and diverse supply available to the community;
. in the development of an educational partnership with Quinta das Flores Basic and Secondary School;
. in the launch and consolidation of the Dance course, which also concerns the level of expansion of the national public network on this area;
. in the launch and consolidation of the professional education, providing the region with a largely disadvantaged offer in this area." (p.2)
Free translation of the original document in Portuguese: "Prosseguindo o esforço de consolidação do papel educativo da EA do CMC [Escola Artistica do Conservatório de Música de Coimbra] na região em que se integra, importa sublinhar os avanços obtidos pela Escola no passado recente, nomeadamente:
. na dinamização do equipamento no qual passou a instala-se em definitivo, produzindo uma oferta permanente e diversificada acessível à comunidade;
. no desenvolvimento da parceria pedagógica com a Escola Básica e Secundária da Quinta das Flores;
. no lançamento e consolidação do curso de Dança, também no que tal significa a nível da ampliação da rede pública nacional nesta área;
. no lançamento e consolidação do ensino profissional, dotando a região de uma oferta largamente carenciada nesta área." (p.2)

[655] From the Portuguese "articulado".

regime, to the supplementary[656] regime, professional courses, and also free courses. The articulated regime is taken with Quinta das Flores Basic and Secondary School and also Martim de Freitas Basic School (Inspecção-Geral da Educação e Ciência, 2014c, p.2). This articulation is also supported by the straight coordination of the Class Director of the artistic teaching with the school's Class Council (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.4).

According to the conservatory's Educational Project (Escola Artística do Conservatório de Música de Coimbra, 2013), it teaches the following courses: Initiation Course (Music and Dance), Basic and Secondary Course of Instrument, Basic Course of Dance, Secondary Course of Singing, Secondary Course of Composition, Secondary Course of Music Formation and Professional Course of Jazz Player (p.10). From which the instruments that are taught are the following: Keys - piano, carnation, organ, accordion; Woodwind - transverse flute, bevel flute, clarinet, bassoon, oboe, saxophone; Brasswind - trumpet, horn, trombone, tuba; Percussion and Drums; Strings (arches) - violin, viola d'arch, cello and double bass; Plucked String / Plectrum - Portuguese guitar, classical guitar, mandolin, harp; and Singing (Escola Artística do Conservatório de Música de Coimbra, 2013, pp.10,11).

The Basic Course of Music and the Secondary Courses of Music - Instrument and Composition, are held in both supplementary and articulated regimes. Whereas the Basic Course of Dance is taught only in the articulated regime, and the Courses of Singing and Professional Jazz Player only in the supplementary regime (pp.6-8). This wide educational offer has been considered in the External Evaluation Report as impactful in the "valuing of the artistic teaching of Music by the community" and also "in the demand of this teaching"[657] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.10).

This adds to the fact that, for the artistic teaching, learning holds different and very diverse instruments and courses, taught in multiple situations and also in distinctive spaces, determined by their specificities; which underline the need for adaptability from the existing spaces for the several learning activities of different sort, like: knowledge creation, group interaction, individual training, evaluation moments and even public displays.

Overall, according to data from Inspecção-Geral da Educação e Ciência (2014c), just the music school *per se* had at the time of that publication 967 students, from which 83 were from the Initiation Course, 604 from the Basic Course, 238 from the Secondary Course and 42 in the Professional Course. Its community was also composed from 107 teachers and 24 staff members (*ibid.*).

In what regards Quinta das Flores School and according to the data from 2014 for

[656] From the Portuguese "supletivo".

[657] Original quote in Portuguese: "A oferta educativa proporcionada tem tido um impacto muito significativo na procura da formação ministrada e na valorização comunitária do ensino artístico da Música." (p.10).

the academic year of 2013-2014 (Inspecção-Geral da Educação e Ciência, 2014b, p.2), the school had 1194 students, from which 361 were from the basic teaching, 222 from the basic courses of music and dance in the articulated teaching regime with the conservatory, 833 from the secondary course and 211 from the professional courses.

Additionally, this school under both the regular and articulated teaching regimes also holds a widespread educational offer on "Sciences and Technologies, Socioeconomic Sciences, Languages and Humanities, Visual Arts and professional Courses on Technical Sporting Assistant Management, Technical Computer Equipment Management and Technical Health Assistant, and also Professional Jazz Player in articulation with the Conservatory" (*ibid.*)[658]. This had already been highlighted by the previous report that already stated a diversity in the educational offer of "cultural, sporting and scientific nature" (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.4), whose knowledge interplay accentuated the "integral formation" of the student (p.4) referred in both reports from 2011 and 2014.

Student achievement is quite documented and attested by the External Evaluation Report of the Music Conservatory from 2014 (Inspecção-Geral da Educação e Ciência, 2014c), which after a thorough analysis to each Artistic Deparment concludes that "in a global analysis, it appears that the Conservatory has a very positive academic performance [...]"[659] (p.3), which has set a goal of 95% student achievement for the academic year of 2013/2014 (p.5).

Actually, the social results from the referred External Evaluation Report of the Music Conservatory from 2014 (Inspecção-Geral da Educação e Ciência, 2014c) also point out that all protocols and events from the music school promote "a positive and motivational school environment"[660] (p.3)[661]. This environment is appraised by teachers, workers and parents that are generally pleased with the living and educational experience in the conservatory (*ibid.*), and also with its facilities[662] and overall its Educational Service has been ranked as "Very Good" in the Evaluation Report (*ibid.*).

[658] From the original quote in the referred document in Portuguese.

[659] Free translation of the original quote in Portuguese: "numa análise global, verifica-se que o Conservatório tem um desempenho bastante positivo ao nível académico […]" (p.3).

[660] Free translation of the original quote in Portuguese: "um ambiente escolar positivo e motivador" (p.3).

[661] Already in 2010 the External Evaluation report appraised this network of partnerships "for the improvement of the educational service and creation of stimulating opportunities for learning". ((Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.6).
Free translation of the original quote in Portuguese: "A rede de parcerias e protocolos é muito significativa, contribuindo expressivamente para a melhoria das condições de prestação do serviço educativo e para a criação de oportunidades estimulantes de aprendizagem." (p.6)

[662] According to External Evaluation Report of the Music Conservatory from 2014 (Inspecção-Geral da Educação e Ciência, 2014c): "Parents and guardians of students show high satisfaction with the school facilities, the appreciation that their child attends the Conservatory and incentive him/her to achieve good results […]" (p.4).
Free translation of the original quote in Portuguese: "Os pais e encarregados de educação dos alunos revelam elevada satisfação com as instalações escolares, o gosto em que o seu filho frequente o Conservatório e o incentivo para a obtenção de bons resultados [...]" (p.4)

The Student Association plays a relevant role in the engagement of the students to the community and a sense of belonging to the school, with the promotion of initiatives, like the *Journal 441 Hz*, and the Laureates Concert, or by management decisions, such as: the Cultural Week, Final Students Recital and a selection of public performances by the best students, besides its exposure in the media and social networks, its monthly agenda and the performances done in public spaces throughout Coimbra (p.5). In fact, in its Educational Project, the conservatory states that it is crucial that the school continues to "go outside" (Escola Artística do Conservatório de Música de Coimbra, 2013, p.19), meaning that it has to pursue its aim to extend its activities outside the school's boundaries and to promote the artistic culture throughout.

The Conservatory Friends Association also draws the school community closer to the general public and to the city. Consequently, the school has a recognised role in the surrounding community, for its cultural, educational and social role, proven again by the External Evaluation Report of the Music Conservatory from 2014 (Inspecção-Geral da Educação e Ciência, 2014c) which ranks the conservatory results has "Very Good" (*ibid.*): "The Conservatory has a relevant role in the development of the surrounding community, because of its artistic production that it develops, being generally recognised at a local, regional and national level."[663] (p.4). Already in the previous report from 2010 (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010) the conservatory admitted to hold several events that promoted students' learning and a positive communitarian appearance[664] (p.4).

Additionally, the artistic productions opened to public display as well as the creation of strategic partnerships with local and regionals organisms such as other schools, the City Council and the University of Coimbra (p.7), have been considered strengths by this latest evaluation, that enable a higher prominence of the school towards the city, an increase in the demand from students to seek the school and the creation of formative events for the social and cultural development of the community[665] (p.9).

[663] Free translation of the original quote in Portuguese: "O Conservatório tem um papel relevante no desenvolvimento da comunidade envolvente, pela produção artística que desenvolve, sendo objeto de reconhecimento generalizado a nível local, regional e nacional." (p.4)

[664] Full quote in English: "Consistent actions are organised, aimed at the stimulation and enhancement of student learning and compelling the effect that public musical performances have produced towards a favourable image of the Conservatory in the community." (p.4)
Free translation of the original document in Portuguese: "São organizadas acções consistentes direccionadas ao estímulo e valorização das aprendizagens dos alunos, sendo incontornável o efeito que as actuações musicais públicas têm produzido na imagem favorável do Conservatório junto da comunidade." (p.4)

[665] Full quote in English: "The provided educational provision has had a very significant impact on the demand of the training and community appreciation of the artistic education of Music." (p.9)
Free translation of the original quote in Portuguese: "A oferta educativa proporcionada tem tido um impacto muito significativo na procura da formação ministrada e na valorização comunitária do ensino artístico da Música." (p.9)

In fact, the large extent of students that attend the conservatory, namely in the supplementary regime that come from outside the city, besides the external and internal events that take place there, implied an extension of the time the building is opened, from 8.30p.m to 10.pm (p.7), for a more extensive use of the spaces and a stronger justification of the investment in financial terms, but also because of its wide users, activities and a larger surrounding area of influence[666]. In its Educational Project (Escola Artística do Conservatório de Música de Coimbra, 2013), the conservatory adds that, despite the growing demand for the articulated teaching regime, the most required schedule is from 6p.m. to 8p.m., due to the students from the supplementary regime and the availability of parents to bring their children to the conservatory mostly after work. It continues by stating that it is one of its intentions to offer the artistic teaching to all students, even the ones that live outside the city's outskirts, which explains the enlargement of its schedule (p.13).

This concern of openness to the community is also stated in the School's Educational Project as one of the aims of its "mission" to be an "inclusive, solidary and equitable school" (Escola Básica e Secundária Quinta das Flores, 2014, p.13). This meets with the aims of the general intervention by the Secondary School Modernisation Process on being inclusive (Heitor, 2008) and open (Parque Escolar, n.d. a).

Equally, it is also very noticeable in the External Evaluation Report on Quinta das Flores School (Inspecção-Geral da Educação e Ciência, 2014b), the relevance of encouraging "an open school culture" (p.7), by the engagement of the educational agents[667] (*ibid.*), besides an increasingly active participation of the students in a wide range of activities (p.3), and the establishment of protocols and with several other institutions (p.8). Moreover, this latest External Evaluation considered as some of the school's strengths, its ability to promote an active engagement of the school community and its partnerships towards students' and the overall community's interests (p.9). All in all, the school has been ranked "Very Good" in regard to its Educational Service (p.7), respective Results (p.5), and to its Leadership and Management (p.9), that have led to a positive improvement on the learning process and student achievement (p.9).

[666] According to the External Evaluation: "The educational resources and physical space of the Conservatory are well monetized through its use in autonomous and collective work from the students and in the events open to the educational community." (p.7)
Free translation of the original quote in Portuguese: "Os recursos educativos e o espaço físico do Conservatório estão bem rentabilizados, através da sua utilização em trabalho autónomo e coletivo dos alunos e em eventos abertos à comunidade educativa." (p.7)

[667] Full quote in English: "The direction promotes an open school culture, promoting the dialogue and the identity, highlighting the contribution of the various educational agents and their full participation in the School life." (p.7)
Free translation of the original quote in Portuguese: "A direção promove uma cultura de escola aberta, fomentando o diálogo e a identidade, valorizando o contributo dos vários agentes educativos e a sua plena participação na vida da Escola." (p.7)

The impact of Quinta das Flores School on the community's social development and the increasing significance of the school is also proven by the External Evaluation from 2014 (Inspecção-Geral da Educação e Ciência, 2014b), supported by "a strong connection with the surroundings, based on a network of partnerships established with local entities, in increasing work with the Parents' Association and in the multiple activities opened to the exterior"[668] (p.4). But it also acknowledges its articulation with the conservatory as an opportunity that has led to an increasing demand from students to enroll in this school. In fact, the attractiveness of this school had already been considered in the school's report from 2011, that attributed this fact to "the educational offer and the existing environment"[669] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.4).

Actually, according to the External Evaluation Report on the School (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011) this "partnership between the School and the Music Conservatory [is considered an "opportunity"] for the possibilities it represents for the development and establishment of both institutions on the city of Coimbra"[670] (p.13). This has also been highlighted by the School's Educational Project (Escola Básica e Secundária Quinta das Flores, 2014, p.12).

Therefore, this school acts as a urban and community hub, enhanced by its artistic nature, which leads to frequent public exhibitions, as well as a special openness to external organisations that use these spaces outside the school hours. This proves that this school holds a high complexity on the adaptability of its learning environments.

Moreover, because this school holds a particular curriculum where regular and artistic teaching share common spaces, it proves that this pedagogical model and its spatial layout enable an effective use that is clearly participated by all, and that

[668] Full quote on the impact of the school in the community: "The impact of the action of the School is widely recognised by the community, translated, especially in the opening of the 2nd cycle for the teaching of the Basic Courses of Music and Dance in collaboration with the Conservatory of Coimbra, in the increasing demand for the School from the families, in the job offers and internships available by companies and local and regional institutions. There is a strong connection with the surroundings, based on a network of partnerships established with local entities, on the increasing work with the Parents' Association and on the multiple activities opened to the exterior, which contribute not only to enhancing the school but also for the development of the social environment." (p.4)
Free translation of the original quote in Portuguese: "O impacto da ação da Escola é amplamente reconhecido pela comunidade, traduzido, especialmente, na abertura do 2.º ciclo para ministrar os cursos básicos de Música e Dança em articulação com o Conservatório de Coimbra, no aumento da procura da Escola pelas famílias, nas ofertas de emprego e de estágios disponibilizados por empresas e instituições locais e regionais. Existe uma forte ligação ao meio, alicerçada numa rede de parcerias com entidades locais, no trabalho crescente com a associação de pais e nas múltiplas atividades abertas ao exterior, que contribuem não só para a valorização da Escola mas também para o desenvolvimento da envolvente social." (p.4)

[669] Full quote in English: "The school shows a good ability to attract students and families, to which contributes, among other things, the educational offer and the existing environment." (p.4)
Free translation of the original quote in Portuguese: "A Escola mostra uma boa capacidade de atracção junto dos alunos e famílias, para o que contribui, entre outros aspectos, a oferta formativa e o ambiente existente." (p.4)

[670] Free translation of the original quote in Portuguese: "Oportunidades: Parceria entre a Escola e o Conservatório de Música, pelas possibilidades que representa para o crescimento e afirmação das duas instituições na cidade de Coimbra." (p.13)

enables higher levels of peer interaction, socialisation and ultimately cross-curricular informal learning[671].

This is proven by the Evaluation Report on the Quinta das Flores School (Inspecção-Geral da Educação e Ciência, 2014b), that informs that there is a wide set of pedagogical activities that occur outside the formal classrooms, that support particular learning needs (p.5).

But its artistic environment is also noted as being particular to this school and leading to an "integral formation" (p.6) of the students, composed by the regular teaching with the artistic teaching and also with the regular teaching of artistic expression and theatre workshops, that organise artistic events of different sort, from visual arts exhibitions, to performative shows on body expression and theatre and music displays (*ibid.*), attesting a "high general artistic dynamics in the whole school's daily life"[672] (*ibid.*), despite the curriculum of each student.

Particularly, the main hall and the library, both shared spaces, are considered to be spaces of excellence for activities and cultural events and are acknowledged as being adequately used for such purposes[673] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.4).

The main hall in the new central building represents the main entrance of the school and is shared by all visits and inhabitants, despite each one's purpose for entering the building, their teaching regime, or the activity or event each one will attend. What is more, that particular space holds both moving and standing activities that enable peer interaction, spontaneous and informal events, as well as occasional formal public displays or formal exhibitions.

In fact, the prominence of the main hall for cultural activities, formal and informal, spontaneous or pre-determined events has already been highlighted in the External Evaluation Report from 2011 for Quinta das Flores School:

> "There is a great dynamism in organising scientific, sporting and cultural

[671] The high level of activities, when connected to their allocations to educational spaces has been presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London, for validation of the procedure and of the potential correlation. This communication was published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

[672] Free translation of the original quote in Portuguese: "Existe uma elevada dinâmica artística no quotidiano escolar [...]" (p.6).

[673] Full quote in English: "The main hall and the library are being very well used as privileged places for the dissemination of the activities and as cultural spaces par excellence." (p.4)
Free translation of the original quote in Portuguese: "O átrio principal e a biblioteca estão a ser muito bem utilizados como locais privilegiados para a divulgação das actividades desenvolvidas e como espaços culturais por excelência." (p.4)

> events, followed by exhibitions, musical demonstrations, dissemination of activities from the different courses and from the Student Association, among other initiatives, within the School hall."[674] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011 p.8)

The report adds that the main hall is used as a permanent exhibition space and holds several events that promote the school's image towards the community (p.9). This is also attested by the External Evaluation Report from 2010 for the conservatory (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010), that already, at that time, observed that it was a space that enabled creative and artistic informal displays, in a spontaneous and encouraging manner:

> "The installation of a grand piano in the common lobby of both schools, with free access for experimentation and leisure, is another example of a stimulus to civic attitudes, in which its use has been registered without harmful effects."[675] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.7).

Additionally, the library is also a significant space in the school life and the community overall, holding several events of different sort (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.8). The fact that it is equipped with significant material resources that enable it to hold different learning activities, make this a central space for the school. This is again attested by the same report:

> "The library is a large space, endowed with important material resources, and with a diversified interventions' project. The activities that it promotes, by supporting curriculum development in the field of information literacy and in an extra-curricular scope, make it to be sought and valued by students and teachers."[676] (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.9)

This becomes quite clear in the whole school, where students from the different teaching regimes get together and interact, where the music students often spontaneously start playing their instruments, whether in groups or individually, and

[674] Free translation of the original quote in Portuguese: "Existe um grande dinamismo na organização de eventos de natureza científica, desportiva e cultural, sucedendo-se exposições, demonstrações musicais, divulgação das actividades dos diferentes cursos e da Associação de Estudantes, entre outras iniciativas, no átrio da Escola." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.8).

[675] Free translation of the original quote in Portuguese: "A instalação de um piano de cauda no átrio comum às duas escolas, com livre acesso para experimentação e lazer, constitui mais um exemplo de estímulo às atitudes cívicas, registando-se o seu uso sem efeitos danosos." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.7).

[676] Free translation of the original quote in Portuguese: "A biblioteca constitui um espaço amplo, dotado de importantes recursos materiais, e com um projecto de intervenção diversificado. As actividades que promove, de apoio ao desenvolvimento curricular, no campo da literacia da informação e de âmbito extra-curricular, fazem com que seja procurada e valorizada por alunos e professores." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.9).

where, all in all, socialisation and informality play a relevant role for this community's knowledge and student achievement, both in formal educational spaces but also, in informal and moving spaces, rather than static ones, this school now provides.

This fact is even noticed by the architect José Paulo dos Santos that also acknowledges the role of experience, spatial fruition and life, by and large, throughout the all school, which encounters the programme's goals for this school of modernisation, multifunctionality and, foremost, of spatial attractiveness for users' well-being, as described above (Heitor, 2008, p.2).

Accordingly, the concept of memory goes along with change readiness and adaptability, for both the people, the space and the curriculum, attesting this school as a high complexity case study for the research on adaptability in educational facilities[677], but also a state of the art answer, that, according to the several internal and external evaluations referred above, is proving to be effective in its actual occupancy since its renewal. Ultimately, it corroborates its adaptable potential to answer current spatial, pedagogical and social needs.

This meets us with the quote that initiated this chapter, by the architect in charge of the school's modernisation, with regard to its challenging need to cope with future change, yet still uncertain, implying a deeper need for spatial features that provide the school with flexible, polyvalent and sustainable solutions towards future developments and agendas, to which we would add, a profound need for adaptability:

> "The differences and uncertainties regarding the brief advised that the proposed project had the intrinsic quality of future metamorphosis capacity. The brief requires a dialogue between the proposal and the nearby urban environment leading to a clear and strong institutional image, jovial but independent from the trendiness of the day. Also necessary - in a country of scarce resources - a structure with a strong sense of permanence in contrast to the ephemeral sense. The brief demands that flexibility and versatility are given to the concept within clear principles of sustainability, more prosaically - common sense."[678] (Santos, 2013)

[677] The choice on the case study and the results from a first application of the methodology to this school prove it to be "a high complexity case study for the research on adaptability in educational facilities" as stated in the text. This has been appraised in peer review and presented in the*10th International Space Syntax Symposium*, in 13-17 July 2015, London. This communication was published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

[678] Free translation of the original quote in Portuguese: "As diferenças e indefinições do programa aconselharam ao proposto projecto a qualidade intrínseca de futura capacidade de metamorfose. O programa requer que a proposta dialogue com a envolvente urbana próxima induzindo a uma clara e forte imagem institucional, jovial mas independentemente da moda do dia. Igualmente necessário - num país de fracos recursos - uma estrutura com forte sentido de permanência em contraste com o sentido efémero. O programa reclama que a flexibilidade e polivalência sejam dados ao conceito dentro de claros princípios de sustentabilidade, mais prosaicamente - senso comum." (Santos, 2013)

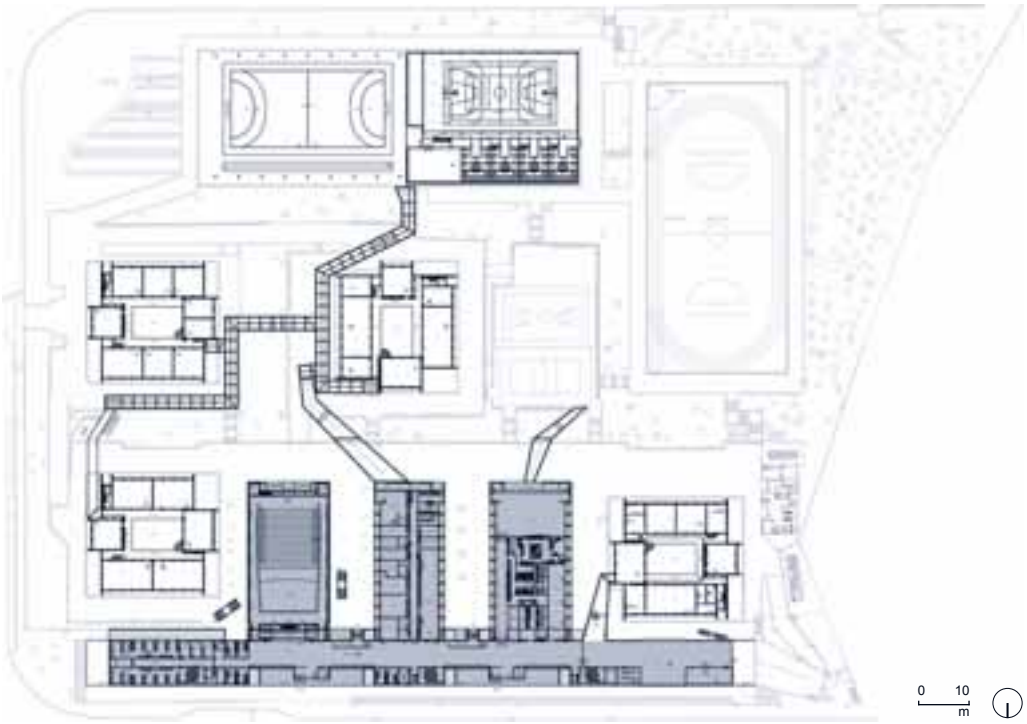


Fig. 146. Quinta das Flores School (ground floor) _ Spatial sample identified in grey
(Plans provided by Parque Escolar with the spatial sample screened in grey by Carolina Coelho)

Justification of the spatial sample

For this paper, the methodology will be focused on the new central building from 2008, built under this modernisation programme, identified in grey in Fig. 146. The following arguments will justify the chosen spatial sample.

1. Narrowing the sample enables a clearer explanation of the methodological procedure.

Narrowing the sample enables to make the methodological process clearer and to better understand its outcomes. Instead, a more complex endeavour could potentially blur the explanation on the process, with all the possibilities that had to be taken into consideration in regard to the activities and spaces and their allocations, according to their respective spatial requirements and features provided.

2. An initial testing of the methodology has already been undertaken in a smaller sample for validation purposes of both the procedure and the results achieved.

This process has, in fact, been already applied, as an initial test to validate the

methodology, within an even more restricted sample composed by the ground and the first floors of the new central building, which hold a very diverse allocation of activities to spaces. Both the methodology and the results achieved have been subject of peer review for validation of the procedure and presented in the *10th International Space Syntax Symposium*, in 13th-17th July 2015, London, and also in the *3rd International Symposium Formal Methods in Architecture*, in 30th November-2nd December 2015, Porto, and published in their respective conferences' proceedings (Coelho and Krüger, 2015; Coelho, 2015c).

This simplification has been done as an initial test to the methodology and for a simplification of its explanation, due to the length required and nature from these publications, but that already corroborated the process overall and the choice of the case study. This endorses the suggestion make by Gray and Baird:

> "Our experience of such empirical planning suggests that it is useful to conduct a trial or test evaluation to start with, developing what works and reworking or discarding what does not work so well in practice." (Gray and Baird, 1996, p.6)

3. Authors of reference also supported narrowing the sample for simplification of the procedure to assess adaptability and for its subsequent explanation and critical assessment.

This has been supported by Fawcett[679] in a communication by email in December 2015, where it was suggested narrowing the sample to better present the methodology, considered to be a core and original development and an architectural advancement made by this Doctoral Thesis, firstly in abstract[680], and then applied to a case study[681]. In fact, after explaining to Fawcett the methodology underlying this research, he suggested narrowing the sample in order to enable to more clearly follow the process proposed by the methodology.[682]

So, acknowledging that this case study was chosen precisely because it holds a higher need for adaptability but also a broader range of activities and spaces, which introduces a higher complexity on measuring the entropy, narrowing the spatial sample from the entire school would benefit the explanation of the methodology *per se*.

[679] We acknowledge William Fawcett in the acknowledgements section, who has always shown interest and availability to accompany this research and its developments since our first email communication from April 2011.

[680] See Chapter 3. Construction of the methodology.

[681] See Chapter 4. Application of the methodology in the case study.

[682] (Fawcett, email from December 2015)

4. The analysis of the whole built compound over-complexifies the methodological application.

The school is composed of several buildings, dating from different time periods and having different uses and morphological layouts. The original school from 1968 has a pavilion layout, to which a new building has been added in 2008-2009 that presents a more asserted school front towards the city.

The analysis of all the buildings alone and followed by the interrelations between the partial results from each building and with a subsequent retrieval of the school's overall adaptability, with all the procedures that it would take, would over-complexify the methodological application, potentially hindering the comprehensibility of the procedure, the results achieved from each stage, the information brought by each approach and the potential correlations amongst themselves, which would add excessive information and calculations to the central problematics.

5. The building from the sample is the most representative in terms of activity, user and spatial mix and allocation.

In order to restrict the level of complexity and the diversity of the spaces and their respective attributes, as well as to reduce the list of all the possible activities that occur in the school as a whole, spaces and attributes, portrayed in the research, the choice of the spaces to be analysed centres around the ones that hold the highest levels of effective use and the ones that are most shared by all the community, potentially representing the spaces with the highest adaptability levels in the school.

The chosen building is the one that holds the common spaces and embodies the main entrance through a new street façade, which underlines its representativeness towards the city and the community, which is also the most representative in terms of activity, user and spatial mix[683], precisely because it receives all the users of the school and enables a broader range of activities in a variety of spaces required for them.

[683] The choice on the case study and the results from a first application of the methodology to this school have been presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London, for validation of the procedure and of the potential correlation. This communication was published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi, K.; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
Besides, this methodology, as an overall procedure, has also been presented in the *3rd International Symposium Formal Methods in Architecture*, in 30 November – 2 December 2015, Porto, for testing and academic validation. It will also be published as: Coelho, C. (in publication). A Gathered Methodology Towards Enhancing Adaptable Learning Spaces. In D. Viana, F. Morais, J. Vaz (Eds.). *Formal Methods in Architecture and Urbanism*. Cambridge: Cambridge Scholars Publishing.
In both cases, the spatial sample was restricted to the ground and first floors of the new building.

6. According to the purposes of this methodology regarding the assessment of adaptability, the chosen spaces represent, in advance, the most adaptable ones.

According to the definition of adaptability used under this Doctoral Thesis, the most adaptable spaces are able to better cope with changing needs, pedagogical and social activities and the uncertainty of future demands. The spaces analysed represent the ones that hold the most diverse set of people and activities, both internal and external to the school, hence, these can be considered the ones that are able to better answer new or different events and demands in a yet unknown future.

As the methodology aims to identify and assess the adaptability of the spatial sample, the spaces chosen should be considered the most adaptable ones, *a priori,* to better understand the results obtained and the validation of the methodology in a real life scenario.

For the purposes of this research it will be crucial to focus particularly on the spaces that are acknowledged, in advance, to be very significant for the learning process and school life overall. By the External Evaluation Reports on both Quinta das Flores School and the Music Conservatory, these are the main hall (Delegação Regional do Centro da Inspecção-Geral da Educação, 2010, p.7; Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.4, 8, 9) and the library (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, pp.4, 9)

Therefore, after assessing their adaptability level under the methodology proposed, acknowledging the nature and amount of different activities that these can allocate, and the diversity of users that they can hold, a comparison can be undertaken, in order to conclude on a potential overlapping on the final results obtained and the information referred on these reports, considered by the educators and external evaluators, for both the artistic and regular teaching.

7. The application of the methodology to the most recent and central building can identify whether it has effectively accomplished the purposes of the Secondary School Modernisation Programme.

The methodology is applied to the new central building designed within the Secondary School Modernisation Programme, whose main goals were, amongst others, flexibility, multifunctionality, inclusiveness and well-being (Heitor, 2008, p.2). By assessing the adaptability of that new built space, and by relating it to the experiences and events that currently take place there, it is possible to retrieve results on its potential and effective allocation of spaces to activities and conclude whether

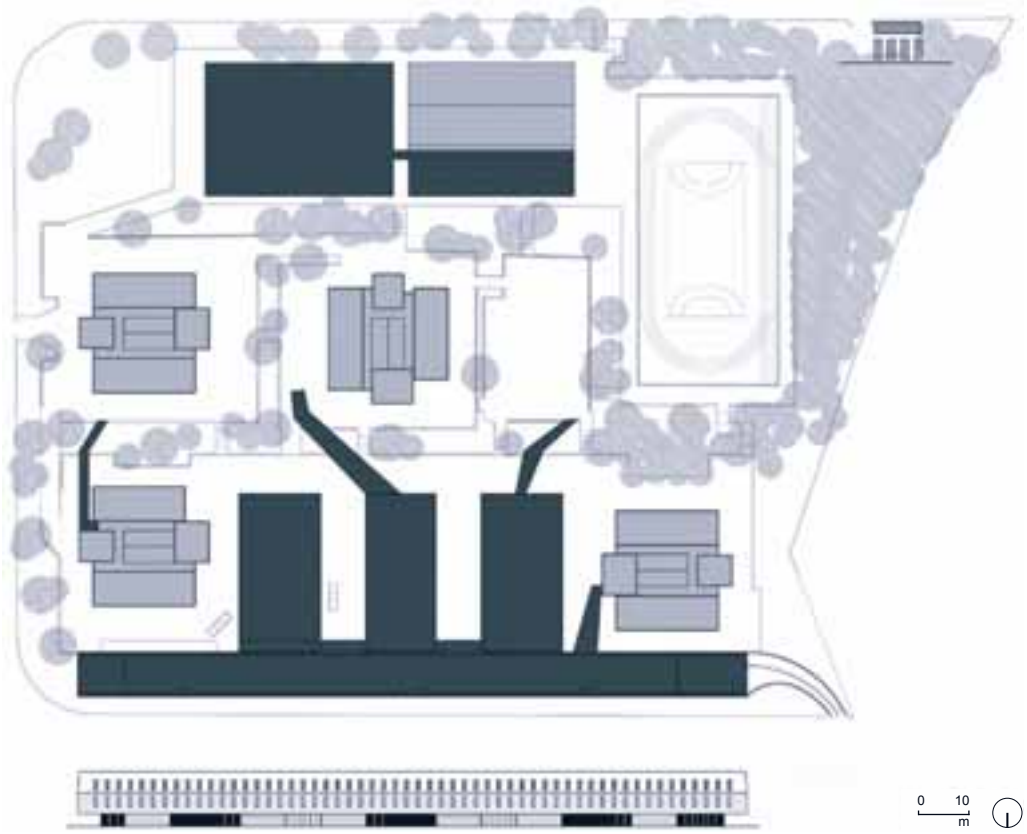


Fig. 147. Quinta das Flores School _ New construction from the Secondary School Modernisation Programme identified in dark grey
(Parque Escolar, n. d. b)

it is multifunctional: if there occur diverse activities in the same space; open and inclusive: if it welcomes a broad internal and external community; comfortable: if considered as such by the focus groups and observations matrices undertaken as a milestone in the proposed methodology.

Finally, it is possible to conclude on its adaptability as a design content, by the acknowledgement of the building's morphology and spatial attributes; as a spatial asset, by the description of all possible activity allocations to spaces; and as a tangible quality by the effective events and experience corroborated by the school's community.

Note that other buildings have been built under this modernisation process that are connected with particular functions and activities, and hence they are not physically and functionally central to the artistic school (Fig. 147). In fact, they are specifically connected with paths for circulation and sporting pavilions. Additionally, even if some classrooms are used for the artistic teaching, it is only for the specific purposes of the Department of Musical Sciences and for the subject of Group Classes the school uses classrooms in the pavilions B and D (Escola Artística do Conservatório

de Música de Coimbra, 2013), not considered relevant for the overall Music School, as all other spaces are placed in the main central building (*ibid.*).

8. Practical procedures when applying the methodology: Functional analysis.

As explained in detail in chapter 3.3.[684], this methodology is composed of a sequential procedure of several approaches in which each of them informs on the adaptability of the space to be assessed in a particular manner, contributing to a final, more informed and supported conclusion overall. So, its intricacy and wide-ranging sequence, while analysing specific features of that space, can become increasingly more complex and extensive according to the extent of the sample and all the spaces, attributes, features, activities and users that characterise it.

The first milestone of the methodology implies the functional characterisation of the spatial sample. This means analysing extensively all the spaces, activities and attributes in the sample. As seen in chapter 3.3., at this point spaces will be described according to their nature, that could either be social and informal, formal and academic or for specialised purposes. Moreover, the activities that occur in the school will also be listed according to their category, from: programmed and formal, to non-programmed and informal to circulation. Finally, all spaces will be described according to their specific attributes namely: dimension, configuration, coating, networks, environmental conditions and accessibility.

The attributes considered on the school's initial construction may have changed from the ones introduced in the modernisation process on 2008-2009, due to educational requirements, to the expansion of the artistic spatial demands for the teaching of music and dancing in the rooms, but also because of the construction developments and the natural modernisation of the materials and technical solutions used today. This identification will be valuable in terms of this research, when pairing this information with the space's adaptability results at the end, for a conclusion on which attributes provide higher adaptability and the cost/benefit relationship in introducing each one.

Consequently, this becomes a very important issue, because it allows a more supported comprehension of the attributes that have been changed, that have now been used and the ones which have been necessary for this adaptive reuse process, in order to provide the spaces with the features to allocate the activities of this new pedagogical curriculum. Gehl (1970) also concurs with the fact that attributes

[684] See Chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

condition the space's occupancy, experience and activities:

> "Any building erected thus creates or situates some human activity and people moving in or around the building will be able to experience the building as well as these activities. Users, visitors and bypassers will be able to experience spaces of various shape, size, colour, light etc., and with various kinds and degrees of human activity." (Gehl, 1970, p.62)

So, clearly a very extensive spatial sample will potentially hinder a rigorous and detailed development of all these initial stages, because listing all the spaces, activities and spatial attributes and then allocating them to each space and activity, in a very extensive space, will not necessarily validate the methodology any more than a narrower spatial sample which is considered to be the most representative of the school, of its modernisation process and of its blending of activities and users in space.

9. Practical procedures when applying the methodology: Space syntax analysis.

In the first milestone of the methodology, as seen in the previous chapter[685], a morphological analysis will also take place, in order to better inform the description of the school space and how it supports activity allocation. As also explained then, it will focus on convex spaces, axial lines and isovists.

The space syntax analysis undertaken for this Doctoral Thesis will, therefore, look into all the floor plans of the new central building from 2008-2009. This will already bring a considerable degree of complexity to the analysis, not only by the quantity of floor plans, but also because of the tripartite process of this procedure, through convex spaces, axial lines and isovists.

Besides, this building holds a particular autonomy towards the others, that bestows upon it the possibility of being analysed solely rather than as a part of a more extensive compound, with several assorted other buildings, with different functional purposes, and from different time periods, not as close, nor as representative of the school's mixed curricula, spatial sharing and urban openness.

Moreover, according to Hillier (2007[686]): "The general form of this measure is called integration, and can be applied to any space in any configuration: the less depth from the complex as a whole, the more integrating the space, and vice versa."

[685] See Chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.
[686] Consulted edition from 2007, original edition from 1996.

(p.25). So, the space syntax analysis of the more topologically distant buildings will provide lower values on the parameters upon consideration, such as integration and connectivity in both convex spaces and axial lines.

Therefore, if the integration has low values, the connections to others spaces are less meaningful, and so these spaces are also less meaningful for the study of the system and their activities[687].

Hillier refers to the connection between integration and activities in his paper *Visible Colleges*:

> "A key syntactic measure of configuration is *integration*. […] This is initially a purely spatial measure, but it gives a configurational analysis of function as one simply looks at the integration values of the spaces in which functions are located. As soon as we can identify common patterns in the degree of integration of different *functions* or *labels* in a sample of dwellings, then it is clear that we are dealing quite objectively (i.e., in terms of the properties of objects) with cultural genotypes acquiring a spatial dimension - that is, with social knowledge taking on a spatial form."[688] (Hillier and Penn, 1991, p.30)

Actually, the spaces with lower integration are less significant for the study of the whole built compound of the school, but also the activities that there take place are also more specific and less central for the all functional analyses of the school as proceeded in milestone one of the methodology.

Again, Gehl (1970) also agrees that spatial morphology can condition or promote experience and activities in space:

> "Shape, location, orientation and the use of a building will determinate which spatial sequences and which activity sequences there are to be experienced in and around the building or the complex of buildings. Buildings can, for instance, be arranged in a way which concentrates and channels activities or they can be arranged in a way which decentralises or plainly hampers activities. Human activities in a building can, as another example, be laid open to bypassers or they can be obscured from anybody who is not participating. Whether the activities are concentrated or decentralised,- are channelled or spread out, - are laid open or closed in, - are integrated or segregated - whether the distances

[687] According to Hillier and Hanson (1984): "[…] integration is a global measure since it takes into account the relations of a space to every other space in the system". (p.109)

[688] Italics from the original quote.

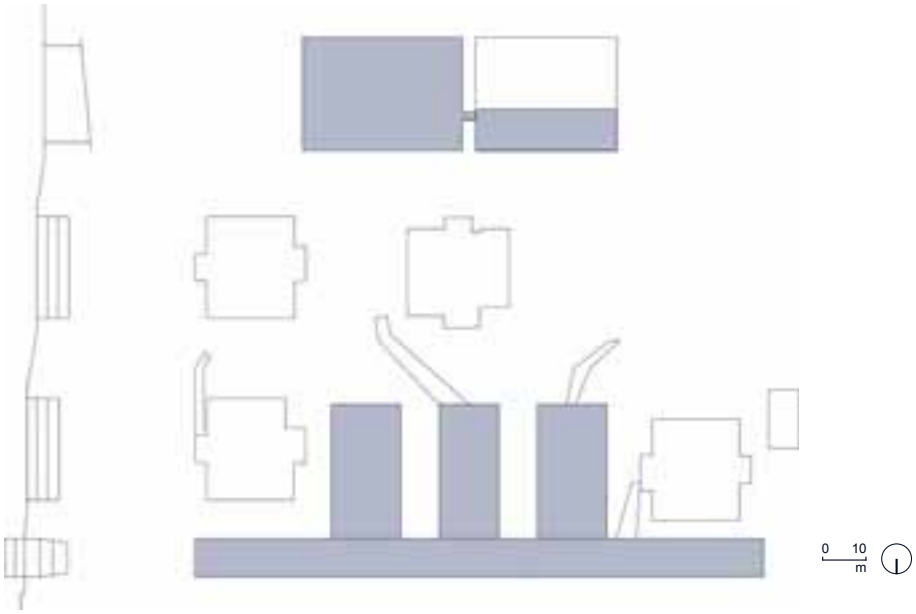


Fig. 148. Quinta das Flores School _ Transversal section of the plot and overall plan
(Drawings provided by Parque Escolar and edited by Carolina Coelho)

> for perceiving are short or long - whether the time for perceiving (i.e. driving, walking) is long or short, are all important factors which determines whether you will be able to experience just the earth, the buildings and the sky, or the people who are using the buildings, as well." (Gehl, 1970, p.62)

Additionally, there are other obstacles that interfere in the pursuit of a space syntax analysis of the entire school compound with all the pavilions that compose it. First and foremost, as explained, and considering the most central space to be the new central building with the street façade that welcomes all the visitors and inhabitants, the most distant pavilions hold very low values of integration or connectivity towards this one. This adds to the fact that the activities that there take place in distant pavilions do not represent as well the mixture of uses and experiences that the central building holds, and that only the students and staff go there for particular purposes, not representing a shared space by a broad or a mixed school community.

Besides, space syntax is usually proceeded with an analysis by floor plans, which is not clear in this school because the plot leans over from south to north (being the south the highest elevation) (Fig. 148).

So, there would only be two possibilities for a space syntax analysis for the all compound: a specific analysis of each pavilion alone - which would bring partial results, mostly for very similar buildings with very similar activities from the regular

teaching that occur there; or an analysis made by horizontal sections on the plot that could imply analysing a lower floor from the central building with a higher one from other pavilions that are located in a higher part of the plot.

However, in the latter possibility the relation between the buildings is not also clear, because the global analysis only becomes relevant when there are pathways that link the buildings, otherwise, the connectivity between isolated buildings is not meaningful for this analysis. In this case, these pathways can either be interior or exterior, which also adds another point of intricacy to the analysis, because it would imply analysing the school's buildings but also its external paths and courtyards as informal pedagogical spaces. This would be intensified by the fact that the procedure implies a tripartite analysis of convex spaces, axial lines and isovists, which would imply a dense and very extensive area, analysed by a not straightforward or literature supported procedure, for the study of a leaning plot with multiple buildings and external areas in a whole single analysis.

All in all, a space syntax analysis to a pavilion layout can be considered uncanny and not providing the results from integration or connectivity that are aimed with such an analysis, aggravated by the fact that the school's plot of implementation is inclined and adds a deeper complexity to this procedure.

If the analysis of other buildings is considered to be non-meaningful in the parameters to be assessed, such as connectivity and integration, because of their low centrality to the entrance and high depth within the plot, and because the method to analyse them would also be more time-consuming and would imply a deeper intricacy and little benefit, not necessarily bringing operative results. Then, these facts all justify not including them in the analysis and potentially being negligible for the final results.

So, by acknowledging that adaptability is a product of several approaches undertaken by this methodology, the chosen spatial sample represents the spaces morphologically most relevant for a space syntax analysis. Thus, having the highest levels in the first stage of the methodology that focus on how school space supports activity allocation, these spaces are potentially the ones with the highest adaptability.

10. Practical procedures when applying the methodology: Entropy approach.

The entropy approach corresponds to milestone two of the proposed methodology. As seen on the previous chapter[689], and following Jaynes (1957) and Tribus (1969)

[689] See Chapter 3.3.2. Description of all possible activity allocations to educational environments.

approaches on entropy, in this context it is related to the uncertainty of an activity allocation to a space, which means, as already pointed out, that low entropy implies a low range of potential activity allocations to a space.

So, with all that has been previously described, the main central building that corresponds to the spatial sample, relates to the spaces that hold the widest range of activities and, therefore, that will potentially lead to the highest levels of entropy, in advance, and according to this definition.

Conversely, the remaining buildings would bear low meaningful values of entropy, not representative to inform the results achieved, because their functional uses are specifically related to particular teaching classes, such as formal classrooms for the regular teaching or sporting activities, rather than a blend of activities, teaching regimes and users - external and internal - like it happens in the main central building. Once more, this justifies the higher levels of entropy, *a priori,* of the spatial sample rather than of the remaining pavilions.

So, recognising that the level of adaptability is a result of the several approaches that compose this methodology, this spatial sample embodies the spaces with potentially the highest entropy. Hence, having the highest levels assessed in the second milestone of the methodology that focuses on all possible activity allocations, these spaces are potentially the ones with the highest adaptability.

11. Practical procedures when applying the methodology: Experience and spatial fruition.

The chosen spatial sample represents the spaces which all the school community uses and experiences, because these spaces hold the widest range of activities of all sorts and teaching regimes, besides internal and external community events. Besides, the fact that this building embodies the street façade, implies that all visitors and inhabitants enter through it and know the school at first from this space, despite their following purpose and path in the school.

Thus, having the highest levels considered in the third milestone of the methodology that focus on effective events and experience, these spaces are potentially the ones with the highest adaptability.

12. If the spatial sample holds, in advance, the highest levels in all the parameters assessed on the methodology, then it will potentially conclude on its high adaptability.

Overall, the balance between the cost and benefit of introducing the methodology in the whole school can be considered extremely extensive for an individual research

and potentially not providing an additional gain on the methodology's potential and robustness. In fact, if all the data to be processed, calculated and correlated is too extensive and complex, it could potentially delay or hamper the results or blur the developments and stages within the all process, here under testing.

The choice of this spatial sample is considered to achieve the higher results in all approaches assessed throughout the sequential procedure of the methodology proposed and hence, the highest final results.

13. The application of the methodology aims at testing it as a robust approach to adaptability, in which the spatial sample is considered adequate in its relevance and extent for this purpose.

The process of applying the methodology to a case study aims, first and foremost, at validating the methodology, rather than assessing the school or the Secondary School Modernisation Programme, so the spatial sample is considered adequate in its relevance and extent for this purpose.

The process of applying the methodology to a case study will both validate the methodology and conclude on the adaptability of the spaces' assessed[690]. Actually, this Thesis's objectives[691] reside firstly on the development of the methodology itself and its sequential and hybrid set of approaches, considering that it is applied to current Portuguese educational spaces. Naturally, because it is tested on a case study, the spatial sample will be evaluated, concluding on its adaptability.

With all that it has been said, the methodology will be applied to a specific spatial sample, which corresponds to the new building from 2008-2009, whose justification has been considered to be extensively supported, acknowledging this building as the most relevant for an adaptability research on this school, whose extent is also considered to be adequate for applying an original methodology, extensively explaining all procedures, and presenting partial results, potential correlations and overall adaptability levels, within the scope of this Doctoral Research.

Indeed, as future developments, and after testing and validating the methodology and considering it to be robust, it could be tested in other school spaces or buildings, or even other schools, whose outcomes may differ.

[690] As explained in tat the end of Chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[691] As seen on Chapter 1.7. Architectural disciplinary scope, relevance and originality of the research.

SCHOOL'S TECHNICAL DATASHEET

School's Typology:	Pavilion
Name:	Escola Básica e Secundária Quinta das Flores Conservatório de Música de Coimbra
Location:	Santo António dos Olivais | Coimbra
Designated capacity:	75 classes
Architecture:	Traço Banal Arquitectura Lda.
Project Management:	José Paulo dos Santos
Collaboration:	João Vieira Campos, Liliana Vieira, Catarina Almeida, António J. Teixeira
Project's Date:	Fase 2A | 2008-2009
Project's Client:	Parque Escolar, EPE
Project's Teams	
Structural Engineering:	Eng. Eugénio Maia | Struconcpet, Lda
Waters | Sewage:	Hidrofunção
Gas:	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A.
Electrical Engineering:	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A. | Eng. J. Viseu
Integrated Security:	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A.
HVAC (Heating, Ventilating and Air Conditioning):	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A.
Energetic Certification:	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A.
Acoustics:	dblab | Eng. Rui Ribeiro
Solid Waste:	Eng. Eugénio Maia
Safety and Health Plan:	Rodrigues Gomes & Associados – Consultores de Engenharia, S.A.
Landscape Design:	Imochiado, Lda. | Arch. João Junqueira

(Adapted to English from Parque Escolar's Characterization sheet #67, n.d., complemented with the Data sheet from the data in *ARQA* 2013 (Santos, 2013) and *Domus* 2016 (Domus, 2016) and explained by the architect José Paulo dos Santos during the interview in 26th June 2017 (Santos, 2017))

4.2. The sequential procedure for the application of the methodology

The previous chapter 3 focused on the overall presentation of the sequential procedures to identify and assess adaptability in educational environments[692]. Departing from the state of the art on the several approaches to identify spatial fruition and, in a more analytical manner, to assess spatial usage[693], overall it has been concluded on the diversity of study fields that tackle it[694]. This was then narrowed to the methodologies for specifically identifying adaptability, namely Fawcett's (1978) Doctoral Thesis *A Mathematical Approach to Adaptability in Buildings* [695], which is considered to be of substantial relevance for adaptability assessment on school buildings, even if a critical reflection on the contemporary educational context, on both the curricula and the school community, have to be acknowledged in order to translate this methodology into the changes in space and practices that have occurred since the 1970s[696]. So, understanding the previous approaches and their diversity in the procedures and in the conclusions achieved, which can lead to outcomes of varied nature, a methodology for identifying and assessing adaptability in learning environments has been then proposed, explained and justified in a general manner[697].

The purpose of this current chapter 4 is therefore to apply it to a specific case study, already presented and justified in the previous sub-chapter[698]. For a validation of the methodology, it was first applied, partially, by means of a space syntax and an entropy weighting on the ground floor and on the first floor of the new building of Quinta das Flores School, which have been considered to be an early test before a more comprehensive and exhaustive application[699]. At this point, this Thesis will now proceed with its sequential application on the chosen spatial sample. As explained in abstract, this approach will be tripartite producing the sequential items of this chapter (Fig. 149):

[692] See chapter 3. Construction of the methodology.

[693] Use and fruition have been addressed initially on chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

[694] See chapter 3.1. Space use assessment methodologies.

[695] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[696] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[697] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[698] See chapter 4.1. Presentation and justification of the chosen case study.

[699] The results encountered then were presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London. It has also been published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 149. Description of the methodology and identification of the current milestone I. (Carolina Coelho)

4.2.1. Description of the school space and how it supports activity allocation

> "The spatial experience starts from the moment of entering a building - the number and location of entrances from the outside, the sequence and linkage of spaces, the 'depth' of the different spaces (that is, the number of other spaces one has to pass through to reach them) and the number of alternative routes to a space (that is, whether it is on one or more rings or on part of a branching, tree-structure). All of these create spatial experiences which relate to function - who does what, where, with, and controlled by, whom.
> Each of these three experiences relates to characteristics of buildings which are capable of theoretical analysis." (Markus, 1987, p.469)

This initial stage comprises a description of the spatial sample, functional and morphological, and informs on how it supports activity allocation. A space syntax analysis regarding convex spaces and axial lines, as places and pathways for learning, will provide a thorough understanding of the sample's morphology and conclude on the relevance of global and local syntactic measures towards activity allocation, spatial cognition and the overall "social logic of space" (Hillier and Hanson, 1984).

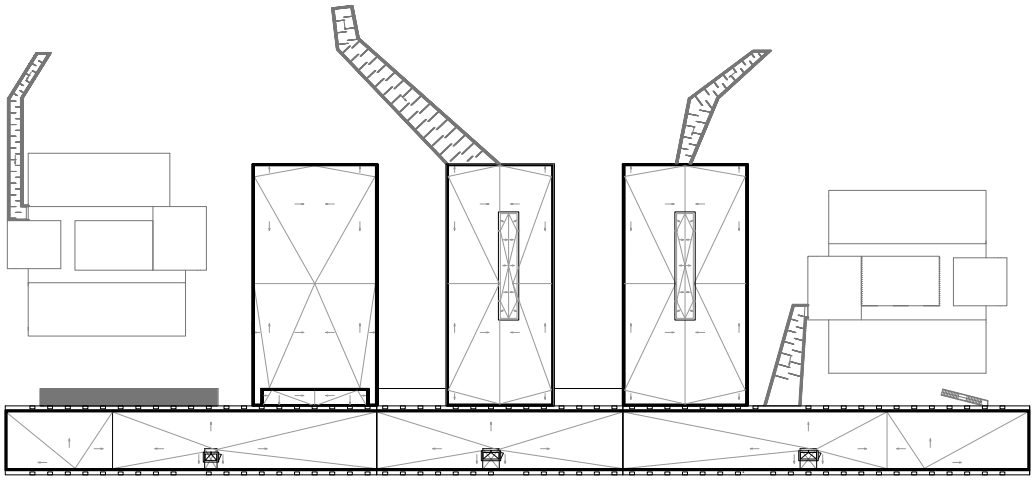
But, primarily, it will be paramount to analyse this spatial sample according to its spaces, activities and attributes. So, the subsequent analysis will be supported by an in-depth understanding of the physical environment, in regard to its main functional allocations and spatial features. After this, it will be possible to understand each space individually, its positioning and links to the whole spatial system, but also its overall topology, and to associate it with natural movement, co-presence and spatial fruition.

4.2.1.1. Definition of the spatial sample _ Functional analysis

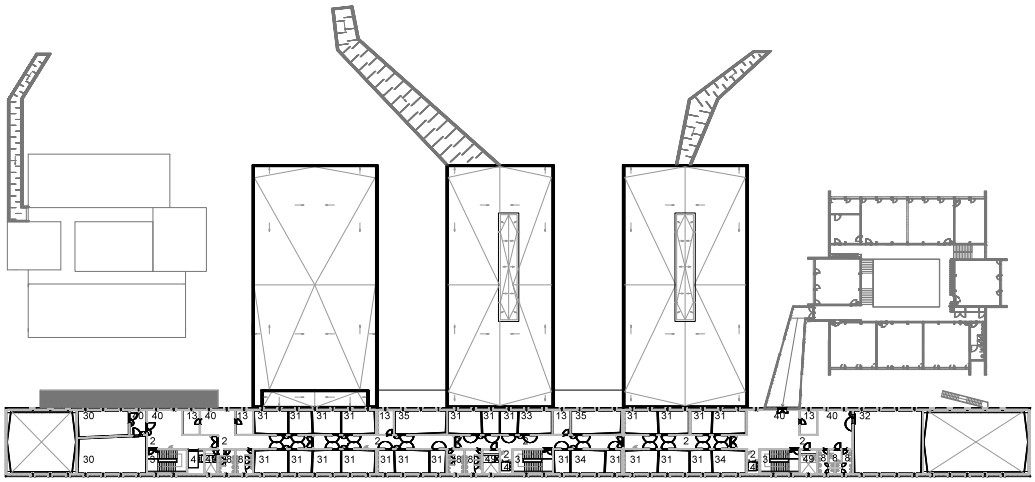
. Spaces

For functionally analysing the spatial sample, the building's final plans provided by Parque Escolar have been studied and edited in Autocad, in order to specifically identify the information needed for this current Thesis and for the implementation of the methodology in this school, leaving out further data that the final plans provided, namely technical one, that added extra, yet unnecessary information, that was not fit for the scale of the drawings here presented and that interfered with its immediate understanding. Besides, the work undertaken in these drawings intended to detach the spatial sample[700], to be studied in particular detail, from the building's final plans from the entire school's rehabilitation.

[700] For the justification of the chosen spatial sample see chapter 4.1.2. Justification of the chosen case study.

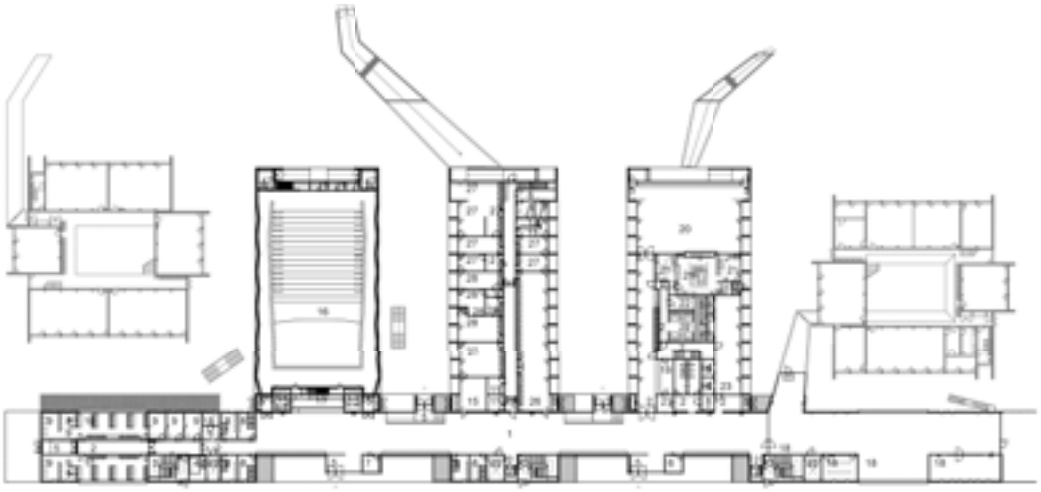


Rooftop plan

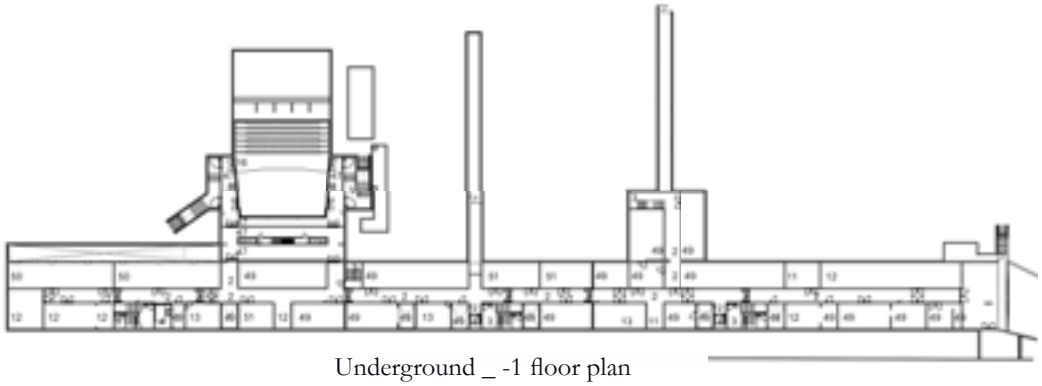


Second floor plan

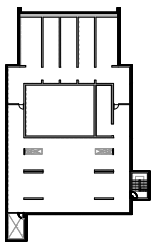
First floor plan



Ground floor plan



Underground _ -1 floor plan



1 main hall
2 access–corridor
3 vertical access–stairs
4 vertical access–elevator
5 entrance–outdoor access
6 reception desk
7 ticket office
8 bathroom–toilet–sink
9 dressing room
10 locker room
11 storage
12 indeterminate supportive space
13 spare space
14 vault
15 archive
16 auditorium
17 auditorium's cafeteria
18 library
19 cafeteria
20 canteen
21 kitchen
22 kitchen storage
23 staff room
24 teachers' room
25 students' room
26 secretariat
27 administration offices regular teaching
28 administration offices artistic teaching
29 orchestra room
30 music studio
31 music instrument training room (individual or for small groups)
32 choir room
33 singing studio
34 song writing studio
35 specific music training room
36 study room
37 dance studio
38 science lab
39 generic classroom
40 common living space
41 teachers' office
42 teachers' meeting room
43 teachers' office for meeting students
44 students' shop
45 photocopy room
46 parent council room
47 auditorium supportive spaces
48 psychologist's office
49 technical area
50 music instrument storage
51 maintenance room

Underground _ -2 floor plan

0 10 20 m

Fig. 150. Quinta das Flores School's new building
(Plans provided by Parque Escolar and edited with captions by Carolina Coelho)

This procedure implied the creation of particular layers on the drawings, divided as such: the main layout of each drawing, the accessory information that still holds relevance for the understanding of the represented space, and the remaining part of the school complex, still visible in light grey in the drawings presented in the previous pages of this current Thesis. For a more clear representation, only the main information has been identified in black lines and all the remaining layers were identified in shades of grey, according to the layout that was considered to be more adequate for this Thesis and then edited in Photoshop for achieving the layout of the plans here presented.

Accordingly, the drawings have been revised from its original source for layout purposes, aiming at a more clear study on the selected spaces *per se* and the overall building's morphology, and additionally for identifying in the plans the main functions conceived for each one and each one's pedagogical potential in the school. Conclusions will then be reached from the analysis of the drawings and from deeper understanding of each floor plan in a number of different layers of functional and pedagogical analysis, to be carried out in this part of the methodology.

The previous Fig. 150 illustrates the final plans from which this Thesis will depart from, followed by a deeper study on the functioning of the building, using coloured hatches, followed by a space syntax and a subsequent entropy analysis.

From the analysis of the plans in Fig. 150, and after a deeper study on the drawings made in Autocad as already referred[701], countered by several visits to the building, the captions on each space have been placed according to the main function indicated in the final plans.

Generally, this building is composed by three floor plans above ground, comprising the ground floor and two upper floors, and two underground floors envisioned mainly for technical services and devices. Both the main façade to the street (Fig. 151) and sections, either longitudinal or transversal (Figs. 152 and 153), clarify the building's layout explanation.

The six plans presented in Fig. 150 provide relevant input on the building and its overall functional arrangement and allow us to determine that the rooftop plan does not feed us information on the building's spaces but rather on its volumetric layout, and that the underground floor plans might also be disregarded from the analysis, because they are largely related to technical functions, in regard to heating, ventilation and air conditioning systems, holding supportive spaces for the main active learning environments, such as the auditorium supportive spaces identified in the captions as spaces' number 47 and that contains all of the -2 floor plan (Fig. 153).

[701] This is considered to hold relevance due to the disciplinary realm of this current Doctoral Thesis on Architecture, which is a discipline that relies on drawings and representations for both conceiving space and representing it. So, drawings provided a specific architectural knowledge from the building.

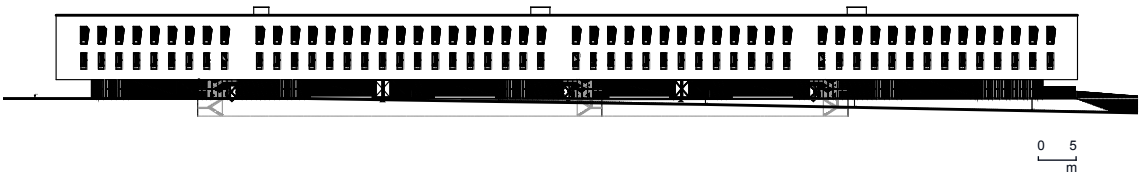


Fig. 151. Quinta das Flores School's new building _ Main façade
(Drawings provided by Parque Escolar and edited by Carolina Coelho)

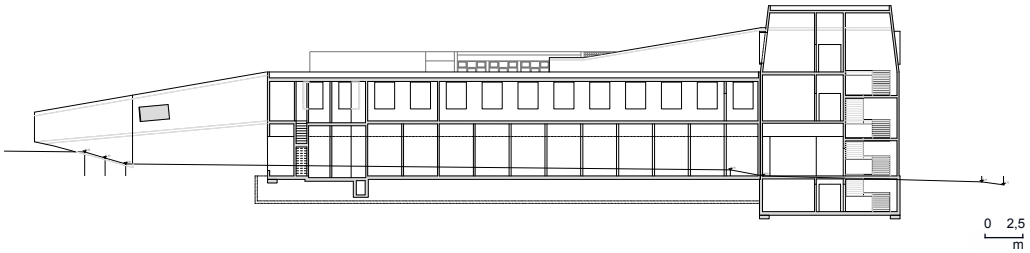


Fig. 152. Quinta das Flores School's new building _ Transversal section through the administrative block
(Drawings provided by Parque Escolar and edited by Carolina Coelho)

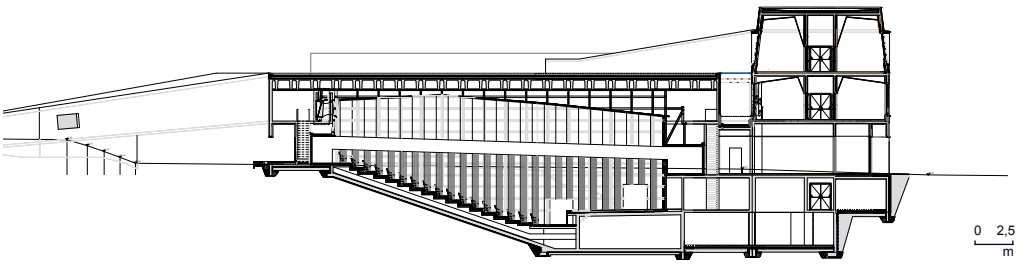


Fig. 153. Quinta das Flores School's new building _ Transversal section through the auditorium
(Drawings provided by Parque Escolar and edited by Carolina Coelho)

Furthermore, the -1 floor plan indicates that it holds supportive spaces for the regular functioning of the school, such as storage - either for the regular teaching or specifically for the music instruments - and also maintenance spaces and spare spaces.

So, having concluded that both the -2 and -1 floor plans only hold technical areas, these have been disregarded from the further analysis carried on, particularly on the spaces with pedagogical potential, or on the ones that functionally but also socially, support active learning environments. Acknowledging that supportive spaces can hold pedagogical potential, for the purposes of future analysis on this school, the spaces isolated in the referred -2 and -1 floor plans, are considered to be technically and physically relevant for the functioning of the school building, but lacking learning potential, not only due to the lack of formal and/or informal activities with that objective, but foremost for not being conceived for the common use of the school community, but merely for its staff. A remark is here to be left, that if activities with pedagogical potential might happen in the future on those

floors, particularly on the -1 floor, which has a broader range of spaces, namely still indeterminate ones, then this floor might be considered in future analyses, because both students and educators might start to be and circulate in this floor. Yet, as these have not been conceived by the architect as such based on the school's final plans, which are currently being used for this milestone's description of the space, then the current analysis will disregard them on their lack of educational events.

So, all in all, and after dismissing the rooftop plan and the two underground floor plans, three main floor plans will then be analysed with further detail: the ground floor and the two upper floors[702].

Another relevant information taken from the analysis of the final plans is the existence of spare spaces, identified as number 13 in the plans and placed throughout the all building, particularly on the first and second floors and not only on the underground floors, potentially implying future change and a wider range of forthcoming spatial needs. Because they are already indicated as such on the original final plans[703], it is concluded that these spaces have already been regarded during the design as spaces without a specific purpose, but leaving it possible to cope with upcoming needs or current spatial requirements that have not been considered in the brief[704]. These spaces are here considered as potential active learning environments. Because, even though their purpose is still underlying in the design, its effective usage can in the present or in a near future, bestow on these spaces functions related to knowledge transmission or acquisition. In further analysis, the dimensions of these spaces may consider them as possible formal or informal study rooms, students' rooms or students-educators meeting rooms, or even informal common living spaces for small groups, all of which can be recognised as active learning spaces. Note that these spaces differ from the ones whose captions are "indeterminate supportive spaces", which are exactly that: spaces that aid other, larger or more relevant supportive spaces, namely on the technical areas of the school but primarily deprived from pedagogical potential from the start, particularly due to their technical specificity or their adjacent location to a supportive area.

Furthermore, the analysis from the direct study of the plans listed 51 different spaces (Fig. 150). These hold different functions, either active or supportive of the learning process, from different teaching regimes, more or less specialised, and for staying or circulation purposes. This is considered to be relevant for the

[702] It is significant to highlight that the first floor plan differs from the second floor plan not only in programmatic terms but also physically, because of the building's volume definition that becomes narrower near the top. This can be better understood in the transversal sections in Figs. 152 and 153.

[703] Originally named "reserva" in Portuguese, which could be translated as a spare space or space of reserve or set aside.

[704] In the captions the spaces with the number 12 are indicated as indeterminate supportive spaces. These are spaces that do not have a specific function but often represent a space of entry for another more relevant space. Originally in the plans, these are called in Portuguese "antecâmara", but could also provide for other functions other that the mere entrance due to their significant dimension and frequency in the building and their physical attributes and location – to be analysed subsequently.

understanding of the building as an educational environment. Therefore, after locating the spaces' main activities in each plan, this procedure will focus on the placement and dimension of each of these spaces by subsequently identifying them in the plans using coloured hatches for each of the mentioned situations. So, in order to better understand the spaces and there main programmatic functions, colours were assigned in a systematic way, to classify the spaces according to the main type of activity those spaces hold.

Active or supportive learning environments

The initial analysis will portray the range and location of both active and supportive learning environments. It is considered that active learning environments are spaces that have pedagogical potential and where students can acquire knowledge, either by a formal or an informal activity, or by a programmed or a non-programmed event. Therefore, classrooms or defined spaces for classes, training and knowledge communication or evaluating, are the most traditional spaces to be considered as active. But also, circulation pathways, both in stairs and elevators, as well as corridors, are places where the school community can gather together for informal activities, programmed or non-programmed events and where the information transfer can also occur. Besides, it is also considered as active learning spaces the social areas allocated to students, such as the cafeteria or common living spaces, where knowledge can be created and passed on to others. For such purposes, the main hall, having a considerable width and length, can potentially be a space where both circulation and staying can occur, and it is hence, a space that can hold a wide range of different activities with pedagogical potential.

Conversely, technical areas are considered deprived of pedagogical potential as explained earlier, and duly pointed out in these floor plans in grey. The spaces considered to be supportive of the learning process are the ones that shelter activities in order to complement the spatial requirements of the educational activities, such as the locker rooms and the dressing rooms for the auditorium and the dance studio, where the artistic teaching takes places. Essentially, activities such as dancing and performing require specific supportive spaces such as these. It is noteworthy the fact that this school carries a wider scope of spatial requirements on supportive spaces, in order to aid with the several music and dance teaching, like the storage of music instruments that comprise a wide area particularly on the -1 floor[705]. Furthermore, it also embraces a broad array of active learning environments for different artistic activities such as: studios for the individual music training or for small group classes on music instruments, music studios for a larger number of students, the choir room and spaces for public display such as the dance studio, the orchestra room or the auditorium for events of a broader scale.

[705] Identified in the plans with the number 50.

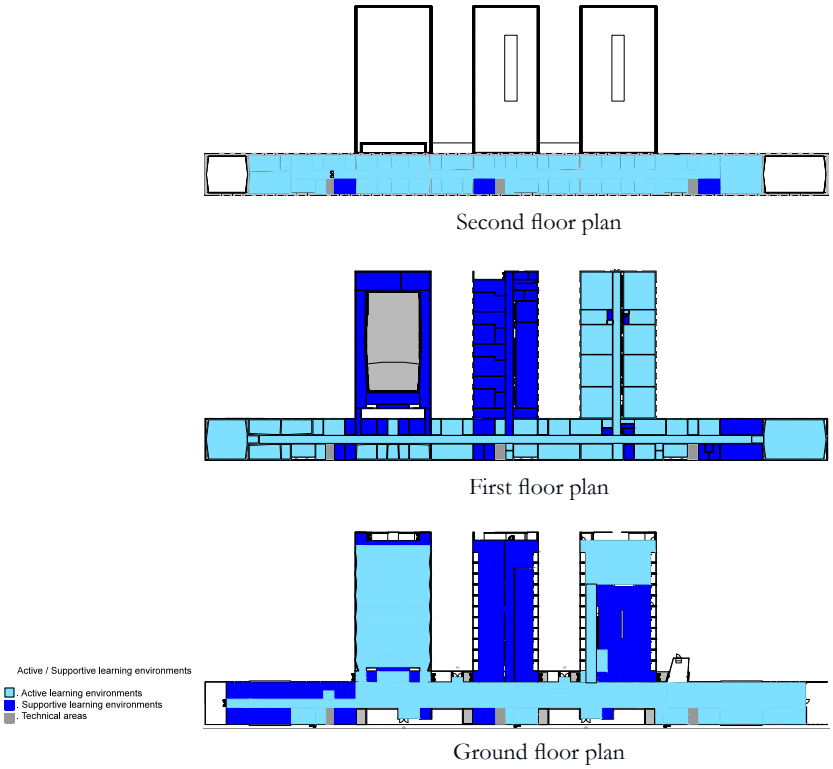


Fig. 154. Quinta das Flores School's new building _ Active and supportive learning environments (Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

Additionally, as supportive learning spaces for all the students' community, the kitchen areas on the ground floor, where the meals' preparation and cleaning take place, have been recognised as supportive of the cafeteria and the canteen. The latter are informal yet with learning potential.

Furthermore, the areas reserved to educators and staff, such as the administrative area on the ground floor and the teachers' meeting rooms, are considered to be supportive spaces, whereas the teachers' offices for meeting students can be understood as spaces where learning can occur, outside the classroom, in a more individual manner.

Overall, active learning environments (in cyan in Fig. 154) imply the gathering of the school community or primarily students' encounters that can convey information and knowledge amongst each other, while in class but also in social events or circumstances of natural movement. On the contrary, spaces only for staff or educators that do not transmit information to students are considered to be supportive of the main, active educational spaces[706] (in blue on Fig. 154).

[706] This distinction will be considered again later on, with regard to the entropy calculation, in which active and supportive learning environments will be dealt as Domain I of the entropy analysis.

In a deeper analysis of the areas in the three main floor plans, it is clear that the ground floor carries a more extensive range of supportive areas than the two upper floors. Nevertheless, it is on the ground floor that there is a wider addition of active but also informal learning environments, whereas, on the upper floors the active learning environments are clearly more defined by formal spaces, such as classrooms and music studios, that can be both for programmed activities but also for non-programmed informal training. This building, as more specifically identified in a subsequent analysis, holds more activities regarding the artistic curricula rather than the regular one that takes place in the pre-existing pavilions of the schools, as it did prior to this rehabilitation[707] (Fig. 154).

Social and informal and/or formal and curricular

It is now relevant to focus on the spaces' nature, not only to what it has been envisaged for on the design, but also on its potential to allocate other uses. Learning activities can be both strictly curricular in the sense that they are embedded in the formality of programmed events, lectures or classes in spaces designed for that purpose, namely classrooms for either the artistic or the regular teaching, and specialised rooms such as laboratories for the teaching of sciences. But also spaces for official meetings between the peers or between educators and students, such as teachers' office for meeting students or the psychologist's office, or even spaces where peer interaction occurs but with a particular official purpose, like the photocopy room and the students' shop that can also be considered as formal spaces with a pedagogical curricular nature.

Contrarily, spaces with a particular social purpose where the gathering of the students is the main purpose in terms of knowledge acquisition, are considered in Fig. 155 as informal and social spaces, bearing in mind their role as an active learning environment. Also, for this analysis, only the identified active learning environments from Fig. 154 have been considered, which are the ones that provide knowledge creation, acquisition and transmission between students.

It is important to underline that Fig. 155 identifies the spaces as formal and curricular from the ones that are considered social and informal, and finally the spaces that are both, or have the potential to be in the future. Nonetheless, it is recognised that this is a simplification that functions at this initial stage of the methodology as a first recognition of the spaces, simplifying their nature to their main purpose. Later in the methodology, after an initial acquaintance with this school space, when addressing the entropy approach, the difference between formal/informal spaces and for social or curricular uses will be cleared out[708]. Because, even though the

[707] Once more is highlighted that it has been within the modernisation process of this school that the artistic teaching has been conveyed into the school's curricula.

[708] At the entropy analysis spaces will be considered either curricular or extra-curricular in Domain II, and for

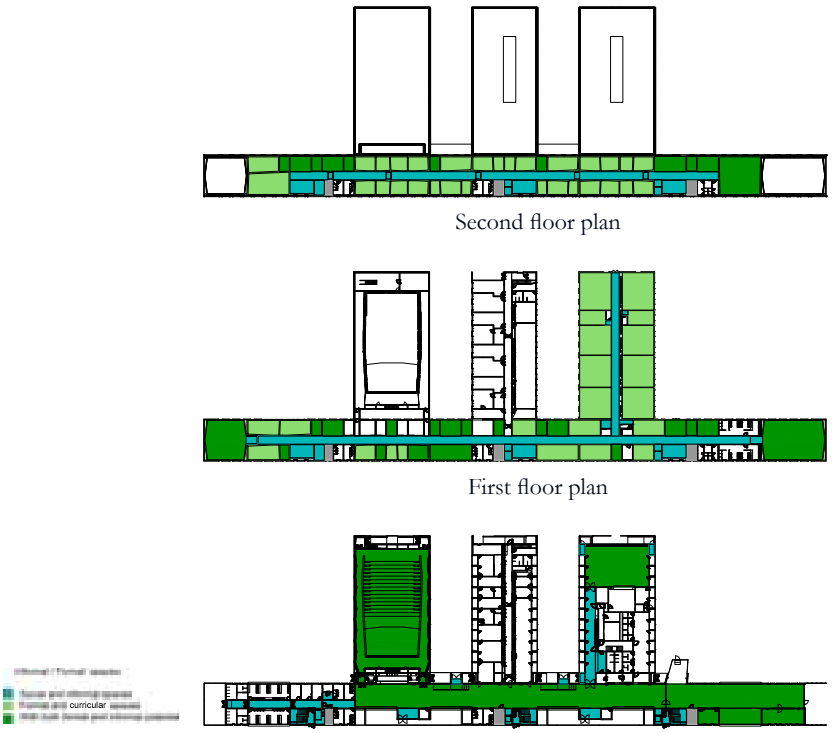


Fig. 155. Quinta das Flores School's new building _ Informal and formal spaces
(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

most straightforward dichotomy may be a formal/programmed/curricular event from an informal/non-programmed/social one, other options can also be possible to consider like: an informal and social event that may be programmed such as a seasonal party, or a social event that can be a formal one such as a public concert from a renown artist; or even a social event that can be of curricular purpose such as a social meeting for the purposes of organising a group work. According to this variability, an extensive activity sample will be produced specifically for this school, considering all of these possibilities for this particular space and then these activities will be allocated in detail to the spaces where they can potentially occur. But for stage one, the application of the methodology will start by an initial and less detailed approach to this space, gathering social and informal spaces as the most striking difference from the formal and curricular ones.

It is also significant to provide a clear explanation of what it is here considered when addressing these concepts. *Programmed* events have a previous arrangement, and a time and location defined *a priori*[709]. *Curricular* is here used as opposed to

programmed or non-programmed uses dividing them in Domain III.

[709] These definitions have already been dealt in detail in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments, have been derived from Krüger (1992, p.7).

extra-curricular, which is an activity with pedagogical potential as opposed to the ones that do not provide knowledge or any learning moment for the students. *Social* implies that the event has in its nature a group gathering in a collective arrangement, that in a school often results in knowledge exchange and learning moments by peer interaction. *Informal,* as opposed to *formal* activities, is related to more relaxed moments often spontaneous, casual and unplanned; where interaction occurs which can also lead to knowledge transmission or even creation, such as an instrument music improvisation by the artistic students.

After a detailed study on the space and the possibility to categorise each space according to its potential as either curricular and formal, or social and informal, or both, Fig. 155 systematises this particular analysis, to be further clarified on the justification and critical examination of the coloured schemes on the following paragraphs.

Generally, the most remarking aspect when comparing the three floor plans is the difference in colours assigned to each one. The second floor has mainly formal and curricular spaces conveyed to the artistic teaching and coloured in light green in Fig. 155, mostly music training rooms or music studios of formal nature for individual or group lectures and music formation at large. In addition, it also has spaces identified as common living spaces (caption 40), which are cluster spaces adjacent to the main corridor in all floor plans and which destitute them from a strictly rectangular shape to a more irregular one that provides them not just with a longitudinal axis for circulation, but also with spaces on that axis that can contemplate group interaction by standing and not only by moving. The existence of these spaces throughout the building is quite relevant for the possibility to bestow on the main circulation other purposes rather than just moving, and mainly the possibility of learning, which is most evident in the main hall, wider and more significant in dimension, accessibility and, hence, in activity allocational potential.

Besides those spaces, also the spare spaces are considered for this analysis spaces with both formal and informal potential, because the common living spaces, while more likely recognised as informal spaces for social gathering, can also shelter small exhibitions of academic nature, displaying contents produced in formal classes, acting as a curricular space with the formality of an official presentation. For this floor plan in particular, another space has been considered to have potential for both situations: the choir room on the west corner of the building, which is a space with a proportion and dimension that enables group activities, both formal for learning, practising and performing, but also for external formal events and informal gatherings, and informal gatherings of social nature. For social purposes alone only the circulation spaces, either vertical or horizontal, have been recognised, acknowledging the possibility of socialising even when moving from one place to another in the same floor or amongst different floor plans. Hence, as assumed

before, the remaining spaces, other than the strictly formal ones, like common living spaces and spare spaces, were presented as having both formal and informal character, assuming their potential for both, even if not designed as such, or possibly not still effective in the present.

The first floor has a well-defined combination of colours and, henceforth, of formal and informal spaces. The transversal wing to the science labs is evidently of formal nature, and social gatherings for those purposes alone may not occur there due to the sensitivity of the materials and equipment on these spaces. As for the artistic teaching, also music studios and music training rooms are spaces for formal learning and practising. Also considered as formal spaces are the already mentioned students' shop and photocopy room, where student interaction occurs but for academic purposes, and also teachers' offices for meeting students, as well as the psychologist office, as formal interfaces between students and educators. Again, circulations have been recognised only as spaces with social potential and neither formal nor academic ones[710]. Once more, common living spaces as adjacent clusters to the main corridor and spare spaces have been identified with potential for both informal and formal activities, here added to the study rooms and students' common living room. If the first study rooms are mainly for curricular functions but able to hold informal extra-curricular conversations or any other spontaneous experiences between students, while studying or on a break from studying; the latter: the students' common living room has social gatherings as its main function and is considered a space for unwind, even if it can also shelter students formal meetings or study groups. Naturally, as a place for student appropriation it has the potential to allocate what the students intend to best suit them on their free time within the school. Finally on this floor, the orchestra room and the dance studio, on the opposite ends of the building, and similarly to the choir room upstairs, are also spaces intended to formal and curricular events, but which can also allocate informal experiences like spontaneous actions or programmed events of social nature.

The ground floor overall, is a place foremost for activity mix and combination of both teaching regimes, of both social and curricular nature. Circulation is again considered to be of social nature, but in this floor in particular the exterior accesses both from the street and from the interior of the school building are also added as circulation spaces. Additionally, the cafeteria is here identified as a social space, due to its narrowness that hinders the possibility of considering it as a space for any formal event because the quite longitudinal proportion of the space does not provide it with the possibility of standing there for some time or to display there any content which would obstruct the circulation between the canteen and the main hall. All the remaining active learning environments recognised in the previous

[710] Circulations will be defined in a detail analysis between vertical and horizontal ones for each floor plan in Fig. 156.

Fig. 154 are considered to have potential to be both formal and informal spaces namely: the auditorium, the library, the canteen and the main hall, due to the several events they can cater for: either social ones, non-programmed, programmed for internal and external audiences, formal exhibitions and displays, or informal and spontaneous artistic practices.

All in all, and after a thorough analysis of each floor, it is possible to conclude on a stratification by floors for academic purposes, where the ground floor can hold both informal and social, formal and curricular events of different sort and teaching regimes; the first floor presents a combination of either formal or informal spaces; and the second floor has mainly curricular and formal spaces, even if it has some common living spaces and spare spaces which could, either in current or forthcoming times, be appropriated by informal activities, diverging from the remaining spaces on that floor plan.

At this point it is possible to recall Fig. 127 in chapter 3.3.[711], where it presented the possible scales of analysis of the spaces of the building for a comprehensive definition of the spatial sample. That table divided the spaces between: social and informal spaces, formal and curricular spaces, and the spaces with both formal and informal potential. This is clearly seen in Fig. 155's colour scheme, when applied to this building, and has been previously explained how and why each space has been categorised as such in this particular spatial sample. At chapter 3.3., while explaining the methodology in abstract for future application in a case study, that table presented a detailed categorisation, considering social and informal spaces to be either for staying or circulation; and formal and curricular spaces to be either classrooms or others. For this spatial sample in particular, only the vertical and horizontal circulation spaces are identified as being social and informal spaces because[712] the other social and informal spaces are here considered to also bear potential as formal and curricular areas, which bestows a higher relevance and diversity on this school as a pedagogical system overall. In fact, the predominance of dark green in Fig. 155, identifying the spaces considered to have potential for sheltering both formal and informal activities, concludes at this stage on a considerable wider array of activities and students and a potential high adaptability[713] from the school, but still to be proven to be more robust after completion of the application of the full methodology on this spatial sample. Therefore, the social spaces that enable staying are recognised here as such due to their dimension to shelter a group of people, their proportion not overly longitudinal and their direct adjacency to the

[711] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[712] The identification of the circulation spaces *per se* will be dealt with in the subsequent text and with an in-depth analysis, systematised in Fig. 156.

[713] According to the definition of adaptability chosen for this current Thesis and presented in chapter 2.1. Adaptability: definition and adjacent concepts.

main corridor in all floor plans, that enable to consider them also to have formal activities even if possibly not effective at this point, but potentially undertaken if management and curricular decisions were to be taken. Also, in Fig. 127 in chapter 3 considered the possibility of these spaces to be exterior or interior, but at this school, only the interior spaces are considered for this particular spatial sample[714].

In what regards formal and curricular spaces, it is possible to identify in this school the classrooms for the artistic, the regular and for both teaching regimes[715]. It is also possible to consider other formal spaces, as stated earlier, such as the photocopy room, the students' shop, the psychologist's office or the teachers' offices for meeting students, namely on the upper floors.

Spaces with both potential are mainly on the ground floor, which are also the spaces shared by all the school community, like the auditorium, the library or the canteen. These spaces, even if more prone to formal performances could also take up informal or spontaneous activities of educational nature. On the other hand, the main hall, even if mainly acting as a circulation, has distinctive spatial features from the upper main corridors, and its direct access to the street as well as its wideness and length, enables it to have informal displays, formal exhibitions and an external public audience, amplifying its usages and experiences. On the upper floors, due to their dimensions, the choir room, the dance studio and the orchestra room can also allocate both formal and informal events. In addition, the quite frequent common living spaces opened to the main corridors extend the corridors outside its social purpose to a wider potential to shelter occasional formal events. Moreover, the spare spaces identified act as indeterminate spaces with the possibility to take up undefined activities both formal and/or informal if needed.

Henceforth, the subsequent analysis, critical examination and systematisation in coloured schemes, will provide particular attention towards: circulation spaces, the approach to interior spaces rather than exterior spaces, the teaching regime on the active learning environments of this school building, the spaces for a more specialised use and the multiple option spaces, and also the spaces that can be used externally for a wider local community. This intends to complete a more comprehensive study of the school building, in regard to its spaces, in order to proceed to the next stages of the methodology.

Pathways for circulation or spaces for standing or both

At this point, space will be identified according to its potential as a pathway or

[714] This will be further analysed in a subsequent text in that specific manner applied for this school.

[715] The division on teaching regimes will be dealt with in the subsequent text and with an in-depth analysis, systematised in Fig. 157. But that analysis will provide further detail because it will focus not just on the formal spaces for each teaching regime, but on all active learning spaces.

a space for standing, which will bear considerable relevance for the space syntax analysis further on.

Spaces conceived for circulation purposes are either corridors for horizontal circulation, which connect two particular points in space, or vertical circulations such as lifts and staircases that connect two particular floor plans.

Circulation could also be considered for staff use only, like the corridors on the technical areas or on the restricted administrative areas and the elevator with the widest area to lift heavier and larger loads, which is the one on the east side of the building.

Despite disregarding the circulation on both technical areas and supportive spaces identified formerly, the remaining circulation spaces in active learning environments hold pedagogical potential and so, they are important to point out in the floor plans. Both by walking from one point to another, as well as by standing in a particular space, students and the general school community, can exchange information and generate knowledge transmission.

Hertzberger (2009) supports that "corridors do not belong in schools" (Hertzberger, 2009, p.9) and so, besides its functional purpose, circulation spaces can hold other activities if provided with physical features to accommodate a group of people standing there in a particular activity, rather than just walking from one place to another. Therefore, if a specific space has the ability to be considered both a pathway for the community to cross, but also a standing space where activities can occur – particularly if it is provided with a larger width, then it is also more probable to hold more frequent and diverse activities and users, potentially tending towards a more adaptable space, as expected in the final conclusions.

Furthermore, if a circulation space connects not only two spaces but more than two, it is more likely that it holds a more extensive range of users and so its fruition would be wider. Besides, if it is placed in a more central, or integrated, location in the building it also is more prone to a more frequent usage. These circumstances will also bear particular significance when resorting to space syntax for analysing this building and variables such as the spaces' placement in the overall system, the spaces that it connects and namely its status as a pathway or a standing space will be of consideration, assessment and further conclusion.

At this point, it becomes important to identify the circulation spaces on their difference from the standing spaces or the ones that can be considered for both. Fig. 156 provides information on circulation, pinpointing in orange the horizontal circulation spaces such as indoor corridors, but also access corridors, whose relevance is clear to recognise the possible external entries.

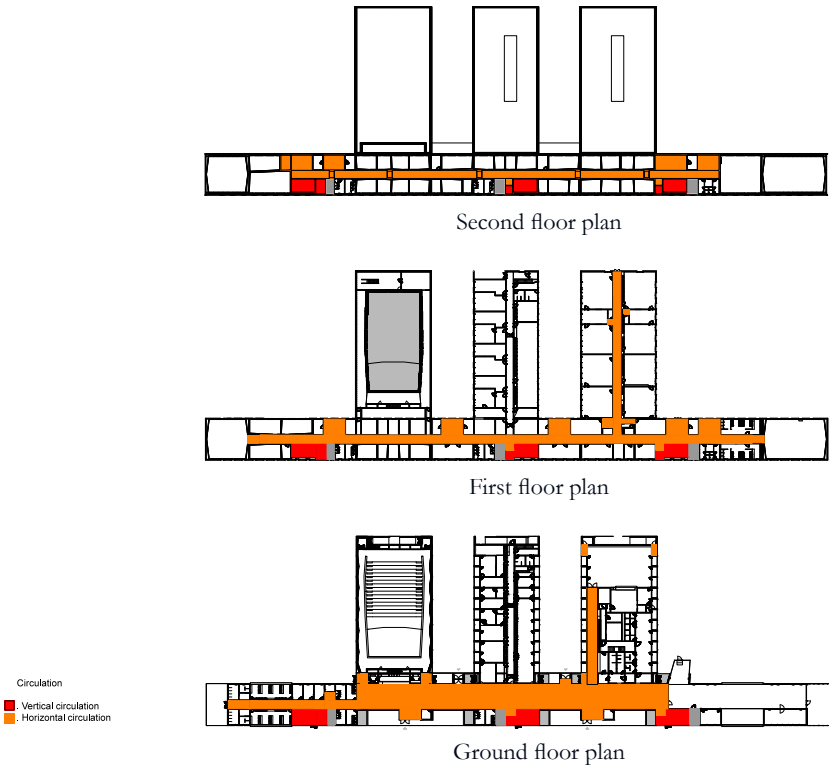


Fig. 156. Quinta das Flores School's new building _ Pathways for circulation
(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

Fig. 156 also recognises spaces identified with the caption "common living space" as circulation spaces if they are a part of the corridor area and do not present any spatial feature that isolates these areas from the circulation space individually. This aims to better portray the boundaries of the circulation spaces, remark that they are not necessarily of rectangular shape, but rather hold corners that can have pedagogical potential for standing alone or in a group. This is very relevant when considering these spaces not just as the corridors mentioned by Hertzberger, but as actual active learning spaces with both circulation and standing purposes. Also to note that all the main three corridors in the three floor plans analysed have particular shape plans, diverse in configuration and area between floors. Crossing this remark with the captions that identify the spaces, it is acknowledgeable that the second floor holds a diverse set of spaces foremost for the artistic teaching and less common living spaces in the main access; whereas the first floor that holds both regular and artistic teaching and a potential wider community of users has more of those spaces in the main circulation space; and finally the main hall on the ground floor, which is wider and clearly traverses all the building longitudinally, has more of these compartments, has also the exterior and interior accesses and also allows the access to other prominent areas of the building shared by all and with pedagogical potential like the library and the auditorium, and also even the cafeteria and the

canteen, more socially engaged.

In Fig. 156 the vertical accesses for community use: the staircases and regular or wide dimension lifts are identified in red, disregarding the vertical and horizontal circulations deployed from pedagogical potential and previously considered in technical or supportive areas.

Interior or exterior spaces

In what regards the identification of the spaces as either interior or exterior, this analysis will only focus on the interior spaces of this new building, which has already been justified.[716]

Teaching regime

This analysis will now consider the teaching regime allocated to each space, which embraces higher complexity in this case study, as a school that has both regular and artistic teaching, in order to recognise spaces that were conceived only for the regular teaching, spaces for the artistic teaching, but foremost to highlight the spaces that can be used by both, which ultimately can be considered the more adaptable to different activities and people[717].

In fact, the spaces shared by the school community overall have a prominent pedagogical implication because these are the spaces where the community can be gathered and where the diverse areas of knowledge conveyed in the school live together and are possibly shared amongst each other.

This is particular important since this school's curricula has a very comprehensive educational offer, both within the artistic teaching of dancing and music of different sorts of instruments, but also in what concerns the regular teaching, with its lectures of diversified fields of study, feasible for a secondary school[718].

For the presentation of the coloured schemes in Fig. 157 only the active learning environments identified in Fig. 154 were again taken into consideration and then categorised, as conceived for the regular or the artistic teaching, or for both. So, the spaces without a coloured hatch are the ones considered to be supportive, and hence disregarded, even if attached to a particular teaching regime, because they

[716] See "Justification of the spatial sample" in chapter 4.1. Presentation and justification of the chosen case study.

[717] The analysis on the association of the teaching regimes to spaces will be further developed on the entropy analysis, namely considered as Domain IV of the spatial sample, which also enhances the relevance of current coloured schemes that aim to point out this diversity early on this study.

[718] See chapter 1.5. The case study.

Fig. 157. Quinta das Flores School's new building _ Teaching regime
(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

are, from the start, considered to lack potential as a knowledge acquisition space, which is paramount for this research. Essentially, only the spaces with pedagogical potential are the subject of this analysis and studied on whether and how they take on adaptability, and so, the spaces deployed of this purpose, even if located in the school building, do not constitute the object of this study and are deprived of relevance when undertaking this methodology.

For example, spaces on the teachers' main area, even if holding interaction between the peers, and even if that interaction may enable information exchange amongst each other, do not immediately concern the knowledge provided towards the students, though it can have an underlying impact how and what contents are provided to the students, from the reunions and dialogues that take place in this particular area. So, being in a school building, it is expected that what happens in the whole space may concern the students, although latently or not immediately, like the spaces for teachers' meetings, the parent council room, the board rooms, or where the administrative staff informs the students on any formal questions they might have. But those are spaces that do not directly assign any knowledge exchange, but rather secondarily contribute to it, supporting the functioning of the school as a pedagogical complex.

From the examination of Fig. 157 some conclusions can be drawn:

. The primary longitudinal wings, mostly on the second floor but also on the first floor, have been mainly envisaged for the artistic teaching, which is proven by all the different artistic spaces with their distinctive geometrical volumes for acoustics performance. Their diversity for the teaching is also well-defined in the multiple captions reserved for identifying these spaces, for formal teaching or instrument training, for individual lessons or group classes, amongst the most diverse music instrument teaching, within music laboratories and songwriting studios and spaces for singing individually or in a choir. This is relevant because this actual building has been constructed, as recalled, within the curricular change that brought the music conservatory to this school, as so it contemplated the spaces for this teaching that the school did not require before, whereas the regular teaching mostly lies in the remnant pavilions from the school's original layout.

. Having said that, this building also provides the students with the shared spaces for all the school community, namely the administrative area, the teachers' area, but most importantly the common living spaces, both formal and informal, that may be used by all such as the library and the auditorium, but also the cafeteria and the canteen, located on the ground floor. This may bestow on that floor a sense of community and act as a gathering place for all the students, more frequently, intensively and differently used - formally and informally, socially or academically.

. If the second floor has been initially envisaged for the artistic teaching (as seen by the predominance of magenta in the coloured scheme in Fig. 157), it is also possible to point out that the spare spaces that have also been considered in the final plans of the buildings, may imply the accommodation of future uses, not just for this teaching in particular, but for the regular one as well, or for all students. And so, if the formal spaces are claimed by the conservatory in this floor, the spare spaces, more numerous than on the other analysed floor plans, can bring in the present or future effective use, the possibility to gather other curricula's students and a more diversified spatial fruition for this floor.

. The first floor is where the colour mix is more evident: with a transversal wing defined for the regular teaching of sciences; both ends of the longitudinal wing with relevant artistic spaces for their dimension and also significance as places for public training and displays; and the darker spaces, more central in the longitudinal wing[719], as the spaces with communal usage potential, such as the students' common living room, the photocopy room and the shop, besides all the small common spaces adjacent to the main corridor, which can provide small group gatherings for informal standing.

[719] To be seen in the space syntax analysis as the *integration* of the spaces on the building.

. The ground floor is very clearly the space shared by all the students (identified in dark purple in Fig. 157), regardless of their curricular options. It is the entrance of the school and, hence, the more attended space in the building, not just for standing but also as a circulation area to reach to other buildings or particular spaces in that one. It is also the gateway for the external usages, namely for the local community to reach the auditorium and the library, or the sporting pavilion outside the building opposite the street, or even to reach to other floors where the orchestra room or the dance studio are located.

. From the upper remarks and from the coloured schemes, it is then possible to conclude that there is a vertical stratification of the assortment of uses and students, in which the most shared spaces are on the ground floor, and the least common and most specific ones for a particular teaching regime and hence, for a defined group of users, are on the upper floor.

Spaces used by the external community or by the school community alone

The recognition of spaces that can be both used by the artistic teaching and by the regular teaching students and educators can be more broadly analysed when considering the spaces that can be open to the external community, either for displays of the students to their families or, in a more public sense, to the performances or exhibitions of the students to the general community. Ultimately, it can be pointed out which school spaces can be used outside the school hours for external or community practices besides the secondary teaching, widening the frequency and occupants of each of these spaces.

Furthermore, the artistic teaching *per se* requires spaces that have a cultural significance at an urban scale, acting not just as learning spaces for the basic and secondary students but also as a cultural focal point for the city, where music, dance and drama can be performed for all the local community, or even other displays deployed of artistic provenance but with communal interest. Particularly, the fact that the school has an auditorium, implies its potential use not just for the students to perform, but also for innovative or renowned artists.

It is possible to conclude, from the adaptability definition used for this current Thesis, that the more varied collective users in the audience and the vastest the range of activities for the events displayed, the more adaptable each space might be. Hence, community use from a number of spaces on this building can suggest a higher adaptability potential.

Nevertheless, the diversity in use can also come from management decisions to allow community activities and collective gatherings in the building, and also from

the external community itself whose direct demand to use certain spaces can prove their possibility to be shared to other activities, even if not initially conceived for those purposes. So, even though some spaces are immediately prone to community uses such as the auditorium, the orchestra room or the library, the spaces with potential to hold external activities or an external community as the audience of an internal display, can vary and are not all identifiable from the start, and hence not straightforwardly marked on a coloured scheme like the previous ones. The acknowledgement of spatial fruition and change through the building's usage can emphasise this fact, because the activities held can vary on the building according to local requirements and/or particular events. For example, formal classrooms can be occupied by groups of the local community for extra-curricular activities, and even the main hall can hold public exhibitions, provided there is a community demand to pursue an event in a particular space and that there is positive feedback from the school to accept it.

Multiple option spaces or with a specialised use

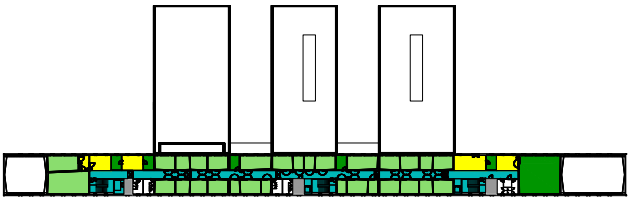
For this analysis it is similarly relevant to acknowledge the specialised spaces for a particular use, which are quite frequent in this school for the spatial requirements of activities like the music teaching – either in groups or individually, varying according to the instruments or the kind of classes taught. This is evident in the variety of captions in the plans that indicates different spaces in the school, particularly in the second floor, all for specific activities and with different physical requirements, namely with regard to the dimension and the acoustics.

Additionally, this also occurs for the regular teaching, where the teaching of sciences, located on the first floor in a distinguishable area of the building, has specific spaces from laboratories to classrooms for those purposes.

On the contrary, other rooms exemplify the multiple option spaces, where a wider number of activities can be held and not immediately determined, such as: the auditorium or the library - in what regards spaces for a diversity of formal events; the cafeteria and the canteen - in a social sense; the students' common living room, the teachers' main office and all the common living spaces – for a varied spatial fruition. These spaces will potentially be acknowledged as more adaptable for the variety of activities that can be allocated there and that potentially will prove to be the ones with higher entropy, to be examined later on this analysis, because its uncertainty on activity allocation is also higher.

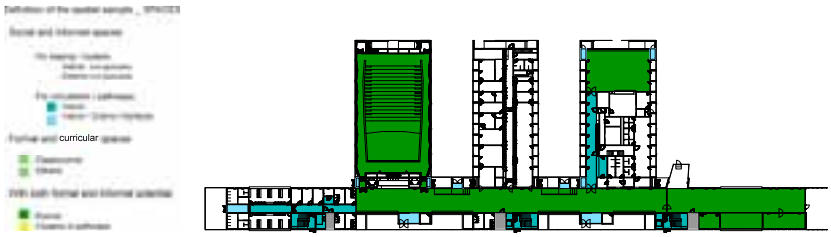
I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. SPACES	. Social and informal spaces	. For staying / clusters	. interior . exterior
			. For circulation / pathways	. interior . exterior
		. Formal and curricular spaces	. Classrooms	. Regular teaching . Artistic teaching . Both teaching regimes
			. Others	
		. With both formal and informal potential for both teaching regimes	. Library . Auditorium . Dance studio . Music studio . Orchestra room	

Fig. 158. Descriptions of the spaces of the school
(Carolina Coelho)



Second floor plan

First floor plan



Ground floor plan

Fig. 159. Quinta das Flores School's new building _ Spatial analysis (according to Fig. 158)
(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

Overall conclusions

From the previous separate analysis, a first outlook on the layout of the school may be undertaken and interpreted for providing the following conclusions:

. From the crossing of Fig. 159 with the circulation scheme in Fig. 156, all circulation areas, both vertical and horizontal, are considered as active learning environments, of general use by all teaching regimes.

. Non-pedagogical formal and informal spaces are shared by the all community, hence common spaces do not segregate users by teaching regime. These are also the most preponderant spaces amongst the space sample in the analysis.

. The situation on learning spaces is quite the opposite, since these spaces have the potential to allocate whether regular or artistic teaching and rarely both. Music rooms require specific attributes in configuration, soundproofing, layout, height, materials,… Besides both individual training rooms as well as group teaching rooms can accommodate less students than a regular classroom which has a high number of students per time period.

. This classification was undertaken according to the final plans, which correspond to the expected use the architect has envisioned to each space conceived. In any case, effective and expected use may not correspond, particularly in the spaces identified by the architect as "indeterminate supportive spaces".

. One general conclusion already possible from this analysis is a clear blend of uses, users and teaching regimes, identified first as a crucial demand in the renewal brief already conceived in the design by the architect, and actual taking place in the spaces' appropriation by all the school community that co-exist in a very tight way.

. Due to the specificity of this school's pedagogical curriculum, its needs on supportive spaces is higher, specially in what concern the artistic teaching and the external uses offered by the school namely for performative activities, that requires more plentifully spaces such as locker rooms, dressing rooms and training rooms, with particular attributes which add to the school's overall dimension.

From the table already presented in chapter 3.3.[720], and again placed at this chapter as Fig.158, it is possible to apply it to this spatial sample in particular, which results in the coloured scheme of Fig. 159, as a systematisation of all the detailed approaches previously provided, that hold the overall information on both the space and the activities it holds.

Fig. 159 much resembles the previous Fig. 155 in regard to social and informal

[720] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

spaces *vs* formal and curricular spaces, but introduces further detail on the analysis specified in its captions. In addition, for the application of the designations introduced by the table from Fig. 158, some specifications had to be adopted due to the particularity of the case study.

Therefore, the spatial sample also considers "social and informal spaces", "formal and curricular spaces" and "spaces with both formal and informal potential", as Fig. 155 already did. Still, the division of social and informal spaces in "clusters" and "pathways" is not applicable for this particular case study. As already explained in the topic that critically reviewed this categorisation presented along with Fig. 155, all social spaces have been considered as circulation spaces alone, and the ones that were considered clusters had also their potential recognised both as social but also as curricular spaces, placing them not on the social and informal spaces category, but on the more general one, which are spaces "with both formal and informal potential". That justifies the fact that clusters are not applicable as social spaces in this building, and are considered with a broader potential. These have been identified in yellow on Fig. 159 and entitled "clusters in pathways", which recalls their placement on the main corridors of the floor plans and their broader width in regard to the latter, which enables standing and not just moving along. Note that from the initial captions these spaces were entitled "common living spaces" identified with the number 40, that already presented them as spaces for standing collectively.

Also, the table on Fig. 158 separated interior from exterior pathways, but for this case study, and as explained in the topic on "Interior and exterior spaces" previously addressed, all the spaces considered are within the building itself and are not exterior. Nevertheless, for a more in-depth analysis, the access spaces identified with caption 5 on Fig. 150 are here specified as interface between the interior and the exterior space, within social spaces for circulation, and coloured in light blue in Fig. 159.

Furthermore, the table on Fig. 158 determined the distinction between classrooms and other spaces considered formal and academic. In this case this has been strictly applied, concluding that the formal spaces are placed on the first and second floor, and that the rooms that are not classrooms themselves are located on the first floor of this building, identified in light green. The division according to the teaching regime refers to the previous topic on that specific matter, systematised on Fig. 157. It is not identified in Fig. 159, because it was thought it would introduce over-complexity to a clear understanding of these coloured schemes, which has already been identified in detail in a separate preceding coloured scheme.

In what concerns spaces with both formal and informal potential, these have been considered as specific rooms bounded by walls and partitions, differentiated from the already mentioned clusters within corridors that have been added to the initial division on Fig. 158.

. Activities

Following this same methodological approach, and recalling the table from 3.3 in regard to the activities allocated in the spatial sample, here presented again as Fig. 160, it is also possible to identify these activities according to the spaces from this spatial sample and presenting the systematisation of this study on Fig. 161, as a coloured scheme.

The table on Fig. 160 establishes three types of activities: programmed/formal, non-programmed/informal and circulation/fluxes. These refer to the activities that can be allocated in this building's spaces and not the spaces themselves, even though a clear correspondence between the previous analysis is expected, because, as already mention before, although some spaces are identified with a specific functionality and may not have been initially designed for a wider array of purposes, the fact that they can cater for other functions in the present or near future has determined their categorisation, not just for their strict current use but for their potential.

So, generally, programmed/formal activities can be approached to formal and curricular spaces, whereas non-programmed/informal activities can be paralleled to social and informal spaces, corresponding Fig. 159 to Fig. 161. Besides, both programmed/formal and non-programmed/informal activities can occur in spaces with both formal and informal potential. Circulation as considered in Fig. 161 corresponds to Fig. 159 circulation/pathways in social and informal spaces. One clear distinction of both tables is the detailed approach in each one, where in the latter it refers to the nature of the activities, mostly regarding the teaching regimes but also introducing other specifications such as administration and social, which, ultimately, can call not just for active but also for supportive learning environments when considering this analysis. Another difference is that in this scheme, a space is matched to its corresponding main activity, in a univocal connection between an activity and its correspondent space(s). Finally, spaces of this sample are identified with a colour, regardless of their nature as active or supportive[721]. It is in fact that correspondence that enables to understand the nature of that activity.

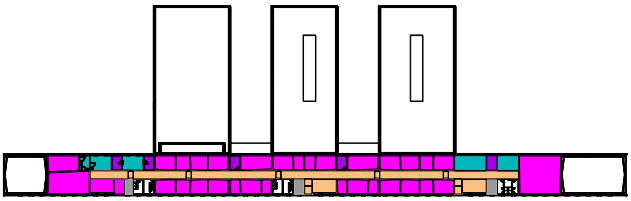
The following Fig. 161 then presents the study of the spatial sample according to the space's main activity and systematises the captions on Fig. 150 rendering a possible arrangement of the activities by their nature.

On this schematic categorisation of spaces according to their main activities, there has also been the need to add further detail to the categories of analysis provided in

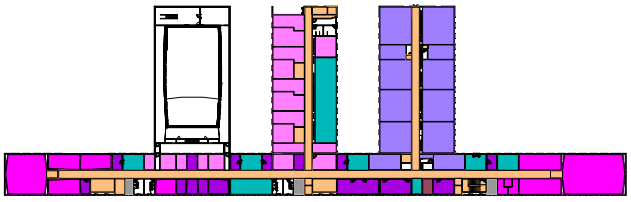
[721] Only technical zones, supportive and indeterminate spaces and toilets/bathrooms (except the ones related to artistic performances like the ones near the auditorium or the dance studio) have not been coloured, considering them of low relevance for the learning process.

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation			
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. ACTIVITIES	. Programmed / formal	. Regular teaching . Artistic teaching . Both teaching regimes . Administration
		. Non-Programmed / informal	. Social nature . Artistic nature . Pedagogical nature for the regular teaching
		. Circulation / fluxes	

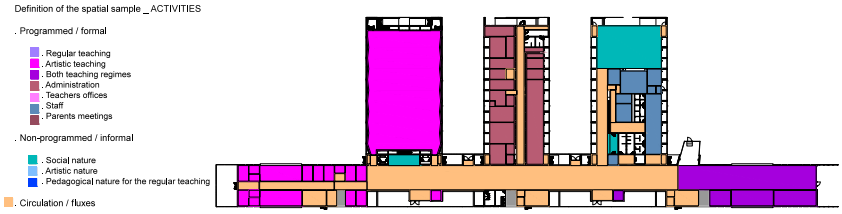
Fig. 160. Descriptions of the activities of the school
(Carolina Coelho)



Second floor plan



First floor plan



Ground floor plan

Fig. 161. Quinta das Flores School's new building _ Activities of the school (according to Fig. 160)
(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

the initial tables, that is the case of the programmed/formal activities, which can be for the regular, the artistic and both teaching regimes, but also for the administration, the teachers, the staff and the parents. By indicating in the plans the spaces allocated to each of these users, it shows a spatial mix that enables the gathering of different members of the school community in the common spaces and circulations. This adds additional information to the previous analysis, because the remaining ones only regarded spaces associated with students and active learning environments specifically for them, and did not portray all the users and their respective activities in space.

On the ground floor, the cafeteria, the canteen and the auditorium's cafeteria hold the social activities, and on the upper floors it is the teachers' main office and the students' common living room.

Also, in this particular Fig. 161 the common living spaces identified with caption 40, which are the ones adjacent to the main corridors, are indicated here as social spaces for informal activities undertaken while moving or meeting the peers, unlike in the previous analyses where their potential as formal spaces has also been recognised, even if considering it not to be its primary purpose. Undetermined supportive spaces are considered to shelter formal activities, because of their formal volumetric definition and placement on a central part of the building, though this can be for both teaching regimes.

All things considered, it is possible to conclude that the second floor has mainly formal activities related to the artistic teaching, the regular teaching as a formal area related to the teaching of sciences transversally to the main hallway on the first floor, and that the ground floor is prone on spaces for social and artistic purposes for all the community and it is also the floor plan which enables more informal activities. Circulation happens both vertically and horizontally, paralleling the street and also as a main corridor for the transversal volumes on the building. Those specific wings have clear purposes: there is a volume for the auditorium; another for the teachers and staff, with the administration located on the ground floor and the teachers' offices on the upper floor; and a third volume on the west side of the building that holds the cafeteria and the canteen on the ground floor, along with the kitchen and the staff's supportive quarters, which also shelters the sciences' rooms on the first floor. On the opposite ends of the main volume there are larger rooms for the artistic teaching, but those can have performative events for a wider community as well, except on the west side of the ground floor where the library is located, designed for the formal purpose of studying, even though informal activities can occur there.

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation			
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. ATTRIBUTES	. Dimension	. Height . Length . Width
		. Configuration	. Openness . Partitioning
		. Coating	. Floors . Ceilings
		. Networks	. Power access . Connectivity
		. Environmental conditions	. Temperature . Acoustics
		. Accessibility	. Direct . By lift . By staircase . By ramp

Fig.162. Descriptions of the spatial attributes of the school
(Carolina Coelho)

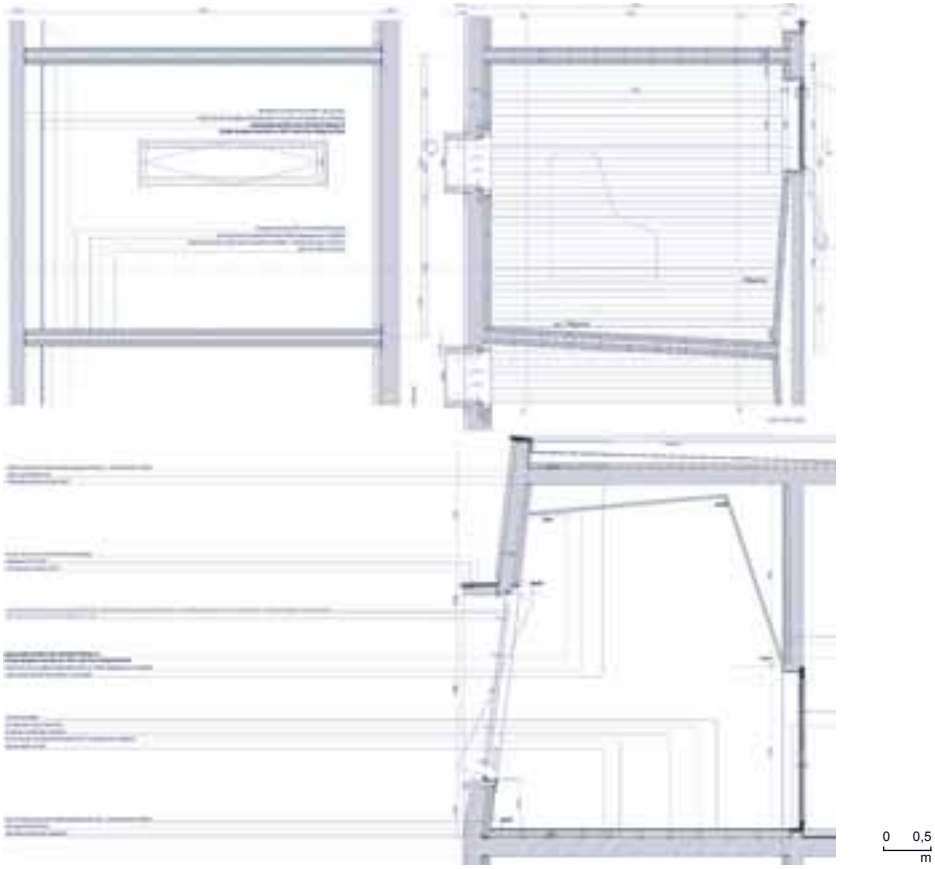


Fig. 163. Detailed drawings of a typical music classroom (plan, section and interior façade)
(Parque Escolar)

. Attributes

Recalling the table in chapter 3.3, on the attributes of the spatial sample, placed again here as Fig. 162, it is currently possible to provide a critical analysis of the physical features that generally enable activity allocation.

The most remarkable difference regarding the attributes on this spatial sample is between the spaces for the artistic teaching from the remaining ones, namely for the regular teaching. In fact, if the environmental conditions concerning heating have to be adequate for every space in the school, foremost to provide physical comfort for learning, the acoustics claim specific requirements as well as a more intricate design for the artist related spaces (Fig. 163). These imply specific configuration properties, namely to avoid reverberation and to improve the acoustics, besides its deeper need for soundproofing that has been envisaged amongst the rooms.

These requirements also involve a particular choice in both interior and external materials for insulation and coating, as well as non-orthogonal configurations that are evident in the plans of the building and that clearly identify the artistic associated spaces. Moreover, the choice in materials on the floors need a thorough choice for the dance studio's moving activities, and the ceilings and walls for the artistic learning overall also have to consider acoustics' properties in both the materials' application and the surfaces' configuration. Fig. 163 also displays the walls and ceiling's geometrical design for a typical music classroom and the heavier load of insulation materials.

Proportion and overall dimension, in regard to height, length and width, are also a relevant attribute not just for circulation, but also for the learning spaces, namely formal ones and for both teaching regimes. As disclosed earlier, the formal classrooms on this school mostly separate the regular from the artistic teaching. Music related rooms are usually smaller for individual or reduced groups. The dance teaching along with the largest rooms for the music teaching, represent the spaces where larger assemblies of students are held, like the choir or the orchestra rooms, or where performances are envisioned to be held with their respective audiences.

The regular teaching does not require such specific environmental attributes, not for acoustics nor for audience's displays. In this particular sample the most representative area for the regular teaching is the science area where laboratories are placed, which also embodies a very innovative working manner from the traditional ones, considered to have supportive equipment "too rigidly placed", often "worn out" or "obsolete" for its current usage and overall "located in difficult access areas with low prominence on the school" (Heitor, Teodoro, Fernandes and Boavida, 2007, p.40)[722].

[722] Based on the original quote in Portuguese: "Com efeito, na maioria das escolas portuguesas, estas áreas integram exclusivamente espaços de laboratório associados a salas de preparação e de armazenamento de materiais

Dimension is also a feature that interferes with spatial allocation, and according to the scale of the collective gatherings the spaces can hold external and wider audiences, or only internal performances for students alone or for small groups of educators, or for all the school community. That justifies the fact that the wider spaces like the dance studio, the orchestra room or the choir room have potential to hold external displays. The possibility of these spaces for holding distinctive artistic displays can vary according to the expected public and the nature of the activities and their respective spatial requirements. The example of the orchestra room on the first floor, where either group classes or public displays can occur, differs from the possible displays in the auditorium, that can hold a wider audience in particular physical conditions provided by the stage and its technical possibilities.

Additionally, from the upper analysis conveyed and particularly from Fig. 155, it can be established that the proportion of each space conditions its ability to shelter activities, because if it is too narrow for its length it can hinder standing and imply moving activities, leading to circulation more than group gatherings on that space.

These remarks enable other considerations on the partitioning of the spaces. The artistic teaching recalls for both open spaces with large dimensions for public performances, but also for small partitions for the music studios for individual training or small group classes. Additionally, the regular teaching usually involves a larger number of students in the classroom with a very clearly defined axial development, whereas these small music studios often revolve around a music instrument and do not bear such a defined longitudinal setting.

The spaces used by all the school community will need to have higher openness and larger dimensions, like the informal spaces of the cafeteria, the canteen or the students' common living room, or the more formal spaces of the auditorium or the library. While the spaces for specific functions or smaller groups, despite their curricula, are more divided spaces, such as the teachers' offices, the shop, the psychologist's office, the music studios or the instrument training rooms.

To note that this building in particular has a very open main hall, that has also a substantial length and width. This proportion enables standing activities, and its openness facilitates a series of different events, a large frequency of movement and numerous patterns of co-presence, all in that space.

Naturally, the acoustics and the environmental conditions of these spaces are also vital to cater for the performances, namely for the artistic teaching but also for external events. Even so, the fact that the choir room is placed on the second floor

e equipamentos. Estão em regra posicionadas em zonas do edifício com acesso limitado e fraca visibilidade face ao conjunto escolar. A par do desgaste físico a que têm sido sujeitos e da precariedade das redes infra-estruturais, incapazes de responder às exigências actuais, denotam sinais de obsolescência funcional derivados da alteração das condições de uso iniciais, da evolução dos curricula e das práticas experimentais e do recurso a meios computacionais. Ao adoptarem uma organização espacial rígida, decorrente da utilização de mobiliário fixo, inviabilizam a prática de diferentes modos de ensino-aprendizagem e dificultam adaptações a situações em que se pretende uma aprendizagem mais activa." (Heitor, Teodoro, Fernandes and Boavida, 2007, p.40)

also conditions its choice for a public performance when considering spaces with similar spatial features on the first floor, and so, it is also concluded that the direct access from the street is paramount, mainly for external displays for a local and diverse community but also for the school community, avoiding them to move through the school in order to reach the intended space. All in all, the direct access from the street can facilitate the choice in space, but also the space's dimension and its physical provision can condition its allocation to the activities.

The direct access spots for this building are placed from the street side and from the external courtyards towards the other building pavilions of the school complex. It is noteworthy that the primary entrance can be done by the main hall from the street or, as a secondary access, on the east side of the building towards the supportive spaces of the auditorium; but also in the school, internally, through the canteen on the south side of the building, leading to an exterior space to reach the other buildings in the school. The street leans longitudinally, and so the school building has stairs in both ends of the volume for its direct access from the street, in which the east side the stairs go down a few steps towards the school entrance, and in the west side there are more sets of steps to reach the school (Fig. 164).

Interiorly, the school has two sets of ramps and stairs, located on the main hall on the ground floor, that enable the access to the external courtyards of the school complex towards the south side, opposite the street (Fig. 165).

Besides, there are also accesses that connect this new building with one existing pavilion on the west side, and two ramps that connect the first floor from the transversal wings of the teachers' offices and the science labs, to external spaces of the school, leading to the other existing pavilions (Fig. 166).

Vertical circulation, which has already been previously subject of detailed study, is achieved by means of staircases and lifts, which are adjacent to one another. There are 3 sets of vertical circulation in the main hallway of the building connecting the remaining floors. From these three, the lift on the east end side of the building, is particularly for heavy loads, namely for carrying music instruments for the upper floors or for its storage on the underground floors.

In what concerns the networks, the current learning processes imply power access and connectivity for technological devices to support the learning process and to reach network connectivity for information research, communication and knowledge acquisition. This is considered in the whole school, not just in the formal spaces but overall.

After a more general approach to the school on its attributes, a more profound analysis of all the spaces would be overly exhaustive at this point. So, at the end of the whole methodological application, the spaces identified to be the most adaptable will have their attributes more detailed, so that conclusions may be drawn specifically correlating high adaptability to the physical attributes detailed on this table.

Fig. 164. Quinta das Flores School's new building _ Entrance from the street
(Carolina Coelho)

Fig. 165. Quinta das Flores School's new building _ Accesses from the main hall to the exterior
(Carolina Coelho)

Fig. 166. Quinta das Flores School's new building _ Accesses from the new building to the exterior
(Carolina Coelho)

4.2.1.2. Space Syntax _ Morphological analysis

> "Through configuration, buildings, like organisms, both contain and transmit information. Second, we know that although the parts of a building do not move, through their configurational differences they do affect the pattern of movement, in that other things being equal, the degree to which spaces are used for movement is a function of their configurational position. This is not an effect of the building on individuals, but a *system* effect from the space structure of the building to the probabilistic distribution of people." (Hillier, 2007[723], p.303)

. Datasets and Methods

The first milestone of this methodology, considered to provide a description of school space and how it functionally supports activity allocation, also includes a morphological analysis made by means of space syntax[724].

The space syntax approach aims to analyse the school from a configurational point of view. Findings allow the understanding of movement and standing spaces and their potential as active learning environments, deepening the knowledge on "spatial form" for a more inclusive understanding of the social relations of people from space, recalling Hillier's (1989, p.13) "Type 3: Laws from space to society", as well as Popper's (1972) thoughts on the third world.

Syntactic analysis has been approached by means of convex spaces, axial lines and visibility techniques (Fig. 167). This acknowledges, for the school brief, the relevance of studying individual spaces as well as their sequential layout and connectivity, which can trigger knowledge development:

> "What do we mean by a deformed grid? First, compared to an orthogonal grid, the length of sightlines from particular spaces - their one-dimensional extension - is sometimes restricted and sometimes extended. This one-dimensional extension we call axiality. Second, the width of spaces - their two-dimensional extension - varies considerably.

[723] Consulted edition from 2007, original edition from 1996.

[724] The initial results encountered by a space syntax analysis on this case study were presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London. These have also been published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi, K.; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
Afterwards, a subsequent study comprising all stages of the methodology, has been presented in the *11th International Space Syntax Symposium*, in 3-7 July 2017, Lisbon. It has also been published in the Conference's proceedings as: Coelho, C.; Heitor, T. (2017). Adaptability Retrieval In Artistic Learning Environments. In T. Heitor; M. Serra; J. Silva; M. Bacharel; L. Silva (Eds.). *Proceedings of the 11th International Space Syntax Symposium*. (pp. 7: 1-19).
Both presentations and publications validate these contents and the methodological application by the academia, which have been developed amongst this current Thesis and particularly in this chapter.

SCHEMATIC SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. SPACES**	**. Social and informal spaces**	. For staying / clusters	. interior . exterior
			. For circulation / pathways	. interior . exterior
		. Formal and curricular spaces	. Classrooms	. Regular teaching . Artistic teaching . Both teaching regimes
			. Others	
		. With both formal and informal potential for both teaching regimes	. Library . Auditorium . Dance studio . Music studio . Orchestra room	
I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. ACTIVITIES**	**. Programmed / formal**	. Regular teaching . Artistic teaching . Both teaching regimes . Administration	
		. Non-Programmed / informal	. Social nature . Artistic nature . Pedagogical nature for the regular teaching	
		. Circulation / fluxes		
I. DESCRIPTION OF THE SCHOOL SPACE Description of the school space and how it supports activity allocation				
I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	**. ATTRIBUTES**	**. Dimension**	. Height . Length . Width	
		. Configuration	. Openness . Partitioning	
		. Coating	. Floors . Ceilings	
		. Networks	. Power access . Connectivity	
		. Environmental conditions	. Temperature . Acoustics	
		. Accessibility	. Direct . By lift . By staircase . By ramp	
I.II SPACE SYNTAX morphological analysis	**. CONVEX SPACES** **. AXIAL LINES** **. ISOVISTS**			

Fig. 167. Detailed systematisation of the first milestone of the methodology (Carolina Coelho)

> This we call convexity […]
> Axiality and convexity will be shown to account for the way in which space - whatever its style or three-dimensional form-structures movement. This does not mean that the third dimension is not an important aspect of an architectural appreciation of urban space, but that the movement of people through an urban area is limited to two dimensions." (Hillier, Hanson, Peponis, Hudson and Burdett, 1983, p.50)

The latter analysis, on the visual relations between spaces is also significant for its potential towards social relations and encounters and for structuring the third milestone of the methodology on the observation spots for analysing effective spatial experience.

As it has already been recognised from the previous chapter, this building is very particular and has specific plans for all floors analysed. This is very relevant because not only is the interior spatial configuration different, but also its overall spatial form differs from floor to floor. So, the analysis will be done by floor plan and will then be examined as a whole integrated spatial system with critical assessment on the partial and overall results, comparing the values on the attributes.

Recognising all the attributes' relevance, this analysis will focus foremost on global integration[725] and local connectivity of radius *n*, for the understanding of spaces' overall syntactic structure and their configurative relations, towards patterns of co-presence and movement.

It is relevant to state that a full space syntax analysis has been done for all three approaches, regarding the several attributes the software provides and also recognising their relevance for a whole outlook on the building's spatial form. The data here presented is based on that comprehensive study and all its parameters, which have enabled a critical assessment of the results gathered and a subsequent detailed acknowledgement of the buildings configurational specificities.

For the axial line and convex space analyses the following results have been gathered: choice, connectivity, integration, line length, mean depth, node count and intelligibility. For the visibility analysis the following results have also been collected: connectivity, visual control, visual integration, visual mean depth and visual node count. Besides, all the attributes that DepthmapX provides for each approach have been dealt and reflected upon, both by maps and by the attributes comprehensive

[725] "The syntactic measure of greatest relevance is integration and it expresses the degree of centrality (or accessibility) of the spaces in the system, thus, working as a measure of spatial hierarchy" (Heitor, 2001, p.62) From the Portuguese original version: "A medida sintáctica de maior relevância é a integração e exprime o grau de centralidade (ou acessibilidade) dos espaços presentes no sistema, funcionando, assim, como uma medida de hierarquia espacial."
This has been thought by Hillier and Hanson in regard to "relative asymmetry": "Relative asymmetry (or relative depth) can therefore be thought of more simply as the measure of integration. […] Note that a low value means a space with a high degree of integration." (Hillier and Hanson, 1984, p.109)
Krüger (1989, 1990) has demonstrated that integration is the inverse of real relative asymmetry.

table of results that has been exported to Excel and worked on. These have not been included here for systematisation purposes, and considering them a partial step towards the final results that may be mentioned and whose results may be regarded without all the graphic materials, maps and tables to account for it. In fact, it is a qualitative consideration made from the quantitative results that is intended, in order to reflect upon the building's form and its specific ability to allocate more or less activities, so that the final aim on retrieving the building's adaptability may be accomplished, in a direct and less blurred manner, than the triangulation of the three approaches of this methodology already implies: functional on the school space, nomothetic on the possible activity allocations and idiographic on effective events and experience.

Still, for the purposes of achieving these milestones amongst the proposed methodology for identifying and assessing adaptability in this particular case study, this subsequent analysis will focus particularly in the global measure of integration in order to generally inform on the spatial system, and also on the local measures of connectivity and mean depth, concerning the neighbours of each node and axial line, and its consideration as deep or shallow, which will impact interaction and encounters where knowledge can be passed on amongst peers.

Anyway, two remarks have to be made on this behalf prior to the presentation of the analysis: the fact that a more detailed study has been undertaken that also justifies the critical examination on these specific results within a more in-depth outlook on the spatial sample. Secondly, the fact that this methodology is composed of several stages and, for presenting each one sequentially, it is relevant to underline the most significant results which support a specific knowledge on the building and its features, which in this case, is its configuration, in order to understand how it can support activity allocation. That justifies the relevance taken on integration, which is the most important for informing on interactions. According to Krüger:

> "It should be emphasized that Integration or its inverse (RRA) is the global configurational property that predicts movement and not Connectivity, which is a local property." (Krüger, 1990, p.35)

Not only will the results have to be systematised, in their description and appraisal, but so as the comparison between the three approaches: convex, axial and VGA. It is intended that, at the end of this part, a supported outlook on the building is able to be provided and also a critical comparison between what are the nodes and axial lines with the highest values from each analysis, whether they coincide or not and, from the building's general knowledge, to provide a critical explanation and reflection upon that.

Thus, it is not possible to compare a wider array of variables, or others that do not coincide between the three analyses. Furthermore, these results will be subsequently compared to the results from the next approaches, and so, they need to be the

most representative and systematic, leaving out others that have contributed to the understanding of these conclusions and the overall spatial form, but reducing the comparisons for a more insightful and less blurred outlook that a wider array of variables might bring along.

Once more, this analysis contemplates the spaces from the floors considered to be active learning environments, rather than the remnant ones: the underground floors for the technical areas. Anyway, on these considered floors, and since this is a morphological analysis, all spaces were considered, despite their original purpose or effective functionality. In fact, at this stage it is the all system that is under scrutiny and its spatial organisation. Hence, no space can be dismissed, which may lead to conclude on the potential correlation between the centrality of a space and its function, already presented as the first milestone of this process.

So, after all the processes of this methodology, it is intended to conclude on the relation between the spatial sample, how it is able to support the activities, provided by the first milestone; the potential to allocate those activities and the detail on their nature, given by the following entropy approach; and finally the spatial sample's effective fruition, both formal and programmed and informal and non-programmed, regardless of their overall potential proven earlier.

. Convex Spaces

For the convex space analysis, the data gathering followed a sequential procedure. First, the final plans, considered to be the closest to the actual built space, as already used for the initial stage of this analysis, constituted the basis in which the convex spaces were drawn.

It is most remarkable in the description of this procedure that this school's specificity on the artistic teaching leads it to have numerous non-convex spaces for acoustics performance, as previously detailed, besides the non-convex spaces designed for functional organisation. But for this analysis on convex spaces, all have been drawn as convex. Fig. 168a illustrates this situation, showing the drawing of the convex spaces as a preparation for the space syntax analysis, by overlapping them to the plans. Spaces that were already convex are specified in magenta and the convex spaces that have been adjusted from non-convex spaces for the purposes of this analysis are indicated in green.

Finally, Fig. 168b shows all the convex spaces from the studied floors, that have been saved from Autocad in *.dxf* format by floor plan, so the files can be opened on DepthmapX and worked on as a basis for the space syntax analysis.

Then, in DepthmapX polygons were drawn over the convex spaces already identified

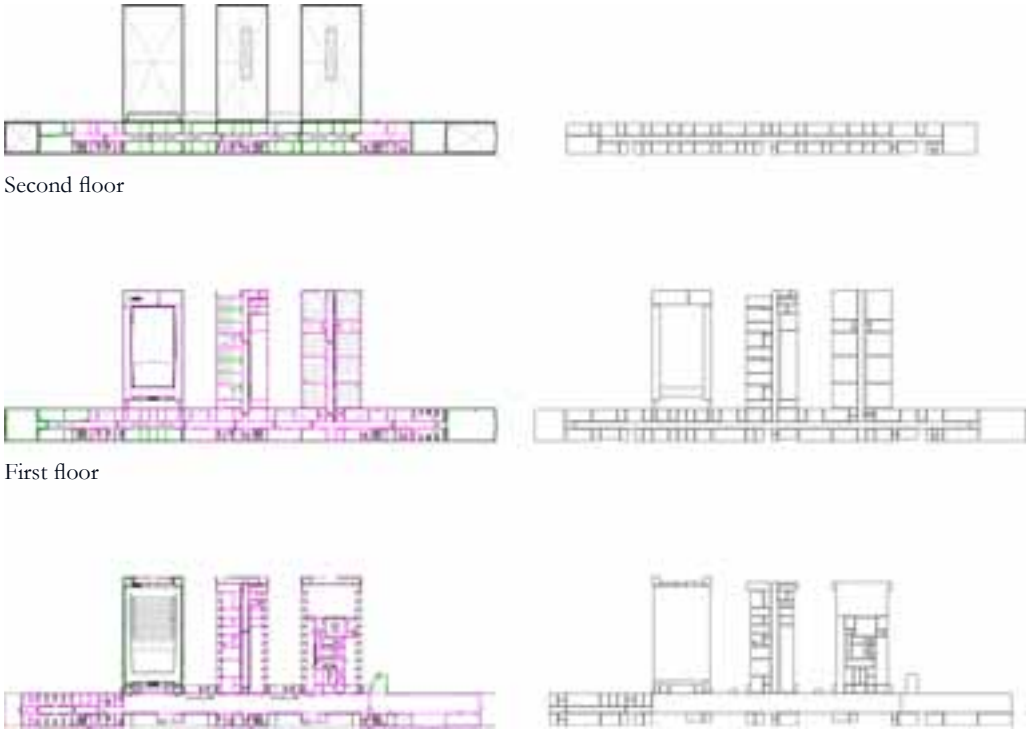


Fig. 168. Quinta das Flores School's new building, Convex Spaces: a) over the plans; b) detached
(original spaces as convex spaces in magenta; convex spaces adjusted from the original non-convex spaces in green)
(Original plans provided by Parque Escolar, editing and convex spaces' drawings by Carolina Coelho)

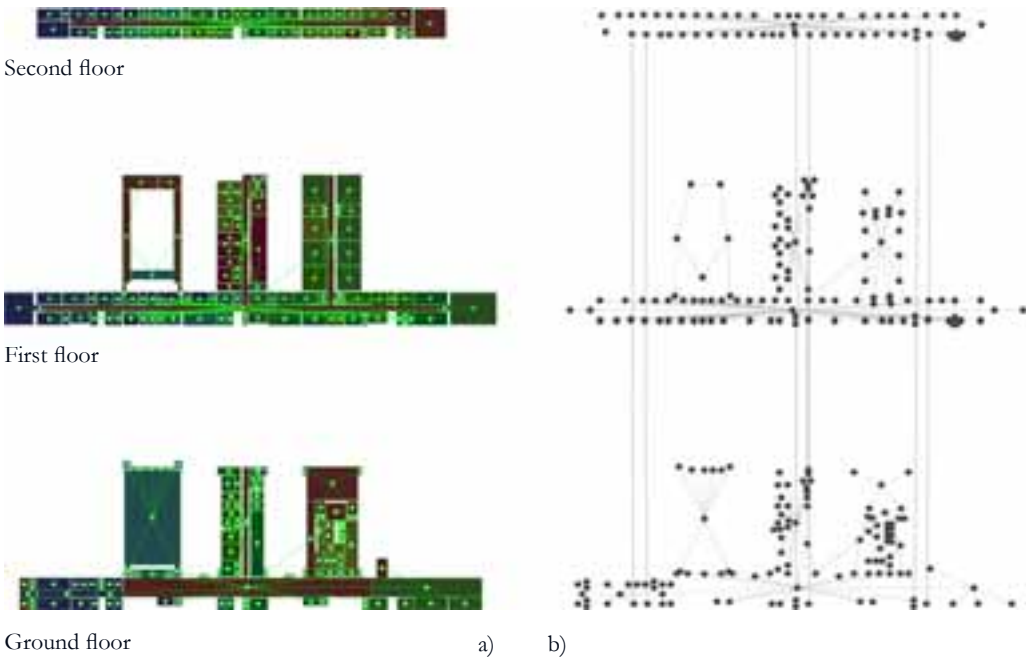


Fig. 169. Quinta das Flores School's new building: a) Convex spaces; b) Pajek graph
(Carolina Coelho)

from Autocad and then they were linked by joining those polygons (Fig. 169a), in order to produce a convex map. Subsequently, a graph analysis was run in order to generate the visual images of the map according to the chosen attributes. This file has also been exported to Pajek software in order to make a correspondent graph on the spaces' connectivity (Fig. 169b).

General findings from the convex space analysis

Following DepthmapX's colour scheme[726] the most integrated space (HH radius *n*) is the main hall on the ground floor, followed by the corridor that accesses the auditorium's dressing rooms, the corridor that accesses the administrative services and the library. Spaces such as the secretariat, the auditorium, main hall's adjacent rooms and the cafeteria, are also highly integrated. These rooms correspond to common living spaces, shared by all, which corroborates once more the school's cross-curricular teaching. On the first floor it is also the main corridor and the transversal corridor towards the teachers' offices are the most integrated, followed by the adjacent spaces and the perpendicular corridor towards the science labs (Fig. 170a).

When the integration map is ran by r_3 there are only slight differences in what regards the ground and the first floor plans, because it analyses the local convex integration through the number of changes in direction until the radius chosen, which in this case is a maximum of three[727]. This aims to identify "all spaces *j* which have a topological distance d_{ij} equal or inferior to a certain radius *r*", being *r* in this case three (Figueiredo, 2004, p.38[728]). As it is perceive by Fig. 170b, although these figures change, it does not imply a hierarchical change from the previous r_n maps.

According to the attributes summary there is an average integration on the ground floor of 1,34 that ranges from 0,76 to 3,00, an average integration of 2,08 on the first floor that spans from 0,83 to 7,35, and an average integration of 2,70 on the second floor that goes from 1,13 to 14,17. These results clearly identify the upper floors as being more integrated than the lower ones (Fig. 171). This would be straightforward to understand because morphologically, the floor plans change and along with that change, vertically the plans become less and less scattered and so, the spaces are more integrated in the system, reaching to a point where the second floor plan does not have transversal hallways, making those spaces morphologically less deep.

[726] The colour range chosen for the graphic materials provided by DepthmapX has been "Equal Ranges (3-Colour)", because it is one of the default colour schemes and the one considered to be more clear on a white background, as opposed to the classic Depthmap's colour range, that did not provided such a clear presentation due to the very light and bright colours the maps had for Quinta das Flores School. Still, it does not involve different interpretation from the classical colour scheme from warm to cold colours.

[727] Although different numbers of *r* can be chosen, *radius* 3 is widely used in local measures of syntactic analysis (Figueiredo, 2004, p.38).

[728] From the Portuguese: "Integração local (*local integration*): a integração de um espaço *i* pode ser calculada em relação a um subconjunto *k'* correspondente a todos os espaços *j* que estão a uma distância topológica d_{ij} menor ou igual a um dado raio *r*."

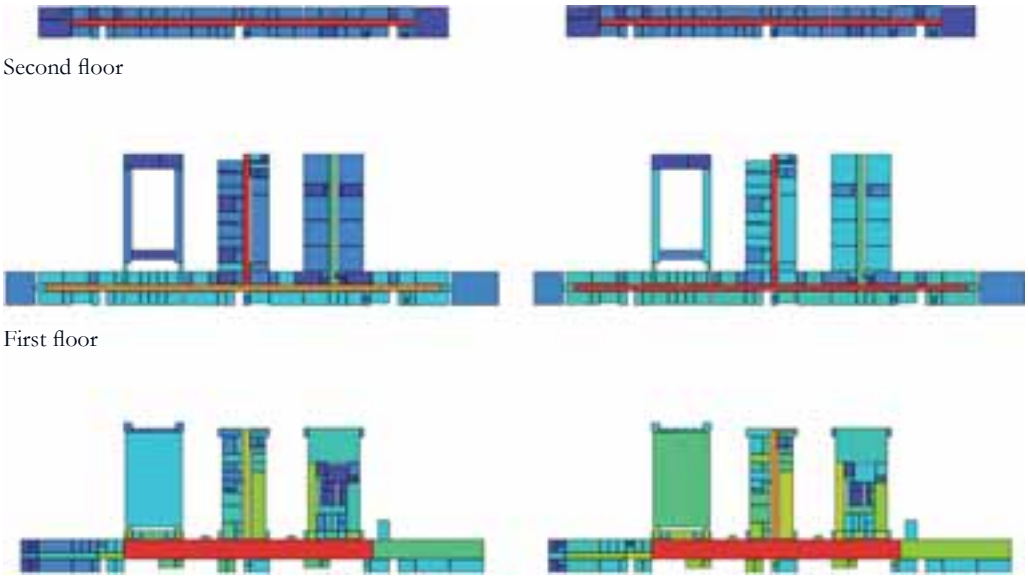


Fig. 170. Convex Space Analysis: a) Integration HH r_n map; b) Integration HH r_3 map (Carolina Coelho)

Generic classrooms and science labs, because of their location in one building section predominantly for regular teaching, present lower values of integration. Also the dance studio, the music room and the orchestra room, located in the extremities, are poorly integrated. Consequently, from the rooms which have a more communal use and an *a priori* expectation of high entropy, because they are expected to allocate numerous activities, when plotted against this syntactic analysis, indicate that it is the library and the auditorium on the ground floor that correspond to high levels of integration, whereas on the first floor this correspondence would probably not be so noteworthy. This will be subject of analysis after the entropy approach, as the following milestone of this methodology. Nevertheless, the most integrated spaces: the main hall and the main corridors, present a strong correspondence between activity allocation concluded from the initial analysis on the spatial sample[729] and integration, all similarly significant.

The mean depth and the connectivity charts added to this conclusion (Fig. 172). The main hall is also the space with the highest connectivity, as well as the mains corridors on the upper floors, followed by the transversal corridor on those hallways – the administrative services corridor and the dressing room corridor from the auditorium and the teachers' offices corridor and the science labs corridor, besides, also the auditorium itself and the library present high values of connectivity, whereas the remaining present extremely low values.

[729] See chapter 4.2.1.1. Definition of the spatial sample _ Functional analysis.

CONVEX SPACE ANALYSIS (ATTRIBUTES SUMMARY)

		Ground Floor			First Floor			Second Floor		
	Attribute	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
1	Choice	0	420,793	11897	0	133,807	6281	0	80,8333	3272
2	Choice [Connectivity Wgt]	262	2368,71	58810	49	703,123	19744	69	238,25	5362
3	Choice [Connectivity Wgt] [Norm]	0,0064967	0,0587361	1,45829	0,0079224	0,0593834	1,09385	0,0102556	0,0187475	0,796968
4	Choice [Norm]	0	0,0589346	1,66625	0	0,0645515	1,90887	0	0,0322343	1,97943
5	Connectivity	1	2,34711	21	1	2,2807	46	1	1,93333	46
6	Integration [HH]	0,764492	1,33832	3,0015	0,834672	2,07998	7,34511	1,13372	2,69885	14,1715
7	Mean Depth	2,46667	4,50661	6,75833	1,34483	2,87308	4,95181	1,24138	2,37701	4,01724
8	Mean Depth [Connectivity Wgt]	2,02113	4,05797	6,42254	0,885714	2,47263	4,47368	0,741379	1,88534	3,51724
9	Node Count	121	121	121	30	69,7895	84	1	58,0333	59
10	RA	0,0246499	0,0589437	0,0967787	0,0146929	0,0645515	0,216749	0,00846945	0,048901	0,105868
11	Total Connectivity	284	284	284	70	158,421	190	116	114,067	116
12	Total Depth	296	540,793	811	39	202,596	411	72	137,867	233

Fig. 171. Attributes Summary r_n
(Carolina Coelho)

This analysis corroborates the previous results indicating the main hall and the corridor as being central to the system, followed by the library, the auditorium and the cafeteria on the ground floor. According to the values encountered, there are well-defined differences amongst the spaces: the ones with high connectivity from the ones with low values, which are amongst themselves similar. This is proven by an average connectivity of 2,35 on the ground floor, although it varies from 1 to 21; and on the first floor the average connectivity of 2,28, ranges from 1 to 46, similarly to the second floor which as the same space and an average connectivity of 1,93. This again could be explained by the morphological distribution of the spaces adjacently to the main corridors in the upper floors, which is more spread out in the ground floor.

The mean depth also proves these results, providing some additional information (Fig. 172b). Because the building is not straightforward in accessing the spaces from a central location, certain spaces are syntactically very deep because their location implies numerous changes in direction and through several other spaces to reach them. These are the ones identified with the warmest colours in the mean depth map, because according to the DepthmapX's colour scheme, they have the highest values on this attribute and also by the attributes figures provided by the software. On average, the ground floor has the highest value of 4,51, significantly different from the first floor with 2,87, which has also perpendicular sections to the building but which are not has significant for the topological distance of their spaces, and finally, the second floor, only with a longitudinal layout has the lowest average mean depth of 2,38.

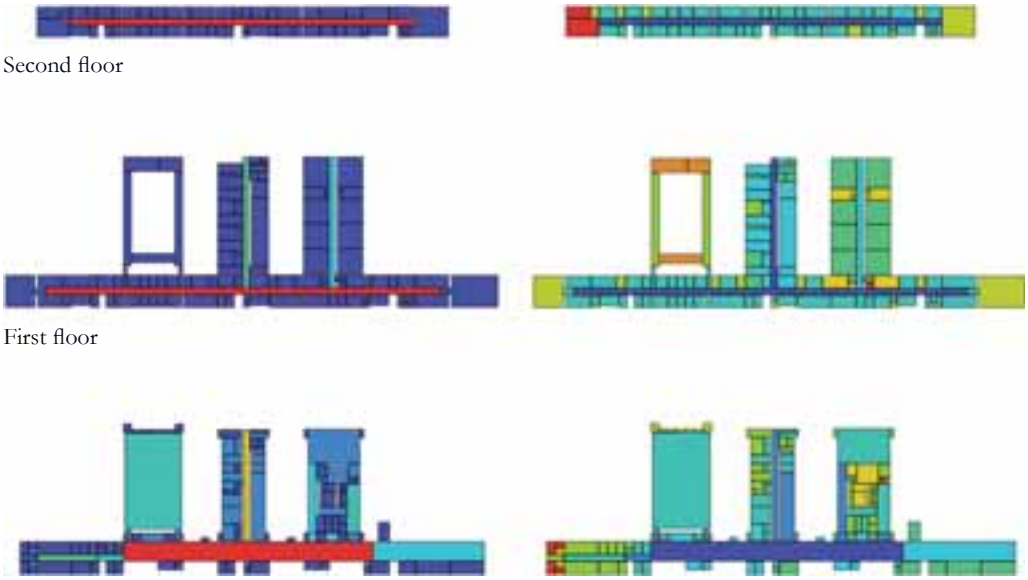


Fig.172. Convex Space Analysis: a) Connectivity r_n map; b) Mean Depth r_n map (Carolina Coelho)

Moreover, it is also on the ground floor that the spaces with the highest minimum mean depth of 2,47 are located, decreasing vertically to the second floor to 1,24. Additionally, convex spaces also on the ground floor have the highest values of mean depth of 6,76, whereas convex spaces on the first floor have a lowest of 4,95, similarly to the second floor with 4,02.

Besides those mentioned hallways, the layout of the building itself and the accesses provided to reach to each space explain these high values of mean depth. This is the case of the canteen and cafeteria's hallway where small supportive spaces are not easily accessed by the corridors, as it also happens on the second floor; as well as on the offices overall: the secretariat offices on the ground floor, and the teachers' offices and the supportive spaces to the laboratories on the first floor, whose location involves the previous crossing of other spaces, and so they hold a higher mean depth.

The following tables and scattergrams (Figs. 173 and 174) were produced in order to provide a more immediate comparison between the figures obtained by the software and potentially rank them with regard to r_n and r_3 and the range of values achieved from the spaces analysed. Note that it is not the purpose of this assessment to be redundant to what has already been identified and explained. It was simply considered the most adequate means of comparing the explained results and to critically analyse possible correlations. This will be done sequentially in each approach – for convex spaces and axial lines, by floor plan, and overall in a more comprehensive table and scattergram all results will be displayed for the final interpretation.

ATTRIBUTE SUMMARY		CONVEX SPACES r_n		
		Ground Floor	First Floor	Second Floor
INTEGRATION	minimum	0,76	0,83	1,13
	average	1,34	2,08	2,70
	maximum	3,00	7,35	14,17
CONNECTIVITY	minimum	1,00	1,00	1,00
	average	2,35	2,28	1,93
	maximum	21,00	46,00	46,00
MEAN DEPTH	minimum	2,47	1,34	1,24
	average	4,51	2,87	2,38
	maximum	6,76	4,95	4,02

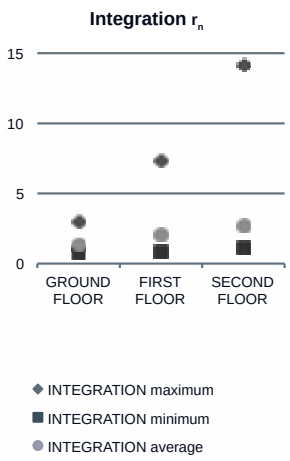


Fig. 173. Integration, Connectivity and Mean Depth r_n comparison for the convex space analysis (table and scattergram)
(Carolina Coelho)

Integration has a great span of values from 0,76 on a convex space from the ground floor, which is the least central to the spatial system, to very high levels on the second floor. Overall, integration by floor plan is considered to increase vertically, which is also explained by the lesser scattered layout plan on the second floor as compared to the ground floor with the transversal hallways and secondary accesses to supportive spaces.

As for connectivity, the wide span of values for the upper floors continues to occur, paralleling the integration results, which may be justified by the main corridor that connects to most of the spaces by a very forthright morphology that differs from the ground floor. Still, despite having significantly higher levels of maximum connectivity on the first and second floors, the average connectivity is higher for the ground floor and decreases vertically to the upper ones. This implies that the ground floor has spaces with higher connectivity but, due to its spatial form, it does not have a space such as the main corridors with these much connected spaces to it.

From the mean depth comparison, it is once more the ground floor that has the higher levels both the minimum as well as the maximum ones, implying it to be the floor with the deepest convex spaces.

From the analysis by r_3, the results are generally similar, as it has already been scrutinised, but as it dismisses the situations where the "topological distance" (Figueiredo, 2004, p.38) is superior to three, then the spaces considered are the most shallow. This has implications on the mean depth that decreases and becomes closer between floors, as in the r_n analysis in the ground floor that had a very superior

ATTRIBUTE SUMMARY		CONVEX SPACES					
		Ground Floor		First Floor		Second Floor	
		rn	r3	rn	r3	rn	r3
INTEGRATION	minimum	0,76	0,53	0,83	0,33	1,13	0,53
	average	1,34	1,56	2,08	2,22	2,70	2,77
	maximum	3,00	3,64	7,35	7,35	14,17	14,17
CONNECTIVITY	minimum	1,00	1,00	1,00	1,00	1,00	1,00
	average	2,35	2,35	2,28	2,28	1,93	1,93
	maximum	21,00	21,00	46,00	46,00	46,00	46,00
MEAN DEPTH	minimum	2,47	2,00	1,34	1,34	1,24	1,24
	average	4,51	2,53	2,87	2,44	2,38	2,22
	maximum	6,76	2,87	4,95	2,94	4,02	2,94

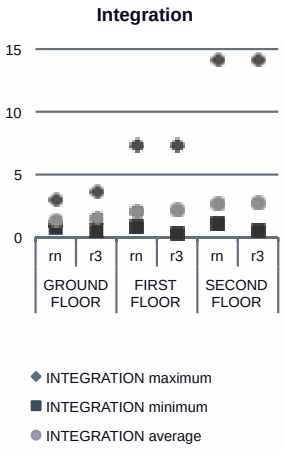


Fig. 174. Integration, Connectivity and Mean Depth r_n and r_3 comparison for the convex space analysis (table and scattergram)
(Carolina Coelho)

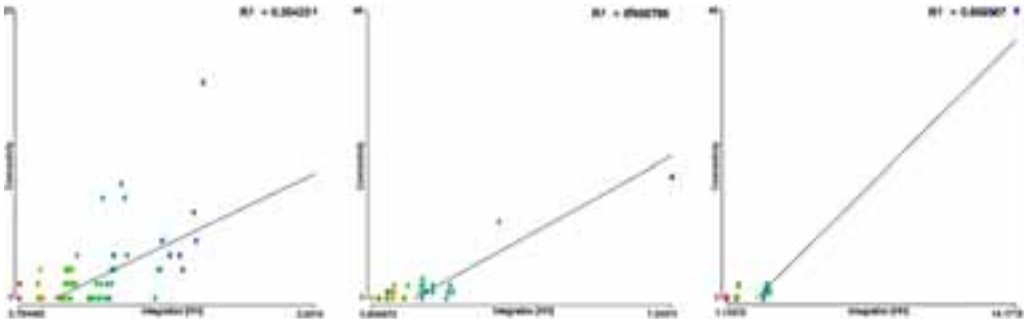
average and maximum mean depth then, and is no longer that distinctive from the other two floor plans. Besides, the minimum integration r_3 is held by a space on the first floor and not on the ground floor, which continues to have least integrated spaces, but whose minimum integration r_3 is equal to the one of the second floor.

All in all, the differences from the attributes can be explained by the differences from the plans' spatial forms and its consideration as more scattered, which is the ground floor; to the more cohesive, which is the second floor plan, guided by the main corridor in a longitudinal arrangement and deployed of perpendicular sections.

The intelligibility results, as a second order measure, have been produced by the scattergram that correlates integration (in the x axis, because it is the global measure) to connectivity (in the y axis, as a local measure) and will be examined according to its regression line (Fig. 175), according to Hillier's account[730]:

> "We can read the degree of intelligibility by looking at the shape of the scatter. If the points (representing the spaces) form a straight line rising at 45 per cent from bottom left to top right, then it would mean that every time a space was a little more connected, then it would also become a little more integrated - that is to say, there would be a perfect 'correlation' between what you can see and what you can't see." (Hillier, 2007, p.94)

[730] "The location of the point on the vertical axis is given by the number of other convex spaces that space overlaps with, that is, the 'connectivity' of the space with other spaces, and on the horizontal axis by the 'integration' value of the space, that is, its 'depth' from all others." (Hillier, 2007, p.94)



Ground floor First floor Second floor

Fig. 175. Intelligibility r_n Scattergram
(Carolina Coelho)

This analysis has concluded that the highest intelligibility regards the second floor plan when analysed in r_n, of 0,89. The first floor is also more intelligible than the ground floor, respectively with an R^2 of 0,50 and 0,35, even though all the community enters by the same access on the ground floor and should, at first glance, realise each one's pathway from the possible ones. So, the ground floor is the least intelligible, from the definition of intelligibility[731] this potentially indicates a certain dispersion of the spaces amongst the several sections in the system that hampers users' orientation in space.

Nevertheless, this information comes along the previous conclusions on the building, supported by the integration, connectivity and mean depth analyses, which have provided an overall outlook on the building's morphology. Again, if the second floor has a main corridor that distributes to its connected spaces it is easier to perceive than the lower floors, which have transversal hallways. If both the first and ground floors have those perpendicular spaces to the central longitudinal part of the building, the first floor is more intelligible than the ground floor, which can also be held by the mean depth higher values of some of the convex spaces on the ground floor, more than on the first floor and which have already been subject of analysis.

. Axial Lines

Afterwards, the same analysis was undertaken for the axial line map. This time the perimeter of each floor has been drawn as the closed polygon that specifies the floors layout. Fig. 176a shows the closed polygons identified in red over the final plans of the building and the following Fig. 176b clarifies the closed polygons as

[731] "The property of 'intelligibility' in a deformed grid means the degree to which what we can see from the spaces that make up the system - that is, how many other spaces are connected to - is a good guide to what we cannot see, that is, the integration of each space into the system as a whole." (Hillier, 2007, p.94)

Second floor

First floor

Ground floor a) b)

Fig. 176. Quinta das Flores School's new building: a) Closed polygons for axial maps over the final plans of the building (in red); b) Closed polygons for axial maps

(Original plans provided by Parque Escolar, editing and closed polygons' drawings by Carolina Coelho)

Second floor

First floor

Ground floor a) b)

Fig. 177. Quinta das Flores School's new building, Axial line map:
a) With all axial lines; b) Reduced to the fewest lines

(Carolina Coelho)

separate drawings that, once more have been saved in *.dxf* format by floor plan, to be opened in DepthmapX and considered the basis of the axial map analysis.

Having the outlines of the building drawn over the final plans and exported to DepthmapX, then an axial map was produced automatically by the software, first as an all-line map, and then reduced to the fewest lines (Figs. 177a, b).

Subsequently, a graph analysis was run primarily for the same attributes analysed for the convex map. These results can be analysed visually either by the map colour arrangement, which has been produced by exporting the screen pictures, and the chart's values, by exporting the file as a *.txt* format and opening them as an Excel's chart where it can be worked on, or even by the attributes summary table provided by DepthmapX (Fig. 180).

General findings from the axial line analysis

Clearly, the most integrated axial lines on both floors, identified in red, cross the building longitudinally paralleling the street (Fig. 178a). This matches the analysis on convex spaces, where the main hall and longitudinal corridors were also the most integrated. Furthermore, all the other axial lines placed in those same convex spaces bear high levels of integration, rather than the remaining in the perpendicular sections of the building, more segregated and identified in blue. This fact can be explained by the highest segregation that the spaces further from the main hall have towards the overall system's morphology.

Similarly to the convex space integration analysis, when undertaken by radius *3* there are very minor changes and mostly regarding the figures themselves rather than the rank between them, which is natural since it only specifies the maximum "topological distance" (Figueiredo, 2004, p.38), which has been chosen to be three, as it seldom is (Fig. 178b).

These results coincide with the values of mean depth encountered during the analysis and also the connectivity results (Fig. 179a). Besides coinciding with the outcomes of the integration analysis in the axial line map, these also meet the results from the connectivity analysis of the convex spaces, where the main corridors had the highest values, followed by the main corridors from the perpendicular wings of the building in both floors. All in all, the values of mean depth and connectivity reflect the integration's interpretation and also the previous convex space analysis. But this time the remnant axial lines hold very distinct values both in what concerns connectivity and mean depth, which is very straightforwardly perceived by the different colour of the axial lines from red (the upper values) to blue (the lower ones).

It is on the ground floor that a more varied mixture of coloured axial lines can be found, particularly on the longitudinal area of the building for comprising the corridor for the supportive spaces of the auditorium, but most importantly, the

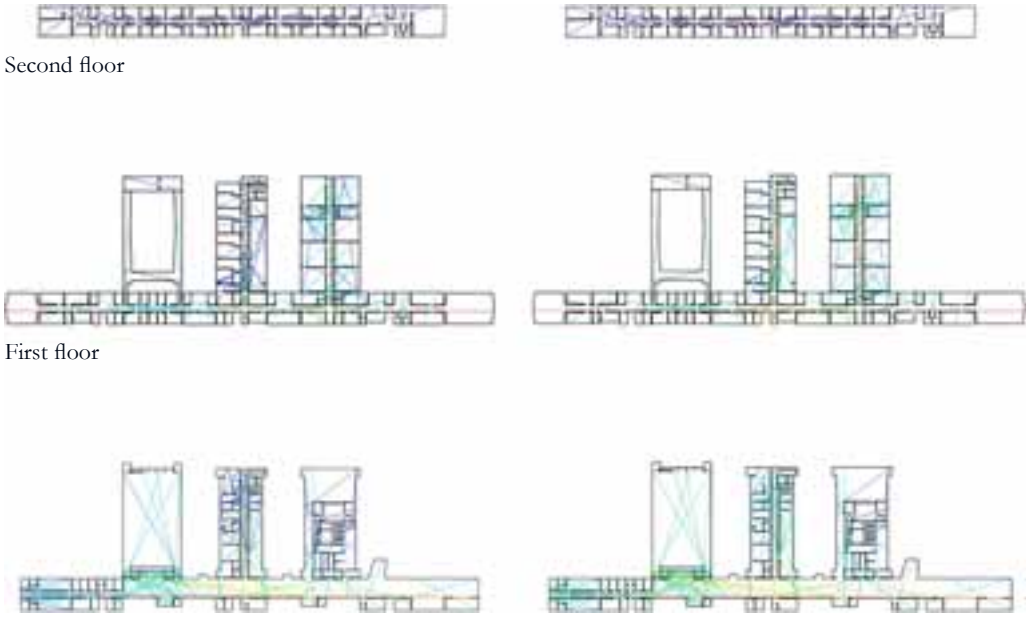


Fig. 178. Axial Line Analysis: a) Integration HH r_n map; b) Integration HH r_3 map (Carolina Coelho)

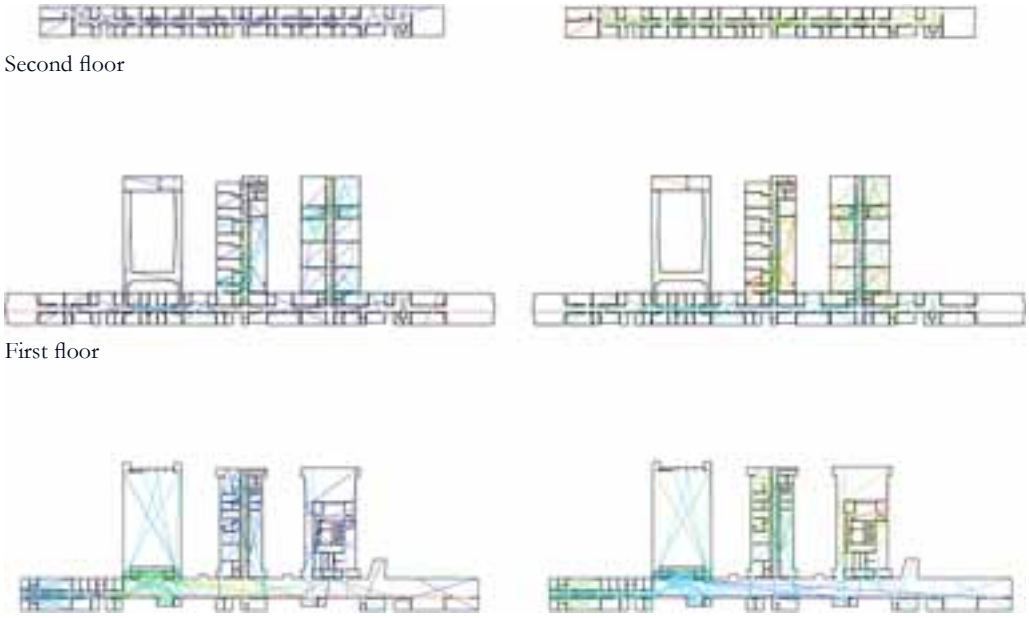


Fig. 179. Axial Line Analysis: a) Connectivity r_n map; b) Mean Depth r_n map (Carolina Coelho)

AXIAL LINE MAP ANALYSIS (ATTRIBUTES SUMMARY)

		Ground Floor			First Floor			Second Floor		
	Attribute	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**
1	Choice	0	250,262	8362	0	250,262	8362	0	33,9	1126
2	Choice [Connectivity Wgt]	2136	61729,6	1,45637	2136	61729,6	1,45637	621	1990,1	33397
3	Choice [Connectivity Wgt] [Norm]	0,0000931	0,0269082	0,634836	0,0000931	0,0269082	0,634836	0,0189514	0,060733	1,0192
4	Choice [Norm]	0	0,0243067	0,81216	0	0,0243067	0,81216	0	0,045749	1,51957
5	Connectivity	1	14,7724	69	1	14,7724	69	3	6,4	38
6	Integration [HH]	1,39032	2,89507	7,79224	1,39032	2,89507	7,79224	1,85728	6,05159	113,294
7	Line Length	1,27368	8,32686	64,73	1,27368	8,32686	64,73	3,5676	7,73841	47,9622
8	Mean Depth	1,59722	2,73793	4,34722	1,59722	2,73793	4,34722	1,02564	1,86923	2,5641
9	Mean Depth [Connectivity Wgt]	1,3366	2,48408	4,19795	1,3366	2,48408	4,19795	0,867188	1,70107	2,39062
10	Node Count	145	145	145	145	145	145	40	40	40
11	RA	0,0083527	0,0243067	0,0468143	0,0083527	0,0243067	0,0468143	0,00134953	0,045749	0,0823212
12	Total Connectivity	2142	2142	2142	2142	2142	2142	256	256	256
13	Total Depth	230	394,262	626	230	394,262	626	40	72,9	100

Fig. 180. Attributes Summary r_n
(Carolina Coelho)

entire main hall and the library. This is very specific of the axial analysis, as opposed to the convex space approach that separated the bounded spaces. Here, the axial lines cross several of the previously considered convex spaces in an overall system and, as proven by the integration and connectivity maps, these are most significant in terms of a morpho-syntactic approach. Recalling the specificity of this spatial sample as being a school, a relevant conclusion provided by the space syntax approach is the higher significance of the study of the learning spaces in a set and not in isolated units, by axiality. In doing so, corridors are considered significant learning spaces and movement a potential activity where knowledge transmission may occur, which is very significant, particularly for contemporary schools where informality is valued, and the creation of knowledge and its communication amongst the peers is considered a means for learning. This will be even deeper studied throughout this chapter.

As for the more detailed analysis of the results of the mean depth map, it again parallels the overall outlook on the building (Fig. 179b). The deepest axial lines comprise the transversal areas of the building and imply the most changes in directions to reach them. Anyway, when overlapped with the primarily functions on those areas, these are mostly supportive areas or regard activities for a particular part of the school community, like the teachers' offices, the staff rooms, the administrative quarters, the kitchen's private spaces or even the dressing or locker rooms, and so, it is naturally explained to be deeper because of its specificity in users and the need for a more reserved use.

ATTRIBUTE SUMMARY		AXIAL LINES r_n		
		Ground Floor	First Floor	Second Floor
INTEGRATION	minimum	1,39	1,39	1,86
	average	2,90	2,26	6,05
	maximum	7,79	5,33	113,29
CONNECTIVITY	minimum	1,00	1,00	3,00
	average	14,77	8,96	6,40
	maximum	69,00	41,00	38,00
MEAN DEPTH	minimum	1,60	1,82	1,03
	average	2,74	3,03	1,87
	maximum	4,35	4,15	2,56

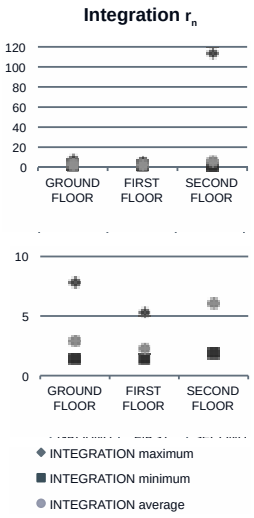


Fig. 181. Integration, Connectivity and Mean Depth r_n comparison for the axial line analysis (table and scattergram with and without outliers)
(Carolina Coelho)

Then, a comparison is now possible to be achieved between floor plans for the attributes analysed, which intends to identify the higher and lower levels, to rank them, to compare them and to critically assess these results (Figs. 181 and 182).

The highest integration levels are from the second floor, which also has the widest span because of the most integrated longitudinal axial line that reaches 113,29, which is a fairly different value from the remaining ones that are even indicated in blue on the axial line integration map. A scattergram has also been produced comparing the minimum, average and maximum integration for all floor plans, but it was conclude that, due to this disparity, the scattergram did not provide a clear outlook on the results, because all the other values were very close together and separate from this outlier. Hence, after its completion, another one has been undertaken leaving out the outlier 113,29 from the mentioned axial line, so a more detailed comprehension of the remaining values could be critically considered.

Naturally, that along with this increase on the maximum integration from the second floor comes an increase on its average integration. When comparing the ground and first floors, even graphically on the maps, it becomes very prominent the wide scope in warm colours, opposite to the second floor map with extreme levels, which implies that there are not as significant differences as it occurs on the second floor. But it is the ground floor, when compared to the first one, that has the highest average and maximum axial integration.

ATTRIBUTE SUMMARY		AXIAL LINES					
		Ground Floor		First Floor		Second Floor	
		rn	r3	rn	r3	rn	r3
INTEGRATION	minimum	1,39	0,98	1,39	1,44	1,86	1,86
	average	2,90	3,18	2,26	2,73	6,05	6,05
	maximum	7,79	7,79	5,33	5,32	113,29	113,29
CONNECTIVITY	minimum	1,00	1,00	1,00	1,00	3,00	3,00
	average	14,77	14,77	8,96	8,96	6,40	6,40
	maximum	69,00	69,00	41,00	41,00	38,00	38,00
MEAN DEPTH	minimum	1,60	1,60	1,82	1,82	1,03	1,03
	average	2,74	2,39	3,03	2,40	1,87	1,87
	maximum	4,35	2,85	4,15	2,84	2,56	2,56

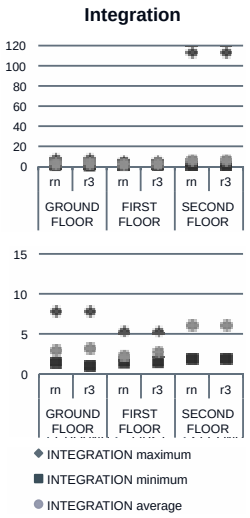


Fig. 182. Integration, Connectivity and Mean Depth r_n and r_3 comparison for the axial line analysis (table and scattergram with and without outliers)
(Carolina Coelho)

It is also the ground floor, when axially examined, that has a very significant higher connectivity, both average and maximum, from the upper floors, even recalling that the second floor indicated a very elevated maximum integration with the outlier. This implies that the ground floor axial lines have more "immediate neighbours that are directly connected to a space" (Al_Sayed, Turner, Hillier and Iida, 2014, p.12). This can be comprehensible from a deeper examine on the plans provided in the previous chapter[732], where the more scattered configuration of the ground floor is also paralleled with more numerous accesses from spaces to others, than on the upper floors, where the accesses are mostly done through the longitudinal or perpendicular corridors.

In fact, when overlapping the floor plans and their interior configuration to their specific activities on the building, the ground floor has less corridors and more general areas that may be functionally considered more than a corridor, as both convex spaces and axial lines, for moving and standing, such as the main hall, the library or the cafeteria because, despite their longitudinal form, they facilitate gatherings and are even embedded with a communal function for the school building, which is connected to other spaces from which people arrive. The main hall is the paramount example of this situation, since it is connected very extensively and even more so when analysed by axial lines, because of its moving nature which is very specifically engaged with a standing area overall. It is connected to its adjacent spaces and

[732] See chapter 4.2.1.1. Definition of the spatial sample _ Functional analysis.

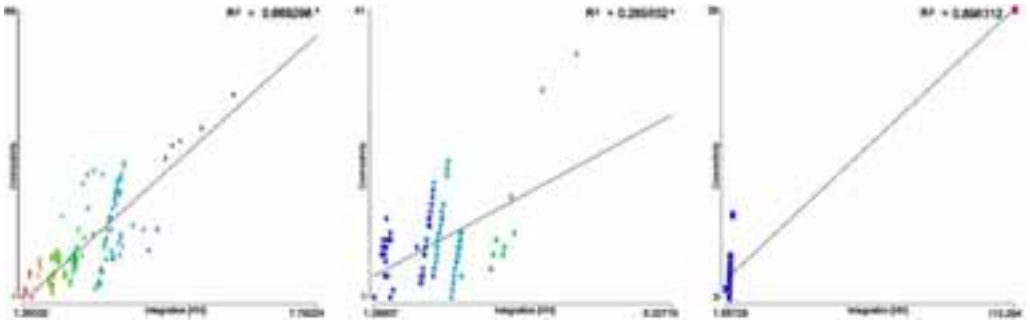
lines longitudinally towards the library and the auditorium supportive spaces, and transversally to all the perpendicular sections of the building: the auditorium, the secretariat and the cafeteria. Being analysed by axial lines more than by convex spaces, it is not only the space *per se* of the main hall that is more significant, but the most representative axial line that comprises the library and the east corridor that hold even higher levels of integration and connectivity, and all the partial ones to these, with similar levels but logically lower.

As far as the mean depth goes, the lowest levels are held by the second floor, which indicates it to have more shallow axial lines than the remaining floors. The average mean depth is higher for the first floor and the maximum mean depth is held by the axial line map from the ground floor. Both have similar values and a wide span of warm to cold colours on their mean depth axial line maps and, analogously, the higher values are on the transversal sections of the building that the second floor lacks, which also inherently decreases its mean depth in general, explaining these results.

In regard to the comparison provided by the two tables on the analyses by r_n and r_3, there are some differences worth of a more detailed examination, namely for the integration. When the analysis is restricted to r_3, the axial integration for the ground floor differs from the previous r_n, in which the minimum integration decreases but the average integration increases, implying a wider span in levels, potentially because the axial lines considered are only those three or "less steps away" (Al_Sayed, Turner, Hillier and Iida, 2014, p.12). The first floor's lowest and average integration slightly rises and the second floor remains equal, even with regard to the previous mentioned potential outlier of 113,29, whose "neighbours [are] located [three] steps away from it" (*ibid.*)[733]. The connectivity remains equal and the mean depth decreases considerably on the ground and first floors, implying that the higher levels considered previously where related to higher "topological distances" (Figueiredo, 2004, p.38) than three.

This fluctuation in the values is also supported by the intelligibility analysis, in which the second floor is the most intelligible, which might be explained by its straightforward configuration, easily perceived by its users. The intelligibility for the first floor has decreased from the previous analysis on the convex space map, for a more scattered regression line (from R^2=0,50 to 0,27). While, the second most intelligible floor plan, when analysed by axial lines is not the first floor as it was by means of the convex space analysis, but the ground floor, with a very prominent regression line and a very relevant R^2=0,67 (Fig. 183). This implies that the ground floor's intelligibility has increased significantly from the previous analysis to this

[733] "Radius *n* is usually used to find measure values for each node in relation to the whole system. Radius 2 (sometimes called radius 3), is used to measure the relationship between each node and the neighbours located two steps away from it." (Al_Sayed, Turner, Hillier and Iida, 2014, p.12)



Ground floor First floor Second floor

Fig. 183. Intelligibility r_n Scattergram
(Carolina Coelho)

one (from R^2=0,35 to 0,67), leading to the hypothesis of this floor to be intelligible, when analysed through axial lines, which infers that "well-connected spaces also tend to be well-integrated spaces" (Hillier, 2007, p.94).

According to Hillier's findings on intelligibility, axial intelligibility is more comprehensive: "We find that the intelligibility of the system seen axially is better than seen convexly, because lines are more 'global' spatial elements than convex elements, in that they explore the full limits of visibility and permeability within the layout." (Hillier, 2007, 98). So, these latter figures better demonstrate the easiness to perceive a space and are more representative of the system. So, the high increase on the axial intelligibility of the ground floor, can be considered a more accurate outlook on its intelligibility, which considers it to be highly intelligible in its relation between global integration and local connectivity of its axial lines.

. VGA Analysis and Isovists

Besides the convex and axial analyses, a visibility analysis has also been performed (Turner, Doxa, O'Sullivan and Penn, 2001). This takes deeper relevance since observations are intended to be pursued in a later stage of this methodology, and so, it is important to identify the most visually integrated spaces and also the isovists from each observation spot.

For that purpose, a *.dxf* format file has been produced in Autocad and imported to DepthmapX, as a basis for the development of the graphs. This has been undertaken for all floors analysed, namely: the ground, first and second floors. After importing the *.dxf* file with a closed polygon for the software, a "sensible grid spacing" has been determined that "matches the human scale" [734] with 0,5 units of spacing, as

[734] Also according to Turner, Doxa, O'Sullivan and Penn (2001): "If analysis is to relate to human perception

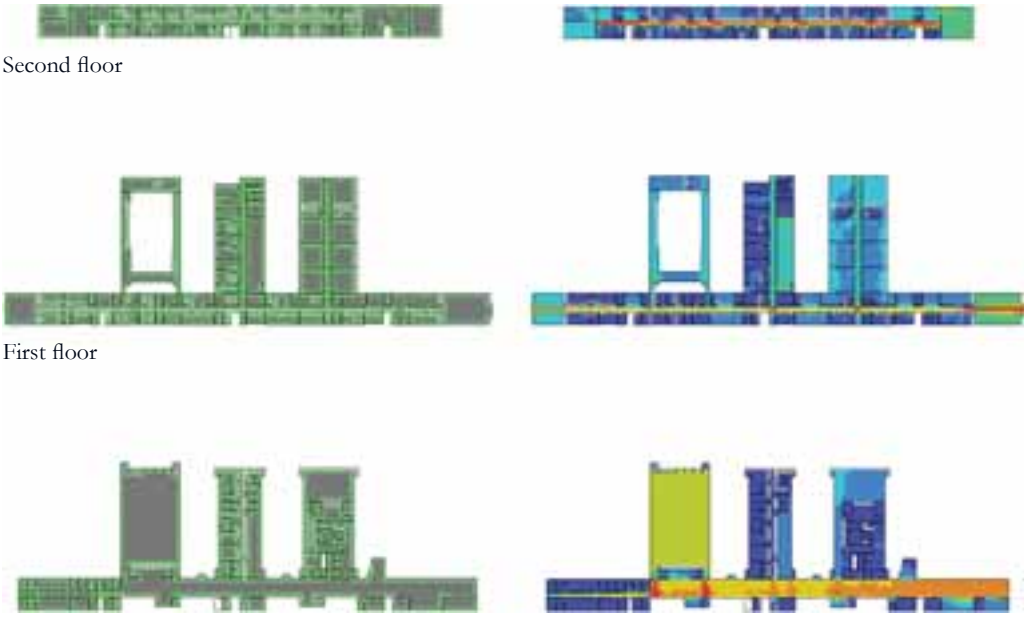


Fig. 184. VGA Analysis, Visibility graph: a) Filling in the spaces; b) Connectivity (Carolina Coelho)

Fig. 185. VGA Analysis, Visibility graph: a) Visual integration HH; b) Visual clustering coefficient (Carolina Coelho)

suggested by the textbook from The Bartlett (Al_Sayed, Turner, Hillier and Iida, 2014, p.32). Then, the spaces have been filled (Fig. 184a) and a visibility graph has been made that provided connectivity properties (Fig. 184b).

General findings from the visibility analysis

Afterwards, the visibility graph has been run in order to achieve other measures, namely to include visual integration HH with radius *n,* which informs on the visual perception from a particular location that ultimate can be more central in the building, enabling more encounters and patterns of co-presence:

> "Similar to integration in a convex map, visual Integration is representative of potentially core area in the layout where one can see much of the layout and can be easily seen. We can't really establish that people will want to be in such areas, may be if they want to see much of the layout and communicate with others." (Al_Sayed, Turner, Hillier and Iida, 2014, p.35)

From the analysis of visual integration, most like the convex integration map, it is the main corridors, particularly on the intersections with other perpendicular paths that enable visual integration in both longitudinal and transversal directions; and also the main hall, namely in the areas that provide pathways to the auditorium, the administrative transversal hallway, the cafeteria and the canteen transversal hallway, and the library, with specific regard for the west side of the building towards the library; that hold the highest levels (Fig. 185a).

Afterwards, local measures, considered to be of significance for this methodology, have also been attained[735], namely: the visual clustering coefficient and visual control.

Visual clustering coefficient as stated by Al_Sayed, Turner, Hillier and Iida (2014, p.35) specifies the areas that are "potentially occupational spaces" from the ones more prone to "high movement activity", from the Depthmap's colour scheme, respectively in red and blue. This gains higher importance after having analysed in depth the results from a convex space analysis from the ones from an axial analysis, which showed similarities but also provided a differentiation between spaces that were bounded by its configuration and the areas that comprised a more directional movement along several spaces. By reporting the visual clustering coefficient, a systematisation from a visibility perspective is possible, that differs between the convex spaces and the ones with a more axial description.

From the results, the highest levels of visual clustering are held by the very defined spaces whose configuration is clear and potentially facilitates gathering rather than

of an environment, then the resolution of this grid must be fine enough to capture meaningful features of the environment."

[735] Local measures have been provided by Depthmap 10 (Pinelo and Turner, 2010).

movement through them (Fig. 185b). When overlapped with their actually uses, it is possible to acknowledge that these spaces have very defined educational activities, able to occur inside closed doors, such as: the choir room, the dance studio, the orchestra room and the auditorium, where the artistic community is gathered in a more conjoint manner; but also the teachers' common living room and the secretariat main office, where clusters of specific users of the school gather; and also the canteen.

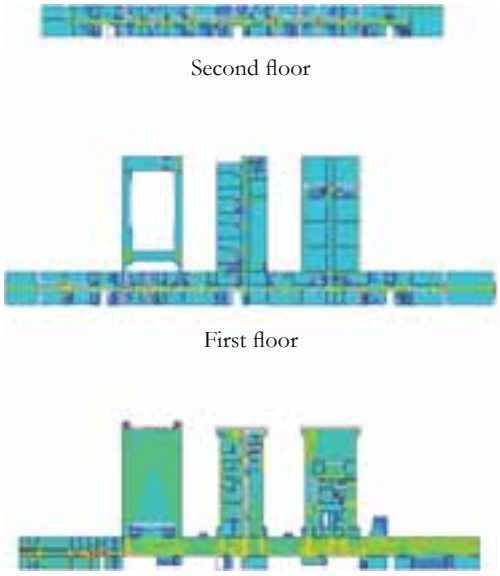
Pedagogically this is relevant because learning may occur both through movement but also by gatherings, either formally in the classes, as is the case of the large science rooms that hold the classes and where knowledge is conveyed; but also in the separate room in the library, where formal activities may occur in a non-recurrent way, like a book reading that implies a formal space for a specific event outside the regular classes schedule. Additionally, other clusters have been noted such as the canteen where programmed meal serving occurs, but which can also allocate more informal events of social nature such as seasonal celebrations or, in this particular case, artistic performances.

Finally, the possible clustering of users on the main hall near the longitudinal wall facing the entrance is something to be studied in deeper detail when observations on effective spatial fruition take place, in order to conclude on the possible overlapping of the potential for visual clustering coefficient of those areas and the actual gathering of people in space. Because, these are in fact spaces where people may stay and wait for their colleagues or even accomplish some activities, rather than simply moving through the hall towards other space.

In what regards control, this is also important for this current analysis, but mostly in what concerns the following procedure on observation of effective experience in space. According to Turner (2001):

> "Control for a location, which we will label ci, is defined by Hillier and Hanson (1984), and is calculated by summing the reciprocals of the neighbourhood sizes adjoining the vertex […] It should be noted that in VGA many of the immediately adjoining neighbourhoods will overlap, so that perhaps a better definition of VGA control would be the area of the current neighbourhood with respect to the total area of the immediately adjoining neighbourhood - that is, rather than use the sum the size of all the adjoining neighbourhoods, use the size of the union of those adjoining neighbourhoods […]" (Turner, 2001, p.5)

This implies that this measure is relevant for observation purposes, because control recognises the areas "where observers can have a large view of the spatial layout" (Al_Sayed, Turner, Hillier and Iida, 2014, p.28). Therefore, those might be the areas to consider for placing observers for identifying effective spatial fruition. When applied in this building, the high level spaces of visual control are



Second floor

First floor

Ground floor

Fig. 186. VGA Analysis, Visibility graph: Visual control
(Carolina Coelho)

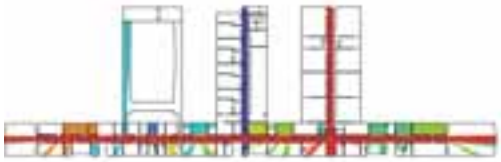
located on the main hall, the main corridors, the canteen, the cafeteria and the library – all places of common use which are intended to be analysed subsequently in regard to effective spatial fruition on the third milestone of this proposed methodology[736] (Fig. 186).

Isovists as "location-specific patterns of visibility" (Benedikt, 1979, p.48), have also been studied for considering the possible observations points and their visual scope, which is specified by the visibility analysis from DepthmapX. So, having considered the spaces with most informal potential and the ones that possibly are more frequented, according to the initial analysis of the spatial sample, a set of isovists has been pinpointed on DepthmapX on the following spaces: the main hall, the library, the cafeteria and the canteen on the ground floor, and the main corridors on both the first and second floors (Fig. 187). These have been produced for a quarter isovist (90º) and the coloured graphs provided by DepthmapX indicate the visibility from several points on these spaces, which may justify the choice in observation spots further on, because isovists "provide a description of the space 'from inside', from the point of view of individuals, as they perceive it, interact with it, and move through it." (Turner, Doxa, O'Sullivan and Penn, 2001, p.103).

Then, a final analysis has been undertaken, considering the situation where classes are taking place in the building, and therefore, the doors leading towards the main corridors are closed. This leads to a different spatial layout that conditions the

[736] See chapter 4.2.3. Description of effective events and experience in the school.

Second floor _ Main corridor



First floor _ Main corridor

Ground floor _ Main corridor and library

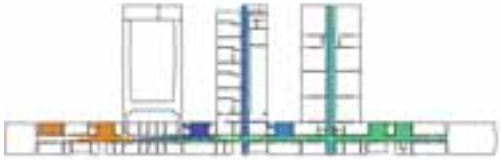
Ground floor _ Cafeteria and canteen

Ground floor _ All isovists chosen

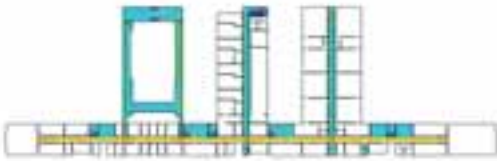
Fig. 187. VGA Analysis, Visibility graph: Isovists
(Carolina Coelho)

Second floor _ Main corridor a)

b)



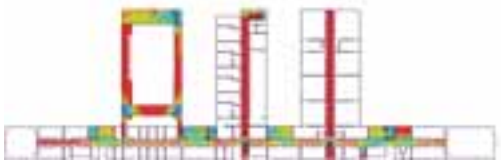
First floor _ Main corridor a)



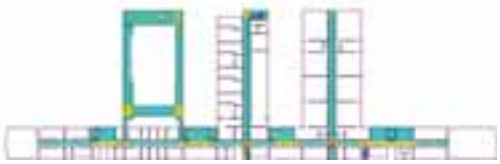
b)

Second floor _ Main corridor c)

d)



First floor _ Main corridor c)



d)

Fig. 188. VGA Analysis, Visibility graph: a) Isovists with closed doors; b) Visual integration HH with closed doors; c) Visual clustering coefficient with closed doors; d) Visual control with closed doors
(Carolina Coelho)

isovists from the corridors (Fig. 188a) and also the respective visibility graphs with visual integration, visual clustering coefficient and visual control (Figs. 188b, c, d).

Naturally, that if doors are closed, the visual scope of possible observers within the corridor embraces only the whole corridor and the several openings that each corridor has, duly pointed out in the initial analysis for the spatial sample. This also confirms whether these spaces, with standing potential, are visually integrated in space or whether an observant from the corridor has visual control over them, which may condition the activities that these spaces may effectively allocate[737].

At this point it is also relevant to recognise that DepthmapX also provides two measures: visual entropy and visual relativized entropy under the visibility graph. However, these are different indicators from Shannon's entropy, as already explained in detail in chapter 3.3. when the methodology was presented in a detailed manner prior to its application in this case study[738], considering that he entropy calculation undertaken for this methodology relates not only to topology, as space syntax does, but rather to a wide range of constraints regarding activity allocational potential.

All in all, the visibility analysis provides data on the potential of a spatial system to allocate people and infers on the possibility of patterns of co-presence according to its configurational properties. Naturally, that this potential will have to be critically assessed when arriving to the third milestone of this methodology which regards the effective spatial experience after the acknowledgement of the spatial sample's potential to gather people, to enable interactions, movement and ultimately, to be adaptable to multiple activities and users amongst this space. The individual, societal and cultural context of this specific community may introduce further information on this space's use and compel or even enlarge its potential to allocate activities, but this initial description of the school space and how can it support activity allocation through its configuration is a constraint that will potentially facilitate or hinder higher or lower adaptability towards multiple uses and users:

> "In this sense, sets of locations within the isovist of a point determine conditions of copresence of occupants and hence potential action and interaction. The isovists we employ are used to derive the graph of intervisible locations and hence the visibility graph is a tool with which we can begin *consciously* to explore the visibility and permeability relations in spatial systems. We must of course be careful to note that any population of a space will lead to changes in the visual field which we have not considered and that members of the population will experience a space through their personal memory of the previous

[737] This will be subject of particular analysis within the observation stage of the methodology.

[738] Please see chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

> spaces they themselves have moved through. However, by looking at relationships at both a local and a global level, we hope to capture the common experience of that space, and so visibility graph analysis may represent a step towards exploring the relationship between architects, as designers of spaces, and users, as architects of their own experience of space."[739] (Turner, Doxa, O'Sullivan and Penn, 2001, p.119)

. Overall conclusion from the morphological analysis by Space Syntax

Integration as a global measure provides an overall description of the space: "Clearly the more a space is integrated, the more it may be able to exploit the existing pattern of movement of people caused by the arrangement of space." (Hillier et al., 1983, p.59).

The most integrated spaces and axial lines have been identified by DepthmapX's graphics, coloured in red according to the interpretation of the software's colour scheme from the highest values in warm colours to the lowest in cool colours, and also by its attributes' extended listing. The most integrated convex spaces are the main hall and the main corridors and the axial lines placed on those same corridors are also the most integrated ones. On the second floor the most integrated axial line throughout the all corridor highly differs from the remaining segregated axial lines that connect formal classrooms of the artistic teaching. On the ground floor this has particular relevance because it relates the main hall to the library, as well as on the first floor longitudinally joining the small auditorium, the main corridor and the dance studio, in what might be considered potential "learning streets" (Hertzberger, 2008, p.114), for both moving and standing activities, spontaneous and/or programmed. Overall, and besides the main corridors, the most integrated convex spaces are generally the most connected ones, like the library, the auditorium and the cafeteria: all spaces with a communal use.

Similarly, axial integration has also been paralleled to convex integration (Fig. 189), and the overall conclusion is the potential correspondence between the corridors as convex spaces and their axial lines, bearing in both situations the highest values of global integration and local connectivity. Note that the library, the auditorium and the cafeteria, all spaces with a communal use are also highly connected convex spaces. On the first floor it is clear that the main corridor is the most connected, followed by the corridor on each transversal wing (Fig. 172). And again on the second floor this coincides with the integration analysis.

It is now possible to parallel the values from integration, connectivity and mean depth, in order to critically analyse their proximity or variance on all floors and both

[739] Italics from the original quote.

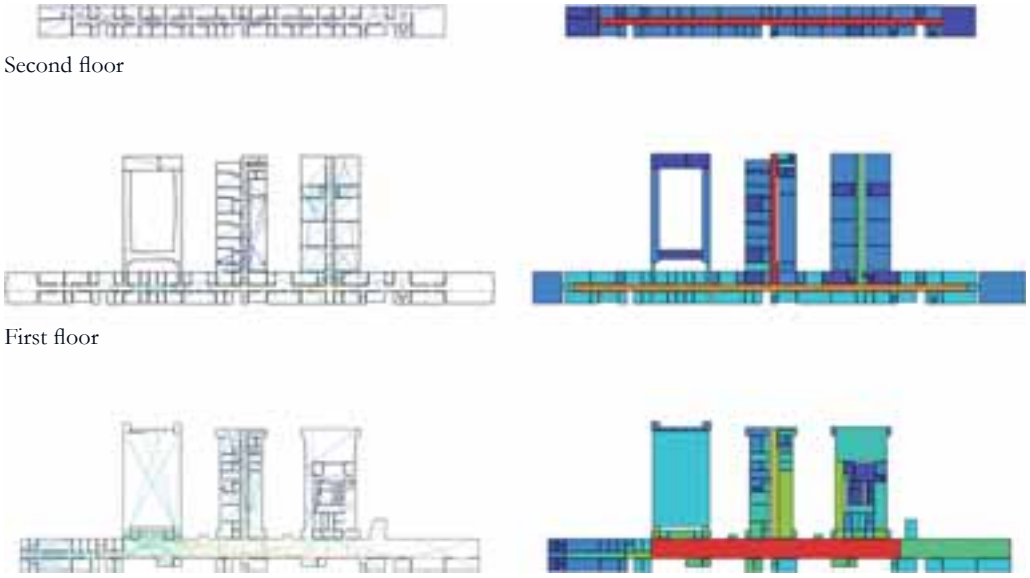


Fig.189. Axial and Convex Integration HH: a) Axial map; b) Convex map
(Carolina Coelho)

convex and axial approaches (Figs. 190 and 191). Generally, in terms of integration and connectivity the highest values are from the axial maps rather than the convex ones. Contrarily, the convex map from the ground floor holds the lowest and the narrowest range in values and hence, the highest mean depth.

In terms of integration, axial integration widely increases in values in all floors when compared to convex integration. The highest maximum and the average integration are held by the second floor axial map, whereas the lowest integration is held by the ground floor convex space map. The convex figures increase very significantly for all floors, when analysed by axial lines, foremost the second floor that reaches a maximum of 113,29 from a previous maximum of 14,17. Having already examined this value in detail on the part of the individual axial results, again this high increase constraints the comparison because of its significant distinctiveness. In fact, when plotting the values together on a scattergram this high number impedes to make a more detailed analysis of the remaining ones because they come too close together, so the scattergram reaches 113. So, as it has been done previously for the separate axial analysis on compared results, a second scattergram has been produced without this number, and considering it an outlier it is now possible to comprehend the other values in a more detailed manner in which the scale of analysis is fine-grained.

Generally, it could be argued that the values rise from convex to axial analysis and from the ground to the second floor, where the highest integration both by convexity and axiality is on the second floor, an the lowest in regard to minimum,

ATTRIBUTE SUMMARY		Ground Floor		First Floor		Second Floor	
		convex spaces	axial lines	convex spaces	axial lines	convex spaces	axial lines
		rn					
INTEGRATION	minimum	0,76	1,39	0,83	1,39	1,13	1,86
	average	1,34	2,90	2,08	2,26	2,70	6,05
	maximum	3,00	7,79	7,35	5,33	14,17	113,29
CONNECTIVITY	minimum	1,00	1,00	1,00	1,00	1,00	3,00
	average	2,35	14,77	2,28	8,96	1,93	6,40
	maximum	21,00	69,00	46,00	41,00	46,00	38,00
MEAN DEPTH	minimum	2,47	1,60	1,34	1,82	1,24	1,03
	average	4,51	2,74	2,87	3,03	2,38	1,87
	maximum	6,76	4,35	4,95	4,15	4,02	2,56

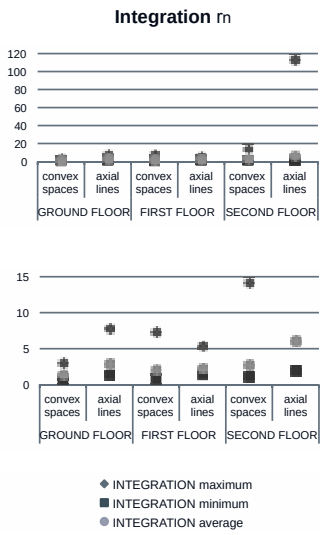


Fig. 190. Integration, Connectivity and Mean Depth r_n comparison between all parameters (table and scattergram with and without outliers)
(Carolina Coelho)

ATTRIBUTE SUMMARY		Ground Floor				First Floor				Second Floor			
		convex spaces		axial lines		convex spaces		axial lines		convex spaces		axial lines	
		rn	r3	rn	r3	rn	r3	rn	r3	rn	r3	rn	r3
INTEGRATION	minimum	0,76	0,53	1,39	0,98	0,83	0,33	1,39	1,44	1,13	0,53	1,86	1,86
	average	1,34	1,56	2,90	3,18	2,08	2,22	2,26	2,73	2,70	2,77	6,05	6,05
	maximum	3,00	3,64	7,79	7,79	7,35	7,35	5,33	5,32	14,17	14,17	113,29	113,29
CONNECTIVITY	minimum	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	3,00	3,00
	average	2,35	2,35	14,77	14,77	2,28	2,28	8,96	8,96	1,93	1,93	6,40	6,40
	maximum	21,00	21,00	69,00	69,00	46,00	46,00	41,00	41,00	46,00	46,00	38,00	38,00
MEAN DEPTH	minimum	2,47	2,00	1,60	1,60	1,34	1,34	1,82	1,82	1,24	1,24	1,03	1,03
	average	4,51	2,53	2,74	2,39	2,87	2,44	3,03	2,40	2,38	2,22	1,87	1,87
	maximum	6,76	2,87	4,35	2,85	4,95	2,94	4,15	2,84	4,02	2,94	2,56	2,56

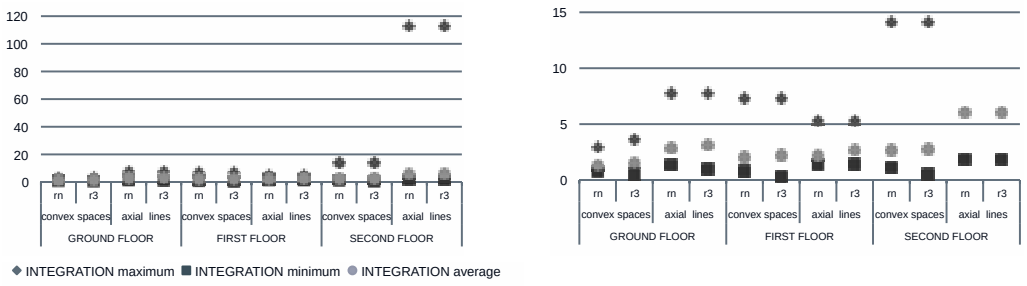


Fig. 191. Integration, Connectivity and Mean Depth r_n and r_3 comparison between all parameters (table and scattergram with and without outliers)
(Carolina Coelho)

average and maximum integration is the convex map for the ground floor. But the conclusion cannot be that straightforward because the lowest values of axial integration are from the first floor and not from the ground floor, in which the average and maximum integration is higher for the ground than for the first floor. Even the second floor has the highest one very distinctive from the latter. If the first floor maps indicate a rise from the convex average integration to the average axial one, it is still lower than the growth from the ground floor that reaches an average of 2,90, as opposed to an average of 2,26 of the first floor's axial integration. And when comparing the maximum integration, if the ground floor increases from 3,00 to 7,79, the first floor's integration decreases when analysed by convexity with 7,35, than when analysed by axiality with 5,33. This is the exception on the overall conclusions by floor plans and convex *vs* axial analysis: not only is the average axial integration higher in the ground floor than on the first floor, but also the maximum axial integration of the first floor decreases when compared to its convex integration.

The widest span in values is also from the second floor precisely because of the potentially considered outlier of 113,29. But leaving out that figure, the widest span is also from the convex space map on that same floor, because of the already mentioned difference between a very integrated main corridor and the shallow spaces, making the map very distinctive between blue and red.

Overall, these results all bring to a general conclusion on the existence of actual differences between floor plans on the attributes studied, due to the differences in spatial form, in which the second floor is more concentrated and lacks the transversal sections the remaining floors and the ground floor is more diffused, influencing the relations on the "part-whole structure" of the spatial system and potentially on patterns of co-presence and movement (Hillier, 2007, p.113).

Another conclusion is that the most representative values are from the axial line map than the convex map, that isolates the spaces *per se* and does not provide a more comprehensive regard on the relations between spaces in a whole area of analysis, that can ultimately gather both movement and standing. Hillier has already reflected upon this difference:

> "Convex elements are not, of course, the most 'global' spatial elements in a layout, and do not exhaust all relationships of visibility and permeability. These limits are found by looking not at two-dimensional convex elements, but at one-dimensional line elements. In a deformed grid, the elements most spatially extended linearly will be the set of straight lines that are tangent to the vertices of blocks of buildings." (Hillier, 2007, p.98)

Therefore, it could be concluded that the axial line analysis is more comprehensive because the axial lines cross not only the mentioned corridors but also other convex

spaces. This is particularly relevant when identifying the most integrated axial line on the ground floor, gathering the library, the main hall and the auditorium's cafeteria, the first with a more formal and programmed activities' profile and the latter space with a more spontaneous and social one. This adds pedagogical diversity to this *pedagogical line or* "learning street" (Hertzberger, 2008, p.114), for both moving and standing activities, spontaneous and/or programmed:

> "The space structure is admittedly highly broken up into 'convex' spaces — but there are always lines which link the convex spaces together, usually several at a time. […] But because people move in lines, and need to understand lines in order to know where they can go, this means that the space structure is easily intelligible from the point of view of movement."[740] (Hillier, 2007, p.116)

Analogously, another highly integrated and connected axial line is the one linking both extremities of the first floor: the small auditorium to the dance studio, where formal and informal artistic events occur, and whose convex integration is low. Again, these findings contribute to a mixture of environments for knowledge transmission that hold diverse situations and even a broad community of students and teachers with different profiles, besides also the possibility of being an external cultural and social aggregator.

Therefore, when analysing this school by means of axial lines rather than convex spaces, the outcomes are more representative of the spaces' actual layout and foremost of its pedagogical enriched curricula. Corridors with movement, associated with socialisation and communication, can be considered active learning environments, having in this school a very integrated position, metaphorically denoting its pedagogical significance. Furthermore, the fact that corridors and spaces for staying, and that also spaces for formal and informal uses, are highly connected enables that formality and informality can be simultaneous, like communication and moving and spontaneity and knowledge creation.

As for the mean depth, the results also coincide with this approach on the building's form and report to the integration conclusions: the highest values are from the ground floor convex space map and the lowest and more shallow spaces are on the second floor when analysed by axial lines.

The connectivity results add complementary information on this building's form. The lowest maximum connectivity is held by the convex map of the ground floor but contrarily, the highest is also held by that same floor, when analysed by axial lines, altering from a maximum of 21 to 69. This implies that the ground floor's analysis

[740] This quote has already been previously remarked on the general explanation of this proposed methodology, due to its high representativeness in explaining convex spaces and axial lines, for active learning environments. See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

changes considerably when analysed by the spaces *per se* or by an arrangement of areas, in which its gathering as pathways or standing spaces, is more representative in terms of a more "immediate neighbours that are directly connected to a space" (Al_Sayed, Turner, Hillier and Iida, 2014, p.12).

This is very different from the situation on the upper floors, where both have the same maximum of 46 by convexity and decrease axially. Still, the first floor is more connected than the second floor, proven by the comparison between the average and maximum axial connectivity on both floors. This occurs, potentially, because of the variety of connections besides the main corridor, which increases that corridor's integration exponentially as already explained, but that decreases the other spaces' connectivity.

A visibility analysis also bears particular relevance for this case study, because highly visual integration may enhance patterns of encounters and therefore informal learning. By the analysis of the graphs, the spaces with the highest visual integration are also the most integrated, namely the main corridors on each floor.

Remarkingly, this analysis carries additional information because it emphasises this school's blending of moving with standing spaces, namely by the introduction of open spaces to the main corridors. And even if this is not particularly significant by axiality or convexity, visually the fact that students stand on those spaces and visually perceive the users that move throughout the corridor, influences the patterns of co-presence. Additionally, highly visual integration of the open spaces to the corridors, deemphasises the sole moving nature of the corridor, introducing pedagogical, artistic and social activities in the common spaces, proven to be highly integrated and connected in the building. This conclusion carries additional relevance on patterns of co-presence, not particularly significant by axiality or convexity, regarding the fact that students there visually perceive others. Furthermore, according to Hillier (2007) the visibility graphs can, ultimately, be a conjoint result of both axial lines and convex spaces:

> "These analysed visibility maps are quite remarkable entities, and appear to synthesise aspects of configurational analysis which had previously seemed to be quite independent of each other. For example, it is clear that, by definition, axial maps are subsets of the lines that make up the 'all-line' visibility map. Visibility maps, we may say, 'contain' axial maps. It follows that they will also contain some account of the global structure of a pattern of space in a configuration because axial maps do. We shall see shortly that this is the case." (Hillier, 2007, p.271)

In this case, and after a separate analysis of the three approaches, the overall results are understood as complementary information for an overall outlook on the building's morphological study that, when overlapped, can also provide correlations of the most

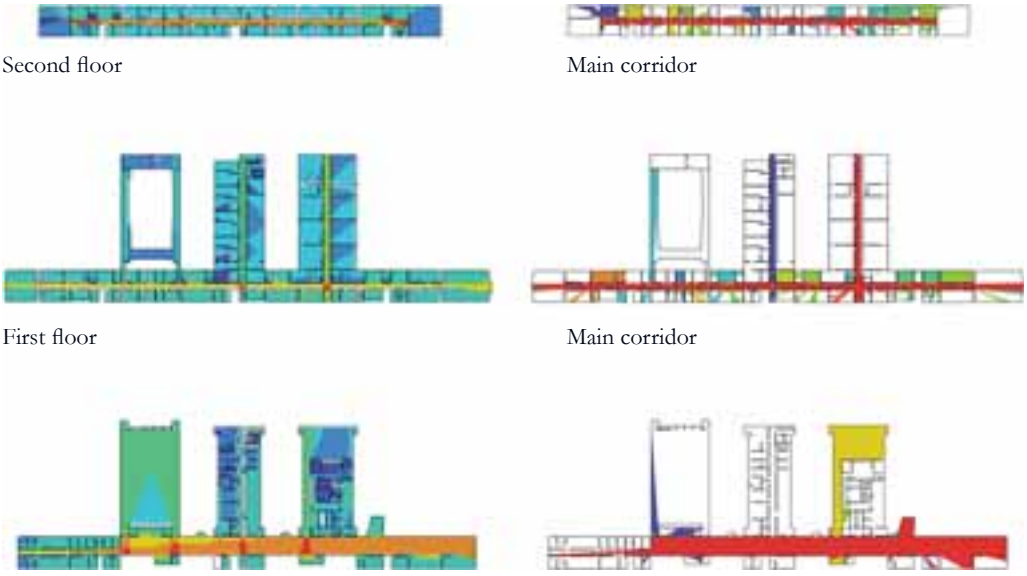


Fig. 192. Visibility graph and Isovists
(Carolina Coelho)

representative approaches, but mostly on the gathered results. Therefore, the crossing of these outcomes with the other syntactic measures may also bring additional information on the morphological, visual and comprehensible relation between the spaces and the overall spatial system. Thus, by the analysis of the graphs (Fig. 192) the spaces with the highest visual integration are also the spaces previously recognised as the most integrated in a convex approach, namely the main corridors on each floor.

Benedikt's (1979) paper on *To take hold of space: isovists and isovist fields* is very representative for the state of the art on isovists, where it is clearly defined the concept: "An *isovist* is the set of all points visible from a given vantage point in space and with respect to an environment." (Benedikt, 1979, p.47). Isovists, therefore, also describe space, complementing the previous analysis on spatial morphology for describing space, as: "Sets of isovists and isovist fields form an alternative description of environments." (Benedikt, 1979, p.47). Even more so, this could also engage the behaviour in space:

> "The nature of isovist boundaries will also be discussed. This in turn will lead to consideration of the capacity of isovist sets to specify completely an environment. The shape and size of the isovist become especially salient since these may change with position research relative to the environment. It will be suggested that various perceptual and cognitive factors are well represented by certain numerical measures of shape and size attached to the isovist. These measures vary over space so as to create fields unique to a given environment. Potentially this may

> allow a number of spatial behaviors to be explained and predicted as field-dependent behaviors. […] The whole should be considered simply as an introduction to a new method of describing environmental or architectural space, and as an exploration of its potential." (Benedikt, 1979, pp.48-49)

This also justifies the analysis of isovists also according to Benedikt's mentioned "size" and shape" (*ibid.*), for the acknowledgement of the more operative locations for the subsequent observations, undertaken as a later approach on the proposed methodology to assess adaptability, provided by the visibility graphs. According to the conclusions achieved by the visibility graphs and subsequently proceeding with isovists of the identified spots with higher visibility, then the methodology is able to propose the most adequate placement of observers to report on effective spatial fruition in space.

Having described and explained the results separately, and after the critical assessment on the correlation between floors, radius *n* and radius *3*, and the convex and axial analyses, the final comparison aims to be the most extensive, comprising all ground floors for all three analyses: convex, axial and VGA. This time, only integration is examined, considered to be the global measure and so the most representative, and to provide a more clear conclusion on the potential parallels, that might be blurred if other parameters were added (Fig. 193).

The lowest VGA integration is from the first floor, both minimum and maximum, as compared to the other floors, potentially due to more closed spaces and a diffused plan. Contrarily, the maximum VGA integration is from the ground floor, which might be explained by the openness of the main hall towards other spaces that makes it also axially very integrated.

The lowest convex integration is from the ground floor and the highest from the second floor, increasing vertically upwards. The axial integration is lower on the first floor, both for the average and maximum values, as opposed to the second floor, in which it is extremely high. This high value has been previously considered an outlier to better analyse the remaining ones in a more detailed manner, that the 113,29 did not enable, which justifies the two scattergrams provided, with and without that figure. In fact, the scattergram that only reaches the other maximum of 14,17, which is the convex integration for the second floor, allows a more detailed scrutiny on the values, their rank, scope and potential comparisons.

Generally, the levels of integration increase from convex to axial and then to VGA analysis, which the ground floor clearly embodies by the highest VGA integration of 9,24 and the lowest convex integration of 0,76. This could be a succeeding conclusion from the previous comparison between convex and axial approaches. But similarly to that, this cannot be stated as straightforward, because there are

ATTRIBUTE SUMMARY		Ground Floor			First Floor			Second Floor		
		convex	axial	vga	convex	axial	vga	convex	axial	vga
						r_n				
INTEGRATION	minimum	0,76	1,39	1,78	0,83	1,39	1,69	1,13	1,86	2,08
	average	1,34	2,9	5,15	2,08	2,26	3,32	2,7	6,05	4,24
	maximum	3	7,79	9,24	7,35	5,33	6,76	14,17	113,29	8,07

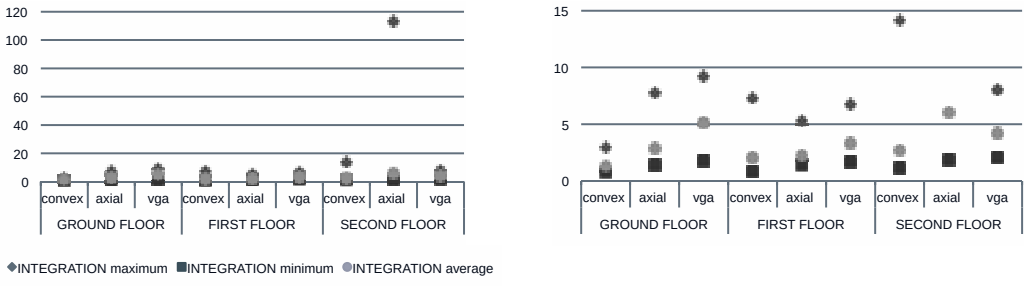


Fig. 193. Integration r_n comparison between convex, axial and VGA analysis (table and scattergram with and without outliers) (Carolina Coelho)

three exceptions where the increase is not directly by this order, which are the second floor average and maximum integration which have higher axial values rather than regarding visibility, and also the maximum integration of the first floor that is higher by convexity.

More specifically, when comparing the maps run by the three analyses it is also important to examine the spaces that provide the highest and the lowest values and reflect upon their compared results (Fig. 194). This is very evident by the colour range of the maps and it brings a very clear conclusion on the coincidence of high integration on the same spaces for all three analyses, that could be widened outside the space *per se* when concerning axial line or VGA. The second floor's main corridor, the first floor's main longitudinal and transversal corridors and foremost the main hall on the ground floor hold the highest integration on all analyses. These are more integrated spaces themselves, hold the most integrated axial lines and represent the "core area[s] in the layout where one can see much of the layout and can be easily seen." (Al_Sayed, Turner, Hillier and Iida, 2014, p.35). Naturally that when axial lines are concerned it is not only the main corridors *per se*, but rather the longest lines that functionally reach the library space and the auditorium supportive areas on the ground floor, the dance studio and the orchestra room on the first floor, and the music studios and the choir room on the second floor. When analysed by axial lines and visibility maps, the transversal corridors on the first floor decrease on their representativeness, because longitudinal axial lines become even more relevant and the visibility increases, not on those hallways, but rather the specific intersections.

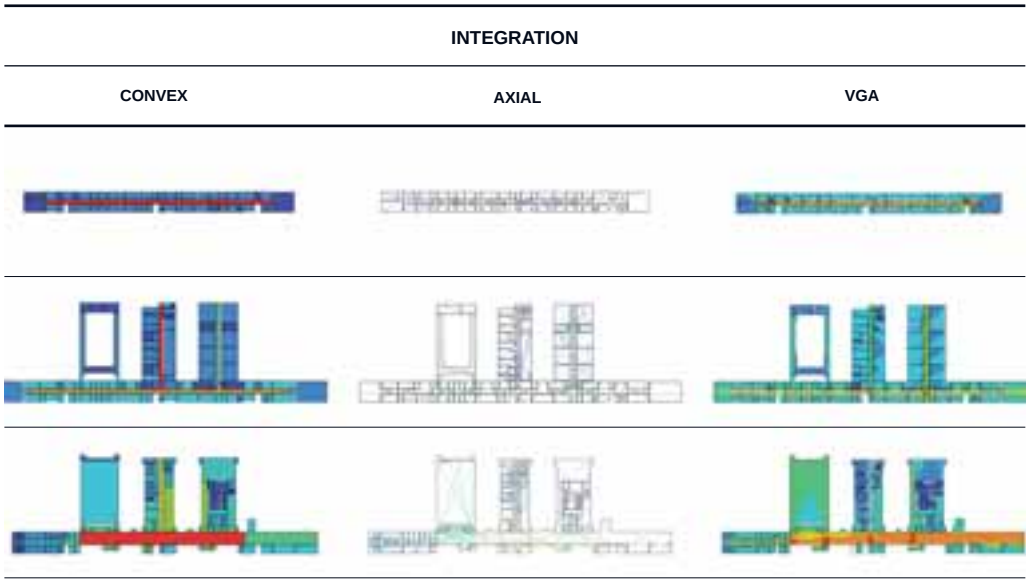


Fig. 194. Integration map for convex, axial and VGA analysis
(Carolina Coelho)

The convex space analysis can be considered constricting because some of the less integrated convex spaces, being located on the extremities, are deeper even if, functionally, they are very significant common spaces for a school, as large artistic rooms on the upper floors. Contrarily, by means of an axial line analysis, these are already comprised in the most integrated axial lines and so become very significant for the spatial system. The difference between the warm colours of the most integrated spaces to the cold colours of the less integrated ones is very clear and enables its identification from the remaining ones and also its overlapping between all three forms of syntactic integration. Furthermore, even if the second floor along its concentrated plan holds a very distinctive high integration from the other spaces, proven by the outlier of 113,29 regarding its axial integration, the more scattered plans on the ground and first floors provide a wide range of areas all very integrated, particularly along the longitudinal section of the building. This is even more evident on the ground floor, where the warm colours are very noteworthy in a wide area rather than only on the first floor's main corridor, because it is less partitioned and the openness of the main hall that continues to the library, enables a wide extent of very integrated axial lines, coinciding also with a wide area of high visual integration.

As previously explained on the individual axial analysis, even in what regards intelligibly, naturally that the high intelligibility from the ground floor is brought by the axial analysis[741], which demonstrates a high correlation between global and local

[741] Even if the intelligibility on the first floor has decreased and the second floor is very similar when comparing convex and axial analyses. This all has been explained on that previous separate critical analysis.

measures, rather than by convex spaces because it implies a general understanding of space from which convexity lacks.

All things considered, and despite the differences encountered on a more detailed analysis and the fluctuations on the figures, on rank and scope, between all floor plans, which have been qualitatively assessed and understood, the general outcomes on a larger scale of analysis provide coinciding results on the high integration areas and a common outlook on the school building, from which partial and more fine-grained conclusions have been previously held and commented on.

This overall process depicted above, including a first and a second part of this initial milestone, provides a wide-ranging understanding of the school's activities and layout, its attributes and the topological relations between them all. It also provides a detailed portrait of each space's main activities, significant for the subsequent entropy analysis. It will also be significant when overlapped with the effective spatial fruition, as the final milestone of the proposed methodology, where it is possible to correlate the spaces' attributes and configuration understood from this syntactic analysis, to the potential these attributes provide to activity allocation, but foremost how the space is perceived and actually used from observations, focus groups and walkthroughs on the school. So, recalling Hillier's "laws from space to society", which he entitles of "type 3" [742], in his 1989 paper to *Ekistics*, these regard the influence of spatial form towards people[743], without prior "determinism" but recognising the significance of the potential brought by space:

> "I argue that the belief that spatial form has *no* effects on people and society is patently absurd. […] My proposal is that the determinable effects on people are both limited and precise. Spatial form, I argue, creates the *field of probable* - though *not* all possible - *encounter and co-presence within which we live and move*; and whether or not it leads to social interaction, this field is on itself an important sociological and psychological resource."[744] (Hillier, 1989, p.13)

Nevertheless, this potential is subject to the context of those people that surpasses the "virtual community" impacted directly by design. Still, syntactic attributes of space, namely integration, which is the global measure to be subsequently correlated with other variables such as entropy and effective encounters on the following milestones of this methodology, is understood as a means to enable those encounters, to be thought *from design* and to be observed *on space use*[745], and hence, a paramount "instrument" to work "with" on our Thesis' theory on adaptability and

[742] After "type 1: laws of the urban object itself" and "type 2: laws from society to space" (Hillier, 1989).

[743] "Laws from space to society are those by which determinable and describable effects on *people* arise from spatial form." (p.13)

[744] Italics from the original quote.

[745] From the main title of our current Thesis: "Life within architecture from design process to space use".

on its application on a case study:

> "However, I must not disguise my belief that, important as these other aspects are, it is the syntax of space itself, especially at the global level, and its relation to the virtual community, that is at the heart of the urban question. This I believe is equally true whether we think of it as a question of understanding and research or as a question of design and action. Space syntax, and its associated theory, is both. It is both research instrument and design tool. In either case, it is a "thing to think with"." (Hillier, 1989, p.20)

Quoting Benedikt's (1979) seminal paper, he concludes by addressing the possibility of studying isovists as a possible description of space in a way that it informs the design: "In the latter role it is hoped that an information-field theory such as the one presented can help provide fruitful common ground for designers and researchers." (p.47). In fact, despite the current expansion of that study field at that time, the sense of potential association of behaviour and perception with isovists was considered a possibility:

> "The direct empirical testing of how some human behaviors and perceptions might correlate with isovists, isovist measures and isovist fields. However, remains to be done. Suitable data are not extant, and obtaining such data will require experiments and techniques specifically directed at the problem." (Benedikt, 1979, p.59)

The aim of this milestone has been to better depict the spatial sample, first from a functional perspective that implied the examination of the plans and the activities expected to be held on each of the designed spaces and, in this subsequent stage, to resort to space syntax to analyse, in a more supported manner, the morpho-syntactic specificity of this school building and how it acts as an interface between visitors and inhabitants. Having studied the building by its configuration and acknowledging the differences by floor plans, which are very significant for the results accomplished, it is relevant to overlap these results to the actual building form and to the functions presented in the initial part, so that a conclusion regarding the allocation of the functions to the spaces can be achieved. Overall, by studying the spatial sample, a deeper comprehension of the building is projected upon the potential is has to hold more or less activities, and also to enhance encounters and interactions, all of which relate to the final conclusions on adaptability.

So, it is understood that thorough information on each milestone is relevant, but it is also relevant to acknowledge that this information has to be critically assessed from the specificity of our own problematics on adaptability, and finally that the results obtained may be correlated amongst the several milestones, in order to gradually study their potential parallels and differences, and also their specific contributions

to the identification of the adaptability of this building.

All in all, after resorting to the software, particular to DepthmapX for achieving the levels of the all attributes on space syntax, but particularly the ones considered to be more representative to our study, it has been the aim of this chapter to analyse them from a qualitative perspective, acknowledging that the figures represent qualitative differences from the form of the building that imply critical assessment. It has been very clear that the fact that all floor plans have different internal and external forms and partitions, leads to different results on global and local measures, in which the second floor is more concentrated and the ground floor is more diffused.

Thus, after presenting the values and foremost the fluctuations between floor plans, between the lowest and the highest scores, and between a radius *n* analysis and radius *3*, the following aim has been to study these results and to offer potential explanations regarding their configuration, and finally to provide critical assessment on the correlations between attributes and spaces, axial lines and floor plans.

Then, the functions of the spaces and areas previously reported on the first part of this milestone, have been overlapped to these conclusions on the building's shape, in order to correlate the expected functions to the building's spaces and areas, movement and standing places. Results on the activities held in the more and less integrated spaces, the supposed activities on the deep or shallow spaces, and the connectivity of each one towards their neighbours, are relevant conclusions that are considered to be even more relevant when passing from abstract figures to an actual building and finally to a school, with all the specific spaces and activities it implies.

This, overall, is considered to be a more comprehensive and less abstract outlook on this spatial sample, and to provide considerations on this actual case study, that could be subsequently regarded with the following milestones. In fact, if the next milestone concerns entropy analysis, which correlates activities to spaces, then a large perspective on the spaces' configuration and on the activities expected to happen from the plans, might be considered adequate contents from this first milestone, that will support the following one.

4.2.2. Description of all possible activity allocations to educational environments

> "[…] the function called *entropy*, defined by $S = -\Sigma\ p_i \ln p_i$ was shown to be a measure of the uncertainty of the knowledge about the answer to a well defined question." (Tribus, 1969, p.119)

This following milestone of the methodology aims to calculate the entropy of the spatial sample in order to conclude on all the possible activity allocations to that space. This is only possible after the first procedure of the proposed methodology, in which the space has been analysed, from its morphology and from its physical attributes that allow its compliance to the activities (Fig. 195).

This milestone's state of the art, authors of reference and intentions have already been identified and reflected upon chapter 3.2.[746], and all its stages and tables to undertake this procedure under the proposed methodology have been presented in the chapter 3.3.[747]. That chapter had the detailed explanation and justification of each part of this procedure to calculate the entropy of a space and had already introduced all the tables that are here to be filled in with the figures from the application on this case study. So, we refer to that particular chapter for the theoretical depiction of this sequential procedure and its full explanation.

Having a previous detailed acknowledgement of the spatial sample from milestone one of this methodology, at this point it is intended to undertake the following steps in order to achieve the space's entropy, as depicted in Fig. 196[748], with the actual figures from the school's spaces and activities that enable its specific applicability.

[746] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[747] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments. The sources and theoretical support of this chapter are remitted to that chapter where the entropy explanation and detailing of its calculation has already been undertaken.

[748] This figure had already been presented in chapter 3.3. and it is here again displayed for a better understanding of the following procedures involved.

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 195. Description of the methodology and identification of the current milestone II. (Carolina Coelho)

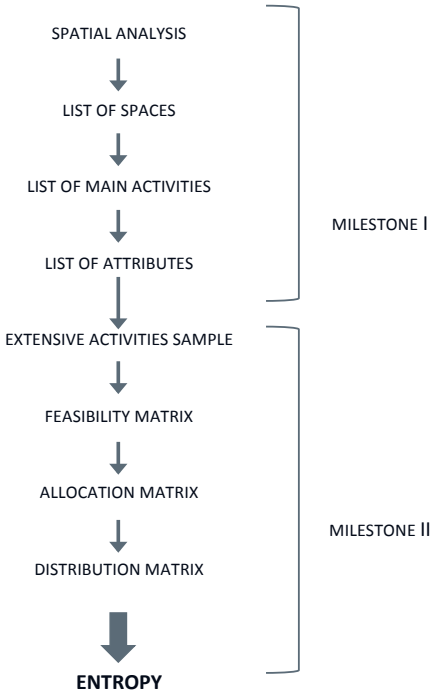


Fig. 196. Sequential procedure for measuring the entropy of the system (Carolina Coelho)

4.2.2.1. Entropy _ Nomothetic analysis

> "If an element had many alternatives and all were equally probable, then the activity would be at its loosest; if an activity could only use one space it would have a probability of 1, and then there would be no looseness. […] The measure of this looseness across the probability distribution is Shannon's entropy." (Fawcett, 1978, p.182)

The following procedure relates to an analytical approach to adaptability, whose foundations have been laid in the 1970s for its assessment as a figure provided by an adaptability model from a combinatorial procedure (Fawcett, 1978). As previously recalled, Fawcett parallels adaptability with a probability.

The procedure for calculating the entropy of a space has been determined by a set of stages. The crossing of the existing spaces of the school identified in the previous stage of this methodology with the possible learning activities that occur there, provides a feasibility matrix that describes the activities that each space can cater for, according to its attributes. Then, other mathematical elaborations are undertaken using stochastic matrices, in order to lastly apply Shannon and Weaver's (1949) entropy formulation for each space: $S = -\sum p_i \ln p_i$. This provides an accurate outlook on the adaptability of each space of the school.

This procedure has also been developed by Krüger (1981a, p.1169) determining "a model building approach towards the maximization of adaptability between activities and spaces, at the architectural scale", which leads to the highest binary matches between activities and spaces. Similarly, this study also proposes maximising entropy for maximising adaptability of activities to spaces.

For that purpose, an initial approach has been made in order to test and validate this milestone and to correlate it to the previous space syntax analysis. This has been done for the same case study but for a smaller set of spaces, which has allowed to produce a list of activities and to critically assess it for providing any changes in it for this final presentation of the implementation of this milestone on the case study. It also enabled to produce the tables from scratch to be filled in with the initial figures and to analyse its adequacy, comprehensibility and fulfillness. Finally with that initial testing of this procedure it was also possible to establish the first correlations between entropy and space syntax measures, namely with integration, in order to consider that possibility and its effective occurrence in this case study. These initial results were presented in the *10th International Space Syntax Symposium*, in 13th-17th July 2015, London, after being peer reviewed and assessed, they have been well considered by the peers. Later on, that initial validation continued on in a subsequent study comprising all stages of the methodology, which has been presented in the *11th International Space Syntax Symposium*, in 3rd-7th July 2017, Lisbon. Both presentations and publications validate these contents and the methodological application by the academia, which have been developed amongst this current Thesis and particularly in this chapter[749].

As perceived from Fig. 196 in order to calculate the entropy, milestone one regarding the space's categorisation and depiction is needed. Then, conclusion can be made in regard to the list of spaces, the main activities that have been identified for each space in coloured diagrams and the main attributes that have been conveyed to each space according to their main purposes. These are paramount as background input for the subsequent entropy calculation, for listing the spaces to which to calculate the respective entropy, to consider the main activities on that sample and to identify the physical consideration from the architect's design that can make the spaces able to cater for those primary activities. In a deeper recalling of that sub-chapter's

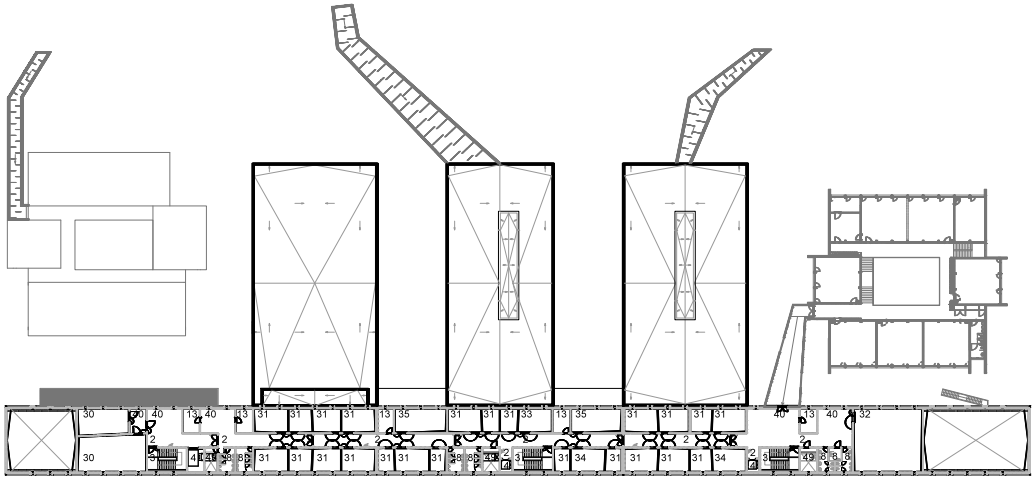
[749] The initial results correlating space syntax to entropy were presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London. These have also been published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
Afterwards, all stages of the methodology have been presented in the *11th International Space Syntax Symposium*, in 3-7 July 2017, Lisbon. It has also been published in the Conference's proceedings as: Coelho, C.; Heitor, T. (2017). Adaptability Retrieval In Artistic Learning Environments. In T. Heitor; M. Serra; J. Silva; M. Bacharel; L. Silva (Eds.). *Proceedings of the 11th International Space Syntax Symposium*. (pp. 7: 1-19).

conclusion, and from the coloured hatches that indicated different activities, it was possible to conclude on a wide variety of different spaces with different and specific spatial characteristics and also a variety of activities that a school with both regular and artistic teaching regime has to cope with, both on the variety of the spaces' scale and its more or less specificities for individual and group learning, formal and informal, besides the very significant communal spaces of that building. All of this adds further complexity to this extensive list of spaces and activities and, therefore, to the entropy calculations.

The first step toward calculating the entropy is to list the spaces from the sample. After the initial testing of this procedure, the actual spatial sample provided by the captions placed onto the final plans from chapter 4.2.1[750] lists a total of 51 spaces, from which the last two are technical areas located only on the technical underground floors that have not been accounted for this case study, as justified in that specific chapter. So, for the purpose of calculating the entropy, a list of 49 spaces is considered, as follows:

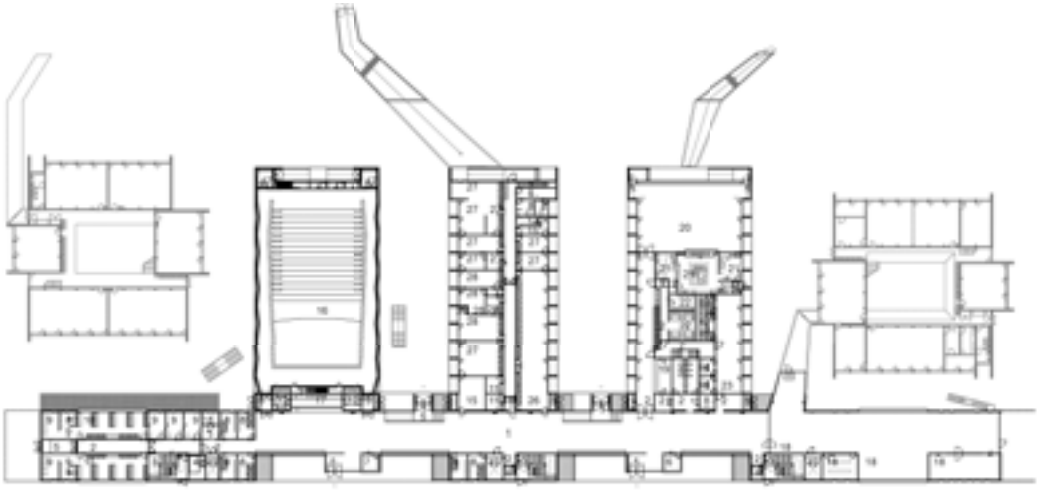
1 main hall
2 access–corridor
3 vertical access–stairs
4 vertical access–elevator
5 entrance–outdoor access
6 reception desk
7 ticket office
8 bathroom–toilet–sink
9 dressing room
10 locker room
11 storage
12 indeterminate supportive space
13 spare space
14 vault
15 archive
16 auditorium
17 auditorium's cafeteria
18 library
19 cafeteria
20 canteen
21 kitchen
22 kitchen storage
23 staff room
24 teachers' room
25 students' room
26 secretariat
27 administration offices regular teaching
28 administration offices artistic teaching
29 orchestra room
30 music studio
31 music instrument training room (individual or for small groups)
32 choir room
33 singing studio
34 song writing studio
35 specific music training room
36 study room
37 dance studio
38 science lab
39 generic classroom
40 common living space
41 teachers' office
42 teachers' meeting room
43 teachers' office for meeting students
44 students' shop
45 photocopy room
46 parent council room
47 auditorium supportive spaces
48 psychologist's office
49 technical area

[750] See chapter 4.2.1. Description of the school space and how it supports activity allocation.



Second floor plan

First floor plan



Ground floor plan

0 10 20
m

Fig. 197. Quinta das Flores School's new building
(Plans provided by Parque Escolar and edited with captions by Carolina Coelho)

The spaces' captions can be identified onto the plans for grasping their specific locations on the building (Fig. 197), which has also been placed on the previous chapter but is placed again here for the immediate recalling of the spaces' location. Again it is underlined that the plans used for this study are the final plans, considered to be the most accurate in regard to the built space, but may differ from the space's effective spatial fruition and each spaces' actual main activity, which will be identified as the subsequent milestone to this one, concluding on the correlation between expected and effective use. So, this entropy calculation regards all the potential the space has for holding a list of activities and not the effective activities it actually holds, which could either be narrowed from these lists or even broadened, according to the school community's appropriation of space.

. Activities sample

Subsequently, an extensive list of activities is needed that goes beyond the spaces' initial purpose or primary activity but that considers all their potential for complying with other activities, even if they could be more suitable or less costly when occurring elsewhere. This list intends to acknowledge a wide array of activities that occur on this precise school, it has been done with all its curriculum specificities and is only possible after a deeper knowledge of the school's activities according to the previous chapter.

As previously explained in abstract[751], in this activities sample, five domains were considered, from the most general to the most detailed scale, projecting a tree-shaped scheme (Fig. 198) that is now concretised for this specific case study.

In addition, for the analysis of this particular case study, details have been introduced in the teaching regimes, which are quite significant for this school and respective activities in each teaching regime. Also the sample of activities is considered to hold great variety due to the numerous different activities that this school holds. Besides, for this specific school, non-programmed activities are quite frequent and have to be accounted primary due to the spontaneous nature of the students of the artistic teaching who naturally rehearse dancing and music instrument playing, individually or collectively, outside formal classes, as well as the programmed activities that occur on that matter. Besides, this spontaneous profile, mostly from the artistic students, adds an even wider range of items to be considered in the activity sample from extra-curricular activities undertaken in diverse ways detailed in domain V, which are also significant in this school. This specificity leads to the following sequence of domains:

[751] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

ACTIVITIES SAMPLE

DOMAIN I **EDUCATIONAL DOMAIN**	DOMAIN II **TYPES OF USES**	DOMAIN III **TYPES OF ACTIVITIES**	DOMAIN IV **TEACHING TYPES**	DOMAIN V **DETAIL OF THE ACTVITIES**
I a) Active learning	II a) Curricular	III a) Programmed	IV a) Regular	Lecture Evaluation class Group work class Individual class Study practice External display Laboratory experiment
			IV b) Artistic	Artistic class Evaluation class Group work class Individual class Study practice External display
		III b) Non-programmed	IV c) Regular	Lecture Evaluation class Group work class Individual class Study practice External display Laboratory experiment
			IV d) Artistic	Artistic class Evaluation class Group work class Individual class Study practice External display
	II b) Extra-curricular	III c) Programmed	IV e) Regular	Lecture Study practice Social interaction amongst all users Peer interaction only External display
			IV f) Artistic	Lecture Study practice Social interaction amongst all users Peer interaction only External display
			IV g) External	Lecture Study practice Social interaction amongst all users Peer interaction only External display
		III d) Non-programmed	IV h) Regular	Lecture Study practice Social interaction amongst all users Peer interaction only External display
			IV i) Artistic	Lecture Study practice Social interaction amongst all users Peer interaction only External display
			IV j) External	Lecture Study practice Social interaction amongst all users Peer interaction only External display
I b) Supportive	II c) Extra-curricular	III e) Programmed	IV k) Regular	Specific uses Social interaction amongst all users Peer interaction only
			IV l) Artistic	Specific uses Social interaction amongst all users Peer interaction only
			IV m) External	Specific uses Social interaction amongst all users Peer interaction only
		III f) Non-programmed	IV n) Regular	Circulation Specific uses Social interaction amongst all users Peer interaction only
			IV o) Artistic	Circulation Specific uses Social interaction amongst all users Peer interaction only
			IV p) External	Circulation Specific uses Social interaction amongst all users Peer interaction only
	II d) Curricular	(not applicable)		

Fig. 198. Activities sample
(Carolina Coelho)

. Domain I) Corresponds to educational domain: active learning environments or supportive environments.

The concept of *active* implies effective learning possibilities in space, while *supportive* implies the activities that aid to that process but do not comprise it *per se*. According to Krüger (1992), this corresponds to the "productive" that comply with the primary activities of learning the school has been conceived for coping with: or the "end-activities"; and the "supportive" spaces are the ones that hold the "means-activities" (Krüger, 1992, p.7).

. Domain II) Corresponds to types of uses: curricular or extra-curricular.

It has been difficult to find the most adequate concept for this domain. Is has been considered the need to divide the activities between active for the learning process and supportive of it (meaning they are not primary activities but that they aid with the learning).

The concepts of *curricular* and *extra-curricular* activities introduce a difference that has been made from the beginning of this Thesis and that adds contemporaneity to this methodology – the significance of activities that complement the learning outside the formality of the classes, evaluation processes and lectures. This could be identified as pedagogical or academic, as opposed to non-pedagogical and non-academic. The concept of curricular has been considered more straightforward to this assumption: the activities held formally by the pedagogical curriculum and the ones that complement it, often with a more informal nature, but that could also be formal activities in the sense of being programmed, public and of representativeness to the school and to the student(s). Curricular uses relate to classes and direct pedagogical and educational activities.

. Domain III) Corresponds to types of activities: programmed or non-programmed.

As explained by Krüger (1992), in which *programmed* activities are held in a routine usually weekly in a school, concerning both classes but also staff and secretariat work schedules, and *non-programmed* activities may imply an "irregular usage of space" (Krüger, 1992, pp.5-7). Naturally that formal events such as classes and artistic performances are the most frequent resemblance to programmed activities, and informal activities to non-programmed and spontaneous ones. Yet, informal events may also be organised by students for a particular schedule in a programmed manner like a celebration or an artistic improvisation performance.

. Domain IV) Corresponds to teaching regimes: regular, artistic and external, particularly meaningful for this school.

This school has both *regular* and *artistic* curricula as explained, but has also a very significant *external* representativeness, that broadens its learning potential outside the student community to an external audience when extra-curricular activities are concerned. The fact that there are several protocols established between the

conservatory and several collectivities of external users that use the school spaces outside school hours, like the library or the auditorium in a more sporadic manner, but also classrooms in a weekly schedule, also reinforces the need to consider them in this domain. That explains the three teaching types in domain IV from the extra-curricular activities in domain II, which is very specific of this school in particular[752].

There is a significant difference to be explained at this point: there are external displays considered in all possible sets of the curricular activities, which are activities held by the effective students of either the school and/or the conservatory towards a public and enlarged audience. But this differs from the extra-curricular activities that occur in this space for other groups, which use the space but that are not students from the school nor from the conservatory. Naturally, that these are only considered applicable in the activities sample in the extra-curricular activities because these groups of people use the space for those purposes and not for the school's curricular uses *per se*. So, the use by the external community is solely extra-curricular and not applicable to the curricular domain. That also explains the extra-curricular activities as supportive of the learning process and the fact that curricular activities are always active and not applicable when supportive ones are concerned[753].

. Domain V) Corresponds to detailed activities according to the previous domains.

As this domain holds the highest complexity and it is this list of activities that will be matched to the spaces according to their potential allocation, some clarification is needed in regard to the detailed activities in domain V according its regard from the previous ones:

The curricular activities are related to classes, in different manners of proceeding with a more formal learning: lecture implies explaining and providing knowledge, evaluation is considered to assess the previously perceived contents, groups and individual classes are held to work on the contents explained and to acknowledge them, study is needed as a support to the acknowledgement of the contents explained in class and external displays occur when the work of a group or individual can be perceived by the all school or a wider audience. So, the curricular activities for both teaching regimes have been considered as follows: lecture, evaluation class, group work class, individual class, study practice and external display, because the learning process implies all of that for both the artistic and the regular curricula.

The difference between individual class and study practice is that individual class has formally a teacher and a student, this is most applied to the artistic teaching, but

[752] Logically this has significance for this school's curricular mixture and also for its community relevance, recognising that in more general terms, if this methodology was to be applied to regular secondary schools this domain could be simplified. Still, in this case it more extensively portrays the effective activities that occur there and its respective spatial needs in a more accurate manner than if this domain was not split into three possible categories.

[753] This implies a change from the abstract table displayed on chapter 3.3. because of the removal of supportive curricular activities, considered not applicable for this case study.

it can also be a supportive class for a student in need. All of these activities could be programmed in the weekly schedule or be a more sporadic complement to the first, as non-programmed.

In what regards the artistic teaching, there are artistic classes both in music and dancing, of both theoretical and practical nature: from lectures to individual training, which all take place in the spaces considered for this case study. This explains its approach to the same types of detailed curricular activities as the regular teaching regime.

The regular curriculum has the specificity of the laboratory experiments. If a wider sample of spaces was to be considered, more activities specific from the regular teaching regime would have to be considered. Nevertheless, they do not occur in this building and in this spatial sample, therefore they are not considered here.

Lectures, study practice and external displays are the three categories that are common in both curricular and extra-curricular activities, because they could be a part of the formal learning process of the student, like a supplementary class from an invited teacher or expert, a study group and an external display that could be enclosed as a final purpose of a particular subject to publicly show the students' final work. Besides, these activities could also be informally defined as an extra-curricular activity, complementing their previously engaged accomplishments from the formal curriculum, such as a non-programmed external display of a group work or, more likely, an artistic non-programmed performance.

External displays are very relevant for this particular school, because they can also be considered a part of the pedagogical curriculum, a part of the formal learning process. An exhibition or a book reading from a noted author and other events within the teaching curriculum, that could be programmed – e.g.: a weekly book signing, or a monthly new exhibition in the main hall with a respective formal opening session. All of these represent formal events relevant for the learning process, with external potential to be outside the classroom.

Programmed and non-programmed activities from domain V are considered the same for each previous domain, because they can occur in a weekly schedule or in a more spontaneous or in a non-repetitive way. This is prominent when considering external displays, that can have a regular programming of a weekly or a monthly happening, or occur just one time.

Most school spaces can be allocated to social interaction, either by all the community or amongst peers, even if not initially considered as such, namely the main access, circulations and common spaces, used by all teachers, staff, parents and students and therefore, these are potential interfaces for social interaction. This specificity is needed because there are spaces for only a specific group of users, such as the staff room, the teachers' offices and others where social interaction can occur

amongst all, like the circulations or the main hall. Interaction is considered to be extra-curricular because it is understated that it occurs throughout curricular activities, not necessarily explicitly or separate from them. But if considered an extra-curricular activity, interaction can be actually the main activity in that space, like the canteen or the cafeteria.

Circulation is an informal, non-programmed activity, hence, its identification in domain V.

Mutually exclusive activities have been removed, such as curricular activities in supportive spaces or curricular activities for an external audience of non-students, generating an overall activity sample that lists a total of 77 possible activities for the analysis of this case study.

To produce this activity sample it has been recognised the relevance of providing extra detail to it, because that would introduce a fine-grained analysis of the spaces' potential to cope with the identified activities and would provide more in-depth conclusions. Moreover, after the initial testing of this procedure, it has also been determined that the more disaggregated the list, in which the more activities and specificities it had, the broader the differences in spaces that can cope with all the activities as compared to a more shallow analysis. And so, by introducing deeper detail, variances in the potential for activity allocation could be identified. This would ultimately provide a more comprehensive understanding of the spaces' allocation potential and a deeper insight in the entropy results. Naturally, that the broader the list of activities and the sample of spaces, by introducing more variables and entities, the more complex all the calculations and the filling in of all the tables and, overall, the more complex the entropy calculations. Anyway, and considering this to be a Doctoral Thesis that may resort to concepts on mathematics and combinatorial calculations, it is first and foremost a Thesis in architecture that aims at the more robust procedures and results, that does not aim at deriving the formulae or to critically consider the mathematical procedures. They are here only in a very simplified manner to reach for results that support architectural knowledge and that may add input when correlated with other results from previous and subsequent milestones of the proposed methodology.

The purpose of having a more specific activity sample lies in the objective of approaching this model to reality and to the specificity of this school's reality and contextual needs and activities. It is recognised that a more abstract model of an activity sample could also have been used. Still, according to what has already been justified, the more detailed this activity sample is, potentially, the more accurate its entropy results and differences will be, and the closer it will depict the actual potential of this building to allocate activities according to its pedagogical curriculum, particularities and specific uses, that are very representative of this school and that have also led to its choice as the most adequate case study.

. Convex Spaces' Entropy

Considering the first step towards the entropy analysis to be the identification of 49 different spaces in the sample, then, an original list of activities with 77 possible activities was produced according to the specific curriculum of this school already explained in detailed. At this point, the following step is to allocate the identified activities from the sample to the spaces listed in the plans, identifying the thresholds of feasibility for this case study.

Then, it will be possible to cross the number of activities that each space is potentially able to allocate with the range of all activities accounted for in this study and listed in an activity matrix produced from scratch for this case study and the methodology. This will conclude on the potential that each space has to allocate each of the activities considered and which are the most prominent attributes that potentiate a higher level of adaptability. Fawcett has referred to this correspondence as "loose-fit" (1976a, p.5).

The allocation has been done according to the assumption of the spaces' ability to cater for the specificity of each activity, also from the previously acknowledgement of its intrinsic attributes and physical features and respectively from the spatial needs for holding each of the activities. Hence, this implies a potential of each space, usually broader than its sole purpose or the objective to which it has been created or simply as it is identified in the plans. Nevertheless, this will occur mostly for spaces that have higher entropy, meaning the possibility of allocating more activities is higher and the uncertainty to what activities are happening in space is also higher. Specifically for a certain space, the higher the x number of possible activities the space has, the least likely is one happening in regard to a broader possible group and thus the higher the uncertainty. Opposite to this, spaces with very specific uses have very low entropy because there is not uncertainty regarding its activity allocation. This will be reflected upon later on, after the final results from the entropy calculations for this school space.

The possibility of a space to change its functional purpose according to its allocational potential, given by the feasibility matrix, is very relevant to reflect upon. Because if the space has the potential to allocate several activities, then over time its main purpose can change according to that time's current needs. So, it will ultimately imply that it is a more adaptable space to change. According to Krüger (1992) the building's lifecycle depends of its physical endurance in regard to "materials, installations and its structure", and also of its functional provision to cope with the "users' changing needs" and the "appearance of new technologies". So, the design of "complex buildings" should attend to the "non-foreseeable changes of the users' needs" and also resort to the most adequate materials. Therefore, research on adaptability, particularly applied to complex buildings, provides a better understanding of this cost-efficiency on the design choices and its compliance towards the future unpredictable changes (pp.16-17). In this regard Krüger adds that:

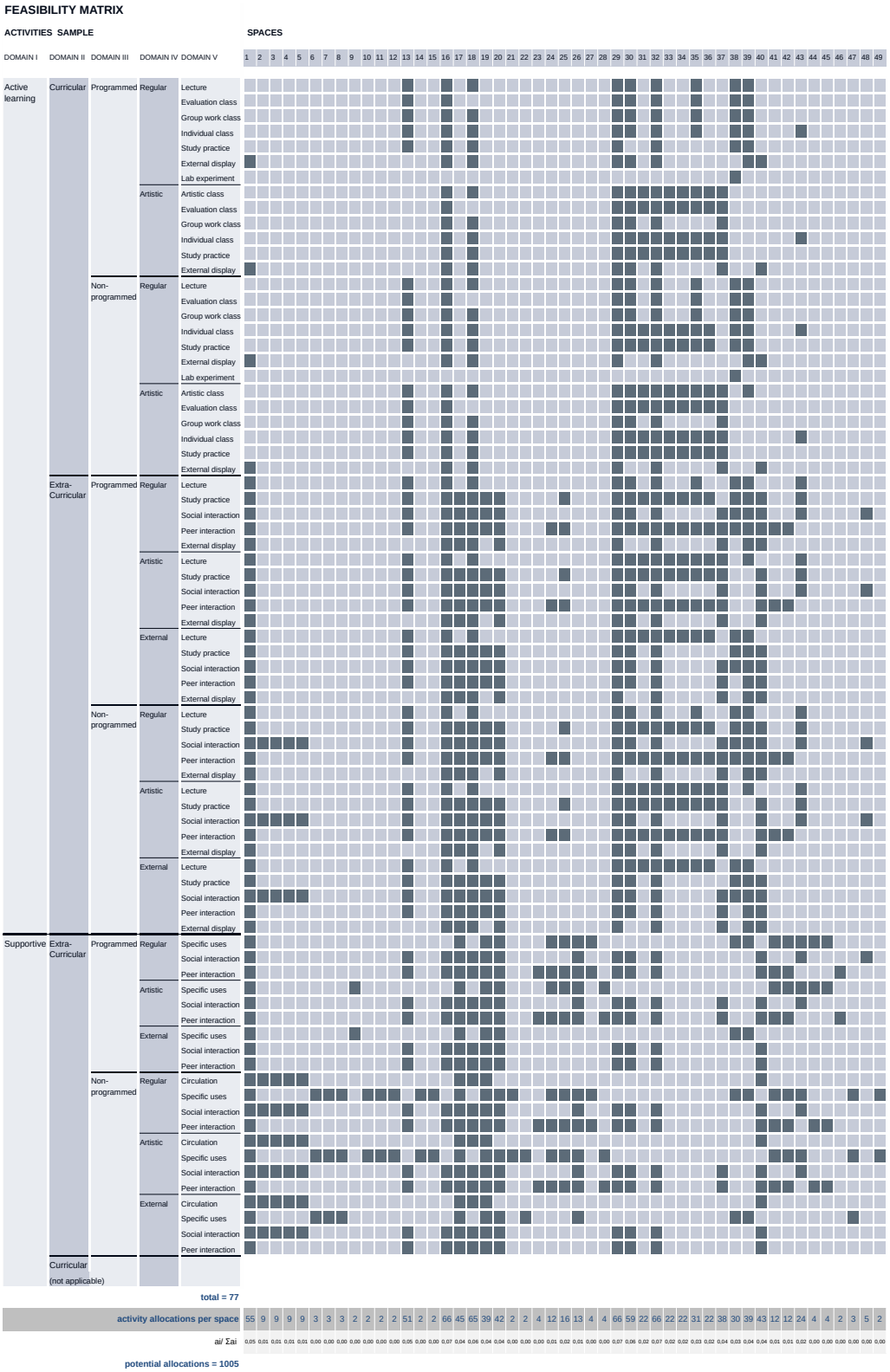


Fig. 199. Feasibility matrix
(Carolina Coelho)

> "Adaptability is the result of the reorganisation of the operational patterns of activities with the minimum environmental and spatial change. In this case it should be considered the locational tolerance of activities, aiming at minimising the costs of possible changes in spatial configuration." (Krüger, 1992, p.17)[754]

Accordingly, adaptability should be considered in the design, because its spatial configuration and physical features, such as the mentioned structure and materials, constrain the future ability of the building to cope with the changing needs and may lead to physical obsolescence. A balanced choice between the initial cost and the future benefits of saving when alterations are needed, should therefore be thought. The feasibility matrix can provide an initial approach to this matter since it identifies the ability of a space to cope with activities according to their physical features and the final results on entropy may also demonstrate how is the distribution of entropy for activity allocations, and when and if there is a stabilisation that informs on the cost/benefit of providing for initially more activities.

In the feasibility matrix designed, if all spaces had the possibility of allocating all the activities, we would have a total of 3773 allocations (from the 49 spaces to 77 activities), but this would involve that all activities could occur in all spaces, not involving time schedules, meaning that all spaces could have the same activity, but also that each space could simultaneously have all the activities. The allocation of activities to spaces has possible variances according to what the activities spatially require and to what spaces can cater for. So, capacity constraints are needed to weigh the spaces according to their functional potential that differs regarding their physical properties. If the spaces are not all physically equal, then there is only a probability of allocating an activity to a space if that space has the specific functional requirements. The sum of all the possible activity schedules leads to 1005 potential allocations, that are the ones that can actually occur in that spatial sample and that represent all possible activity allocations to that space. This is maximising the entropy of the space, because it informs on all possible activities to spaces that can actually occur. This coincides with Krüger's (1981a) studies on the association of entropy to a combinatorial process of activities to spaces, in which maximising the entropy is achieved by the "determination of the feasibility matrix" with the highest "number of biunivocal corresponding matches" between activities and spaces[755] (Krüger, 1981a, pp.1171-1172).

These activities were then matched with the spaces, providing a feasibility matrix of the potential allocations, identifying each allocation activity to a space with a dark square (Fig. 199).

[754] Free translation of the original quote in Portuguese: "A adaptabilidade é o resultado da reorganização dos padrões operacionais das actividades com o mínimo de mudança ambiental e espacial. Neste caso deve ser explorada a tolerância locacional das actividades com a finalidade de se minimizarem os custos de possíveis alterações da configuração espacial." (Krüger, 1992, p.17)

[755] Krüger´s studies on this behalf hold a higher complexity in regard to the combinatorial process of associating activities to spaces in different manners. For the purposes of this current Doctoral Thesis the mathematical formulae have been simplified and are only used when considered to hold results that can be qualitatively interpreted under the scope of architecture and which ultimately provide information for architecture, embracing its disciplinarity.

This correspondence of spaces to activities, can be assessed in order to conclude on the most relevant features towards adaptability and that, when provided to a space, potentiate a higher range of potential uses.

Not only that, but this association might also indicate other possible activity allocations. Actually, there are other constraints that in a real case scenario can compel space use. Management may also influence how spaces are used and what are their functions, even more so in a school, because management can ultimately change the spaces' expected use to a different effective one, according to upcoming needs or pedagogical changes that might occur. Other possible condition is the number of students enrolled in each class and the number of classes, which influence the need for smaller or larger formal classrooms and their specificities from music and dance studios, to generic classrooms, or to laboratories. Another possible constraint is the cost-efficiency of using a room in regard to other, in which two spaces can cater for an activity allocation but one could be over-providing to activities that can occur in a smaller space to lit, heat and overall maintain, which is ultimately also related to management decisions. Furthermore, the spaces' morphology can also condition the choice of a space in relation to another, deeper in the overall system or less connected to the rooms of more frequent use. Anyway this matrix aims to identify all possible activity allocations to spaces, starting from the activities the spaces have been envisioned for, to others also possible there. Only afterwards, in the subsequent milestone of this methodology will the actual usage be assumed and correlated to the expected one, considering individual and group appropriation and all the referred variables that might weigh on the activity allocation.

Time schedules are not here a main purpose, because they regard mostly the management of space. Moreover, if adaptability is concerned, its ultimate application is the possibility of several activities happening in the same space at the same time. Hence, if a space can cater for simultaneous activities, than it would be more adaptable and this would be a significant contribution for the optimisation of the schedule. This is also a part of the contemporary learning model, in which several learning activities can occur at the same time and all with pedagogical potential. The main hall, the library or even the dance studio can have that possibility, and this is something to consider, because in a space like a formal dance studio, different individuals or groups can be performing different learning/practising activities, as it in fact occurs there. For the main hall or the library that is also relevant, because if the library is a more formal space and the main hall a more informal one, then both can hold different activities, both formal and informal, programmed and non-programmed, for different uses and teaching types, hence these are potentially more used and occupied by more people, which coincides with the definition of adaptability.

From the feasibility matrix some conclusions can already be taken regarding the spaces' potential and the location of activities in spaces. This could, in fact, be correlated later on with the entropy results to analyse its possible overlapping.

The main hall has all possible external displays because it acts as the schools' common space towards the community and the first space to be accessed from the outside. It also has the possibility of holding extra-curricular events and as a supportive space to the learning events, such as circulation purposes. Even if curricular learning procedures are not intentionally held here, like evaluations, lectures and study practices, extra-curricular ones could be accomplished here.

The library is also a space with a very extensive list of possible activity allocations for very diverse situations and undertaken by different users from each teaching type.

Accesses like horizontal and vertical circulations hold non-programmed interaction, but these could be either supportive or even as a possible way of knowledge transmission, as an extra-curricular active learning process.

Some spaces are conceived for very specific uses, all supportive of the learning process but with secondary activities related to it, such as the reception desk, the ticket office, the locker room, the dressing room,… This school also has a significant amount of supportive spaces with technical nature such as storage, the vault, the archive, technical areas and even indeterminate supportive spaces, whose allocation is restricted to a specific functionality.

There are also common spaces used by all the community that may have curricular but mostly non-curricular activities for all, some with a more informal set of activities that can lead to knowledge transmission through social interaction amongst all users or even through peer interaction only, like the canteen, the cafeteria and the common living spaces near the main circulations. The library can hold both curricular and extra-curricular activities of different sorts and for different users.

Spaces with still indeterminate functionality can also cater for different activities and users, but do not cope with very specific acoustics requirements. This is the case of the common spaces near the main corridors and also the spare spaces indicated as smaller rooms. Still unknown in the final plans, all in all, these could also have curricular activities for medium or smaller groups. Not been provided with the most adequate soundproofing for the artistic teaching of music instrument practice, holding artistic programmed events is not a possibility, but these could be places for practising, just like a corridor that also does not have the best acoustics. These could also be supportive of other activities, or could even be a social space for a smaller group. So, despite the indeterminacy of these spaces, the array of possible activity allocations is wide.

There are also the spaces that have been concerned for the artistic teaching but that can also hold regular teaching activities, from individual monitoring to group classes and even for holding larger sets of students. Naturally that these spaces are overly provided for the regular teaching because of all the acoustics requirements, but theoretically these do not impede the regular teaching to use them. Contrarily, rooms deployed of acoustics conditioning cannot hold the artistic teaching and are restricted

to the regular and external uses. In addition, large rooms such as the auditorium, the choir room and the orchestra room can cope with most groups and smaller ones, even if that proves to be actually overly costly, whereas small individual training rooms for the music teaching can only be used for individual study or practice.

In the auditorium all activities concerned with the artistic teaching, even individual ones, can be accomplished. Even smaller groups could use it for the regular and external teaching, although in some cases it would be over sized for a class or a smaller group. In this case, most like the library, the use is very disaggregated, meaning that all teaching types can resort to it in very different situations and so, it is not only compelled to a certain teaching regime or domain, despite being conceived because of the conservatory, but could be used in very different situations also for external uses and regular teaching events.

Medium size classrooms are the ones that can cope with a large amount of activities, because the fact they are generic and average in size makes them appropriate for most groups and also adequate in terms of physical sizing for its maintenance. That explains the large activity allocation of music studios of average size and generic classrooms, and even though, as explained, music instrument practising requires physical requirements that a generic classroom does not have, theoretical music classes can be taught in generic regular classrooms.

In what concerned the laboratories, overprovision can also be the case, because most regular classes can occur there but they are over-provided for them. Naturally that this would also dependent on the layout of the furniture and the placement of the sinks and counters.

There are also spaces related more to peer interaction, such as the teachers' offices, the students' room, the staff room and even the parent council room. Others imply social interaction between teachers and students, such as the teachers' offices for meeting students, where curricular and extra-curricular and programmed and non-programmed activities can occur, also connected to learning and most frequently individually-led. Supportive activities such as the ones undertaken in the administration offices are specific of each teaching regime and also engage interaction, as supportive of the learning process. Other supportive spaces of the learning, where services and activities are provided to the students, are spaces such as the students' shop and the photocopy room.

The overall outlook of the matrix is perceived vertically, associating each space with the activities it can cope with, which is its purpose, because it aims at allocating the listed activities to the spaces, and that justifies its immediate vertically perception by space. It is noticed that there are some spaces with a significant array of dark squares that indicate possible allocations, which could be either more or less disaggregated through the all matrix in different domains or altogether within the same one. This will be noted for the conclusions, associating the entropy calculations with the disaggregation of the activities allocations within the domains.

Spaces such as the auditorium and the library hold a very wide array of activity allocations in most domains, meaning that not only do they have an extensive functional potential, but they also can cope with very different spatial requirements from different activities domains. Similar to the auditorium, but regarding its smaller dimension as compared to it, the orchestra room and the choir room can also accommodate several activities, because their size enables holding wider or smaller groups. This will be intentionality dealt further on, in the subsequent analysis on spatial fruition, as to if it is actually used in such a manner, due to a potential over-provision. Still, for the purpose of an entropy calculation, these spaces can cope with larger groups and thus, also with smaller ones.

More generic spaces can also have a wide variety of different activities but cannot cope with more specific requirements, opposite to the laboratories or the dance studio for specific classes and teaching regimes. So, generic classrooms and music studios of average medium size, are spaces that enable curricular and extra-curricular, programmed and non-programmed activities, in a very wide array of possibilities. That explains their significant amount of activity allocations as well, which are also disaggregated amongst several different domains.

Then there are spaces, such as the canteen or the cafeteria, that also hold several possibilities but regarding specific domains. In this case, these spaces serve extra-curricular activities, even if they can be active learning environments for knowledge acquisition and transmissions amongst peers. That justifies their lesser-disaggregated allocations within the matrix.

Finally, the spaces that hold the least allocations are the ones for specific uses, namely supportive ones that have a very clear definition of its purpose and cannot cope with any other. So, there is no uncertainty in which activity is happening there.

A critical analysis can also be done concerning the distribution of activities onto spaces, examining the matrix horizontally.

It is noticeable that there are activities with a wide array of possible locations and some that are site-specific. The latter is the case of laboratory experiments, only held in the science laboratories. Social interaction amongst all users and peer interaction only, can occur in several different supportive spaces, but there are numerous supportive spaces of the learning activities that have a single usage related to a very specific functionality.

In what regards active learning activities, extra-curricular study practice is also an activity that can be held in numerous spaces, according to the choice of the student(s), from larger to smaller size spaces, or from more formal to more informal and socially prone ones. That is also the case of peer interaction for the purposes of information transmission, creation and acquisition that may also occur in formal classrooms of different sizes to more informal spaces of social nature and for all teaching types.

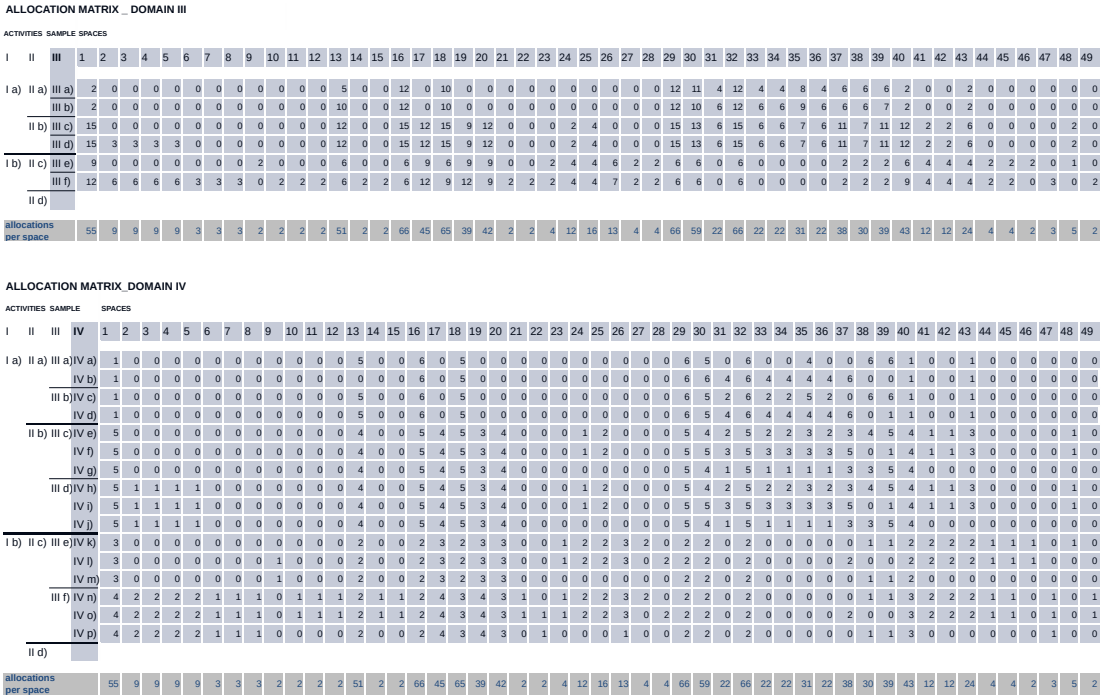


Fig. 200. Allocation matrices per domain

(Spaces 1 to 49 are identified in Fig. 197 and Domains I to IV are identified in Fig. 198)

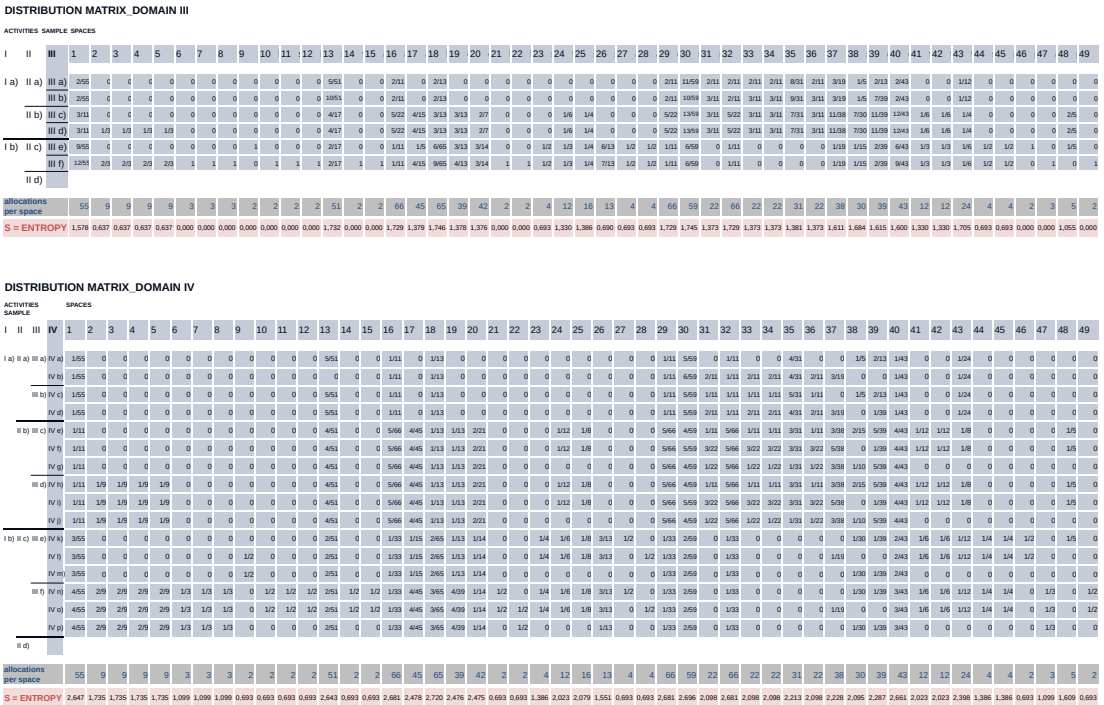


Fig. 201. Distribution matrices per domain

(Spaces 1 to 49 are identified in Fig. 197 and Domains I to IV are identified in Fig. 198)

One of the most striking remarks is the aggregation of artistic related activities to the spaces conceived for such purposes. This is due to its specificities. Activities of more general spatial requirements, such as the regular teaching and external types, can occur on conservatory spaces, but the contrary is not possible because these activities require soundproofing conditions that these more generic spaces are not provided with.

Having identified the thresholds of feasibility when applied to this particular case study, activities and spaces, then the following procedure is to calculate the entropy by a series of matrices. Consequently, an analysis has been done in order to produce an allocation matrix that sums up the number of potential happenings for each space according to the domain specified (Fig. 200). As already studied in chapter 3.3.[756], this is what Fawcett entitles "matrix $\{s_{ij}\}$, of all allocations" (Fawcett, 1978, p.181).

For this research, it was considered relevant to proceed with the calculations for two different distributions – a less and a more disaggregated one – in which the first focused on the types of activities (corresponding to domain III) and the latter on the teaching regimes (domain IV), which displays more extensive items of activity allocations and hence, a deeper complexity.

Allocation matrices were constructed by identifying the distribution of the possible activities for each space according to the sections considered, which are clearly more extensive for domain IV.

At the end of this chapter, and after proceeding with all calculations, the differences or similarities between the results from the two analyses – a more and a less disaggregated, will be examined so that conclusions can be drawn on the relevance of the degree of disaggregation of the distribution towards the entropy results.

By the study of the allocation matrices it is clear that these hold what Fawcett called "integer entities" (Fawcett, 1978, p.181)[757]. So subsequently, a distribution matrix was produced for each domain that divides these figures already displayed in the previous matrices by the all potential activities for that space. Again, comparing to Fawcett's procedure, this can be paralleled to the "stochastic matrix, $\{t_{ij}\}$, by dividing all entries by the total number of allocations, S" (Fawcett, 1978, p.181). The tables displayed as distribution matrices report those results, now already as fractions from a part-whole distribution (Fig. 201).

The entropy calculation for each of the spaces corresponds to the values encountered from the previous allocation and subsequent distribution matrices and their respective calculation using Shannon's entropy formulation:

$$S = -\Sigma_i p_i \ln p_i$$

As already established in chapter 3.3., which proposed this methodology before

[756] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[757] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

VALUES RANK			
ENTROPY CALCULATIONS			
Domain III		Domain IV	
space	value	space	value
18 library	**1,746**	18 library	**2,720**
30 music studio	**1,745**	30 music studio	**2,696**
13 spare space	**1,732**	16 auditorium	**2,681**
16 auditorium	**1,729**	29 orchestra room	**2,681**
29 orchestra room	**1,729**	32 choir room	**2,681**
32 choir room	**1,729**	40 common living space	**2,661**
43 teachers' office for meeting students	**1,705**	1 main hall	**2,647**
38 science lab	**1,684**	13 spare space	**2,643**
39 generic classroom	**1,615**	17 auditorium's cafeteria	**2,478**
37 dance studio	**1,611**	19 cafeteria	**2,476**
40 common living space	**1,6**	20 canteen	**2,475**
1 main hall	**1,578**	43 teachers' office for meeting students	**2,398**
25 students' room	**1,386**	39 generic classroom	**2,287**
35 specific music training room	**1,381**	37 dance studio	**2,228**
17 auditorium's cafeteria	**1,379**	35 specific music training room	**2,213**
19 cafeteria	**1,378**	31 music instrument training room	**2,098**
20 canteen	**1,376**	33 singing studio	**2,098**
31 music instrument training room	**1,373**	34 song writing studio	**2,098**
33 singing studio	**1,373**	36 study room	**2,098**
34 song writing studio	**1,373**	38 science lab	**2,095**
36 study room	**1,373**	25 students' room	**2,079**
24 teachers' room	**1,33**	24 teachers' room	**2,023**
41 teachers' office	**1,33**	41 teachers' office	**2,023**
42 teachers' meeting room	**1,33**	42 teachers' meeting room	**2,023**
48 psychologist's office	**1,055**	2 access - corridor	**1,735**
23 staff room	**0,693**	3 vertical access - stairs	**1,735**
27 administration offices - regular teaching	**0,693**	4 vertical access - elevator	**1,735**
28 administration offices - artistic teaching	**0,693**	5 entrance / outdoor access	**1,735**
44 students' shop	**0,693**	48 psychologist's office	**1,609**
45 photocopy room	**0,693**	26 secretariat	**1,551**
26 secretariat	**0,69**	23 staff room	**1,386**
2 access - corridor	**0,637**	44 students' shop	**1,386**
3 vertical access - stairs	**0,637**	45 photocopy room	**1,386**
4 vertical access - elevator	**0,637**	6 reception desk	**1,099**
5 entrance / outdoor access	**0,637**	7 ticket office	**1,099**
6 reception desk	**0**	8 bathroom-toilet-sink	**1,099**
7 ticket office	**0**	47 auditorium supportive spaces	**1,099**
8 bathroom-toilet-sink	**0**	9 dressing room	**0,693**
9 dressing room	**0**	10 locker room	**0,693**
10 locker room	**0**	11 storage	**0,693**
11 storage	**0**	12 indeterminate supportive space	**0,693**
12 indeterminate supportive space	**0**	14 vault	**0,693**
14 vault	**0**	15 archive	**0,693**
15 archive	**0**	21 kitchen	**0,693**
21 kitchen	**0**	22 kitchen storage	**0,693**
22 kitchen storage	**0**	27 administration offices - regular teaching	**0,693**
46 parent council room	**0**	28 administration offices - artistic teaching	**0,693**
47 auditorium supportive spaces	**0**	46 parent council room	**0,693**
49 technical area	**0**	49 technical area	**0,693**

Fig. 202. Table with the entropy results per space for both distributions (Spaces' locations are identified in the school plans illustrated in Fig. 197) (Carolina Coelho)

applying it to the case study, the fact that this methodology does not comprise activity-schedules differs from Fawcett's original approach[758].

This calculation has been done for all spaces and, as a practical demonstration it will be explained in detail for the main hall, identified as 1 in the less disaggregated distribution, for domain III:

1) In the feasibility matrix there were 55 potential allocations to this space.

2) The allocation matrix for domain III for space 1 indicated: 2 active learning, curricular, programmed activities; 2 active learning, curricular, non-programmed activities; 15 active learning, extra-curricular, programmed activities; 15 active learning, extra-curricular, non-programmed activities; 9 supportive, extra-curricular, programmed activities; and 12 supportive, extra-curricular, non-programmed activities. This adds to the total of the 55 activities, now subdivided in sections.

3) A distribution matrix divided the activities by the total allocations for this space: 2/55, 2/55, 15/55 (=3/11), 15/55 (=3/11), 9/55, 12/55.
The simplified fractions are presented in both distribution matrices (Fig. 201).

4) Finally, the entropy for space 1 is calculated:

$$S_1 = - (2/55 \ln 2/55 + 2/55 \ln 2/55 + 3/11 \ln 3/11 + 3/11 \ln 3/11 + 9/55 \ln 9/55 + 12/55 \ln 12/55) = 1,578$$

Since it depends from the previous procedures, at the end of the distribution matrices for both distributions (Fig. 201), the entropy has already been calculated and displayed for all the 49 spaces assessed from the spatial sample. Still, a table has been produced that ranks the results (Fig. 202).

From its analysis, conclusions can be drawn regarding the highest and lowest entropy values and the similarities and/or differences between the two distributions.

It is the library that holds the highest entropy for both distributions, which can be justified by the fact that it can potentially allocate both curricular and extra-curricular activities, considering that the curriculum also implies events outside the formal classroom and the library copes with that sought for ambiance, with a formal outlook where technological devices, books and magazines are available for knowledge acquisition, but where a more casual environment is also possible compared to the classroom and even the layout of the students in class. This is also a space that can hold external displays, exhibitions, book signings and events for groups, either in a programmed and non-programmed / more spontaneous manner. Furthermore, the library has sofas and a lounge area that potentiates more casual social interaction amongst all or just amongst the peers. It is also a place for storage of books and with supportive uses. The fact that this library in particular

[758] Chapter 3.2. explains Fawcett's (1978) *A Mathematical Approach to Adaptability in Buildings* and chapter 3.3. sets the proposed methodology in this Thesis, to which Fawcett's work is extremely significant, but that also reviews it according to the cultural and pedagogical contemporary context and to the possibility of introducing other inputs from different approaches that complement this more analytical one.

has adjacent spaces to a more relevant one, also enables simultaneous uses, some more formal and curricular within those rooms, paralleled with a more freestanding distribution of people in space in this open space. It is also a place that can be used by all teaching types and users in many different manners.

The music studio has the second highest value also for both distributions. It is a medium size space that can cater for the artistic teaching, but that can also hold regular and external activities, curricula and extra-curricular, programmed and non-programmed.

Overall, there are six spaces that are ranked very high in both distributions, which are the auditorium, the orchestra room and the choir room, that hold consecutively high values of high entropy in both distributions, following the library and music studio. As previously mentioned for justifying the feasibility matrix's allocations, these spaces have the possibility of holding more or less people within them. As they are provided with soundproofing intrinsic attributes, they can have artist activities of different sort, but can also cope with the more general requirements of regular and external activities. Besides, these could cater for curricular and extra-curricular activities, for example external concerts and events, as well as conservatory performances or evaluation displays. The discussion on its potential over-provision can be dealt in the subsequent milestone of this methodology, regarding effective spatial fruition, but even so, these have the potential to cope with smaller groups for less spatially demanding activities.

Then, other spaces have also to be mentioned has holding high entropy levels, more representative when analysed by domain IV, such as: common living spaces and the main hall, and when analysed through the distribution of domain III, these are: spare spaces and the teachers' office for meeting students. Nevertheless, the differences are not striking and even if these spaces have lower entropy values when examined through the other distribution, their placement on this rank is still very high. A deeper assessment of these results will be made on the overall conclusions of this chapter, while comparing both distributions to the activity allocations.

. Axial Lines' Entropy

The previous procedures regarded the calculation of the entropy for each space from the ones listed on the final plans. But two situations may imply an additional development on the entropy results. The first is the fact that the school space today is understood as an environment, an active learning environment towards the learning process, bestowed with informality and socialisation that may go beyond the classroom premises. This involves the consideration of informal spaces as places for learning but, under a broader reflection, it also suggests not only the informal spaces alone to be thought as active learning spaces, but the pathways: vertical and horizontal circulations as a means for knowledge transmission. This has already

been thought in the previously presented entropy calculations that considered all spaces of the school sample, including the stairs and corridors, the main hall and the cafeteria, for example, and not just the formal ones.

Nonetheless, there is another consideration that the concept of environment implies: the fact that it does not have to be bounded by walls or by physical limitations. So, reflecting upon current active learning environments could suggest a gathering of spaces as a whole set to convey and create knowledge. This could be tackled with the preceding study on space syntax for the description of the spaces morpho-syntactic features[759]. That study provided input on the spaces' axial lines. If axial lines are thought to potentially represent a whole space and could describe an active learning environment more comprehensively than the isolated convex spaces *per se*, then that space syntax analysis and the concept of active learning environments and informal spaces in the school building today, may lead to a further development on how to think and to calculate the entropy of the school space.

Therefore, another consideration that provides additional information to the entropy analysis is the introduction of two concepts: "axial line entropy" and "average axial line entropy". The concepts of "axial line entropy" and "average axial line entropy" were originally presented in the *10th International Space Syntax Symposium*, in 2015[760] in London for correlating space syntax to entropy, assuming that space syntax resorts to both convex spaces and axial lines, and these could be conceived as a possible vehicle of correlation, for the purposes of using them within this proposed methodology regarding adaptability in contemporary school buildings.

In fact, these concepts bear particular relevance for this case study, since learning occurs both in formal convex spaces but also in pathways, moving interactions and sequential sets of spaces, better translated onto axial lines, as explained earlier. Following Hertzberger's idea of the "learning street"[761], the analysis of the adaptability potential of the learning environments can more fully be understood not only through the analysis of the clearly defined spaces, but also of the informal and shapeless environments where learning also takes place in the form of different activities, as such as the defined in the sample presented earlier.

Naturally that the identification of the axial lines implies a previous space syntax analysis of the space, that was already comprised in the initial milestone of this

[759] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

[760] These have also been published in the conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

[761] "There are school buildings where learning and instruction are not confined to the classroom, where there is as much going on outside the classrooms as inside, and where there are no longer corridors as such with coats hanging everywhere and bags and rucksacks scattered around, what was originally a space for passing through is now a place to stay." (Hertzberger, 2008, p.113)

proposed methodology as a way of introducing a more in-depth description of the spatial sample and justifying how it can allocate the activities for this entropy analysis. Thus, the calculation of the axial line entropy is based in the same axial lines identified by DepthmapX on the prior procedure, and whose attributes have already been previously studied, namely their integration.

Finally, on the adaptability retrieval milestone of this methodology[762], their correlation will be analysed. But for accomplishing that, it is first required to calculate all the results for the axial lines already acknowledged in all the spatial system under adaptability assessment.

The "axial line entropy" is calculated as the sum of the entropy of all convex spaces intersected by this axial line and the "average axial line entropy" is calculated, by dividing the axial line entropy by the number of convex spaces intersected, as follows[763]:

AXIAL LINE ENTROPY: $S_i = \Sigma_k S_{ik}$

S_i entropy of axial line i

S_{ik} entropy of convex space k intersected by axial line i

AVERAGE AXIAL LINE ENTROPY: $AS_i = \Sigma_k S_{ik}/NK$

AS_i average entropy of axial line i

NK number of convex spaces intersected by axial line i

This has been done for all axial lines identified by DepthmapX on the previous space syntax analysis, because it is considered that the potential correlation have to be on the same number of variables and also on the same variables individually, in this case, both convex spaces analysed by space syntax and also the same axial lines. So, all axial lines from all floor plans have been identified and their axial entropy and average axial entropy has been manually calculated per domain III and IV, similarly to convex spaces' entropy distribution (Figs. 203a, b).

After undertaking this procedure for all axial lines considered from the space syntax analysis, then their axial entropy has been estimated by the sum of the entropy of all the spaces identified that intersected those same axial lines. Besides DepthmapX, only Excel has been used to proceed with these extensive calculations done for each axial line one-by-one. So, as a future development a software could be studied

[762] See chapter 4.3. Systematisation of the results: Description of the potential correlations and retrieval of the school's adaptability.

[763] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

that would identify each axial line from the integration map and that overlaid it to the convex space integration map and that also calculated the axial line entropy by summing up all the convex spaces' entropy of the spaces identified for each axial line, for automatisation of this process that is extensive and time consuming.

As an example of this calculation, it is considered the axial line [ref. 1] on the ground floor, paralleling the street façade with the longest metric length, it crosses the following spaces: library (18), main hall (1), corridor a and corridor b (2) and entrance (5). By summing up all their entropy, the axial line entropy corresponds to: $S_{18}+S_{1}+S_{2a}+S_{2b}+S_{5}$ that equals 5,235 for the distribution for domain III and 10,572 for the distribution for domain IV. Its average entropy results from dividing these values by this number of spaces, which is 5,235 /5 that equals 1,047 and 10,572 /5 that equals and 2,114, respectively for domains III and IV (Fig. 203a).

The same calculation can be applied to the most integrated axial line [ref. 30] from the first floor, which corresponds to the entropy of the orchestra room (29), access, main corridor, access (2) and dance studio (37). This corresponds to an axial line entropy of 5,251 for domain III and 10,114 for domain IV and an average axial line entropy respectively of 1,050 and 2,023 (Fig. 203b).

Crossing the axial line entropy with the entropy of individual spaces, we conclude that the values can be very diverse, from entropy values lower than the entropy value of a sole space, to higher entropy levels when we consider an axial line with spaces with high entropy levels *per se*. In what regards the maximum entropy found for each domain, these represent significantly higher values than the ones for individual spaces, because they represent a sum of spaces.

The axial entropy for domain IV ranges from a maximum of 13,497 to the lowest 1,386. The maximum result is due to the fact that it crosses several spaces and most of them with high entropy. Naturally that if an axial line intersects several high entropy spaces, its sum explains a high axial line entropy. The minimum value is explained by the intersection of only two convex spaces with low entropy *per se*. Still, the axial line entropy, in average, is 2,533 for domain III and 5,315 for domain IV's distribution, hence, significantly higher than the individual spaces' entropy.

When analysing the average axial line entropy, it can also be both higher or lower than the average entropy value of a single space. The average axial line entropy is lower, in average, than the average entropy of individual spaces, because for domain III the average axial line entropy is, in average, 0,803 and the individual spaces' entropy is 0,905 for the same domain. Similarly, for domain IV the average axial line is also, in average, lower than the individual spaces' entropy, which is 1,672 for the average axial line and 1,706 for the convex spaces' entropy. So, overall the average axial line does not increase the entropy of the individual spaces that are intersected by the same axial line.

CORRELATION ENTROPY / SPACE SYNTAX (GROUND FLOOR)						
AXIAL LINES INTEGRATION		SPACES INTERSECTED	AXIAL LINE ENTROPY		AVERAGE AXIAL LINE ENTROPY	
Line ref.	Value	Spaces ref. in plans	Domain III	Domain IV	Domain III	Domain IV
1	7,792	18+1+2+2+5	5,235	10,572	1,047	2,114
4	5,983	18+18+1	5,07	8,087	1,690	2,696
3	2,978	18+18	3,492	5,44	1,746	2,720
2	3,019	18+18	3,492	5,44	1,746	2,720
6	3,088	18+18+1+2+4	6,344	11,557	1,269	2,311
5	3,317	18+18+1+2	5,707	9,822	1,427	2,456
7	3,527	3+2+1+2+21+19+19	6,245	13,497	0,892	1,928
8	3,334	1+2+23	2,908	5,768	0,969	1,923
17	3,131	1+2+8	2,215	5,481	0,738	1,827
18	3,131	6+1+2+8	2,215	6,58	0,554	1,645
111	3,527	5+1+19+20	4,969	9,333	1,242	2,333
116	3,472	5+1+19+19+2+2+22	6,245	13,497	0,892	1,928
35	4,137	5+1+2+11	2,852	6,81	0,713	1,703
34	5,277	5+1+17+12+5	4,231	9,288	0,846	1,858
16	3,368	1+2+8	2,215	5,481	0,738	1,827
104	4,654	1+17+12+5	3,594	7,553	0,899	1,888
50	4,498	3+1+17+12+5	4,231	9,288	0,846	1,858
59	4,821	4+2+1+2	3,489	7,852	0,872	1,963
19	4,323	8+1+2	2,215	5,481	0,738	1,827
84	3,490	8+1+17	2,957	6,224	0,986	2,075
81	3,368	8+1+15+27+28+28	3,657	6,518	0,610	1,086
117	3,454	1+5	2,215	4,382	1,108	2,191
85	3,317	1+5+12	2,215	5,075	0,738	1,692
86	3,317	1+5+16+47	3,944	8,162	0,986	2,041
89	3,437	7+1+5	2,215	5,481	0,738	1,827
90	3,437	7+1+17+12	2,957	6,917	0,739	1,729
91	3,402	7+1+17	2,957	6,224	0,986	2,075
87	3,385	7+1+5+16+47	3,944	9,261	0,789	1,852
88	3,351	7+1+5+12	2,215	6,174	0,554	1,544
108	3,317	5+1+2+8	2,852	7,216	0,713	1,804
113	3,437	5+1+5+16+47	4,581	9,897	0,916	1,979
114	3,419	5+1+17	3,594	6,86	1,198	2,287
107	3,402	5+1+17+12	3,594	7,553	0,899	1,888
106	3,385	5+1+5	2,852	6,117	0,951	2,039
109	3,351	5+1+5	2,852	6,117	0,951	2,039
110	3,385	5+1+17+12	3,594	7,553	0,899	1,888
99	3,472	5+1+5	2,852	6,117	0,951	2,039
92	3,437	5+1+17	3,594	6,86	1,198	2,287
30	3,472	8+2+1+5+16+47	4,581	10,996	0,764	1,833
105	3,419	8+2+1+5+12	2,852	7,909	0,570	1,582
118	3,527	8+2+1+17	3,594	7,959	0,899	1,990
83	3,509	8+2+1+5	2,852	7,216	0,713	1,804
103	3,546	8+2+1+17+12	3,594	8,652	0,719	1,730
0	3,527	8+2+2+10+9	1,274	5,955	0,255	1,191
120	3,206	8+2+2+9	1,274	5,262	0,319	1,316
97	3,603	8+2+1+5	2,852	7,216	0,713	1,804
102	3,546	8+2+1+17+12	3,594	8,652	0,719	1,730
122	3,060	2+2+8	1,274	4,569	0,425	1,523
123	3,060	4+2+9	1,274	4,163	0,425	1,388
125	3,237	3+2+10+9+9	1,274	5,549	0,255	1,110
124	3,206	3+2+10	1,274	4,163	0,425	1,388
121	3,102	3+2+2+8	1,911	6,304	0,478	1,576
127	3,088	2+9	0,637	2,428	0,319	1,214
128	3,191	10+2+5	1,274	4,163	0,425	1,388
129	3,237	10+2+10+9+9	0,637	4,507	0,127	0,901
137	3,191	2+10+9+8	0,637	4,22	0,159	1,055
132	3,237	10+2+10	0,637	3,121	0,212	1,040
131	3,161	10+2+5	1,274	4,163	0,425	1,388
130	2,025	10+9+9	0	2,079	0,000	0,693
126	3,206	10+2+9	0,637	3,121	0,212	1,040
143	1,989	8+9+9	0	2,485	0,000	0,828
142	3,191	8+9+10+2	0,637	4,22	0,159	1,055
119	3,285	9+10+2+2+8	1,274	5,955	0,255	1,191
135	2,037	9+9+10	0	2,079	0,000	0,693
138	3,237	9+9+10+2+10	0,637	4,507	0,127	0,901
140	3,237	9+9+10+2	0,637	3,814	0,159	0,954
139	3,191	5+2+10	1,274	4,163	0,425	1,388
134	3,161	5+2+10	1,274	4,163	0,425	1,388
144	2,075	9+9+8	0	2,485	0,000	0,828
133	2,114	9+9+10	0	2,079	0,000	0,693
136	2,127	9+9+10	0	2,079	0,000	0,693
101	3,131	1+17+12+5	3,594	7,553	0,899	1,888
115	2,926	1+5+12	2,215	5,075	0,738	1,692
94	2,735	5+16	2,366	4,416	1,183	2,208
112	2,816	5+12+17	2,016	4,906	0,672	1,635
100	2,939	5+12+17+12+5	2,653	7,334	0,531	1,467
96	2,249	17+12+5	2,016	4,906	0,672	1,635
95	2,702	5+12+17+12+5	2,653	7,334	0,531	1,467
93	2,148	5+14	0,637	2,428	0,319	1,214
48	2,681	2+26	1,327	3,286	0,664	1,643
40	2,500	11+2+26	1,327	3,979	0,442	1,326
55	2,804	2	0,637	1,735	0,637	1,735
57	2,577	2	0,637	1,735	0,637	1,735
56	2,548	2	0,637	1,735	0,637	1,735
43	2,482	26+27+27	2,076	2,937	0,692	0,979
71	1,692	28+28+2	2,023	3,121	0,674	1,040
49	2,538	15+27+2	1,33	3,121	0,443	1,040
66	2,568	2+28+28	2,023	3,121	0,674	1,040
77	2,311	28+28+28+2+28	3,409	4,507	0,682	0,901
79	2,327	28+2	1,33	2,428	0,665	1,214
82	2,411	28+28+27+27+27+27	4,158	4,158	0,693	0,693
80	1,778	28+28+28+27+27	3,465	3,465	0,693	0,693
68	2,568	27+2+2	1,967	4,163	0,656	1,388
70	2,548	27+28+2	2,023	3,121	0,674	1,040
76	2,548	27+27+2	2,023	3,121	0,674	1,040
69	2,538	27+2+27	2,023	3,121	0,674	1,040
73	1,759	27+27	1,386	1,386	0,693	0,693
64	2,538	27+27+2	2,023	3,121	0,674	1,040
78	1,736	27+27+27+27	2,772	2,772	0,693	0,693
53	2,548	27+2+27	2,023	3,121	0,674	1,040
54	2,510	27+2	1,33	2,428	0,665	1,214
75	2,529	27+27+2	2,023	3,121	0,674	1,040
74	1,764	27+27+27	2,079	2,079	0,693	0,693
58	2,538	27+27+2+15	2,023	3,814	0,506	0,954
62	2,428	2+8+8	0,637	3,933	0,212	1,311
60	2,437	2+8	0,637	2,834	0,319	1,417
72	2,510	27+2+8	1,33	3,527	0,443	1,176
61	1,603	8+8	0	2,198	0,000	1,099
38	2,510	2+15+27	1,33	3,121	0,443	1,040
52	2,510	2+15	0,637	2,428	0,319	1,214
46	2,519	2+27+27	2,023	3,121	0,674	1,040
47	2,500	2+27+27	2,023	3,121	0,674	1,040
39	2,311	27+27+15+14	1,386	2,772	0,347	0,693
20	2,037	2+8	0,637	2,834	0,319	1,417
21	2,176	2+21+19+19	3,393	7,38	0,848	1,845
32	2,169	19+2+2	2,652	5,946	0,884	1,982
33	2,190	19+2+23	2,708	5,597	0,903	1,866
24	1,555	2+2+2+21	1,911	5,898	0,478	1,475
22	1,544	2+2+22	1,274	4,163	0,425	1,388
23	2,049	22+2	0,637	2,428	0,319	1,214
28	2,088	22+2+2+19	2,652	6,639	0,663	1,660
25	2,197	19+2+2+2	3,289	7,681	0,822	1,920
13	2,190	19+19+20+5	4,769	9,162	1,192	2,291
31	2,088	19+2+21+21+21	2,015	6,29	0,403	1,258
29	1,451	2+21+21	0,637	3,121	0,212	1,040
26	1,454	21+21+20+5	2,013	5,596	0,503	1,399
27	2,062	19+20+5	3,391	6,686	1,130	2,229
9	1,971	8+8+23	0,693	3,584	0,231	1,195
10	1,971	8+8+23	0,693	3,584	0,231	1,195
11	1,971	8+8+23	0,693	3,584	0,231	1,195
14	1,977	8+8+8+23	0,693	4,683	0,173	1,171
15	1,390	8+8	0	2,198	0,000	1,099
12	2,037	8+8+23	0,693	3,584	0,231	1,195
141	3,269	10+2+10	0,637	3,121	0,212	1,040
98	3,584	8+2+1+5	2,852	7,216	0,713	1,804
45	4,037	1+26+2	2,905	5,933	0,968	1,978
37	3,786	1+26+27+27+15+14	3,654	6,97	0,609	1,162
36	3,565	1+26	2,268	4,198	1,134	2,099
63	2,608	2+8	0,637	2,834	0,319	1,417
67	2,558	2+2+27+27	2,66	4,856	0,665	1,214
65	2,491	28+2	1,33	2,428	0,665	1,214
42	2,500	2+27+15	1,33	3,121	0,443	1,040
41	2,519	2+2+26	1,964	5,021	0,655	1,674
44	2,510	27+2+2+27	2,66	4,856	0,665	1,214
51	2,538	2	0,637	1,735	0,637	1,735

Fig. 203a. Axial line entropy and average axial line entropy distributions for the ground floor per domain (Carolina Coelho)

CORRELATION ENTROPY / SPACE SYNTAX (FIRST FLOOR)

AXIAL LINES INTEGRATION		SPACES INTERSECTED	AXIAL LINE ENTROPY		AVERAGE AXIAL LINE ENTROPY	
Line ref.	Value	Spaces ref. in plans	Domain III	Domain IV	Domain III	Domain IV
30	5,327	29+2+2+2+37	5,251	10,114	1,050	2,023
31	2,415	9+2+9	0,637	3,121	0,212	1,040
32	2,426	40+2+8	2,237	5,495	0,746	1,832
34	2,426	40+2+8	2,237	5,495	0,746	1,832
33	2,437	40+2+8	2,237	5,495	0,746	1,832
37	2,461	13+40+2+48	5,024	8,648	1,256	2,162
36	2,472	40+2+46	2,237	5,089	0,746	1,696
35	2,437	40+2+3	2,874	6,131	0,958	2,044
38	2,437	2+2+4	1,911	5,205	0,637	1,735
29	3,113	2+2+48	2,329	5,079	0,776	1,693
28	3,094	2+2+46	1,274	4,163	0,425	1,388
27	4,069	2+2+40	2,874	6,131	0,958	2,044
47	3,250	2+2+45	1,967	4,856	0,656	1,619
45	3,113	2+2+44	1,967	4,856	0,656	1,619
46	3,113	2+2+3	1,911	5,205	0,637	1,735
56	2,545	13+40+2+45	4,662	8,425	1,166	2,106
57	2,970	2+2+44	1,967	4,856	0,656	1,619
72	3,614	4+2+2+2	2,548	6,94	0,637	1,735
58	3,210	2+2+2	1,911	5,205	0,637	1,735
91	2,936	8+2+2	1,274	4,569	0,425	1,523
90	3,004	25+2+2	2,66	5,549	0,887	1,850
96	2,449	13+40+2+8	3,969	8,138	0,992	2,035
97	2,472	13+40+2+25	5,355	9,118	1,339	2,280
100	2,521	40+2+36	3,61	6,494	1,203	2,165
99	2,533	42+2+25	3,353	5,837	1,118	1,946
98	2,545	42+2+25	3,353	5,837	1,118	1,946
103	2,508	2+2+36	2,647	5,568	0,882	1,856
101	2,521	2+2+30	3,019	6,166	1,006	2,055
102	2,521	42+2+8	1,967	4,857	0,656	1,619
109	2,508	42+2+8	1,967	4,857	0,656	1,619
111	2,508	42+2+4	2,604	5,493	0,868	1,831
113	2,484	13+40+2+8	3,969	8,138	0,992	2,035
107	2,533	42+2+36	3,34	5,856	1,113	1,952
110	2,472	42+2+36	3,34	5,856	1,113	1,952
105	2,496	42+2+36	3,34	5,856	1,113	1,952
112	2,496	8+2+2+47	1,274	5,668	0,319	1,417
106	2,521	2+2+47+47	1,274	5,668	0,319	1,417
104	1,640	47+47+47	0	3,297	0,000	1,099
108	1,605	47+47	0	2,198	0,000	1,099
114	2,437	40+2+8	2,237	5,495	0,746	1,832
116	2,426	35+2+30	3,763	6,644	1,254	2,215
115	2,461	30+2+4	3,019	6,166	1,006	2,055
117	2,426	2+13	2,369	4,378	1,185	2,189
118	2,426	2+2+3	1,911	5,205	0,637	1,735
94	1,493	42+41+41	3,99	6,069	1,330	2,023
43	2,171	41+2+41+24	4,627	7,804	1,157	1,951
95	1,515	41+41	2,66	4,046	1,330	2,023
87	2,135	41+2+2	2,604	5,493	0,868	1,831
92	1,957	41+2	1,967	3,758	0,984	1,879
93	1,489	41+2	1,967	3,758	0,984	1,879
89	2,126	41+41+2	3,297	5,781	1,099	1,927
88	2,171	41+41+2+41	4,627	7,804	1,157	1,951
69	2,126	41+2+41+41	4,627	7,804	1,157	1,951
82	2,153	41+2+2	2,604	5,493	0,868	1,831
66	1,520	41+24	2,66	4,046	1,330	2,023
65	2,109	24+2	1,967	3,758	0,984	1,879
81	2,180	41+2	1,967	3,758	0,984	1,879
62	2,171	41+2	1,967	3,758	0,984	1,879
80	2,162	13+2	2,369	4,378	1,185	2,189
84	2,118	43+2+2	2,979	5,868	0,993	1,956
61	1,502	24	1,33	2,023	1,330	2,023
71	2,034	41+2	1,967	3,758	0,984	1,879
78	2,051	41+2	1,967	3,758	0,984	1,879
63	2,059	42+2+2+24	3,934	7,516	0,984	1,879
59	2,059	41+41+2+24	4,627	7,804	1,157	1,951
85	2,003	41+2	1,967	3,758	0,984	1,879
77	2,011	41+2+41	3,297	5,781	1,099	1,927
79	2,067	2+41+41	3,297	5,781	1,099	1,927
86	2,034	41+2+2	2,604	5,493	0,868	1,831
75	2,026	2+8+8	0,637	3,933	0,212	1,311
74	2,018	2+8+8	0,637	3,933	0,212	1,311
73	1,393	2+2+8	1,274	4,569	0,425	1,523
76	1,389	8+8	0	2,198	0,000	1,099
25	2,218	38+38+2+38	5,689	8,02	1,422	2,005
16	1,566	38+38+39	4,983	6,477	1,661	2,159
22	2,286	38+2+2+2+38	5,279	9,395	1,056	1,879
18	2,247	8+2+2+38	2,958	6,664	0,740	1,666
5	2,208	8+2+2	1,274	4,569	0,425	1,523
19	2,227	2+38	2,321	3,83	1,161	1,915
14	2,256	2+2+38	2,958	5,565	0,986	1,855
15	1,552	12+2+38	2,321	4,523	0,774	1,508
23	1,529	12+12+2+38	2,321	5,216	0,580	1,304
24	2,256	2+2+12+12	1,274	4,856	0,319	1,214
53	1,566	38+38+38	5,052	6,285	1,684	2,095
21	1,552	38+38	3,368	4,19	1,684	2,095
20	2,227	38+2	2,321	3,83	1,161	1,915
26	2,227	38+2	2,321	3,83	1,161	1,915
70	2,084	41+2	1,967	3,758	0,984	1,879
52	2,266	2+38	2,321	3,83	1,161	1,915
49	2,266	2+38	2,321	3,83	1,161	1,915
68	2,171	39+38+2	3,936	6,117	1,312	2,039
42	2,297	2+39+2+8	2,889	6,856	0,722	1,714
17	2,190	38+38+2	4,005	5,925	1,335	1,975
44	2,208	39+2+38+38	5,62	8,212	1,405	2,053
12	2,370	39+2+2+2+38	5,21	9,587	1,042	1,917
13	2,360	39+2+2	2,889	5,757	0,963	1,919
51	1,595	39+38	3,299	4,382	1,650	2,191
40	2,349	39+2+2	2,889	5,757	0,963	1,919
54	1,533	39+38	3,299	4,382	1,650	2,191
41	2,266	39+2+2	2,889	5,757	0,963	1,919
39	2,266	38+39+2	3,936	6,117	1,312	2,039
9	2,266	38+2+2	2,958	5,565	0,986	1,855
55	1,595	38+39	3,299	4,382	1,650	2,191
48	2,180	38+38+2	4,005	5,925	1,335	1,975
50	2,256	38+2+39+2	4,573	7,852	1,143	1,963
6	1,605	12+2+38	2,321	4,523	0,774	1,508
10	1,605	12+2+38	2,321	4,523	0,774	1,508
4	1,542	38+38	3,368	4,19	1,684	2,095
8	2,276	38+38+2	4,005	5,925	1,335	1,975
3	2,307	38+2+2	2,958	5,565	0,986	1,855
7	2,286	38+2+2	2,958	5,565	0,986	1,855
1	2,286	38+38+2	4,005	5,925	1,335	1,975
0	2,286	38+2+2	2,958	5,565	0,986	1,855
2	1,610	38+38	3,368	4,19	1,684	2,095
11	2,276	2+38	2,321	3,83	1,161	1,915
67	2,109	24+2+41	3,297	5,781	1,099	1,927
64	2,067	24+2	1,967	3,758	0,984	1,879
60	1,556	41+24	2,66	4,046	1,330	2,023
83	2,162	41+2+41+41	4,627	7,804	1,157	1,951

CORRELATION ENTROPY / SPACE SYNTAX (SECOND FLOOR)

AXIAL LINES INTEGRATION		SPACES INTERSECTED	AXIAL LINE ENTROPY		AVERAGE AXIAL LINE ENTROPY	
Line ref.	Value	Spaces ref. in plans	Domain III	Domain IV	Domain III	Domain IV
4	113,294	2	0,637	1,735	0,637	1,735
0	3,237	32+40+2	3,966	7,077	1,322	2,359
1	3,147	40+2+8	2,237	5,495	0,746	1,832
2	3,147	40+2+8	2,237	5,495	0,746	1,832
3	3,147	40+2+8	2,237	5,495	0,746	1,832
5	3,147	13+40+2+31	5,342	9,137	1,336	2,284
6	3,147	40+2+3	2,874	6,131	0,958	2,044
7	3,062	40+2+2+4	3,511	7,866	0,878	1,967
8	3,147	31+2+31	3,383	5,931	1,128	1,977
10	3,147	31+2+31	3,383	5,931	1,128	1,977
11	3,237	31+2+31	3,383	5,931	1,128	1,977
9	3,332	31+2+34	3,383	5,931	1,128	1,977
13	3,237	31+2	2,01	3,833	1,005	1,917
12	3,540	3+2+31	2,647	5,568	0,882	1,856
15	3,332	35+2+2	2,655	5,683	0,885	1,894
14	3,237	13+2+31	3,742	6,476	1,247	2,159
20	3,433	33+2+8	2,01	4,932	0,670	1,644
36	3,540	13+2+8	2,369	5,477	0,790	1,826
21	3,433	31+2+2+4	3,284	7,303	0,821	1,826
19	3,540	31+2+31	3,383	5,931	1,128	1,977
18	3,540	31+2+34	3,383	5,931	1,128	1,977
17	3,540	31+2+31	3,383	5,931	1,128	1,977
23	3,237	31+2+31	3,383	5,931	1,128	1,977
24	3,147	2+31	2,01	3,833	1,005	1,917
27	3,433	13+2+31	3,742	6,476	1,247	2,159
28	3,332	31+2+31	3,383	5,931	1,128	1,977
31	3,332	2+8	0,637	2,834	0,319	1,417
29	3,433	13+40+2+4	4,606	8,774	1,152	2,194
32	3,332	40+2+3	2,874	6,131	0,958	2,044
39	1,857	40+40+30	4,945	8,018	1,648	2,673
16	3,540	30+40+40+2	5,582	9,753	1,396	2,438
37	4,357	40+40+2	3,837	7,057	1,279	2,352
30	3,433	40+2+4	2,874	6,131	0,958	2,044
34	3,332	13+40+2+31	5,342	9,137	1,336	2,284
33	3,433	31+2+31	3,383	5,931	1,128	1,977
35	3,433	31+2+31	3,383	5,931	1,128	1,977
25	3,147	31+2+31	3,383	5,931	1,128	1,977
26	3,147	13+2+8	2,369	5,477	0,790	1,826
22	3,237	35+2+8	2,018	5,047	0,673	1,682
38	3,332	40+2+8	2,237	5,495	0,746	1,832

Fig. 203b. Axial line entropy and average axial line entropy distributions for the first and second floors per domain (Carolina Coelho)

VALUES RANK					
FEASIBILITY MATRIX		ENTROPY CALCULATIONS			
Activity allocations		Domain III		Domain IV	
space	value	space	value	space	value
16 auditorium	**66**	18 library	**1,746**	18 library	**2,720**
29 orchestra room	**66**	30 music studio	**1,745**	30 music studio	**2,696**
32 choir room	**66**	13 spare space	**1,732**	16 auditorium	**2,681**
18 library	**65**	16 auditorium	**1,729**	29 orchestra room	**2,681**
30 music studio	**59**	29 orchestra room	**1,729**	32 choir room	**2,681**
1 main hall	**55**	32 choir room	**1,729**	40 common living space	**2,661**
13 spare space	**51**	43 teachers' office for meeting students	**1,705**	1 main hall	**2,647**
17 auditorium's cafeteria	**45**	38 science lab	**1,684**	13 spare space	**2,643**
40 common living space	**43**	39 generic classroom	**1,615**	17 auditorium's cafeteria	**2,478**
20 canteen	**42**	37 dance studio	**1,611**	19 cafeteria	**2,476**
19 cafeteria	**39**	40 common living space	**1,6**	20 canteen	**2,475**
39 generic classroom	**39**	1 main hall	**1,578**	43 teachers' office for meeting students	**2,398**
37 dance studio	**38**	25 students' room	**1,386**	39 generic classroom	**2,287**
35 specific music training room	**31**	35 specific music training room	**1,381**	37 dance studio	**2,228**
38 science lab	**30**	17 auditorium's cafeteria	**1,379**	35 specific music training room	**2,213**
43 teachers' office for meeting students	**24**	19 cafeteria	**1,378**	31 music instrument training room	**2,098**
31 music instrument training room	**22**	20 canteen	**1,376**	33 singing studio	**2,098**
33 singing studio	**22**	31 music instrument training room	**1,373**	34 song writing studio	**2,098**
34 song writing studio	**22**	33 singing studio	**1,373**	36 study room	**2,098**
36 study room	**22**	34 song writing studio	**1,373**	38 science lab	**2,095**
25 students' room	**16**	36 study room	**1,373**	25 students' room	**2,079**
26 secretariat	**13**	24 teachers' room	**1,33**	24 teachers' room	**2,023**
24 teachers' room	**12**	41 teachers' office	**1,33**	41 teachers' office	**2,023**
41 teachers' office	**12**	42 teachers' meeting room	**1,33**	42 teachers' meeting room	**2,023**
42 teachers' meeting room	**12**	48 psychologist's office	**1,055**	2 access - corridor	**1,735**
2 access - corridor	**9**	23 staff room	**0,693**	3 vertical access - stairs	**1,735**
3 vertical access - stairs	**9**	27 administration offices - regular teaching	**0,693**	4 vertical access - elevator	**1,735**
4 vertical access - elevator	**9**	28 administration offices - artistic teaching	**0,693**	5 entrance / outdoor access	**1,735**
5 entrance / outdoor access	**9**	44 students' shop	**0,693**	48 psychologist's office	**1,609**
48 psychologist's office	**5**	45 photocopy room	**0,693**	26 secretariat	**1,551**
23 staff room	**4**	26 secretariat	**0,69**	23 staff room	**1,386**
27 administration offices - regular teaching	**4**	2 access - corridor	**0,637**	44 students' shop	**1,386**
28 administration offices - artistic teaching	**4**	3 vertical access - stairs	**0,637**	45 photocopy room	**1,386**
44 students' shop	**4**	4 vertical access - elevator	**0,637**	6 reception desk	**1,099**
45 photocopy room	**4**	5 entrance / outdoor access	**0,637**	7 ticket office	**1,099**
6 reception desk	**3**	6 reception desk	**0**	8 bathroom-toilet-sink	**1,099**
7 ticket office	**3**	7 ticket office	**0**	47 auditorium supportive spaces	**1,099**
8 bathroom-toilet-sink	**3**	8 bathroom-toilet-sink	**0**	9 dressing room	**0,693**
47 auditorium supportive spaces	**3**	9 dressing room	**0**	10 locker room	**0,693**
9 dressing room	**2**	10 locker room	**0**	11 storage	**0,693**
10 locker room	**2**	11 storage	**0**	12 indeterminate supportive space	**0,693**
11 storage	**2**	12 indeterminate supportive space	**0**	14 vault	**0,693**
12 indeterminate supportive space	**2**	14 vault	**0**	15 archive	**0,693**
14 vault	**2**	15 archive	**0**	21 kitchen	**0,693**
15 archive	**2**	21 kitchen	**0**	22 kitchen storage	**0,693**
21 kitchen	**2**	22 kitchen storage	**0**	27 administration offices - regular teaching	**0,693**
22 kitchen storage	**2**	46 parent council room	**0**	28 administration offices - artistic teaching	**0,693**
46 parent council room	**2**	47 auditorium supportive spaces	**0**	46 parent council room	**0,693**
49 technical area	**2**	49 technical area	**0**	49 technical area	**0,693**

Fig. 204. Correlation between activity allocations and entropy per domain _ Table
(Spaces' locations are identified in the school plans illustrated in Fig. 197 and the numbers near the spaces' identification refer to their caption on those plans)

(Carolina Coelho)

In fact, the average axial entropy ranges from 2,720 to 0,693 for domain IV's distribution and 1,746 and 0 for domain III, which are exactly the same as the respective ranges for domain IV and III when analysing individual spaces' entropy, which implies that the axial line entropy does not increase the maximum entropy of individual spaces and it can also be similarly low and near zero, if the original spaces also have those low entropy values.

Clearly, both axial line entropy and average axial line entropy vary according to the entropy of the convex spaces that each axial line intersects. If more spaces are accounted which have low entropy values, the average entropy of that axial line will be low. On the opposite, if an axial line crosses space with high entropy, its axial line entropy and average axial line entropy will also be higher.

. Overall conclusion from the nomothetic analysis by Entropy calculations

In a compared analysis of the entropy calculations for both distributions, plotted against the activity allocation of the feasibility matrix, and despite each one's level of complexity, the entropy values are ranked similarly, meaning the highest and lowest entropy are consistent for both analyses and also with the results from the feasibility matrix (Fig. 204).

The following spaces were identified with the highest entropy in both distributions: library, music studio, auditorium, orchestra room and choir room. The least disaggregated distribution also considers the spare space, the teachers' office for meeting students as spaces with high entropy, and the most disaggregated distribution also comprises the main hall and the common living spaces, followed by the spare spaces as well. The feasibility matrix encloses all the mentioned six spaces as the ones with the highest activity allocations, followed by the main hall similarly to domain IV's distribution and also the spare spaces also included in domain III's top distribution.

These conclusions support their similarity overall. Even so, although mostly the same spaces have been identified with the highest results in all three analyses, they have slight differences in the entropy rank, due to the accuracy of the values that go up to 3 decimal places and their grouping together according to the detail of the domains chosen.

The spaces with the lowest entropy are supportive and conceived for a particular activity, such as: the dressing room, the locker room, storage, indeterminate supportive space, the vault, the archive, the kitchen, the kitchen storage, the parent council room and technical areas. These are the spaces with the lowest entropy for both distributions. Similarly to what has been perceived for the highest values, there

are also smaller differences in the lowest values, in which domain III's distribution also includes the reception desk, the ticket office, the restroom and the auditorium supportive spaces. These still have very low levels of entropy for domain IV's distribution, slightly higher than the previously mentioned lowest spaces. In addition, domain IV's distribution also included the administration offices as holding the lowest levels of entropy, identical to these referred spaces, but that rise the entropy rank significantly when regarding domain III's calculation.

All in all, the library has been acknowledged as the highest entropy space for both distributions and, although very high on the feasibility matrix's rank, it is the auditorium that holds the top position with the largest number of possible activities allocations. These results may reflect the school's artistic and regular curriculum, which requires spaces with several features to allocate diverse activities of different nature. In fact, these spaces identified as the ones with the highest entropy hold several features that provide them with the potential to shelter both curricular and extra-curricular activities, group and individual practices, of external and internal uses, and for both formal and informal situations, which fundaments these results.

Under a closer study, the high entropy spaces are larger or medium size spaces that can cater for groups for diverse activities. There is no visible difference between the spaces' entropy when analysed according to their floor plan placement, because the highest entropy spaces are placed on all floors: the main hall, the auditorium, the library, all communal spaces, are on the ground floor; the orchestra room is on the first floor and the choir room on the second floor; and the music studios are placed near the remaining classrooms for the artistic teaching, either on the first and on the second floor.

The fact that these calculations were based on two different distributions, also provided higher values for the most disaggregated distribution from domain IV, which is the most complex and holds the widest activity allocations. Naturally, this difference is clearer between the initial results from the feasibility matrix and the end results from the entropy calculations, because the comparison between the entropy results and the activity allocations can only be regarding the rank of spaces and not the values *per se*, due to the formulation applied.

Anyway, domain III's distribution presents lower overall values in regard to domain IV's. Amongst the results per distribution, often very close, implied to be presented with three decimal numbers for a more well-defined ranking.

From a closer examination on the previous matrices, it can be concluded that spaces that hold the more diverse activities, meaning possible activity allocations in the most diverse domains, are the ones that have higher entropy. Naturally that a more disaggregated distribution, such as domain IV's, has the widest extension of fields to be considered. So, if a space has the possibility of allocating activities from all the detailed domains in the most aggregated distribution, it might not potentially

allocate activities from all domains when they are more and more detailed. So, its entropy could decrease. This can explain the differences between the spaces rank for each distribution. The main hall and the common living space have allocation possibilities in all domains from domain IV's distribution, but the high entropy spaces from domain III's distribution: the spare space and the teachers' office for meeting students, when analysed in the most disaggregated distribution have specific domains where there are no activity allocations which makes their final entropy to decrease significantly.

Another possible conclusion, is that the more diverse the activities and teaching types the space can cater for, the higher the entropy of that space. This concurs with the basic assumption of adaptability as the ability to cope with different uses. In this case, the most spread the uses amongst the all activities sample - as opposed to an aggregation of the possible activity allocations all to a specific domain - the highest the entropy. Ultimately, the most extensive and assorted the activity allocation potential regarding the listed activities, the most adaptable the space is for answering different functional requests.

Overall, the most disaggregated distribution, despite being more complex and holding a more extensive set of possible activities, introduces more detail in the analysis that ultimately may approach the analytical model to a potentially closer outlook on the actual activities that occur in the school. So, it could be argued that the most disaggregated the distribution, the more accurate the results regarding the entropy, because they depict an activity allocation potential that most precisely describes the events of that school, their functional requirements and the spaces' ability to cope with them.

Subsequently, a correlation between the activities in the sample and the entropy of each space produced a scattergram that overlapped the two distributions (Fig. 205). When plotting the activities allocations from the feasibility matrix to the entropy results from the calculations, the distribution is rather similar between the two domains and there have not been noted significant outliers that could diverge drastically from the overall distributions. Both of them start by increasing rapidly with the increment of activities allocations and then they get stationary at about twenty activity allocations. Overall, both distributions are visibly skewed to the left and the tendency for entropy stabilisation is very clear.

This graph confirms the previous hypothesis on the entropy correspondence between both domains, and that the features of the growth trend tend to be similar. But it also provides another central conclusion: whatever the level of aggregation in the correlation between activities and entropy, the entropy tends to stabilise when the activities schedules increase. This can be interpreted in terms of uncertainty: at some point, which corresponds in this graph to about two dozen activities potentially allocated to a space, the increase in the number of activities that can

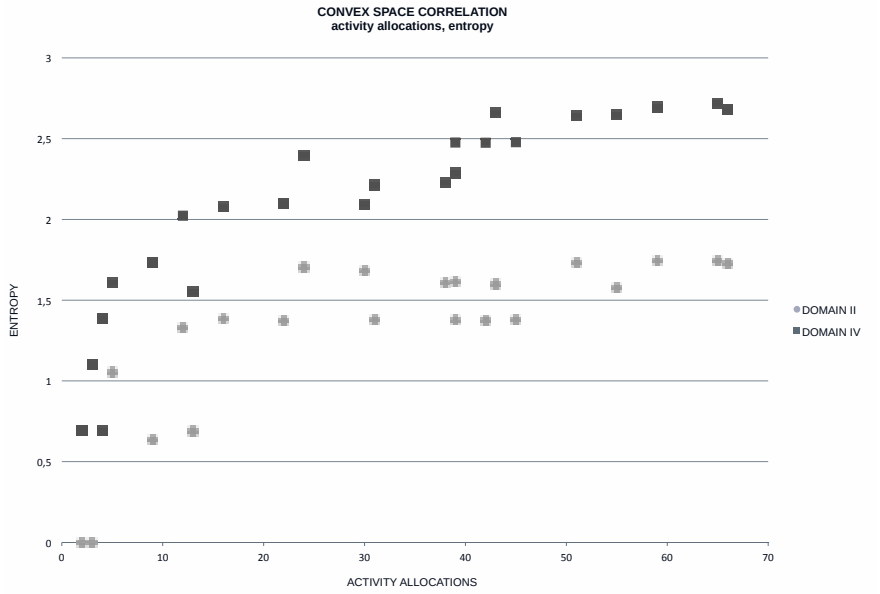


Fig. 205. Correlation between activity allocations and entropy per domain _ Scattergram (Spaces' locations are identified in the school plans illustrated in Fig. 197)

(Carolina Coelho)

potentially be allocated to a space does not interfere with the entropy value of that space, and the probability distribution does not change significantly.

In short, from this analysis what is more significant in terms of adaptability, are the first 20 activities the system can allocate to spaces, and from that point the system is practically invariant.

This could be paralleled to Cowan's (1963) conclusions on the regard of activity allocation per room size (Fig. 206), because it displays a similar distribution when plotting activity allocation against entropy. Cowan demonstrates a stabilisation of the possible activities when the room size reaches an average and from that point on, even if the room increases significantly there is not a proportional extension of the activity allocations, presumably because it relates to more specific uses:

> "If we list as many human activities as possible, starting with the five senses and ranging up to large group activities such as dances and conferences, we may count the number of activities which can be accomplished in various areas of floor space. From these data we may draw a curve which starts at a minimum value of about four square feet, when about ten basic activities are possible, and then rises very rapidly to about 200 square feet, at which point the curve levels off abruptly. After this even large increments of floor space make possible relatively few additional activities. [...]

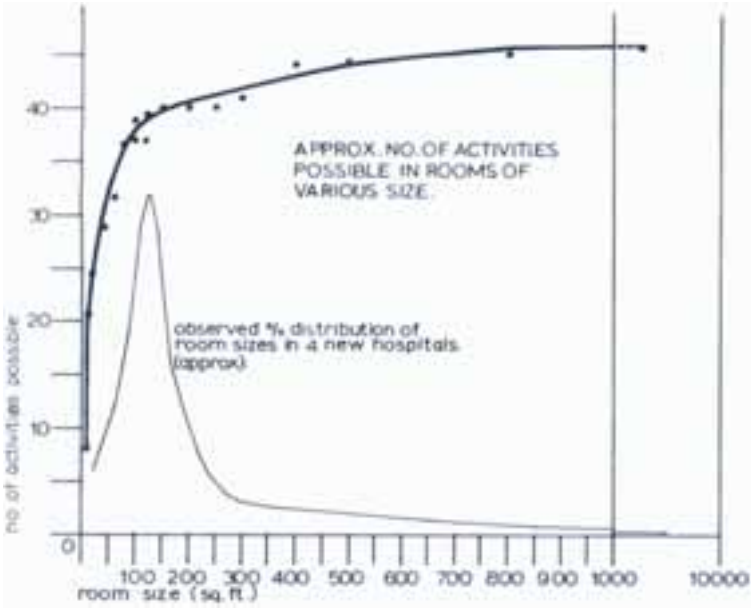


Fig. 206. Distribution of activities per room size
(Cowan, 1963, p.57)

> Of course the exact shape of the curve depends upon the basic list of activities. But we can check the general idea if we count the number of rooms of each size in existing buildings, and plot the results as frequency distributions. Although minor differences do appear, the distributions are all skewed far to the left." (Cowan, 1963, pp.57-58)

Even though Cowan mentions particularly hospitals, this could be paralleled to the school building and to the application in this case study, specifically with the mentioned activity sample. This could also be reflected upon according to the high entropy results of the generic classrooms and music studios of average size. This can again be supported by Cowan, stating that the widest array of activities can be accommodated in average size spaces:

> "Between one-half and two-thirds of the rooms in most hospital buildings are under 200 square feet in area. The largest single group of rooms almost always occur in a very narrow size range, between 100 and 150 sq. ft. [...] Hospitals contain a fairly typical cross section of social functions, and since most rooms in houses are also about this size, it may well be that the majority of human activities occur in spaces of under 200 sq. ft. In addition, it is quite reasonable to suppose that rooms of 150 sq. ft. will serve a very large proportion of human needs." (Cowan, 1963, pp.58-59)

In a real life scenario, this can also justify the effective preference and cost-benefit in using the orchestra room for external performances with a smaller audience and not using the auditorium as much as its potential would initially imply. A potentially higher appropriation and more frequent use of these average size rooms in regard to the auditorium, or a larger room such as the orchestra or the choir room for smaller groups, could also be justified after the subsequent analysis on effective spatial fruition that will complement the description of the building according to its actual use and beyond what it is able to prove at large.

So, the subsequent milestone of this methodology is to analyse whether these results on possible activity allocation portray the actual use of the school spaces and if they are under or over-providing for the current usages they are accommodating. Also information can be gathered on whether the effective and the expected use identified in these plans coincide or differ and why.

This overall, can widen the array of possible uses to others not foreseen during the design, or can constraint their occupancy to a particular function. Observations, focus groups and walkthroughs will then provide data on this regard. Ultimately, in the last milestone of this methodology, these can be correlated with the entropy of each space and conclude on their potential overlapping or divergence between what are the effective activities of the school and where or how is the space complying with them.

4.2.3. Description of effective events and experience in the school

> "The school must be an ever-changing, stimulating environment where there is a lot going on and there are choices to be made, as in a shop where everything is laid out waiting for you. Not only that, children have to contend with other children; they learn to do things together, take another into account, work things out between them, understand each other. This is a great deal more than reading, writing and arithmetic and the school space must encourage it." (Hertzberger, 2008, pp.8-9)

. Datasets and Methods

This stage corresponds to the description of effective events and informs on behaviour and appropriation, holding higher relevance in the artistic ambiance bestowed in this school. This is, in fact, clearly experienced in this case study and represents its specificity, even if the previous methodological milestones, either functional, morphological or nomothetic, due to the nature of these analytical approaches and the abstraction of the conceived models for representing spatial experience, have not entirely depicted this ambiance.

In fact, after a background reflection on experience and sensory fruition made in chapter 1.2[764], it can be considered that this school potentiates a sensory environment, both intellectual and sensitive. Intellectual experiences, such as Plato and René Descartes described them, are often triggered in this building by the prominence of light and matter, most present in the school's main hall and auditorium. Sensory experiences, such as John Locke or David Hume described them, are prominent in an artistic school, since any form of artistic communication triggers the senses in a multi-sensory experience that engages the human being, as Edward T. Hall (1990[765]) considered. Therefore, this school acts as "life-enhancing" example (Goethe *apud* Pallasmaa, 2005, p.44), having the ability to arouse the senses in order to be an active learning, cultural and social environment for the whole community.

So, following the analysis of the physical features of space and the overall potential of each one, this stage intends to realise its effective appropriation, how and by what means do the students use space and why may a space be more often chosen than another one. It also aims to identify the activities that occur in each space, both the ones conceived for it from the start, or the experiences that may be more spontaneous or informally decided by the students, who perceive the spaces' potential to allocate them. Having already considered informality and social activities in the prior approaches, this one intends to determine what activities can be considered on this behalf and where do they take place in the school. It also aims to recognise the knowledge conveyed through social and artistic activities and to identify the effective

[764] See chapter 1.2. Motivation and background: Architecture and Life – conceiving forms of engagement.
[765] Original edition from 1966.

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 207. Description of the methodology and identification of the current milestone III. (Carolina Coelho)

learning environments of a contemporary school that gathers regular and artistic teaching.

Consequently, this final methodological procedure takes a relevant part in the findings on spatial experience and its diversity, and complements the previous approaches. It corresponds to an idiographic approach on singularities, while the latter to a nomothetic approach on regularities (Windelband, 1894)[766].

In fact, this stage depicts three methodological approaches that can be triangulated with the previous analysis on the overall spatial potential of the school on generalities. All three of these procedures consider effective spatial fruition, as an approach to individual assessment, complementing or constraining the overall allocation of activities to spaces according to the actual situations that are verified in the school space. All in all, these three processes aim to inform on the adaptability of this school space, complementing the previous entropy approach that focused on the whole potential allocation of activities to spaces.

This is undertaken by three following procedures. Observation matrices aim to report both the activities and movements on space, as well as their nature and density. These consist of non-participated accounts of *life within the school*. Walkthroughs aim at gathering information from specific target users of space on the research question, in this case, on the spaces considered to be the most adaptable, which may differ or coincide with the previous conclusions taken from the analytical and abstract models. Focus groups complement this information, focusing on this question and accounting for different perspectives and uses of the spatial sample from each group. This represents the moment to pose more direct questions, where some elaboration can occur and further justification on the answers according to personal habits and perspectives (Fig. 207).

Aiming for a wide-ranging account of the living and learning experience in this school, all three of these procedures have implied the gathering of a wide part of the school community, regarding its diversity in people, curriculum and activities.

In fact, appropriation can be recalled at different levels, portrayed by the activities and actions undertaken, either individually or collectively by this particular school community, which is intended to identify and critically analyse who uses and learns within it at this specific time period, by means of the observation of the uses and by direct query to the people within this environment. So, it is relevant to underline that these procedures validate the contemporary usage of this space, which may differ from the previous ones, namely when this school was rehabilitated, but also not proceeding with any speculation on future uses[767]. Thus, the observations and the

[766] This parallel between nomothetic and idiographic has been approached in detail in chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

[767] This justifies the time period chosen for the application of the methodology, specifically pointing out its contemporaneity. See the title of the current Thesis: "Life within architecture from design process to space use: Adaptability in school buildings today – A methodological approach".

findings through these surveys report to people's current activities and movements in space, subsequent to the school's spatial and curricula change.

All in all, the three procedures undertaken in this milestone intend to add further information on space use in a real life scenario, in order to complement the data from prior milestones of this methodology for identifying and assessing adaptability. Therefore, all three of these procedures are directly associated with assessing how effectively adaptable are Quinta das Flores School's learning spaces and how do their users perceive them in such a manner. So, more than assessing space use, these intend to inform on adaptable spaces for a wide diversity of uses and users, hence their specific definition and framework within this methodology.

At this point it is paramount to justify that the population for each of these three procedures is representative for the purposes of this research. As seen, the first procedure undertaken in this milestone consists of observations of users in space. There, the observed population is, in fact, the entire "universe" (Bryman, 2008, p.168) of people in the school. So, there is no sampling[768] or selection of the individuals whose space use is reported onto the plans, because it coincides with the whole population. Moreover, the observation process consists on observing and recording the movements of all the individuals that use that space, so the plans of each observation actually show the use that the space has in terms of density and types of fruition of the entire population in that space, regardless of the profile of each individual in the school. The most tangible case to exemplify this situation is the main hall of the school, which is the common entrance to all the people who are inside: students, teachers, parents, staff, ... Thus, the observation in this space immediately denotes all its users and what their uses are within this space.

As for the remaining two procedures for describing experience in school, these are more specific for the proposed methodology and hence, more particularly focused on spatial adaptability. Indeed, after an initial procedure that describes effective experience by means of observations, these two processes: walkthroughs and focus groups, seek to question the users of the school in relation to this particular research.

Since there is a higher specificity of these two procedures towards spatial adaptability, these focus on the users for whom the issue of spatial adaptability is more relevant, which are the students and teachers, because they are the active users of the active learning environments. Hence, and opposite to the observations of the whole population of the school, both walkthroughs and focus groups are undertaken by a sample of the population, considered to better inform on the effective space use of the active learning environments, how diverse it is enabled by spatial provision, and how varied it is actually perceived through effective use.

[768] According to Groves et al. (2004, p.45): "A sample is selected from a sampling frame. This sample is the group from which measurements will be sought. In many cases, the sample will be only a very small fraction of the sampling frame (and, therefore, of the target population)."

As already depicted in chapter 3.3.[769], where this milestone of the methodology has been described in detail, the sampling process for these two procedures could be selected by different approaches to sampling, either by a "probability sample" (Bryman, 2008, pp.171-176) or "non-probability sampling" (pp.183-187). For this approach the selection of the population has lied on its representativeness for the learning process, also guided by the "reliability" and "validity" of the results (Bryman, 2008, p.149). Hence, it was considered that both students and teachers, either of the regular and the articulated teaching, would better report space use in regard to formal and informal learning that the school environments might comprise. So, focus groups and walkthroughs have been undertaken in subsets of population arranged by "cluster sampling" (Groves et al., 2004, p.102)[770], gathering the participants by "groupings or aggregations of population units" (Bryman, 2008, p.175).

In this case, and similarly for walkthroughs and focus groups, the above criteria support four profiles of participants, as it will be subsequently explained. As seen, the nature of the activities proceeded in this school, as well as the teaching regime taken on by each student, enable to consider groups of users with common profiles, even if more individual in-depth information on spatial experience and fruition may be retrieved further on during the focus groups, which complement collective findings from the observation matrices and more comprehensive remarks from the walkthroughs. All in all, educators and students can be conceived as two major groups, described in more detail according to their teaching regime: articulated (where students have both regular and artistic classes altogether) and regular (for the students whose curriculum is deployed of the conservatory classes). In each of these teaching regimes, students represent an extensive group, whose ages are wide-ranging from the basic to the secondary levels. This has also been taken into account for the teachers, and both the walkthroughs and focus groups conceived aimed at presenting that diversity in curricula and age and have been formed with educators from different study areas. Other focus groups could have been arranged, but the cost-benefit in proceeding with a more complex set of information to process and also with all the background agencies to implement, like asking for the Directors and parents' permissions and fostering more contacts for volunteers in this process, has led to conclude on the following 4 focus groups and 4 walkthroughs with:

. teachers of the regular teaching

. students of the regular teaching

. students of the articulated teaching

. teachers of the artistic teaching

These are considered to present the learning community more directly and are also the more representative profiles in the school. Students from the supplementary

[769] See chapter 3.3.3. Description of effective events and experience in the school.

[770] Also according to Groves et al. (2004, p.70): ""Clustering" is the term used when multiple elements of the target population are linked to the same single frame element."

regime[771], the ones that attend artistic lessons after the regular teaching schedule, have not been considered to be as representative, because by not attending a whole day of classes these students have a potentially narrower perspective on space, arriving straight for a particular class, leading a very driven pathway to get there and leaving the conservatory afterwards, which deprives them from a wider perspective on the diversity of collective spaces and foremost of collective activities.

Although neither the staff, nor the parents, have been asked to participate on focus groups and walkthroughs, they have been accounted for when asking for their feedback in informal interviews, whose information has been introduced when considered relevant and their presence has been taken into account on the observations, when they were remarked to be within the building. Generally, parents of the students of the regular teaching do not normally have a routine or pathway within this building, leaving their children outside. Hence, their feedback is more relevant to report on their children's experience and learning process and also on the school's curricula, but not specifically on their individual experience in space.

There has been the opportunity to ask questions to the staff in each of their respective workstations on the school space analysed and their activities have all been identified in the observation matrices, along with all the community perceived during the time periods observed. Staff has a particular pathway that is specific of each one and that leads to his/her own workstation, making each report very individually focused and not collective, or with a wider perspective on the whole space. Even so, staff has been asked questions whose information has been translated onto the findings, as well as the parents' feedback on the school space.

In what regards the parents, conversations have occurred with them concerning the learning process of their children in the school, the external and community assets of this school in particular, and the curriculum changes introduced in this school, to which the generality of the contacted parents have responded very positively. It is very important to highlight that the wide majority of the students in this school are under-aged, and therefore, contacts had to be made in order to inform the parents of the context and the activities that each of the students in the focus groups and walkthroughs was intended to do and their purposes. This naturally triggered individual conversations with each of the parents whose children have participated more directly in the last two procedures, concerning the school and their feedback on the context of this current research, which has also been invaluable[772].

Also within this topic, personal information from all participants has been safeguarded, not only from the children involved but also from the teachers, staff and parents, according to the indications for individual data protection. This is most relevant on the focus groups and walkthroughs, whose contents will present

[771] From the Portuguese "supletivo".

[772] When considered relevant some of this information may be presented, but naturally that personal e-mails exchanged with the parents as well as personal or phone conversations are not disclosed, safeguarding the informality and personal contents of each conversation.

the information needed for the purposes of this research along with all the input brought from individual experience, but without the identification of the students involved. This has been a personal and professional commitment taken from the start, and shared with the School and the Conservatory Directions and also with all the parents involved. Analogously, all the visual and audio contents are deployed of personal data and have, therefore, been edited to focus on the activities portrayed rather than on the individuals who portray them. It is considered relevant that the activities are reported on photographs and videos, as well as its density and frequency, but without identifying the students who undertake them.

The materials for this procedure have been gathered from the initial contacts with the School and Conservatory Directions from the beginning of this research, under the form of interviews, observations and photographic, audio and video records, but it has reached the highest peak during the observations, walkthroughs and focus groups done throughout January and February 2017.

Naturally, Portuguese schools today have high levels of control on their visitors and the activities that occur within them. So, this methodological approach took an extensive time in formal and informal contacts with the Directions, teachers, students, staff and parents, in order to get their approval for undertaking all three approaches, and particularly in arranging for volunteers for the walkthroughs and focus groups from different profiles of users of the school community.

First and foremost, observations, walkthroughs and focus groups have then been authorised by the Directors of the Music Conservatory - Professor Manuel Rocha and the Director of Quinta das Flores School - Professor Margarida Marques, whose invaluable contribution is once more stated at this point of the research. After these frequent contacts for contextualising the research and for proving the relevance of the proposed procedures as valuable input for our conclusions, the approval has been given for entering the building in prearranged schedules informed to the Directors and also for progressing with the procedures previously explained in detail. During all the time spent on the school, and besides previous contacts from the Directions, dialogues with teachers, students and staff have also facilitated the observations and surveys in a more supportive manner.

Besides, all the school community has been widely open to the procedures, namely the staff on each of their workplaces in the building, who have been very diligent in elaborating on their routines on the school. Regular teachers have also been contacted for volunteering on both the walkthroughs and focus groups, to whom we have again to thank for their time and contribution. Artistic teachers have been contacted by the Direction of the Music Conservatory, under its Director at the time Professor Manuel Rocha and Vice-Director Professor Catarina Peixinho, who have always been remarkably accessible and attentive towards this research. The students and parents from the artistic and regular teaching have also volunteered for the recalled tasks, after acknowledging its context and the relevance of the children's participation. The Student Association of the Music Conservatory has also been contacted, after the approval of the Conservatory Direction and

Fig. 208. Observation matrices, 3rd February 2017
(Carolina Coelho)

the parents involved. To them we recognise their consideration in answering this request, and their motivation in volunteering to participate, and we thank again the feedback provided and also the photographs that have been kindly shared, depicting the activities prior to these procedures.

Each of the procedures will be detailed and subsequently critically analysed, but at this point it is important to note that each one provides specific data under the form of a particular set of records, drawings and accounts.

Observation matrices aim to depict activities and movements in the time periods considered to be most noteworthy. This has been done by a team spread around the whole building in also representative spots considered to be, at front, locations with the highest amount and variety of users and activities. Findings are reported on plans where each observer, in each day, for a particular location and time period, registers the movements and the activities remarked and their density during those times. These findings provide general information on collective uses and locations, associated users, density of people in each location, the nature of their activities, the movement in those spaces and in which time periods each activity is more frequent and whether it differs according to the day of the weekly schedule or along a regular school day.

Afterwards, from the initial drafts complemented with the field notes that register the observations on location, results are critically assessed and redrawn in a final plan of each observed space that congregates all the findings. This is particularly relevant for locations where there is the need to have more than one observer, because of the amount of activities and the length of the observed spaces. For example: the main

Fig. 209. Walkthrough, 3rd February
(Carolina Coelho, Jéssica Barreto)

hall or the long longitudinal corridor on the first floor cannot be observed only by one person because they allocate several activities and users simultaneously, which is very difficult to note and draw on the plans in a detailed manner by only one person, having to be complemented by a set of more than one observer (Fig. 208). In cases such as these a final plan gathers all the information from that time period in one drawing that discloses all the data from the collective of observers on that location.

Subsequently, walkthroughs aim to travel through the building in a route chosen by the participants, according to the research question for identifying the most adaptable spaces (Fig. 209). The participants choose which spaces to go through and justify their choices along the way. Naturally that each separate group of users may have a different account on the spaces considered to be adaptable, according to their own experience in space. The reports on this procedure are done by drawing the routes in a plan and identifying the spaces considered to be adaptable, which are ranked graphically on that same plan. Finally, a plan can be arranged with the joint findings from all the separate groups that have volunteered for the walkthroughs. This procedure is also registered by audio, video and photography, and by notes from the comments made by the participants in the meanwhile, taken by team members.

Finally, focus groups gather more individual information from the participants, by asking them more personal questions on their activities in space, namely curricular and non-curricular, artistic and regular, programmed and non-programmed events and their more frequent locations. They are also asked to identify adaptable spaces on plans provided to each participant and to point out their normal routine and movements on a regular school day (Fig. 210). This will provide a more

Fig. 210. Focus group, 3rd February
(Carolina Coelho, Jéssica Barreto)

comprehensive outlook on each profile of users and the way learning happens in the school, where and how it occurs: collectively, individually, informally, formally, programmed or spontaneously… These reports have also been registered by audio, video and photography, but once again individual details and personal identities have been edited in order to safeguard personal information.

The references on the state of the art of social research methods considered more transversal to all of the following three approaches will be analysed in detail prior to their undertaking. The others, considered to be more specific of each of the approaches: observations, walkthroughs and focus groups, will be referred and its relevance analysed in the duly place prior to the procedure, and at the end when paralleling the conclusions from those studies to the findings achieved by the current establishment of this methodological approach in Quinta das Flores School's main building.

The fact that the prior chapter[773] does not point out a specific way in which these procedures will be portrayed for the description of effective events and experience in the school has been intentional. The contextual framework of each of these three methods, namely on the number and grouping of the participants, the best time period in which to undertake them and the interval in which they would be done and their frequency, has been decided after a thorough understanding of the case study. This has been done after the previous descriptions of its potential activities that will be compared to its actual spatial fruition, and also after the earlier visits

[773] See chapter 3. Construction of the methodology.

and contacts that have enabled their undertaking. Note that all these procedures imply a carefully anticipation of the intentions and their exact establishment, in order to explain them to the Directions of both the Conservatory and the School when asking for their permission, the acquaintance of the parents and their direct contact and official written authorisation for the children's participation, and all management and logistics deeds that have to be cautioned for making it possible, namely arranging a common schedule for all groups and the spaces for undertaking these methods. This has only been possible to be achieved after a number of visits, the contacts with the most different social actors of the school community and after providing them with detailed explanations of the context of the research and the exact procedures to be done. But previously, all methods have had to be well lined up and defined in sequential stages, number of volunteers needed and time schedules, in order to explain them to all the people involved.

By acknowledging that spatial fruition is an essential stage of the methodology here proposed, the way in which each method would be applied has been constructed throughout the process. Even though the intention to depict the activities and movements on the plans of the school had already been recognised, as previously explained in chapter 3.3., the bibliography informing on the specificity of these procedures is here explained, closer to their actual undertaking in the case study, because of its possible diversity in scope, framework and purpose, intended to more acutely address the specificity of this school.

On the contrary, the entropy analysis has been explained in further detailed beforehand[774] because it followed a very specific approach by Fawcett and aims at continuing it further on, according to the complexity of this case study.

Additionally, the space syntax approach to the case study is also guided by a very well-defined framework, whose main references are straightforward and lie in Hillier and his colleagues earlier works from the RIBA Intelligence Unit and, later on, at the Bartlett.

These latter two methods provide very clear findings that will inform the methodological application onto this building. Social research methods, on the contrary, as open-ended as they are, have to be considered according to the aims of the analysis, chosen from a wide array of possible approaches, and its references are, therefore, presented closer to its establishment, to better frame the contextual approach of this case study and to critically comment on the results perceived and on the assets that each technique brings to the overall conclusion on spatial adaptability[775].

Hence, it is noteworthy from the start, the relevance of the surveys undertaken and coordinated by Lynch in Argentina, Australia, Mexico and Poland, supported by Unesco and published in *Growing up in cities: Studies of the spatial environment of*

[774] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[775] According to Lynch (1977): "Rather than elaborating the study, we should aim to abbreviate it while still permitting local elaboration according to interest." (p.59)

adolescence in Cracow, Melbourne, Mexico City, Salta, Toluca, and Warszawa (Lynch, 1977). This represents a very influential study on the state of the art on the methods to depict children's behaviour in space, that also resorted to observations, interviews and tours, registered both in photos and videos, as well as in sketches and field notes, for indicating the remarks observed and the imagery of the children. These methods aimed at examining "the way small groups of young adolescents use and value their spatial environment" (p.1). This is considered to be of the utmost relevance for our current research, despite being still rather underdeveloped in 1977:

> "Even these few studies bring out poignant indications of the relations of children to their surroundings. In doing so, they convey the color and substance of social conditions that are usually summarized in a more arid and general form. However uncertain the findings may yet be, they reverberate in the mind, and suggest new techniques and new occasions. Open-ended, naturalistic studies of how people use and value their spatial surroundings are in an early stage. The values of children have been particularly neglected." (Lynch, 1977[776], pp.1-2)

Largely, these surveys bear relevance for the methods here proposed for depicting children's actual use and perception of space, reflected upon later on the "revised guidelines" (pp.81-104) for undertaking them, as well as the graphic supports for recording and communicating the outcomes. But, from the start, Lynch assumes that these procedures are crucial for the design, which brings added originality for this study and convenience for its reference at this point of our study, focusing on social research, the methods to accomplish it and its relation to the conception of the built environment: "Planners, designers, and environmental managers will have to became more concerned with children's needs. Observation and research should be a part of the design process." (Lynch, 1977, p.57).

Lynch also supports that the definition of the procedures should be elaborated according to its locality, even if general guidelines are presented at the end of the book:

> "[…] This determination can only be made on the ground. What we would hold to is that the study should deal with the way children use and value their settings and that it may be made via open-ended dialog and observation, dealing in depth with a small number of children in a restricted locality, and if possible, producing some experimental evidence concerning the relevant perceptual clues." (Lynch, 1977, p.60)

And despite its potential simplicity, it holds relevance for the definition of children's environment: "Simple and modest as these studies are, we feel that they will prove crucial in managing the human environment of the future." (p.80).

For our current research some of these guidelines will also be set forward, despite the indoor nature of our case study, which is a school building rather than the city

[776] The first part of the book published in 1977, from pp.1-80 is dated from 1975 and signed by Kevin Lynch, the remaining text is not dated nor signed and the book itself is referred to have been edited by Lynch.

surroundings overall, mostly in regard to the "revised guidelines" (*ibid.*), such as: the "choice of areas" (p.83) to be most representative, the "selection of subjects" (pp.84-85) to volunteer for providing significant input for our study, the search and study of "background information" (pp.85-86) on this particular case study, and finally the "analysis of children's spatial behaviour" (p.88).

According to Lynch, these surveys "consist of several actions to be carried out in this sequence: (1) making an acquaintance with the interviewees, and becoming familiar with the area and their mode of life; (2) individual interviews; (3) optional group discussions and guided tours." (Lynch, 1977, p.88). For this case study, the relevance of these early studies is taken into high account, but also the understanding of its differences in spatial and time context, as well as in its scale.

Naturally that the mentioned "acquaintances" will be undertaken, prior to the observations. Several individual interviews will also be prepared, particularly to the Director of the Conservatory and to the Director of the School, as an early account of the school's ambiance and its physical and pedagogical features, in order to better introduce the following surveys. Then, interviews to students and teachers will also be fulfilled, individually but foremost collectively, in the form of focus groups, where each group, duly balanced in gender and curriculum options, will explain in deeper detail the general behaviour perceived in the school and the specificities of each individual or group of users. The referred "tours" (Lynch, 1977, p.93), optional as Lynch considered them, will also be carried out in the walkthroughs, as the defined groups will be asked to display the school and explain their behaviour in space, particularly applied to this current problematics on their thoughts on the most and least adaptable spaces. "Observations of children's spatial behaviour" (p.95) will also be vital for depicting the collective fruition of space[777].

So, all in all, the techniques pointed out by the researchers' teams in 1977 in different countries, will be put in place, although the sequence for analysing this case study in particular will be carefully set in the following sequence: observations for depicting the general behaviour, perceiving groups of users and activities in space; then walkthroughs will be completed for understanding each group's perception of adaptable spaces during an open tour of the building under analysis; and, finally, focus groups will be formed to explain the details on the choices of the spaces shown on these tours, to clarify the results from the observations and also to complement this information with certain specificities and with sketches and diagrams indicating the individual activities and pathways by each volunteer, closer to Lynch's approach on the "image of the locality". It is believed that this sequence, as established, will gradually provide insightful information on the children's use of space and on adaptability.

[777] Observations are explained to specify the activities by registering them "on a simple diagram supplemented with verbal notes and one or more photographs". (Lynch, 1977, p.95). This will be undertaken in the observations, where sketches over the plans will be complemented with photos and videos of the activities and movements in space, as well as field notes that inform more profoundly the experiences observed, routines and their exceptions.

4.2.3.1. Observation matrices _ Idiographic analysis

. Justification of the observations

The observations derive from the need to assess effective spatial fruition of the common spaces of the school, with particular emphasis on potential active learning environments, in which the frequency of movements and users is *a priori* considered more representative. The purpose of these observations is to register the movements, directions and accesses to spaces and to identify the activities undertaken whether pedagogical, social and/or artistic.

It is noteworthy at this point to state that, even though observations can be a part of other research approaches such as social sciences, they are also considered amongst the field of space syntax, previously addressed, in order to "retrieve something that might be considered as an objective view of human behaviour in the built environment" and to "observe movement flows and patterns of space usage in complex buildings or urban contexts" (Sayed, Turner, Hillier and Iida, 2014, p.39). This bears representativeness when analysing space use because effective use may differ from the potential of a building, or from the intentions of the architects.

All in all, observations are used within space syntax to provide information from the collective patterns of movement and activities, so as to "retrieve something of the objective properties of the built environment" (Vaughan and Grajewski, 2001, p.2). Foremost observations under this approach lead to collective inputs on behaviour and flows, and "generate numerical data on space use and movement" from which morphological features may be associated, understanding a potential correlation (Vaughan and Grajewski, 2001, p.17)[778].

Specifically, space syntax resorts to a set of techniques for this purpose such as: the gate method, static snapshots, people following, directional splits and movement (Vaughan and Grajewski, 2001). Some of these procedures can aid to establish some of the principles for our current methodology, assuming its specificity and the aims for undertaking it. Similarly to static snapshots (Fig. 211), this current methodology also focuses on "predefined areas" where observers map movements and "static activities" and respective "categories" onto the plans and by the notes taken during this process, which is repeated throughout the day and intended to "outline the patterns of space use in an area and spot the locations where more potential interaction takes place naturally" (Sayed, Turner, Hillier and Iida, 2014, p.42). This current approach has similarities in the process and its purposes, because static snapshots are also "especially relevant to recording the use pattern of spaces within buildings" (Vaughan and Grajewski, 2001, p.7). Besides, the graphic material that results from it is similar both in the representation of movement and the

[778] According to Vaughan and Grajewski (2001): "The most important is between integration and encounters (observed use and movement). […] This is because integration is an independent measure – it is the integration value of a space that can produce the people […] but the presence of more people cannot make space more integrated." (p.17)

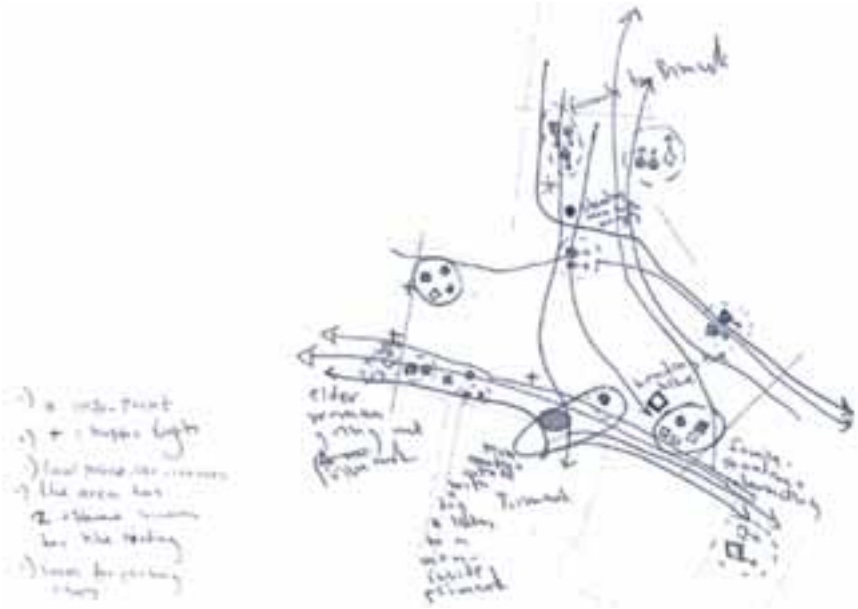


Fig. 211. "Movement traces and static activities are drawn on a 1:50 plan of the target area. Notes on behavioural patterns and special features and conditions are recorded. © Screens in the Wild @UCL." (Sayed, Turner, Hillier and Iida, 2014, p.42)

differences amongst activities, added by the commentaries aside.

Likewise, movement traces have also similarities with our procedure, foremost in its purposes because it "enables tracking and mapping the collective flow dynamics through a predefined area" (Sayed, Turner, Hillier and Ida, 2014, p.43) and it is also frequently used with the static snapshots (Vaughan and Grajewski, 2001, p.12). Overall, these procedures intend to identify movement and "static activities" in space, but they are chosen according to the aims of the research.

For our current methodology, it is important to acknowledge the specificity of the case study as a building with a diverse array of users and activities, and the actual objective of proceeding with the observations which coincides with the need of an actual and sensitive knowledge on programmed/non-programmed, social/pedagogical/artistic, informal/formal, individual/collective behaviour and movement in space, as well as the users and/or visitors who undertake them.

Observations, for the purpose of our current research, are used to complement previous methods already undertaken, on the physical features of space and their analytical potential to allocate activities. Observations will then comprehend space's effective fruition, identifying patterns of co-presence and natural movement, realising also the activities taken, the density in flows, but in a more detailed manner, than the five minutes suggested by the previously referred procedures. So, it can be detached from space syntax and also be approached to social sciences, with regard to the interest in getting acquainted with individual reports to space and social

interaction. Still, this does not imply the "participant observer" of the ethnographic observations, usually pursued in social sciences, because it is not intended that observers move in the space in the same way as the reported users, instead they are intended to report the effective spatial fruition in a comprehensive way.

The fact that observers stay in the defined areas for thirty minutes in each of these observations, and that this process is repeated throughout the day and in several days, allows a more in-depth knowledge of the users, a more detailed identification of the activities in a fine-grained analysis, related to an overall experience of space, in a qualitative and wider sense than the quantitative report on use. Ultimately, due to this more comprehensive understanding of the reality, it will not only focus on quantitative information, collective patterns or the highest densities for correlating them to space. Overall, if a thorough acknowledgement of space is undertaken, then a critical assessment on the activities and movement is possible, associating them with the quantitative, but also with the cultural and social dynamics in space, and correlating those findings to each of the observed areas.

Furthermore, in this case, space and experience are thought in a bounded way, in which space may constrain and/or facilitate people's movement and behaviour, but cyclically people are expected to be appropriating space. Ultimately, even the choice of their activities and respective locations may be a generator of a higher density of inhabitants and/or visitors in a certain space, as also activities may be considered a social/pedagogical/artistic aggregator of people, despite their integration or connectivity in the building. If this is the case, then the adaptability of a space to different activities may not necessarily be highly correlated to morphology, as to users' spatial fruition.

Another state of the art reference on observations is Whyte's (1980) *The Street Life Project* started in 1971 with the analysis of New York city parks. This study is particularly relevant because of its novelty in observing city spaces:

> "At that time, direct observation had long been used for the study of people in far-off lands. It had not been used to any great extent in the U.S. city. There was much concern over urban crowding, but most of the research on the issue was done somewhere other than where it supposedly occurred." (Whyte, 1980, p.10)

Even though the study focuses on city spaces and starts with the plazas, it brings relevant conclusions that could be paralleled with the findings from these observations in matters such as sitting spaces, densities, movement and standing locations, which will be deepened further on in the conclusions of our approach.

Naturally that cultural and contextual issues will have to be recalled, because of both the time and location of these studies. Additionally, Gehl's findings (2011[779]) "related to the meetings of people in the public spaces" (Gehl, 2011, p.7) will also

[779] Consulted edition from 2011, original edition translated to English from 1987.

be relevant to analyse in his initial studies in North Europe, which are contemporary of Whyte's American cities from 1971[780]. In fact, on a foreword written in 2006 to the consulted edition, Gehl (2011) recalls that this continues to be a significant topic on the need for environmental quality in regard to public spaces, supporting the importance of our current research and also the appropriateness of both of these authors to its state of the art:

> "These intervening years have also shown that careful work with the livability of cities and residential areas continues to be an important issue. The growing intensity, with which high quality public spaces are currently used around the world, as well as the increased general interest in the quality of cities and their public spaces, emphasizes this point. The character of the life between buildings changes with changes in the society situation, but the essential principles and quality criteria to be used when working for human quality in the public realm have proven to be remarkably constant. (Gehl, 2011, p.7)

Still, an initial connexion to Whyte's comments may already be assumed, acknowledging the interest on observations that take in people in space, from which photographs may be deployed of (Whyte, 1980, p.22). This has also been clearly anticipated by means of our current research that assumes the relevance of studying people in space as a means to better and more fully understand how, when and by whom are the school spaces occupied, concluding at the end of these observations what Whyte had formerly perceived:

> "Whatever they may mean, people's movements are one of the great spectacles of a plaza." (Whyte, 1980, p.22)

. Observation locations and timings

The sampling of spaces for our current approach to observations is also representative, because the spaces in which to place the observations are the ones considered to be the most attended spaces from the spatial sample. Thus, the initial spatial analysis at the beginning of this methodology[781] has also contributed for this choice, considering the spaces where both the artistic and the regular teaching would meet, the spaces with a wider array of informal and social activities rather than formal ones, but foremost the spaces that have the potential to gather moving and staying, formal and informal events, programmed and non-programmed ones, all with learning potential. This considers that the wider the array of activities the spaces have, the more representative towards spatial adaptability, as defined by this research[782]. From this analysis, and also, from prior visits to the school and the feedback of both the Directors of the Music Conservatory and Quinta das Flores

[780] Even though the translation of his book to English happened only in 1987.

[781] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

[782] See chapter 2.1. Adaptability: definition and adjacent concepts.

School on the school's living experience, it has been concluded that the spaces in which to proceed with the observations would be the following, amongst the three floor plans analysed:

. the main corridor of the second floor
. the main corridor of the first floor
. the main hall of the ground floor
. the library on the ground floor
. the cafeteria on the ground floor
. the canteen on the ground floor

These have been identified in the plans, their boundaries specified so that the observers would understand the spatial perimeters of their areas and the placement of the observers has been indicated, even if movement is accepted so that it completes the information observed from these particular spots. Fig. 212 indicates the observation areas, distinguishing them by colour and pointing out the suggested observers' placement by red dots. These red dots will appear in all the plans reported from each observation.

It is noteworthy, as it has also been emphasised in the initial spatial analysis, that the corridors have specific niches in which standing activities may occur, which leads to an *a priori* possibility that the analysis on these areas might be denser and more complex, both on the trajectories but also on the activities that these can shelter and because both corridors have different layouts.

Each observation takes 30 minutes and regards the time intervals that have been considered to be the busiest, and in which most of the school community attends these spaces, of which:

. 8.00 a.m. / 8.30 a.m.
. 10.00 a.m. / 10.30 a.m.
. 1.30 p.m. / 2.00 p.m.
. 5.00 p.m. / 5.30 p.m.

Their specificity is justified by the school breaks between classes, when students, teachers and staff have to move around from classroom to classroom, or to the teachers' offices or meeting rooms, or even to a communal space such as the cafeteria, the canteen, or even to the library.

Specifically, the first observation intends to register the community arrival at the school and to identify the first movements and activities in space prior to the classes. This has particular emphasis on the school's main entrance and the building's accesses to the existing pavilions where other classes are taught, but it also regards vertical and horizontal circulations within the building that lead to the spaces under observation, identifying their main chosen accesses and exits.

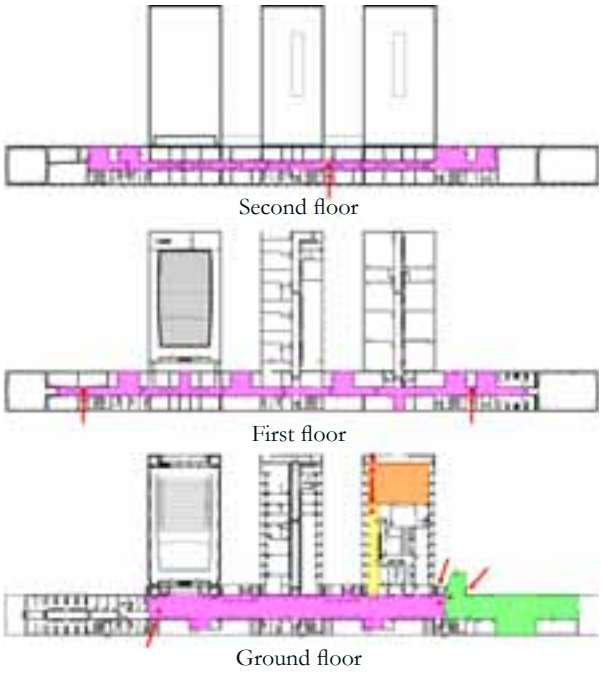


Fig. 212. Indication of the observation location by floor
(Carolina Coelho)

The following observation intervals are related to the school's main breaks, which occur respectively at 10 a.m., 1.30 p.m. and 5 p.m. Observations will start at the beginning of the break, they will last the all break and will continue on during an additional 15 minutes afterwards for accounting for any delays after the break for students and teachers to arrive at the next class. This implies that activities and movements may change during this time period.

The final observation later in the afternoon has been considered to register the arrival at the school of the students from the artistic teaching that do not attend Quinta das Flores School's regular teaching. Being a time period later in the afternoon, some students, teachers and staff may be remarked to leave the school for the day, regardless of the extensive school day of the conservatory that ranges from the first class at 8.30 a.m. to the last class at 7.50 p.m.

Generally, observations have been determined by a team of eight people displaced on the building according to the observation locations as follows: two people in the main hall, one in the library, one in the canteen, one in the cafeteria, two in the main corridor of the first floor and one in the main corridor of the second floor. The number of observers has been determined by the *a priori* expected densities of movement and diversity of uses; the overall area, configuration and length of each location; the general visibility that it enables and that each observer has from a specific point on that space. Specifically, areas with more furniture or niches need more observers, as well as locations with higher densities, that imply more notes and a more extensive and detailed report on space use.

The corridor on the first floor has two observers because it has a joint community of users from all the teachers that go to the teachers' offices, the conservatory community and the science labs' students, teachers and staff. This explains the need for two people to perceive its spatial fruition. This is also justified by the numerous niches adjacent to the corridor that need to be accounted for in terms of activities.

On the second floor, the density of movement and activities is expected to be less because students and teachers are generally driven from the vertical accesses to their respective classrooms, possibility with less spatial experience on the common spaces to report than on the first floor. This justifies the indication of only one observer on this space.

It is significant to explain that the indication of two observers on the main hall has been rearranged according to the time schedules for two determining reasons: the first lies on the fact that two people may sometimes not suffice for reporting all movements and activities that occur there, in particular in high-density time periods, such as the morning arrival when all the school community enters through the same access point and uses the main hall to get to each one's destination, and the mid-morning and mid-afternoon breaks, used for moving from a particular place to another in the school for particular tasks like accessing the library, the cafeteria, the toilet, the staircase, the secretariat,… and for staying activities in that place, which gather a very significant amount of teachers, staff and students whose activities, for their diversity and placement on the whole length of this space, are difficult to be perceived by only two observers. Another reason is that at the morning arrival the library is closed and on the afternoon break the cafeteria is already closed as well, so, these remaining team members help observing the main hall's fruition. At the same time, the canteen is only open at lunch time, and so the person designated for registering that experience is dislocated to the main hall on the remaining time schedules.

The time sample is also representative and not skewed because the observation days do not report any disruptions from the current school days. In fact, in one of the initially planned observations days there has been a strike and, hence, it was decided not to include it on the general findings because it did not report the actual routine of space use. Keeping in mind that the Portuguese school year is arranged by three terms and that each term is organised in months and weeks, the school schedule is established by weekdays, with possible variances between them. So, the choice for observing the school space in different week days enables a wider understanding of the whole functioning of the school and how are its spaces experienced through the week by the population.

Furthermore, the selection of several time frames amongst the whole observation day is also justified by the aim to more fully describe the school's uses and users, that could be narrower or selective if the observation times would be lesser or specific of only a part of the day.

In fact, the choice of four observations per day is highly relevant in this school

whose functioning differs from the morning, to the afternoon and to the evening, according to the intensity of uses from the regular, articulated and artistic teaching. Indeed, the supplementary students of the Conservatory only have classes in the building at the evening, whereas at that time the regular teaching students have ended their classes. This fact changes the uses at this time of the day to intensively more artistic ones, while during the remaining part of the day they are potentially mixed between all the students from the diverse curricular options of the school.

Therefore, the time sample is intended to be representative, by extensively remarking the functioning of the school throughout the whole day: from the morning arrival of all students, teachers and staff; to the mid-morning break where the population has more time to collectively meet; to the lunch break that is open for all; and finally to the afternoon when the regular teaching students, teachers and staff leave the school and when the artistic community of students, teachers, staff and parents gather around more specifically. Furthermore, the fact that observations have been made in different weekdays, also intends to widely report space use in the different ways arranged by the school schedule, better depicting experience and effective events in the school, being representative and providing more robust information able to be valid and generalised (Bryman, 2008, p.168)[783].

Specifically, the first day of observations, 23rd January 2017, has served as a test for validation of the procedure to recognise the activities and movements in space, to represent them onto the plans, to assess whether the plans provided to the observers were the most adequate, to validate the adequacy of the captions for categorising the activities, to evaluate the uniformity of the drawings, to corroborate the locations and the amount of observers and their placements per space and, finally, to consider the representativeness of the time periods chosen for the observations. After the first full day of observations, it was concluded on its appropriateness towards the aim of this procedure. Additionally, it was also established that a further and more detailed account on each observation period in each location could complement the iconographic representation on the plan, specifying the activities and explaining their relevance and frequency. This procedure would allow not just the comparison of the drawings by the representation of the different types of activities and the density of movement, but could also provide a more detailed depiction on a qualitative background that would promote the subsequent critical analysis of the findings on all the observation days after its overall realisation.

The first two observation days took place on a regular school week. They occurred respectively on Monday 23rd January 2017 and on Wednesday 25th January 2017. The fact that this week relates to a regular school week implies its regular functioning and the apprehension of the overall habits and routines of its users. Monday also corresponds to the first day of the week, which might imply a more socially engaged

[783] According to Bryman (2008, p.156): "[…] we will want the sample to be as representative as possible in order to be able to say that the results are not unique to the particular group upon whom the research was conducted; in other words, we want to be able to generalize the findings beyond the cases (for example, the people) that make up the sample."

day, on meeting the peers and discussing the previous weekend and that week's pedagogical and social prospects.

The second observation week happened on an exam week, which was on the mid-term week, when tests were frequent amongst the students. Despite being a regular week within the school term, it possibly holds more studying activities, which are expected within the school year. Still, this differentiation on the weeks will be analysed in order to assess whether it caused a more specific activity set during the breaks and if it also changed the nature of the collective engagements and even the students' movements. Potentially, this week will imply more pedagogical activities during the breaks and consequently less spontaneously social ones, as well as more movements towards the library and activities before classes more keen on studying or talking about the contents or the tests' results.

The two days during this week where observations occurred were Tuesday 7th February 2017 and Thursday 9th February 2017. This complemented the previous school days. Friday was intentionally left aside, because of the found repetition of the previous schedules and observations, which a fifth observation day would potentially only repeat. Moreover, Friday is a particular school day with fewer classes, particularly on the afternoons, which would bring little additional information to this study. In fact, and acknowledging the possible variances between the 4 observation days and information that each one brings to this research, each with 4 observations per day in a total of 16 time intervals, pursued in a maximum of 6 locations per interval, in a total of 76, it is possible to generalise the remarks, concluding on the representativeness and "meaningfulness" (Levy and Lemeshow, 1999, p.13)[784] of the time sample.

Finally, it should also be added that besides the drawings with the iconographic representation of the activities and movements on the chosen locations, and the comments added to these drawings, records have also been made for audio, video and photography recording of the observations, for each observation time and location, which complement the description of the events and movements and also add to its critical analysis.

. Initial procedures: gathering a team and attending a preparatory reunion

A team of eight observers was chosen, from architects to graduate architecture students[785] that are familiar with drawings, understand spatial representations and can cope with the context of this current research.

The first team reunion took place on 19th January, prior to the first observation day on Monday the 23rd January 2017, for explaining the representation process and the observation timings and locations.

[784] According to Levy and Lemeshow (1999, p.13): "[...] we develop the foundations of sampling methodology by first defining the components of a population in terms that are meaningful with respect to taking a sample from it."

[785] The team was composed by: Carolina Coelho, Bruno Gil, Micael Soares, Stephanie Torres, Daniela Aires, Jéssica Barreto, Maria Catré and Juliana Ferreira.

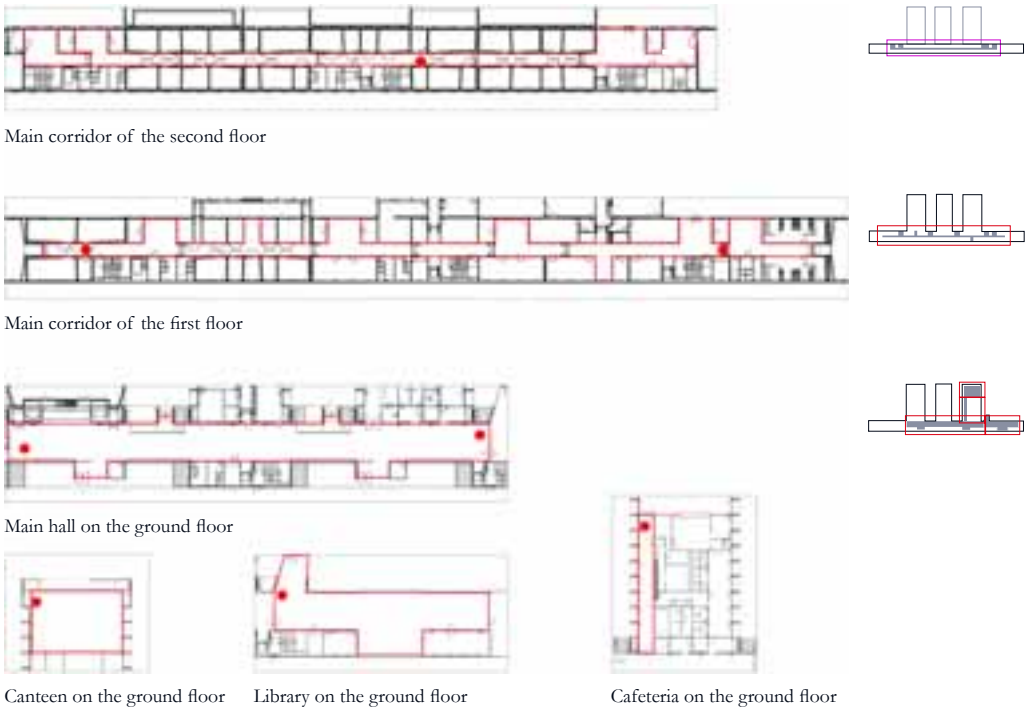


Fig. 213. Detailed plan of the observation locations, in which to register the data, highlighted with a red boundary and with a dot representing the observers' positioning

(Carolina Coelho)

The initial meeting aimed at explaining the context of the research and the purposes of the observations. It also intended to specify a uniform representation manner and to plan the stages ahead.

Each of the observers were given a general plan of the floor in which they will be working on and a number of plans that zoomed in on the observed area, highlighted in red, and with the placement of the observer visibly specified (Fig. 213).

. Representations and caption of the activities

Besides the drawings, observers were also given a set of coloured markers and a caption with the colours' representations, so that the drawings on the plans could be identical and report to a uniform activities list that identifies the nature of the activities with the same colours.

From this list, movement is represented in black lines, for pathways, that are thicker according to the density of the users that move through them. Arrows indicating the direction of these movements complement the information provided by the black lines and accesses, marking the beginning and the end of the lines and indicating the entries and exits according to the direction of the trajectory.

ACTIVITIES RECORD

Moving (lines)	*BLACK*	. pathways . arrows . accesses (entries and exits)	
Standing (circles)	**Non-programmed** activities	*(light colours)*	
		learning	*LIGHT GREEN*
		social	*CYAN*
		artisitic	*ORANGE*
	Programmed activities	*(dark colours)*	
		learning	*DARK GREEN*
		social	*DARK BLUE*
		artisitic	*RED*

Standing activities, which imply staying in space for a continuous time period[786], are identified with small circles or dots, that similarly to the lines, are denser and more frequent in the plan according to the density of people that proceed with this activity. The colour of these dots indicates the type of activity from: non-programmed and programmed ones, respectively in light or darker colours. As explained in chapter 3.3.[787]: programmed events regard a habit or a routine (Krüger, 1992), whereas non-programmed are spontaneous.

Then, each of these can have activities of the following nature: learning (mostly related to the regular teaching), social (for all the school community but often bearing pedagogical potential by peer communication) and artistic (namely by the artistic community of the school).

The definition of social activities has been set by Gehl (2011) in regard to life in public spaces as:

> "*Social activities* are all activities that depend on the presence of others in public spaces. Social activities include children at play, greetings and conversations, communal activities of various kinds, and finally - as the most widespread social activity – passive contacts, that is, simply seeing and hearing other people.
> Different kinds of social activities occur in many places: in dwellings; in private outdoor spaces, gardens, and balconies; in public buildings; at places of work; and so on; but in this context only those activities that occur in publicly accessible spaces are examined." (Gehl, 2011, p.12)

[786] Gehl analyses the concept of "standing" explaining that: "Standing activities, however, will be examined thoroughly because they demonstrate very clearly some important behavioral patterns characteristic of a large number of stationary activities in public spaces. It is important, naturally, to be able to stand in public spaces, but the key word is staying." (Gehl, 2011, p.147)

[787] See chapter 3.3. A methodology for identifying and assessing adaptability in learning environments.

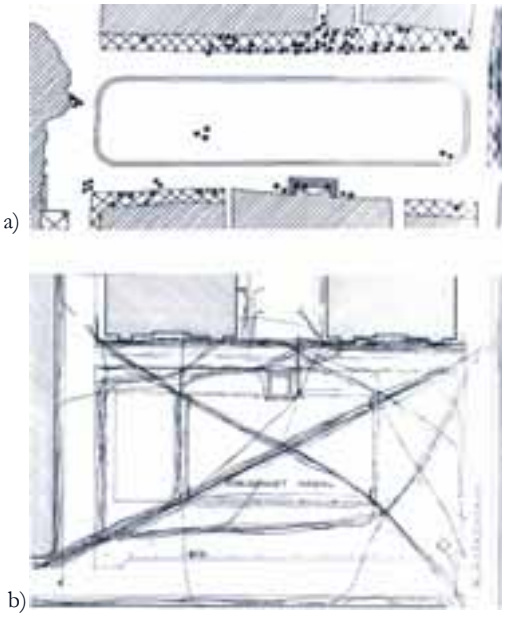


Fig. 214. a) "Survey of the city square, Ascoli Piceno, Italy"
b) "Survey of pedestrian routes on a square in Copenhagen"
(Gehl, 2011, p.148 and p.138)

According to the above list "Activities Record", learning activities are to be identified in green, social ones in blue and artistic in orange/red, respecting the light colours as non-programmed and the darker colours as programmed events.

Results from these observations are expected to be similar to Gehl's surveys in regard to the dots for representing standing activities and the lines for movement (Fig. 214).

Additionally, the researchers teams' from the studies depicted by Lynch (1977) on *Spatial Environment of Adolescence,* have also used drawings for communicating the children's "imagine of the locality" (Fig. 215), but foremost their use of sketches for diagrammatic representation of spaces, routes and activities (Fig. 216), added by field notes (Fig. 217), are also similar to the graphic approach undertaken for our current research and whose results are expected to be visually closer to these. Although Lynch recognised the potential adaptation of these procedures to the locality in which to applied them, even so they could be transposable to the specificity of our graphics undertaken on this particular case study under observation:

> "The naturalistic, open-ended techniques of dialogue and observation, which involve the children directly and openly and use graphic languages as well as verbal ones, must be continuously improved and modified to fit each new culture." (Lynch, 1977, p.80)

Fig. 215. "A vivid image of Kleparski market"
(Lynch, 1977, p.41)

Fig. 216. "Diagramming the activity in a public park in Melbourne and the photograph keyed to the diagram"
(Lynch, 1977, pp.68-69)

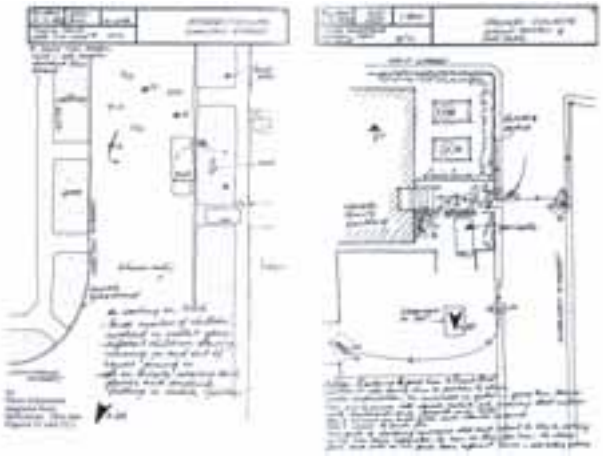


Fig. 217. "Behavioral diagram from Melbourne"
(Lynch, 1977, pp.110-111)

. During the observations

In each of the registration sheets, observers have to indicate their name, time and day for organisation purposes.

As explained, throughout the 30 minutes observers will report on their drawings: moving and standing activities, programmed and non-programmed, and of learning, social and/or artistic core, under the form of lines and dots and according to the arranged colours.

Besides all the drawings in the plans, observers are asked to list the activities observed so that on the team meeting these can be discussed and their frequency analysed on other spaces, as well as their possible categorisation according to the list provided.

Naturally, these observations have to be done in a non-participated manner, so that they do not constrain, in any way, the natural movement on space. So, even though some movement by the observers may be accepted in order to better understand the nature of the activities and to fully disclose all the movements in space, they aim not to make themselves noticed and to sensibly make the recordings.

. Subsequent procedures to the observations

After each observation and respective registrations, there has always been a team meeting to report on the movements and activities noted, to compare the data collected and the densities of those movements and activities and to clear out any doubts that may occur, namely on the classification of certain activities observed (Fig. 218).

Subsequently, and acknowledging that during the observations the recordings may not be completely clear, all the team makes another drawing to systematise the data gathered and to make it the most uniform with all the others as possible, so that no individual variables or specificities in the design may constrain the outcomes. In fact, uniformity in the representations has to be paramount so that all data is gathered in the same manner and all spaces treated with the same procedure. Considering that all remaining variables are equal, the changes in movements and activities are the sole parameters to compare amongst time periods and amongst the chosen spaces.

These moments of interval between observations also act as moments to better understand the school's morphology *in situ* and to be embedded with the *living experience* of this artistic school. Besides, it is also the moment to photographically register the events and experiences in the school, focusing on the activities rather than on the individuals that perform them. Finally, these time periods also allow listing the physical attributes of the observed spaces and whether they diverge from the adjacent spaces[788].

[788] The spatial attributes have been focused in the initial stage of the analysis in the spatial sample, but can be

Fig. 218. Team meeting after each observation
(Carolina Coelho)

. Expected results

After frequent visits to the school, several interviews to the Directors of both the Conservatory and the School, and after an in-depth acquaintance of the school's curriculum, some results are to be expected, which will be critically analysed at the end of the observations.

Spaces

The observed spaces are considered to hold different spatial fruition and to enable different frequency of users and sorts of activities.

Some spaces such as the canteen and the cafeteria have more specific functions and, hence, the range of activities will potentially lay mostly on social activities, either programmed like lunch time, or non-programmed like going to the cafeteria during a class break. It is of high relevance to specify that the canteen has a very rigid schedule, opening only from 12.00 to 2.00 p.m., so only one observation coincides with that interval that will portray the activities on the canteen.

Similarly, the library has also a fixed schedule, between 8.30 a.m. until 4.30 p.m. with the school's staff in charge, and from 4.30 p.m. to 8.00 p.m. bestowed to the conservatory's staff. It enables to register activities on all of the time intervals

better perceived on site and not just by the detailed drawings of plans and sections.

chosen for the observations except on the first. Generally, this space has a more controlled learning environment, allocating non-programmed activities with learning potential but also programmed ones determined by students or teachers. Curiously, as this school does not have a student living room for all, because only the Student Association uses the one determined for that, the library and the cafeteria act as informal gathering spaces. The library in particular, at the end of the school day is considered to be a potential lounging space for socialising and learning, mostly in a particular niche with seating spaces at the entrance.

The cafeteria also has a determined schedule from 8.00 a.m. to 4.30 p.m., being replaced by the auditorium's cafeteria in the main hall after that time. Considering this space quite narrow for standing, it is expected that students purchase the selected items and eat them outside, on the tables in the adjacent exterior courtyard that also lead to the other pavilions on the school. According to this schedule, only the last observation is impeded because the cafeteria is already closed and so that observer goes to the auditorium's cafeteria for further observations.

The corridors and the main hall are considered to be horizontal circulations, accessed from the street in the case of the main hall on the ground floor, and by the staircases and lifts on the upper floors. These are expected to work as connecting pathways between classrooms or crossings that lead to other spaces. For example, the ground floor has to be crossed to go from the main entrance of the school to the other pavilions, traversing the space. The corridor on the first floor also leads to vertical circulations, to the teachers' hallway that also connects the building to the remaining pavilions where the regular teaching is mostly taught, and also to the laboratories area for specific sciences classes.

Floors

A vertical stratification of the building by floor plans verified in the initial analysis of the spatial sample[789] may result on a respective vertical stratification of the users of the building, in which the ground floor congregates all the school community as it is the main access to the school, the first floor holds all teachers, artistic students and the regular teaching students with science courses; and the upper floor is expected to only have artistic teachers and students justified by the nature of the activities that occur there.

Note that even if the final plans indicated spare spaces, the Director of the Conservatory has stated that all of these rooms are currently occupied with the artistic teaching of music instruments, which complements the data on effective fruition, diverging from the architect's plans and restricting the use of the second floor to this community[790].

[789] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

[790] For further detail see the end of this chapter regarding Final remarks on spaces' appropriation and testimonies from the contact with the Directors.

Users

Henceforth, users are also considered to move on different paths on this building, according to what has already been perceived in the prior visits to the building and also according the personal testimonies of the Directors.

Teachers usually enter the school, take a vertical circulation to the first floor where they cross the main corridor, leading to the teachers' offices and their common living room, from where they take their pathway towards the pavilions.

Regular teaching students simply cross the main hall at the arrival at the school to reach the exterior spaces or the pavilions.

Staff also crosses the main hall to get to their specific area between the cafeteria and the library, and from there on each takes the direction of their respective workstation. Administration staff moves across the main hall towards the administrative area that works from 9.00 a.m. to 1 p.m. and reopens between 2 p.m. and 5 p.m..

Artistic students and teachers are the ones that are expected to most often use all the building's floors, namely for classes on the first and second floors, either for music or dance.

Time periods

Remarks from the observations may differ in each of the chosen intervals and according to each space. The morning arrival at school is estimated to conclude on a higher frequency of moving activities namely on the main hall accessed by the street and leading to the first floor's corridor towards the teachers' offices. The canteen and the cafeteria will still be closed at that time and there are very few music classes at 8.30 a.m. on the second floor.

The mid-morning interval is also expected to conclude on movement on the referred areas, but also on the cafeteria for a morning snack. The library may also be a place to stay. But it is also estimated that standing activities might take place on both the corridors and the main hall, because students and teachers wait for the beginning of the class and have some spare time.

The lunch break is when the cafeteria and the canteen are considered to be highly frequented, standing in line to be attended or having lunch, but possibly also leading social and/or artistic non-programmed activities.

As the afternoon progresses, and according to the conservatory classes' schedule, so does the frequency of use of the artistic classrooms, which may lead to an increase observation of activities and movement on the upper corridors and overall programmed and non-programmed activities, on the corridors, near the classroom doors or on the spaces adjacent to these corridors.

This is also the time in each the library acts as an informal space and where the auditorium's cafeteria opens, increasing the social and artistic assets of the main hall.

Activities

According to the activities' categories to be identified during the observations, early expectations estimate that programmed activities of social nature will occur at the canteen, as opposed to the cafeteria that will have mostly social non-programmed activities. The library may shelter programmed and non-programmed learning activities and even social at the afternoon, but rarely artistic because of the sound restrictions and controlled environment.

Both corridors might have movement, but may also be a set for social non-programmed encounters. Finally, the main hall is expected to gather all activities, programmed and non-programmed, social, artistic and learning, with its potential to have movement but also to stand: with the cafeteria and its tables on the afternoons; and with its significant width and length that support several simultaneous activities of different sort; besides its accessibility between the street and the other pavilions, which enables more movement and external events.

Furniture

Furniture can condition the activities that occur in a particular space, because of its existence, density and disposition, all the apparel existing in a space can justify the choice of a specific space. For example, the placement of seating spaces can indicate the location of the students during their breaks and consequently, the definition of that location for staying rather than for movement.

At the same time, the location of a particular machine, such as a vending machine or the card machine which the students frequently use for purchasing their meals, will potentially justify the density of students around them and can even generate a particular routine and promote a density of natural movement towards their specific location. Recalling Hertzberger's words:

> "In the organization of a plan, as you design it in terms of groundplans and sections and also in the principle of installations, you can create the conditions for a greater sense of responsibility, and consequently also greater involvement in the arrangement and furnishing of an area. Thus users become inhabitants." (Hertzberger, 1991, p.28)

Moreover, assuming that furniture can be relocated, the possibility of changing the layout of each space can also change the movement and staying activities of their users, this is expected to be confirmed by the observations.

Therefore, by acknowledging the relevance of furniture towards spatial use, the most relevant furniture in each observation spot has promptly been identified, in order to subsequently analyse the observation findings also according to the

a)

b)

c)

Fig. 219. Plans and photos of the observed spaces with furniture and devices' location:
a) Library on the ground floor; b) Main corridor of the second floor; c) Main corridor of the first floor
(Carolina Coelho)

location of a particular set of devices that matter towards life within the school space: functionally, socially, pedagogically, …

Figs. 219 and 220 depict the placement of the furniture, which has been drawn previously to the observations. Note that in some cases, furniture has been considered as important that it has always been drawn henceforth in all observation plans, because it represents a specific layout that conditions the activities and movements in that place, differently from an open space.

This is the case of the library, where the shelves, computers and tables hinder the visibility of the space and its control by the staff and recall pedagogical corners for different learning activities. Behind the reception area there is a lounging space with sofas. In the longitudinal north wall there are lockers and wooden shelves. In the central area there are non-movable shelves and tables with computers, also holding the ventilation set. On the south wall there is a display for magazines and metallic shelves placed after the original design. There is also a closet for students to leave their backpacks at the entrance. All this furniture implies the need for shelving space and shows its appropriation by students, teachers and staff after the space has been built. This diversity also proves the diversity of activities and different sets of users that experience the library, either individually or in groups, either through computer usage, magazine or book reading or by studying or resting. The adjacent space to the library also enables its diversity of usages, bestowing the possibility of gathering larger groups in a more formal space without disturbing the regular functioning of the library. But naturally, that the more furniture the space holds, the lesser the visual control over all the students and the increasing need for moving around to acknowledge the activities that are taking place (Fig. 219a).

The main corridor on the second floor has three benches throughout the longitudinal corridor, potentially to be used while waiting for a teacher or for a class. The walls are used for displaying contents particularly related to the artistic teaching and events, which may imply the appropriation of that space. There is one table in each extremity of the corridor where usually the school staff is located for controlling the activities in that space. Lockers are also displaced on those extremities of the corridor, on the largest niches (Fig. 219b).

The main corridor on the first floor has also lockers in four out of the five niches. It also has benches, but in this corridor the benches are not only on the corridor itself, but also on the niches, as well-defined spaces for staying. There is even a round table displaced on the niche near the small auditorium that enables group gatherings. One niche in front of one of the transversal hallways is occupied by the staff with a table, chairs and the classes' schedules. Curiously, on this floor there are displays in one central niche. The diversity of furniture in this corridor and adjacent open spaces lead to the possibility of diverse uses and different sets of students from different teaching regimes at different times (Fig. 219c).

a)

b)

c)

Fig. 220. Plans and photos of the observed spaces with furniture and devices' location:
a) Main hall on the ground floor; b) Cafeteria on the ground floor; c) Canteen on the ground floor
(Carolina Coelho)

The main hall on the ground floor has a wide variety of equipment and furniture, placed mainly near the longitudinal walls. There are two counters near the entrances – one that is effectively used and where staff is always located for controlling the entrances, and another that works mainly during the events concerned with the auditorium. The counter near the main access is considered to be a very aggregating location, for greeting the peers and the staff and as a meeting point. Sofas are placed near the library and near the central staircase. Naturally, these are the first chosen spots for seating, followed by the benches against the wall. Near the secretariat entrance there are five displays with official information for the school community and another five from the cafeteria to the library placed longitudinally in the wall. Vending machines and card machines are located throughout the main hall and are a very significant aggregator of students. Card machines are used by all students to purchase lunch, snacks or anything they may need. Two of them are placed near the library. There is another that only relates to the conservatory and is located near the auditorium's cafeteria. Vending machines are located near the central staircase and near the library. Finally, there are tables and chairs both regular and high ones, on the auditorium's cafeteria (Fig. 220a).

The cafeteria has five square tables with chairs and three high and round tables on the extremities. It also has machines for snacks and cards (even if the snack machine was not working at that time), a higher stand for placing the snacks, and the display with all the snacks behind which the staff works. Even if the cafeteria is provided with these tables the space can be considered overly narrow for staying (Fig. 220b).

The canteen has large tables for the high amount of students to have lunch, as well as the display for serving lunch, and also shelves for placing the used dishes (Fig. 220c).

. Critical commentaries on all observations and findings

The first approach to the materials gathered from the observations, namely the drawings on the plans and the field notes taken during these time periods, will be analysed and critically assessed. Then, after this more specific and detailed approach, overall conclusions regarding each day, the representativeness of each time schedule, and the activities and movements concerning each one, will be disclosed.

23rd January, 2017 (Monday, regular week)

The first day represented the time for testing and validation of the methodology, with regard to the representativeness of the time periods chosen, the locations for the observations and the description requested and the colour code considered.

All in all, after this first day, the methodology has been considered fruitful for the sought results on spatial fruition, densities, movements, activities and respective

locations. It has also been considered that the field notes added in the plans, commenting the sketches for each observation were of particular interest for this research. Therefore, observers were asked to more fully describe and comment what they were observing and particularly the specificities of each observation, so as to conclude on potential differences regarding time periods and locations. These are also a way of complementing the information from the drawings of a more abstract nature, and to provide commentaries of a more qualitative and cultural character that complement the conclusions on spatial fruition, as this idiographic approach intends.

After each observation the drawings made by each member of the observation team were gathered in a sole drawing regarding each location and also the field notes taken from each person were discussed in a team meeting and placed in the same sheet with the plan and the final drawing per time period and location, as a way of systematising all the information gathered. Even if the observation was made by only one observer in a particular place, when considered useful, that drawing would be done again for a more clear and uniform understanding along with the other ones produced *in situ* during that schedule.

. 8.00 a.m. / 8.30 a.m.

. the main hall of the ground floor (4 observers)

The main hall is the arrival location of all the school community. There are other entrances for services and for auditorium support during events, and also a particular one for the auditorium outside school hours. But for the purpose of arriving at the school, the entrance is one and only, shared by all. This explains its relevance when observing the space, because during the time period observed all the school's users go through that space and eventually stay there while proceeding with any individual or collective activity until classes start at precisely 8.30 a.m..

The placement of four observers at this time period on this location is justified by the high density of users and also by the diversity of pathways taken and activities pursued in this space that could not otherwise be strictly perceived by lesser people.

This situation explains the highest density of users through the exterior access door, heading mainly towards the left or right staircases that lead to the upper floor, or going straight towards the external area, crossing the main hall transversally to get to the external pavilions with regular classes. These movements are well-defined according to the specificity of each user: teachers from the regular teaching arrive at the school and take a staircase in order to reach the teachers' common living room, which also explains the movement from the staircases to that transversal wing on the first floor.

Artistic students have three different pathways: generally they take the stairs to go to the room where they can leave their music instruments during the regular school

time or either to get to their own lockers to place their instruments until the artistic classes. Others arrive early at the school for practising in the music classrooms while they are available and before any of the formal classes scheduled. This is particularly relevant in the case of students that play voluminous instruments or very expensive ones that cannot be played at home, or even the ones that wish to practice in groups.

Dance students are clearly perceived amongst the others, specially the ballet dancers, with all the apparatus needed for the practice and their path is very well-defined from the entrance to the staircase on the top of the building, closest to the dance studios and the dressing rooms. All this explains the longitudinal movements across the main hall.

Normally, it is the regular teaching students or the ones that carry a lighter music instrument that go across the main hall directly to the external courtyards near the pavilions for their classes.

Staff also arrives at the school from this outdoor access, generally crosses the main hall towards their common living room and from there each one goes to their own location.

The secretariat staff and the Direction boards of both the Music Conservatory and Quinta das Flores School move across the main hall towards the transversal wing that holds their particular offices.

The library only opens later on at 8.30 a.m. even if the library staff arrives early to manage the space and tidy it up. The cafeteria opens at 8.00 a.m. and so some movement is noted towards that space, besides the movement towards the toilets on the main hall near the library.

Another relevant movement noted has been towards the card machines that allow students to make purchases within the school, as well as towards the snack machines. These are very relevant aggregators of students, and at the morning arrival and at the mid-morning break there are particularly extended queues for those devices, which ultimately can even distort the natural movement of the other users that have to go around the queue.

The main hall at this time period is also a place to stay. Students usually wait for their colleagues to arrive and from there they depart for their destinations. It is also a place for informal conversations and individual use of the phone, listening to music or reading. The collective gathering of peers on the main hall is most representative in this observation day. As it was a Monday, students wanted to get together and discuss their weekend, thoughts and situations.

It is also clear that furniture aggregates users, not only because of the card machines, but also of the seating arrangements near the library and near the middle staircase, as well as the longitudinal benches contouring the glass windows between the

exterior and the interior of the school, and the tables and seats of the auditorium's cafeteria though it is not open at that time. These are all places where students seat and wait for their colleagues. At a later time, when the benches are all occupied, students choose to stand next to them, but always near their peers, which lead to conclude on the importance of the existence and placement of those machines and the overall furnishing towards the space's layout and, hence, towards the location of activities and movements in space.

The sound that indicates the beginning of the classes, at 8.30 a.m., generates a very sudden movement from the users that are still in this space towards their destinations. This starts fifteen minutes prior but intensifies itself in the last five minutes before classes.

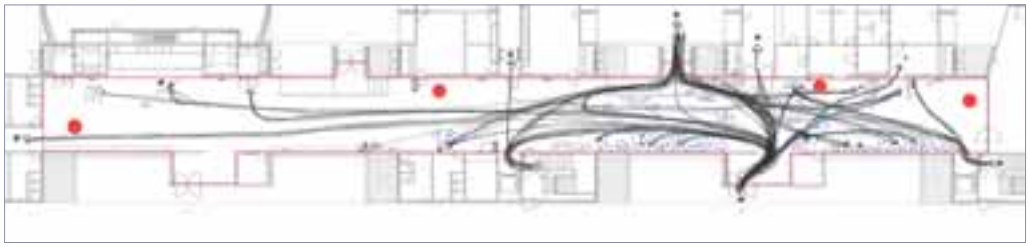


Fig. 221.a) Main hall

. the cafeteria on the ground floor (1 observer)

The cafeteria space is open at 8.00 a.m. but the bar is still closed then, therefore it does not have many people going through that space at that time. The registered activities at this time are solely talking amongst the students or using the card machine to purchase lunch tickets. This is clear in the plan that accentuates the longitudinal movement towards the machine and very little staying activities in space.

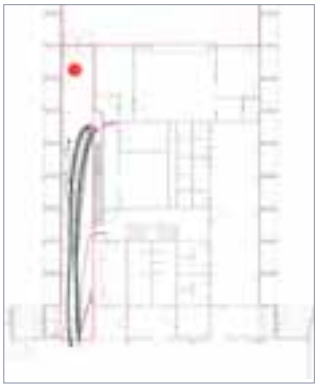


Fig. 221.b) Cafeteria

. the main corridor of the first floor (2 observers)

This floor congregates diverse users: the regular teachers that pass there towards the teachers' common living room and to their offices, the music teachers towards their

classrooms and also using the common living room, music students that go to the specific room for leaving their music instruments and/or to ask for a classroom to practice in, regular or articulated students to have science classes on the laboratories and their respective teachers, dance teachers and students, students crossing the interior corridors towards other pavilions and staff. Therefore, activities and pathways are very diverse, justifying the two observers in this space.

As seen on the sketched plan, movement during this observation has been particularly more intense near the dance studio and dressing rooms. It has also been remarked the intense access from the central staircase towards the teachers' transversal offices and from there towards the external pavilions, also from the lateral staircase near the dance studio towards the corridor leading to the exterior pavilions. Therefore, the remaining staircase on the opposite end of the building has been less used and the transversal movements are from the vertical accesses towards these referred directions, according to the users: teachers go to the teachers' offices, dance students go to the dance studio, regular curriculum students go to the external corridor, and music students go to the room for leaving their instruments.

Observations made during this time period on this corridor have concluded on the following activities: groups waiting to have class and talking in the meanwhile, going to the lockers, and dance students using the dressing rooms for preparation for the dance lessons.

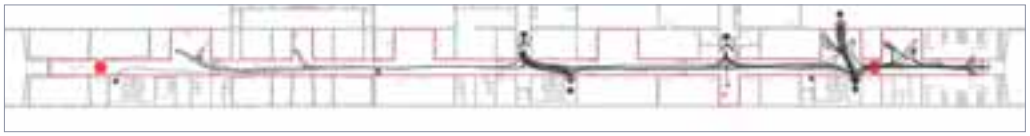


Fig. 221.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

As easily perceived on the following plan that depicts the activities and movements noticed on the main corridor of the second floor, these are both very diminished compared to all previous spaces analysed.

The traces drawn in this plan represent very few users or just an individual path. The observed activities comprise: talking amongst students; students using their phone, which is a common activity amongst all students during the breaks and done in all observed spaces throughout and particularly on the corridors; and students going to their lockers to place their music instruments or related materials. That explains why only one observer is needed to perceive this space's fruition, because the users are less than on the remaining spaces and specifically driven there for particular purposes, namely artistic ones, since this space is effectively used only for the artistic teaching.

Fig. 221.d) Main corridor of the second floor

Fig. 221. Observations 23rd January, 8.00 / 8.30 a.m. _ final drawings
(Carolina Coelho)

. 10.00 a.m. / 10.30 a.m.

. the main hall of the ground floor (3 observers)

At the mid-morning break there have been three members of the team of observers designated to this area, also because the fourth member present at the morning arrival is now at the library proceeding with the observations there, which was closed at the previous observation time. This is also in agreement with the density of people noted at this time period, for which three people are able to describe, both in field notes and by drawings, what will afterwards be joint together in a whole final drawing.

From the observations it is concluded that there is a higher density of people in the main hall during this morning break because the break occurs from 10.00 to 10.15 a.m., implying that activities and movements are quite concentrated in this quarter of an hour of the morning for getting from a place to another or pursuing some activity. Hence, students act rather quickly and are located in the same common spaces that congregate them all at this same time period. This is the case of the card and snack machines, that have also been noted at the morning arrival, but that are particularly used during this break. The queue for these machines gets so extensive that it conditions the natural movements of both students and teachers who move longitudinally on the main hall.

Interestingly, students also come inside for this space, sitting on the benches or on the sofas for getting together, which implies that the main hall acts as the common living room the school lacks.

Besides being a place for standing, it is also a space of multiple crossing of pathways: from the people that arrive from the outside to the staircases or the exterior courtyards, from the staircases to the exterior courtyards and vice-versa, from the exterior to the library and to the cafeteria. Specifically, the use of the library during the morning break is particularly relevant and very specific of this schedule, which introduces further complexity in the occupation of this area for accessing the library - for entering and leaving. Besides, that area is also a seating space with benches and it also accesses the staircase, the toilets and the card machines. All of this leads to a very high density of movement and staying in a rather narrow space for all, but is also proves that it is a highly morphologically integrated space for getting

to another spaces and a relevant part of several and diverse pathways. It is also a place for actively engaging with the peers and hence, an assumed active learning environment, either individually and collectively, for staying or in movement.

While this is particularly clear on the west side of the building, from the staircase in the middle of the main hall to the east side of the main hall, near the auditorium there is significantly less density of movement, supported by the fact that the auditorium's cafeteria only opens in the afternoon.

There is also a noticeable movement by the teachers from the central staircase to the secretariat and Directions' offices and the transversal movement from the exterior of the school to the external courtyards continues to be highly meaningful to remark.

Fig. 222.a) Main hall

. the cafeteria on the ground floor (1 observer)

In a compared analysis with the previous plan from the observation at 8.00 to 8.30 a.m. the density of use has increased significantly, but the movements perceived are still very longitudinal and talking and using the card machine are still frequent. At this time period, students also use the space for having a mid-morning snack, either purchased at the cafeteria or brought from home. Still, it is concluded that this is not a very used space for staying and that students spend only the necessary amount of time there. This could be explained by it narrowness that inhibits the adequacy or comfort of the students to stay both standing or sitting near the tables while there is a deep amount for students using the card machine in a queue or near the display of the cafeteria.

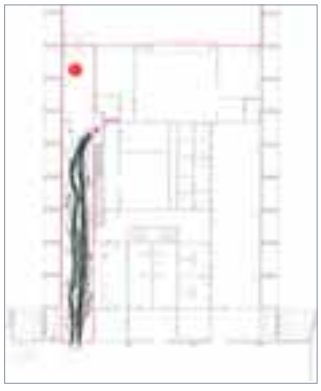


Fig. 222.b) Cafeteria

. the library on the ground floor (1 observer)

The library has rigidly placed furniture, namely the shelves with the books, through which the ventilation also occurs. This hampers visual control of the students by the staff that has to move around in order to perceive the activities taking place. This placement of the shelves also creates niches either for studying, conversing, using the computer, individually or in groups. The niches provide a more casual and diversified spatial experience, added by the fact that the school is deployed of a students' common living room. The seating area at the front of the library acts as a lounging space, where periodical exhibitions occur and where users can learn in small informal groups.

Realising that furniture is paramount for the understating of activities in this space, it has been drawn in every plan. Clearly, if visual control is diminished, the observer on this space has to move around very frequently to report the activities and movements occurring during the observation times. The library has also a room for pre-arranged activities. The heating and lighting conditions and its location towards both the street and the external courtyards, and also the diversity of furniture, shelves, technological devices, sofas, assorted tables and seating areas, provide the library with a cosy and comfortable ambiance prone for diverse learning experiences.

The activities reported during this observation have been the following: numerous demands of information to the library staff near the counter, on the tables there were small sets of students making some group works, there was also noted students reading books and doing their homework and also, more informally, group conversations. Interestingly, the shelf that was more frequently sought was the one related to the music books, very relevant for the particular student profile of the articulated students.

The initial ten minutes of the observation were clearly more intense in terms of movement and activities, which correspond to the initial ten minutes of the mid-morning break, because afterwards students have to head towards their following classes.

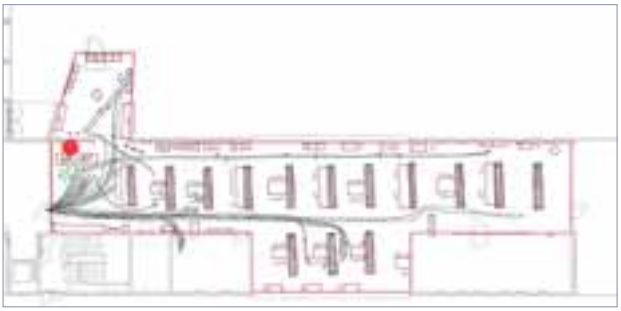


Fig. 222.c) Library

. the main corridor of the first floor (2 observers)

The observation done during the mid-morning break recalls not only transversal movements towards specific places, but it also perceives longitudinal movements between spaces on that same floor. Naturally that the sought directions from the previous observations at the morning arrival continue to be paramount: the access to the teachers' offices, the dance studio, the students' lockers and the external pavilions from this first floor. There has also been noted informal talking, occasional stops during these movements with potential information transmission amongst peers or simply social interaction, and the use of the toilets and dressing rooms. The niches opened to the corridor start to be more significantly used for students to stand and pursue some social or pedagogical activities. This is proven by the observation of students leaving the classrooms towards those spaces and standing there for a few moments during the break and only proceeding to the next classroom afterwards. The following plan shows that situation and points out the students' placement and density on those spaces during this observation.

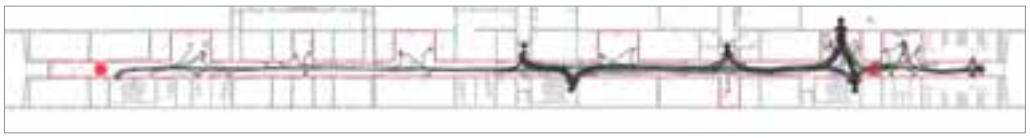


Fig. 222.d) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

This observation is consistent with the report from the previous one, in which this is a less frequented floor plan but very specific of the artistic teaching. The activities remain the same as the ones identified earlier, which are added to the cleaning the staff undertakes at this time. Locker visits are regular to pick up or place something, as well as talking amongst students and using their phones.

While during the morning arrival the frequency of use is diminished, at this time it has increased, because students come from pavilion A through an interior corridor that links this pavilion with this building, crossing the main hall towards the nearest staircase, descending to the lower floor plans.

The corridor is a place to go to and from somewhere else, and during the morning period the classes from the artistic teaching occur, but are significantly less than during the afternoon period, where the supplementary students are added to the users of this space.

It is during the morning that students more easily request a room to practice in, but it is noteworthy that both the music lessons and the music training are individually done or in small groups, which shortens the amount of users of this floor, both on the corridor and in the classrooms. This also explains the fact that at this time multiple classrooms were being used, particularly by students without a teacher,

who had asked to practice on their music instruments or on their singing. There has also been noted more students standing on this floor, which is explained by this higher density of uses. The dance studio has had a significant attendance from both teachers and students.

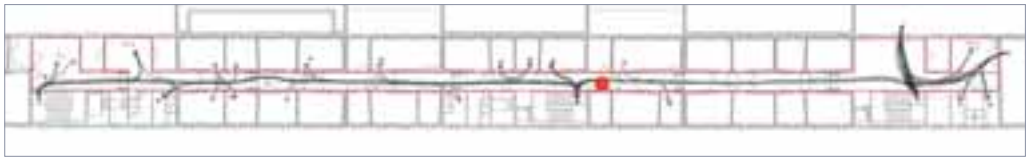


Fig. 222.e) Main corridor of the second floor

Fig. 222. Observations 23rd January, 10.00 / 10.30 a.m. _ final drawings

(Carolina Coelho)

. 1.30 p.m. / 2.00 p.m.

. the main hall of the ground floor (2 observers)

The observation on the main corridor during this time period has been done by two observers, because functionally two people can disclose the movement and activities that occur at this time period, given that they are lesser and also because the third observed has been dislocated towards the canteen, whose opening time only coincides with this one observation on this schedule.

Overall there is less frequency of movement of users. Students and teachers leave school from their diverse locations, coming from the staircases, the secretariat, the Direction offices or the external courtyard, to the exterior access of the school. For many it is the lunch break and for others the end of a day that may not have classes in the afternoon.

So, the main movement is towards the exit. There is a very dense movement of both teachers and students in the following five minutes after the end of the last morning class and there is also the exit of students after lunch.

The remaining students, which are still quite significant, are located in the canteen to have their lunch. From there, they exit the space through the cafeteria until the main hall, going to the external courtyards, the library, the toilets or the upper floors.

Anyway, after these five minutes, students tend to stay on the main hall between 1.45 and 2.00 p.m. After lunch and similarly to the previous observations, students get together on the sofas and benches near the library, which is a very significant staying spot and group gathering in this school, namely because it crosses very diverse student paths. Also, there are students that do not have lunch at the canteen and eat a quick meal or a light snack seating there. Since that the lunch break implies more free time than the morning break, this is also a time where students choose to go to the library.

Overall on the main hall at this time some pedagogical activities have been noticed, such as: reading or skimming books, discussing about tests that have been taken or to be taken in a near future, artistic activities like listening to music, and individual activities related to the use of technological devices.

It has also been noted that students like to stay in the exterior of the school under the roof top as a shelter place for bad weather, but which enables them to proceed with activities not accepted inside school premises like smoking, or simply to have a sense of higher freedom, informality and less control from the teachers and staff. The card machines continue to act as aggregators of students that use every break to charge their cards.

Again, the library side of the main hall is significantly more used that the auditorium side, because the first connects to the both staircases, the library, the cafeteria, the exterior and the external courtyards and the toilets, and the latter to the auditorium and to the auditorium's cafeteria that is closed until the mid-afternoon.

Fig. 223.a) Main hall

. the cafeteria on the ground floor (1 observer)

This is the time where most students are gathered in the cafeteria, possibility because it coincides with lunchtime and some have a light snack there rather than a whole meal in the canteen. This gathering also diminishes drastically after the sound for returning to class. This is proven by the large queue for the cafeteria noticed in the first fifteen minutes of the observation. There has also been noted an extensive line for the card machine, needed prior to getting lunch in the canteen.

The door that connects the canteen to the cafeteria only opens at 2.00 p.m. so that students do not cut the line for lunch from the remaining ones that enter from the outside door to the canteen. The consequence on the cafeteria's occupation is that there are some students who walk longitudinally from the cafeteria entrance to its exit towards the canteen and return back because that door may not be open at the time they pass.

The time students take to stay in this space has been approximate to the time registered at the previous observation at the mid-morning break, and hence, higher than the first observation at the morning arrival.

Most of the activities are social ones, specifically students talking to each other on the line for the cafeteria or the card machine, which is concluded to be a very aggregating spot.

During all three observations made in this day, it has been noted that between five to six employees or teachers were at this space, even though this is predominantly to students. From 1.30 p.m. to 2. p.m. there have been two pedagogical, non-programmed, activities noted here: a teacher explaining something to a student and two teachers discussing pedagogical contents related to teaching, which contributes to the notion that informal talking can be a means to bettering education and knowledge transmission, and that spaces such as the cafeteria, can be gathering spaces where informal activities can hold pedagogical potential.

Fig. 223.b) Cafeteria

. the library on the ground floor (1 observer)

The afternoon period was reported to have significantly more users in the library than in the morning period, potentially because students do not have so many classes and, hence, have more free time to pursue their homework, but also because during the afternoon the library acts more like a lounging space, also because the school lacks a common living room for the students. So, students go there for both pedagogical and social activities, either alone or in a group.

As already explained, because the library has a diversified furniture it leads to different nature spaces: spaces for computer working, for reading books, for doing research, for consulting magazines, for group work and also for individual production, besides, the display area for the temporary exhibitions and the sofa for a more informal knowledge transmission and gathering. That is why the activities reported in these observations are numerous and varied, namely: group work and group studying; individual reading and individual studying; research in books or on the internet; doing the homework; talking; using the computer for research, games or writing; watching videos; … There is also a location at the front of the library for placing the students' bags that is very much used.

So, the library is a clear active learning environment that holds formal and informal, individual and group experiences, for content research, writing, production and creation. The diversity of furniture and spaces also contributes for that diversity of learning experiences, either more exposed at the front of the space, or more demure in the side with smaller tables near the surrounding walls. In fact, the tables nearest to the counter, where the staff is located, are the ones that are more frequently occupied, which are also the ones where students that have more immediate help from the teachers and the staff.

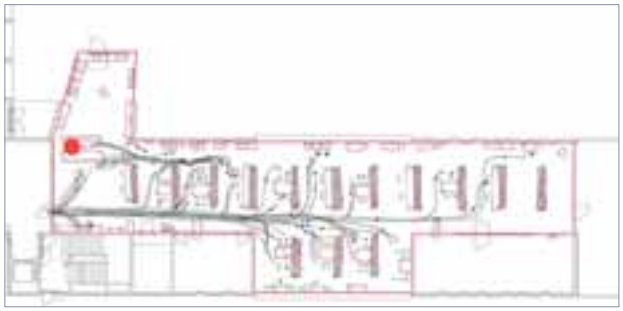


Fig. 223.c) Library

. the canteen on the ground floor (1 observer)

According to the time frame previously defined for these observations, this is the sole time period in which there is a coincidence between the opening of the canteen and the observations undertaken, making it possible to produce one single observation per day on the canteen, which will have to be compared with the future ones undertaken on different days of the week. Nevertheless, the functioning of the space and the well-defined structuring of its usage makes its very orderly and clear to explain. This is also the way to best accomplish the number of meals served by day to the large amount of students that attend the school both in the regular and the articulated curricula.

Students enter the canteen by the exterior access and leave their backpack at an adjacent bench near the glass windows or on the floor if there is not enough space on the bench. Then students go to the line, pay their meals, have the tray with their lunch and the salad on the side. Then, they choose a seating space to have lunch and afterwards they leave their trays and exit the space. In order to avoid over-crowding the space, the door to the cafeteria is open from 2.00 p.m. so that students can exit that way. According to the staff, it is not open before to avoid students entering that way and cutting the line for lunch, from the ones that have arrived by the exterior access.

The least selected seating spaces are the ones near the queue. There are numerous students that go to get salads and dressings. The highest density of students is at 1.30 p.m., which disperses from that time on. From the observations done and according to the orderly functioning of its usage, the sizing of the canteen

can be considered adequate for the amount of students there during lunchtime. Besides eating, students also use their phones, listen to music and have informal conversations.

Fig. 223.d) Canteen

. the main corridor of the first floor (2 observers)

During this schedule this corridor has again significant and very frequent transversal movements from the teachers' offices towards the central staircase for the lunch break. Students and teachers from the science classes also proceed to the staircases, either at their right or left, and there continues to be students from the exterior access from the pavilions to the staircase and vice-versa.

The use of the dressing rooms for the dance lessons is also constant. Similarly to the previous break, artistic teachers go to the music classrooms and students also wait near the classrooms on the nearest open spaces to the corridor. During this time students play and talk together, sing and practice their music, and also, as a pedagogical activity, students have been observed reading and using the computer. Clearly, as the day continues and students are assigned some homework on the classes, they tend to use their breaks for practice or even to work on the benches, besides all the natural social interactions common throughout all the observations.

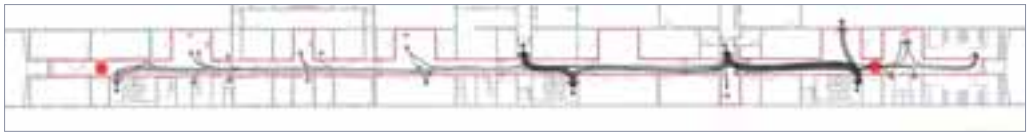


Fig. 223.e) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

During the afternoon this floor plan is much more used than in the mornings. This time period coincides with the beginning of the afternoon and so it has registered a more frequent movement on the corridors and a more intensive use of the classrooms, proven by the repeated in-and-out movement from each room and by the fact that almost every classroom on this floor has been occupied at this time. People move around and also stay in the corridor or in the adjacent small spaces open to the corridor.

The access to and from pavilion A is not so relevant as it was in the previous observation during the morning break. Teachers started to be perceived from this time on, as opposed to the morning period when mostly students used this space.

This observation has noted that talking happened but not just between students as it did before, but also between teachers and students, which is consistent with the concept of active learning environments and the possibility of learning amongst the corridors or other informal spaces. It is relevant to consider that corridors hold movement, and during that movement, or before leaving or entering a class, conversations can be developed providing knowledge to students. Besides movement, activities have also been remarked that support that learning ambiance, such as a student studying musical theory on a bench on the corridor before entering his class.

At this time the niches adjacent to the corridors become more frequented, while waiting for a classroom or staying during the spare time in a more demure place, these niches provide a sense of privacy but also of a pedagogical environment prone for individual or group learning activities, either programmed if they are a part of the students' routines, or non-programmed, if they have been spontaneously decided. These informal experiences can trigger knowledge and its transmission amongst the peers in the niches, or between educators and students in the corridors, as perceived by this observation.

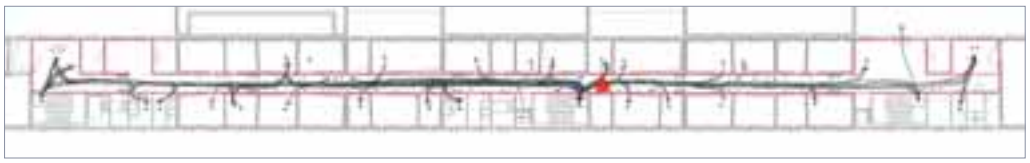


Fig. 223.f) Main corridor of the second floor

Fig. 223. Observations 23rd January, 1.00 / 1.30 p.m. _ final drawings
(Carolina Coelho)

. 5.00 p.m. / 5.30 p.m.

. the main hall of the ground floor (4 observers)

The experience on the main hall during the afternoon is quite different from the morning period, because the conservatory classes become more intense and hence, so does the space allocated to the artistic curriculum. Besides, the artistic teaching relates not only to the students from the articulated regime, but also to the supplementary students that arrive at the conservatory after their classes elsewhere.

All this implies that the main hall at this time period becomes highly dense from the auditorium side, where the cafeteria is already open and where the central staircase becomes more used.

The users of the main hall are clearly artistically related, from the parents that bring their children to the conservatory classes and wait in the main hall, to the teachers and parents that use the auditorium's cafeteria, to all the people that move along the main hall entering or existing the premises. Regular students, overall, at this time usually leave the school or just stay on the main hall while waiting for their educators to pick them up. Similarly, the regular teachers and staff, if they have not departed the school earlier, also proceed towards the exit.

Even if there are numerous movements, at this time the striking difference is the less transversal movements, only taken by the students who leave the school who have not done it before. The remaining pathways are mainly longitudinal, from the exterior access to the central staircase that links to the upper floors for the artistic classrooms.

Additionally, at this time period the main hall is used throughout, within all its length, bearing different users and activities – from the conservatory students and educators, to the teachers that get together in the cafeteria, to the regular students waiting to leave the school, to the regular teachers that also leave the school at this time.

Again, four observers are needed at this time period to inform on all activities and movements on the main hall, because there is the need to place one in each extremity, since the auditorium's cafeteria is now functioning, and the west side still presents a relevant exit/access point to the first floor and to the library that also closes later on, and two other observers are needed to recall the movement on the central area.

In fact, on that extremity substantial movement is reported because there are many people, either students alone or in groups or with their parents, or simply the parents alone, that use the library at this time, and so that attests the intense movement near the access to the library.

Other conclusion to be taken is that, not only are the users mainly related to the conservatory, their ages also diverge from the morning period, because there are also younger students that take music and dance lessons and their educators that bring them to the conservatory. This is clearer because the remaining regular students at this time are not usually at the school, which makes these students more noticeable.

Fig. 224.a) Main hall

. the library on the ground floor (1 observer)

At this time the library continues with the same activities as already stated in the previous observation at lunchtime. This time there are clearly more parents studying with their children, as a programmed activity previously arranged or as a part of an established routine. There are lesser movements amongst the space and more activities that demand longer presence in the same space rather than moving around. The students' ages are generally lower, which implies they stay there until their parents pick them up, proving that the library is considered a waiting space that provides the students with pedagogical materials for their spare time after school. While, probably, the older ones can go home alone in a more independent way.

Curiously, the fact that the library holds the functioning of a common living room with highly and diversified pedagogical potential, makes the students like going to this space and use it in very diverse manners. The hide-and-seek game played there during this observation time, by two small children, as lower as it could be played, proves its potential as both an informal and formal space, where children like to spend time, and where knowledge can be introduced and passed on outside the strictness of the formal classroom and the content provider teacher.

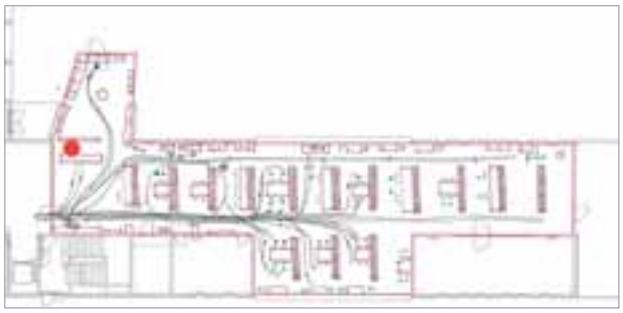


Fig. 224.b) Library

. the main corridor of the first floor (2 observers)

This observation considers more longitudinal movements throughout the whole corridor, because at this time music students are intensively placed on this floor and on the upper one for their lessons. The movements have been traced from the vertical accesses towards each one's classrooms and while waiting for the lessons the activities in the corridors are diverse. Playing the guitar as an artistic practice before class, reading as a pedagogical activity, the use of the locker before exiting the school, or talking amongst the colleagues, are regular activities perceived in this space.

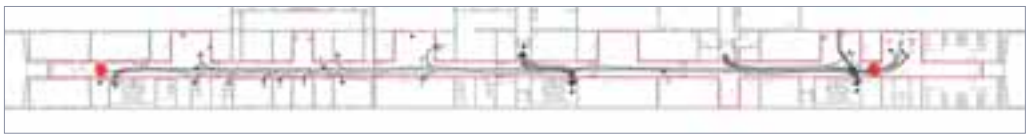


Fig. 224.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

The use of this floor plan, particularly noted on the corridor has been increasingly higher as the day goes by. No programmed activities have been perceived during the observations, but informal learning has been noticed by individual practising of music instruments, studying, or by group working, done along the niches adjacent to the corridors. To this situation the lighting and heating conditions fairly contribute to the well-being of the students and their choice for being there, considering them comfortable spaces for learning or socially engaging in small groups. Also, its location near the classrooms and its dimensions enable the students to consider them to be adequate and more private spaces for social, pedagogical or artistic activities. Even if they are open to the corridors and deployed of any strict walls or boundaries of enclosure, these spaces are a part of the school and specially integrated as part of the main corridor on that floor, which has representativeness towards spatial fruition and appropriation.

The afternoon period has more remarkable social interactions in the corridor between teachers, teachers and students, and also the presence and interaction of the parents who come with their children, who had not been perceived in the morning, potentially due to the younger age of these supplementary students.

The observed movement has been uniform throughout the all corridor and the corridor has been perceived as a common living space, as did the niches, enabling social conversations and stay. The lesser use of the niches in the extremities, which have been rather used during the morning period, may be due to the fact that the employee has moved to that space, potentially hindering some activities that may have moved to the corridor. Therefore, a sense of privacy may condition the choice of space for students to be, along with a sense of some freedom or less control.

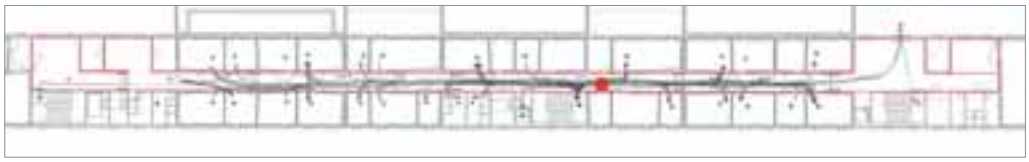


Fig. 224.d) Main corridor of the second floor

Fig. 224. Observations 23rd January, 5.00 / 5.30 p.m. _ final drawings
(Carolina Coelho)

25th January 2017 (Wednesday, regular week)

After validation of the results observed, the following days of observations have been used for identifying any potential discrepancies or special activities that have occurred, more spontaneously or in a programmed, yet not regular, manner.

Therefore, the following commentaries on the five observations per day aim to focus on particularities, and also on proving the constancies of activities and their respective nature, movements and accesses, occurring in each space observed in every representative time period.

. 8.00 a.m. / 8.30 a.m.

. the main hall of the ground floor (4 observers)

The movements observed at the morning arrival on this Wednesday are particularly similar to the ones from the previous Monday. Students, teachers and staff all arrive from the same access door from the street. Students from the regular teaching usually cross the main hall towards the external courtyards and so do the students with light weight music instruments. The students from the articulated regime that have their own music instruments all come into the school carrying them. If they are voluminous or heavy they choose to go up and leave them in their lockers or in the room for that purpose on the first floor. If they have classes afterwards they go from the internal corridors placed on the upper floors to the external pavilions, or to the science labs on the first floor. If not they can arrange a classroom for practising, either alone or in small groups, specially if they do not own an instrument and need to use the conservatory's.

Teachers also come into the school choosing mainly the central staircase that goes straight to the teachers' common living room or to their offices, separated by scientific areas, and from there to the external pavilions through the internal corridors that connect this hallway to the remaining pavilions of the school or the external courtyards. That explains the choice of the central staircase for both the teachers and the artistic students, because it is the nearest to the transversal wing with those offices and the room for the music instruments to be kept. Staff usually goes to their common living room first and then splits up towards each one's placement in the school.

Therefore, the arrival is translated onto longitudinal movements towards the staircases, both central and on the west side of the building, and also transversally to the exterior, to the staff's common living room, to the toilets, to the secretariat and to the Directions' offices. Standing activities are often translated into social ones such as conversing, and pedagogical like studying.

The staircase near the library is also used particularly for the dance students whose studios are on that side of the building on the upper floors – these are easily perceived as dance students, due to their sporting clothes, the hair due of the ballet dancers and their bags carrying all the gear.

As in the previous day, students continue to use the card machines, even if on Monday the usage was significantly higher – potentially because it represented

the beginning of the week. This is the major discrepancy between the previous observation day.

The seating area on the benches and sofas is quite similar and the intensity of movement towards the beginning of the classes at 8.30 a.m. is also identical. Students tend to seat on the benches and from the point were they are all taken, there is an accumulation of students surrounding the ones that are seated. At some point the patterns of co-presence are so dense that the natural moment trajectories have to be contoured because people cannot go in a straight line due to all the agglomerations of students staying on the main hall.

Under a closer observation the students have routines where they separate themselves according to their areas of interest (shown by the nature of their conversations and overall activities), but foremost according to their age group. It is possible to identify that older students get together near the library and that younger ones stay on the longitudinal benches more central in the main hall and near the middle staircase. There are also some students who wait for their friends on the exterior of the school, while others wait for their colleagues near the entrance to the cafeteria in smaller groups. The staff's counter is also a meeting point because it generates conversation and interaction between the staff and some students, particularly younger ones. Some couples wait for one another immediately near the entrance before departing to their classrooms. All of these stays lead to a high density of people near the entrance, which is added according to the increasing arrival of all the school community as the beginning of the classes approaches.

The older students tend to spend their time using their phones, which is a very significant activity on the daily life of today's students, clearly observed during any break in the school. Even at the time when they are together each one is using his phone individually or looking at the other one's. The phone is mostly used for listening to music, playing and using social media. A few also look into books and produce some pedagogical activities. The younger students, on the other hand, talk mostly with each other in a more face-to-face and spontaneous manner.

It is also the younger students who usually arrive earlier, probably because they are brought by their educators who will then go to work. The older ones, if they come by their own, usually arrive closer to the start of classes at 8.30 a.m., when trajectories tend to be quicker and denser amongst this space, in the fifteen minutes prior to the beginning of the classes.

Until relatively 8.10 a.m. there is a significant lower density of people: students, teachers and staff. Activities are done slower and in smaller groups, and movement is also quite slower because the arrival at any point is only due to twenty minutes afterwards.

This has all been possible to observe because the weather allowed this dispersion of people through the exterior and interior spaces. On a rainy day, it is probable that students will not take the external courtyards and choose to climb the stairs to go through the internal corridors to the pavilions, and that the students do not wait for their partners in the exterior of the building.

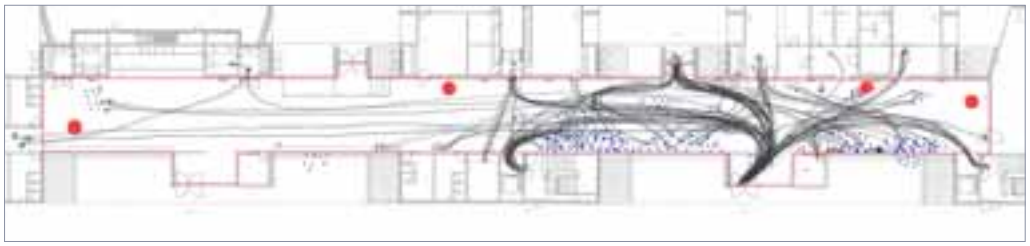


Fig. 225.a) Main hall

. the cafeteria on the ground floor (1 observer)

This observation is quite similar to the previous one on Monday at the same time. The movement was so slow that it could be easily depicted. This time a group of students met, first two teenagers were talking to each other on a table, then two boys and two girls of about the same age joined in. Afterwards a student was alone on a table when another one joined in and they started to talk. When the bell rang for the start of classes all students left the space. Six to ten students of about fifteen to sixteen years old went to the card machine and then went back out.

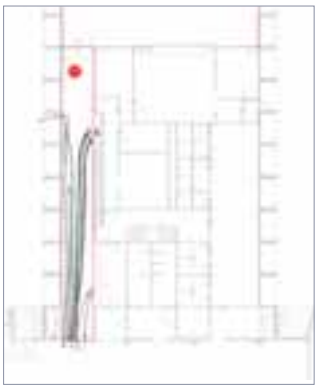


Fig. 225.b) Cafeteria

. the main corridor of the first floor (2 observers)

It is concluded from this observation that the main movement is from the central staircase to the teachers' offices, for teachers and also for the music students that go towards the room in that direction to leave their music instruments. Students overall take the staircases for going towards the first floor and access the external pavilions.

The topside of the corridor used for dance lessons is very intensively used before lessons and generates movement, social and artistic practices nearby. These dance

students are the most frequent users of the staircase near the library on the ground floor that leads directly to this side.

Hence, there is a clear unbalance of density and use from the centre of the corridor towards the science labs, the dance studio and the external access that is highly frequented. The east side of the corridor is more used during the afternoon period when all music classrooms are occupied, whereas during the morning this side is more specifically used for accessing the students' lockers. Naturally, the density of teachers and students in space increases as the beginning of classes approaches.

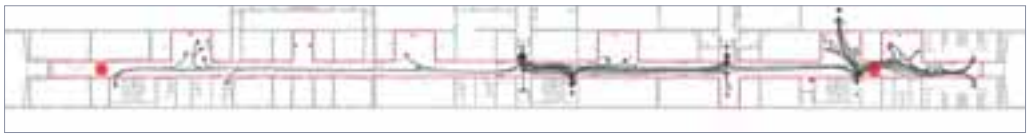


Fig. 225.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

Again this observation proves that at this time this floor plan has very little use. During this observation there have been no staff or teachers perceived in this floor. Only students used the space as a pathway and merely two younger girls were observed to be talking in one of the corridor's niches. Two classrooms have been opened by students to place their instruments and other music materials.

Fig. 225.d) Main corridor of the second floor

Fig. 225. Observations 25th January, 8.00 / 8.30 a.m. _ final drawings
(Carolina Coelho)

. 10.00 a.m. / 10.30 a.m.

. the main hall of the ground floor (3 observers)

There are no significant differences from the previous observation day at the same time period in this space. This is one of the breaks used by students to go to the card machine, which generates long and dense queues near these machines. It is also a break for students to go to the library for quick matters or clearing any doubts near the teacher or staff.

Students singing and studying near the auditorium's cafeteria have also been identified. As it is a more demure space, further from the highest density of users, some artistic students come here, even if the cafeteria is not open at this time, precisely to have more privacy and practice in small groups. Others also come here

for studying in a more reserved and quite place, which is provided with seating and chairs, relevant for this purpose.

At 10.10 a.m. students tend to leave the main hall and head for their classes' location, as classes begin again at 10.15 a.m., which diminishes the density of people on the main hall from that time on. From the moment classes start the main hall is almost deserted, deployed from the students and teachers in class, and has only the staff that uses these moments for cleaning and the passing teachers and staff from the secretariat and the Direction that move through this area.

Fig. 226.a) Main hall

. the cafeteria on the ground floor (1 observer)

Similarly to the previous observation day, during this time period there has been a significant increase in people in space, mostly by students older than fourteen years old.

The most frequent movements are from the entrance to the card machine and then to the bar, because the purchases can only be made after passing by the card machine. Or, more shortly, students come from the entrance door to the card machine and subsequently leave the space. With a few exceptions of small groups that stay in the cafeteria to eat and talk, the remaining leave the bar after purchasing their snacks.

Close to the end of the break the cafeteria gets generally empty, this is the time when a few employees come to have something to eat and the staff cleans the floor and the tables. Unusually, a student still stays there studying after classes restart. If teachers and staff need to use the cafeteria, they use it before or after the students' break, avoiding queues and the high density of people in space.

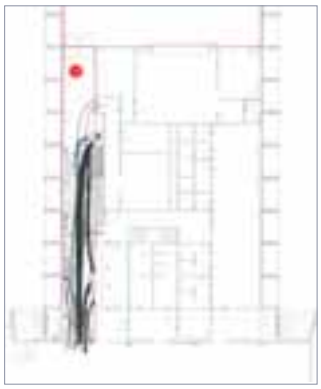


Fig. 226.b) Cafeteria

. the library on the ground floor (1 observer)

This observation has been quite similar to the one on the previous day, for the same schedule. Henceforth, the main activities undertaken at this time have been the following: reading newspapers and magazines, book and online research and doing the homework, which proves that learning activities are supported by diverse media and also diversified ways of working.

As this schedule coincides with the mid-morning break, the errands done in the library are of short duration and so, the entrances and exits in and from the space are frequent, namely for quick searches on computers, books and magazines. The library space also provides conditions for placing the students' backpacks and small group conversations as active, yet informal, learning environments.

There have even been two smaller children that have entered the library only to pursue a short conversation with the library employee, which also proves the informality and foremost the well-being feeling provided by the space and the people and its possible experiences.

The most remarkable evidence reported from this particular observation is that younger students tend to be placed near the entrance and closer to the library employee, whose engagement and support makes them feel welcome. Instead, the older students tend to choose locations further away from the entrance door, where the visual control is more difficult and where a sense of higher freedom could be perceived.

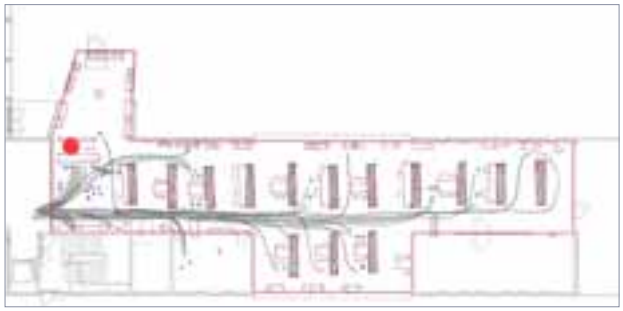


Fig. 226.c) Library

. the main corridor of the first floor (2 observers)

This schedule is much richer in terms of diversity of activities and quantity of users in this space. Contrarily to the previous observation at the morning arrival, this time all the corridor is at use on both sides and the movement towards the teachers' offices gets a more uniform nature in regard to the remaining pathways.

Classrooms that are held on both extremities of the corridor hold students nearby on the two closest open spaces to the corridor, also with the ones waiting to go in the small auditorium. On the dance studio side there is an accumulation of dance students, namely female ones, waiting for their lessons to begin at the entrance of the studio or near the dressing rooms.

Interestingly, the corridor on the transversal hallway of the building where the labs are located serves as a common living space for the students that wait for their classes to start and that stay near their following location. The fact they are seen sitting down on the floor or standing up in small groups and socially interacting proves this situation.

This observation could be divided into separate times: on the first ten minutes of the break the space is more intensively used from the pavilions to the staircases, from 10.10 a.m. to 10.15. a.m. it has lower intensity of movement, and from that time on users go straight to their destinations: classrooms, pavilions, the small auditorium, the dance studio,…

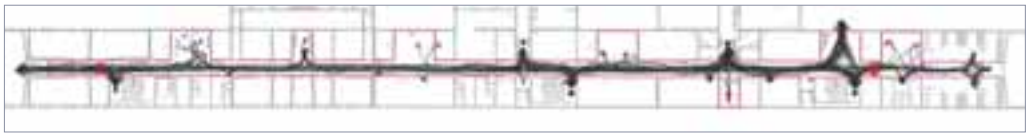


Fig. 226.d) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

Similarly to the previous observation day at the same time, there has been an increased use of the corridor on this morning break, particularly related to the crossing from pavilion A to the staircase downwards. There was noted the passing of four teachers and two employees from the staff, and the remaining users were students.

It is also the dance lessons that generate a high density of movement near the studio and its access is done by the nearest staircase from the first floor. Students of about thirteen to fourteen years old gather around the studio's entrance and the toilet nearby. The remaining students on the floor are located in small groups and attend the secondary teaching or the 5th and 6th grades.

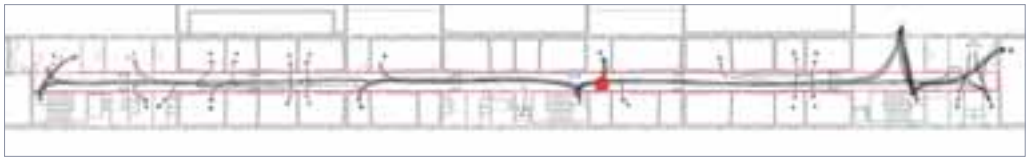


Fig. 226.e) Main corridor of the second floor

Fig. 226. Observations 25th January, 10.00 / 10.30 a.m. _ final drawings
(Carolina Coelho)

. 1.30 p.m. / 2.00 p.m.

. the main hall of the ground floor (2 observers)

As seen, this is the time period in which students and teachers leave the school if they do not have lunch there, again perpetrating the entering and leaving movement from and towards the staircases, the Direction's hallway and the external courtyard to the main access door.

This particular observation has noted a gathering of a teacher with students, which is also due to this common use of the space by all the community, gathering teachers and students in the same place and potentially generating encounters and even conversations, which ultimately can have pedagogical potential.

Even so, also the parents wait outside for their children near the entrance, gathering more people on this access point. As there are no classes from the regular teaching on Wednesdays afternoon, this exiting movement by students from the school is even more profound.

Students are perceived waiting to be picked up by their educators and others eating light snacks at the main hall. While waiting, students also choose to talk amongst each other, start their homework or contemplate the multiple displays on the hall with the latest information and news from the school, as it was perceived during the observations. Younger students continue to be identified as more active and to endure in more physical activities with their peers, which corresponded to small races and playing in groups that happened during this observation time, particularly because the main hall has a long length for those games without bothering the remaining students.

Anyway, there are less people using this space as a staying area compared to the morning arrival or the mid-morning break and it is more concentrated in the central area, on the benches adjacent to the glass windows, that on the remaining spaces. There is always someone, either students, staff and teachers, near the entrance counter for socialising or for any information required.

There is still some movement towards the card machines, but quite less noteworthy. There is some entrance and exiting movement to and from the cafeteria, which also relates to the cafeteria as being the exit place from the canteen. After lunch some movement for entering the school by the teachers has also been remarked, for attending their afternoon meetings.

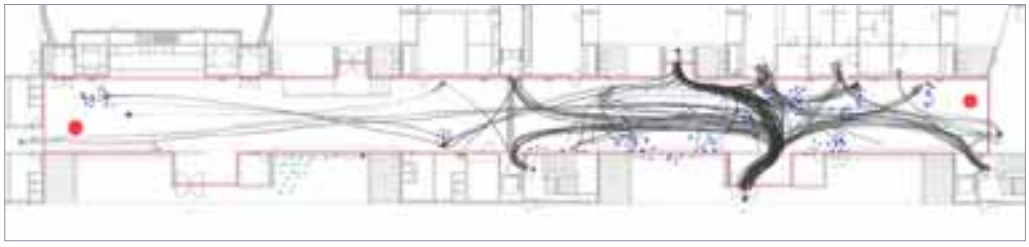


Fig. 227.a) Main hall

. the cafeteria on the ground floor (1 observer)

With regard to the compared observation made at the same time period on the previous observation day, there has been fewer people using this space. Not many

people stay in the cafeteria at the same time and there are no lines to the card machine nor to the bar, this time. Instead, the number of people that stay there to actually eat is larger and they use the free chairs to do it. There are less social activities, also because they do not spend so many times in both lines, where social interaction usually happens here. Most users of the cafeteria are over fourteen years old and staff also goes to the cafeteria, particularly after classes start or after lunch time, also for ensuring that everything is accordingly, for cleaning and for checking the card machine.

At 2.00 p.m. the door to the canteen opens and the cafeteria is turned into a crossing space between the canteen and the main hall, heading towards the exterior, the vertical accesses, the library or the toilets, creating a new pathway.

Fig. 227.b) Cafeteria

. the library on the ground floor (1 observer)

As explained earlier, the fact that there are no regular classes on Wednesday afternoon, leads to a all different use of spaces and respective density of movement and activities. This is proven by a proportionally higher frequency of artistic students because the regular ones have left school at lunch time. Naturally, this impacts all the spaces of the school and the consequent reports from the observations.

The students that remain at the library on the afternoons are students from the artistic teaching, which will have artistic classes later on in the afternoon. The noticeable activities are very similar the previously observed ones, even though the students' profile at this time period is very specific. It has been reported that students use the library at this time for: research, group or individual work, leisure, reading, book requests, games,… The demand for information is very frequent amongst the students that attend the library, probably linked to a comforting support felt towards the library staff.

Again it has also been verified that the tables closer to the entrance and the staff tend to be occupied by the youngsters, while the ones further back are chosen by

the older students. This could also be paralleled to the placement of the students on the main hall, whose observations have also concluded the specific positioning of the older *vs* the younger students. Therefore, habits and routines are very present on spatial fruition and recall a certain grouping, age, or any kind of connotation from the students and their peers.

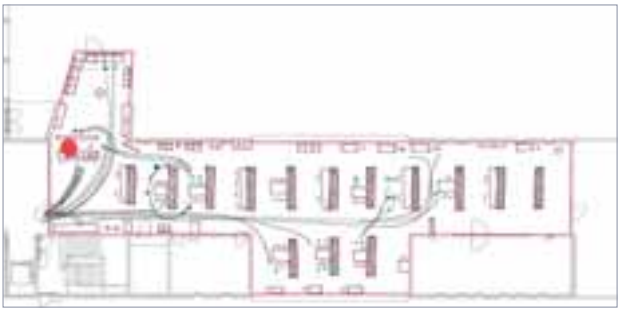


Fig. 227.c) Library

. the canteen on the ground floor (1 observer)

This particular day had the specificity of holding in this space nearly twice as much children from the ones observed on Monday. This implied that children gathered around more intensively at the entrance and on the queue. At 2.00 p.m. it started to get less denser even though the queue was still long, and at that same time the employee who takes the tickets for lunch closed the entrance door and opened the exit towards the cafeteria so that students started to spread around near the exit. Again, besides having lunch, the noted activities were similar from Monday, such as: talking, using the phone and playing.

The most determining pathways are connected with the order defined for the functioning of the canteen: entering the queue and circling the tables laterally until delivering the card, getting lunch near the display, and seating in one of the tables, afterwards the students take their trays to the shelves on the corner and exit the room. The densest paths are the ones that all students have to take, namely the entrance to the line, from there each can choose the seating space, spreading around the canteen.

Fig. 227.d) Canteen

. the main corridor of the first floor (2 observers)

Again a disparity in the density of users is noted from the east to the west side of the floor, due to the higher frequency of movements between the teachers' offices and science labs to the vertical accesses, which is the highest for the first five minutes after classes end.

The niches open to the corridor are now used in a more diversified manner. There are students singing and playing instruments for practising, when classes are all occupied, like an harp student sitting on a bench in one of the well-lit niches, which embed the corridor with a distinctive music ambiance, very specific of this school. This can be perceived as a programmed activity because the student has said to be a scheduled activity taken on every Wednesday afternoon at this time, when a member of the staff helps her to get the harp onto the corridor for practising.

Pedagogically, there are students doing group work, reading books and taking notes in pairs. Socially, there are also students talking informally while waiting for the next classes. When students intend to read, study or practice alone they choose smaller niches for a more private space and ambiance. Teachers use the path between their classrooms, the teachers' offices and the stairs to talk in a quick manner.

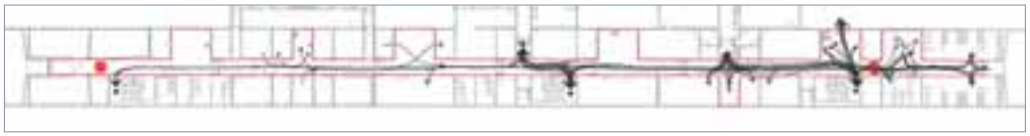


Fig. 227.e) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

During this time there is a significant amount of movement to and from the classrooms in this floor, by both teachers and students, and most intensely from the central staircase towards the east side of the corridor.

During this break there was an employee controlling the activities in this corridor, sat at the desk, but there has been no movement, nor any activity near this employee. The registered social activities have been the following: in front of the central staircase a young student using her phone, a mother sat waiting for her child and leaving the floor plan after the child leaves the classroom, four artistic teachers met in from of the central lift to have an informal conversation and a student was placed outside the classroom waiting for it to start. These are all artistically related activities, linked to the classes and which involve students, staff and even educators/parents, which is particularly relevant in the conservatory rather than in the school.

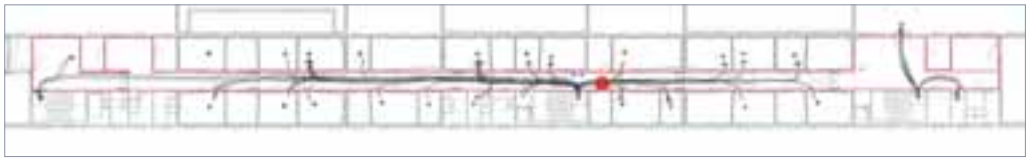


Fig. 227.f) Main corridor of the second floor

Fig. 227. Observations 25th January, 1.00 / 1.30 p.m. _ final drawings
(Carolina Coelho)

. 5.00 p.m. / 5.30 p.m.

. the main hall of the ground floor (4 observers)

During the afternoon and between the two observations, the floor's layout has been submitted to a change in the furniture rearrangement for the purposes of an exhibition. So, already at this observation, an exhibition was already in display and the sofas that were placed longitudinally, adjacent to the glass windows, have been moved towards the centre of the space so that posters could be placed on the perimeter near the library topside of the main hall. Naturally, that this has changed the experience in this space, mostly because students now tended to seat in the same sofas but the way in which they stand to gather themselves has changed. The sofas were placed in pairs and opposite to one another, so that students could not be together in a row or in a semi-circle as they did before, but rather in two sets of two. If that group grew to a bigger set of colleagues, then the ones in the back of the first had to turn towards the first, which proves it is not the most comfortable layout for groups but only for pairs of students alone, particularly if this is a position for stay in for more than the regular break of a quarter of an hour.

This leads to the clear conclusion that furniture plays a very relevant role in the seating position of the students and implies the way in which people act, live and talk amongst each other.

Another relevant statement concerning this observation is that there are no regular classes on Wednesday afternoon, because it is the time for teachers' regular meetings. So, if there are fewer students because the regular curriculum students have already left the building at lunchtime, it is concluded on a significant lower movement and density of co-presence than on the previous observations day at the same time.

Therefore, the movement perceived has been caused by the conservatory, and in the case of this space, it is related to the auditorium's cafeteria, which normally already gathers a high density of users.

The auditorium's cafeteria has predominantly more students but also parents and teachers, acting as an aggregator of a whole artistic community rather than the school cafeteria, which is restricted to students. Here students talk, practice, eat and study, there was even perceived a student studying with his parent; gathering social, artistic and pedagogical activities overall in an informal space.

Overall, movements are mostly longitudinally on the main hall, because students arrive at the conservatory or leave it, but there are also the ones that seat in the benches or sofas, alone or in groups, for social or pedagogical experiences, such as the student perceived studying alone on the bench, even if for this particular observation the densest space for staying has been the auditorium's cafeteria.

Fig. 228.a) Main hall

. the library on the ground floor (1 observer)

Having already perceived the regular routine of the library's usage according to each time period, this observation has been able to be even more thorough and to establish that at this time there were about twenty to twenty-five students in the space. This corresponds relatively to half of the students that were on the same observation on Monday. This is probably due to the fact that regular classes are not held on Wednesday afternoon, which diminishes the overall users to the ones of the artistic curriculum.

From the students accounted for in this observation, relatively half are working formally on their homework or studying, and the remaining half are pursing activities that tend to be more informally engaged like talking amongst each other. This is a specific feature provided by this space, its furnishing, its staff and, foremost, its pedagogical project, that also responds to the lack of a common student room and the need of an informal learning environment, particularly prone for both the regular and the artistic curricula.

Even though visual control can be rather difficult to perceive all the activities undertaken in the library, the staff proves to be keen on ensuring the ambiance of this space, and so, the employee moves around quite often to verify what is being done by the students.

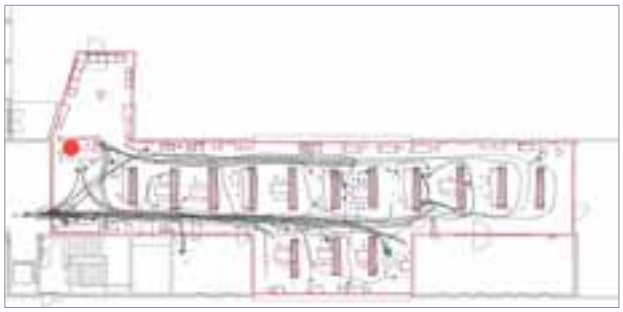


Fig. 228.b) Library

. the main corridor of the first floor (2 observers)

This is the time where there is a higher level of occupation of all the classrooms on this floor. The classrooms are not soundproof towards the corridor which also embeds this space with a very diversified and enriched artistic ambiance and the movement along the corridor provides a change in the instruments and music genre that makes it even more interesting in artistic terms and pedagogically varied in the curriculum options provided.

Again at this time, teachers, students and parents cross the corridor, while others wait for their classes by practising on the corridor benches. Interestingly, this has been the moment when there was noted the least amount of people in space. This could be potentially explained by the fact that there are no regular classes on Wednesday afternoon and that teachers are in meetings or have left the building.

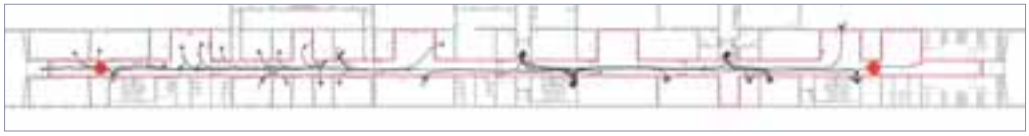


Fig. 228.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

During this time period there have been constant entries and exits to and from the classrooms. There have also always been people standing on the corridor. Socially the users have done the same activities noted previously, to which this observation added the following: younger students playing with a ball in a larger niche near the corridor, leading to the access to pavilion A – this has been noted as a space chosen for particular younger children to spend time and as already perceived in other observations, these children have more active games and physically interact more. Also there were children having a mid-afternoon snack, talking and using their phones. Talking is recurrent amongst the whole artistic community: between teachers, teachers and students, between students, and also engaging their parents.

Particularly during this observation there have been an extensive amount of educators/parents and grandparents on the corridors, waiting for their children to finish or start their classes. These relate to younger, ten year-old children or less.

There were some students who check the information on the display boards on the walls. There was also an employee controlling the activities on that floor sat on a desk. Nearby this employee there were two children sat on the floor producing some craft materials as a pedagogical activity, curiously undertaken on the floor of an informal space. This could be a personal choice from the students due to the privacy of this space compared to the main hall, or to the presence of the employee ensuring their well-being, the adequate lighting conditions, or simply due to the location of the space near a relevant space for them.

Nearly all classroom were being used, which contributed to the highest density of movement in this space noted so far, and contrarily to the same observation on Monday, the high-density of people lasted throughout the all thirty-minute observation.

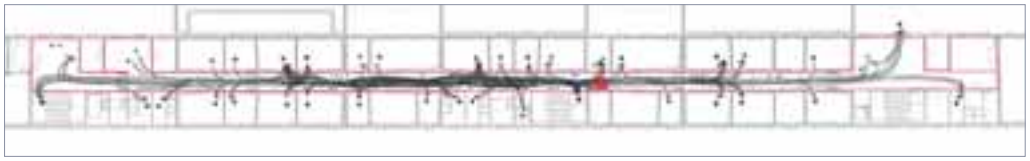


Fig. 228.d) Main corridor of the second floor

Fig. 228. Observations 25th January, 5.00 / 5.30 p.m. _ final drawings (Carolina Coelho)

7th February 2017 (Tuesday, exam week)

After the two previous observation days, the following will serve as validation of the activities and the movements reported and to depict specificities noticed on these particular days. The following observations concern a Tuesday and a Thursday, which differ from the previous Monday and Wednesday chosen. This is relevant since the school has a weekly routine in which classes are arranged and therefore, the scheduled classes infer on the use of space, their movements and activities and the density of people on each of the chosen spaces for observations.

Naturally, the following reports will aim to add further and more detailed information and to confirm or question the previous observations days in regard to their frequency or repetition.

Besides, the week chosen for these observations has been a week where tests have been more frequent, which might imply more pedagogical activities all over the school and undertaken during the students' breaks or free time. This will be added to the conclusions. Again, the noticed activities and movements will also be able to assume if these can be programmed or a part of a repeated routine and not as spontaneous as it appeared on the first two days – this is, in fact, something only perceived with repeated observations.

Redundancy in regard to activities and similar description of spatial experience will be avoided and replaced with the depiction of novel activities and a critical regard on the observed spatial fruition in relation to the space, its features, location and overall conditions it holds for hosting the activities perceived.

. 8.00 a.m. / 8.30 a.m.

. the main hall of the ground floor (4 observers)

Probably because it is raining there are much more children and teachers climbing the central staircase than on the remaining days, and from there they take the interior corridors towards the external pavilions, avoiding to go straightforward by the exterior courtyards. Also because it is raining, the students that usually wait for their peers outside the school have been closer to the entrance trying not to get too wet. It is possible to conclude that the choice of path, when several can be taken to the same location, may differ if some variable changes. And if in situations when all variables remain equal people tend to choose the path they usually do, becoming a routine, if something like the weather changes, then another pathway may be chosen or an activity may be done differently.

In regard to learning activities this could also be potentially applied. In this case, being a week where there are more exams, it will be expected that longer and more frequent pedagogical activities occur, as compared to the previous observation days.

It was also reported that more teachers and staff have entered the secretariat and Directions' offices, before going to their classes, compared to the previous days. Also there are more young children at the main hall than usually, possibly waiting for their colleagues or waiting for the rain to stop before leading on to class.

Another remark during this particular observation is that the distribution of movements throughout the main hall seems more balanced than on the remaining days. It is possible that this may be connected to the fact that there are less older students there and that younger ones tend to spread around the space. Anyway, the activities continue to be quite similar to the previously noted ones: using the phone and talking socially, studying regular curriculum subjects, and studying beats and rhythms by artistic students.

As it has been noted, the layout of the sofas near the library has changed for a temporary exhibition. The current placement of the sofas back to back hampers social encounters and interaction in bigger groups. This could potentially explain the choice for the tables and chairs on the auditorium's cafeteria by some groups of students to seat together and engage socially.

Fig. 229.a) Main hall

. the cafeteria on the ground floor (1 observer)

This observation proves the routines perceived in the days prior. Students enter the space for using the card machine, in order to purchase lunch or a snack throughout the day. Only a student has stood on a table reading and using his phone and two others stood on a table talking. Clearly, this is a less used space at this time period which is mainly used for the card machine, that even holds a small queue near the start of the classes at 8.30 a.m..

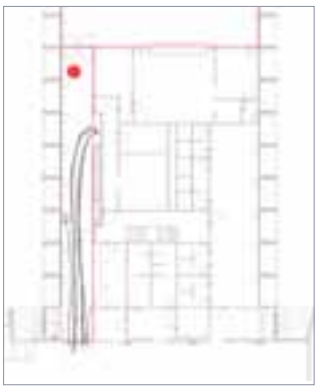


Fig. 229.b) Cafeteria

. the main corridor of the first floor (2 observers)

This observation day led to establish the recurrence of some activities and movements. The highest density on this space during this observation occurs near the start of classes, just before 8.30 a.m., prior to this schedule, students and teachers either have not arrived to school yet or are in other spaces such as the main hall before climbing the stairs. In the first ten minutes of the observation some students have been identified to be there studying, possibly choosing this space for its quietness during this time of the day, the fact that it has natural light and is well-lit and due to the existence of furniture that enables seating and working.

The central staircase is the most used vertical access, both by students and teachers, in which the first head towards this floor for using their lockers or the room for dropping off their music instruments, and the latter towards their offices.

The most socially engaged area of this corridor is the niche near the dressing rooms that is used for waiting until the dressing rooms are open for preparing for the dance lessons. Meanwhile, students stand there talking to each other.

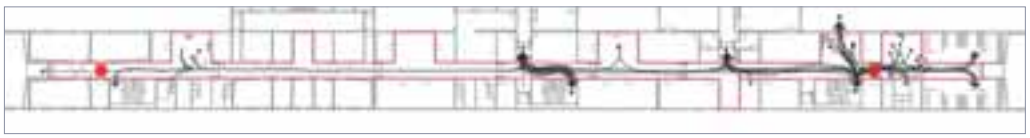


Fig. 229.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

This is one of the least used spaces at this schedule. During the all half an hour of this observation it stood practically empty. There has only been movement of people towards their lockers, which have led them to climb up two sets of stairs, particularly with heavy or voluminous music instruments they leave in there.

There have only been three female students talking amongst themselves and another student using his phone, all in the niches open to the corridor. There was also a student from the secondary level studying there. This observation, as detailed as this is, is only possible precisely because the number of users during the morning arrival is very diminished, while on other spaces, even if the number of observers is higher, it is not possible to make this description, to count the users in this precise manner, or to perceive so clearly the nature of their activities or age range.

Fig. 229.d) Main corridor of the second floor

Fig. 229. Observations 7th January, 8.00 / 8.30 a.m. _ final drawings
(Carolina Coelho)

. 10.00 a.m. / 10.30 a.m.

. the main hall of the ground floor (3 observers)

During this observation older students have been significantly more than younger ones on this space. The snack and card machines are very used and generate queues. There continues to be a more intense use of the central staircase as compared to the previous days, and also following the remarks of the early morning observations, when this situation had already been reported.

Besides, and on the same note as the previous observation, there are more students seating together at the tables of the auditorium's cafeteria and on the benches near the glass windows. This could be explained by the weather that impedes students to go outside the exterior courtyards to get together, and instead they stay on the main hall.

So, lacking a common living room, students use the main hall for both directional movements and also for standing, socially, pedagogically and artistically. Students spread around in the space and choose a seating space, from a wide variety: the sofas near the library, the benches near the glass windows near the library and near the central staircase, and the seating space with tables on the auditorium's cafeteria.

With their scattered location, students tend to be placed in clusters according to their age groups, teaching curriculum, interests and affinities,... Some even choose to stand instead of seating, and just stay in the middle of the space when the lateral areas are already too dense. There are also students who rather stand individually near a wall or on a corner for a more demure placement, and others near the entrance to the cafeteria or the exterior courtyard, for potential higher social prominence or for more easily being seen by their friends. At 10.15 a.m. when the classes restart the staff starts cleaning the space.

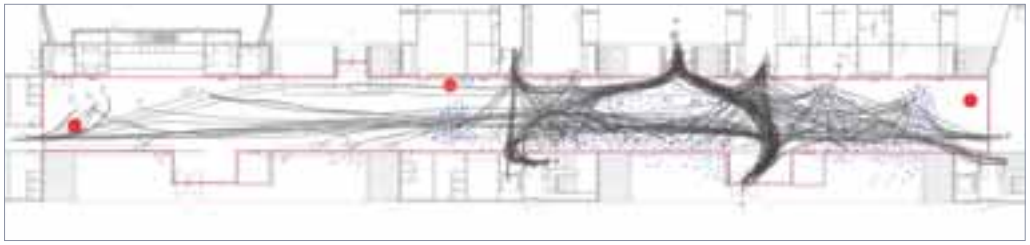


Fig. 230.a) Main hall

. the cafeteria on the ground floor (1 observer)

There are groups of students joint together near the tables closest to the entrance door of the cafeteria. Ten minutes after the beginning of the break there is a queue for the card machine, but on the contrary there is no line at the bar. The space gets overly loud and rather uncomfortable for staying. It has also been noted that the students who have used this space are about fourteen to fifteen years old.

After 10.15 a.m. the cafeteria gets relatively empty because classes have started, the staff cleans the space and the tables and checks the functioning of the card machine.

Fig. 230.b) Cafeteria

. the library on the ground floor (1 observer)

From the previous observation there has been a slight change in the furniture arrangement: a display has been placed where a sofa was before, the lounging area has a new layout and there are also more sofas near the lockers.

There have been students of all ages going to the library during this observation. In the first fifteen minutes the movement and the activities in the library have been quicker and in the last part of the observation the activities have been mostly related to individual study. As already perceived in the previous observations, activities there are very diversified, mainly regarding: the delivery or book request, individual or group study, online research, talking and using the phone and also some artistic activities related to the study of music sheets, where students sang lower and rehearsed the rhythm.

Overall, the nature of these activities is proven to be open, where the conservatory and the school play relevant roles in the kind of activities and also the possibility of socialising in this space that also embeds it with both a formal and informal learning character.

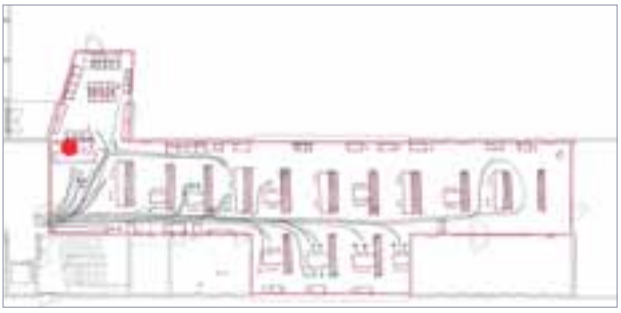


Fig. 230.c) Library

. the main corridor of the first floor (2 observers)

During this time period the movement throughout the corridor is extended towards its whole length and not only transversally connecting some rooms or accesses, as it did during the morning arrival. In the first part of the observation students leave their classrooms either from the science labs, the accesses from the external pavilions or the artistic classrooms and take the staircases, at a later moment students take the opposite way and come from several rooms from the school towards their classrooms on that floor.

It is during the exiting from the classrooms and the moment before the next classes start that the corridor has the highest density of users, in the meanwhile students choose to go to the main hall, to the exterior, or the cafeteria for their few spare time on this break. After classes restart there are only a few teachers and staff that pass through the corridor. The highest gathering of students occurs in the corridor, near the accesses and also on the standing areas on the open niches.

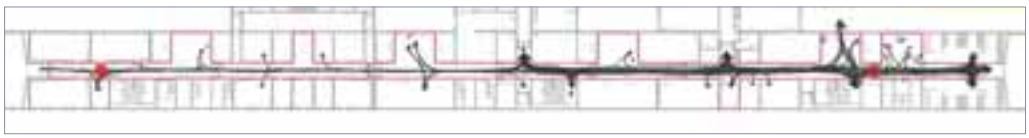


Fig. 230.d) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

Along this observation there has been a wide range of students near the dance studio, which has already been considered an aggregator of many students, also because the lessons take on wider groups, opposite to the music lessons that are individually-led or in small sets.

Between going to the lockers and standing near the classrooms, students take the time to talk amongst themselves. Cleaning has also been done during this time, in the corridor and on the classrooms. There have been a significant amount of students and teachers going in-and-out from the classrooms. Besides the students, also teachers have been noticed to stay on the corridors doing some pedagogical activities connected to their classes, such as consulting documentation and taking notes.

Fig. 230.e) Main corridor of the second floor

Fig. 230. Observations 7th February, 10.00 / 10.30 a.m. _ final drawings (Carolina Coelho)

. 1.30 p.m. / 2.00 p.m.

. the main hall of the ground floor (2 observers)

This observation came to prove the noticed activities and paths pointed out before. There is an intense movement towards the exit after classes finish for the lunch break. The students who choose to stay in the main hall eat, play and talk socially, but also study by books, which is particularly associated with this test week. They also use their computers and there are even students singing, which also proves the highly artistic ambiance this school is embedded in.

Still, this is a space with lesser staying activities on this schedule as compared to the morning arrival or the mid-morning break. At this time people usually leave school rather than being at this space in particular, because there are other spaces they could be in, such as the cafeteria or the canteen.

Fig. 231.a) Main hall

. the cafeteria on the ground floor (1 observer)

As this is lunchtime it has been noted that some students take light snacks on the cafeteria tables. At 1.45 p.m. all tables are fully occupied. There are lesser movements than during the morning break, but more standing activities, explained by the amount of students that occupy all the seating spaces. There continues to be a queue for the card machine as it has happened in the previous breaks.

Nevertheless, there has not been such a density of users as there was in the mid-morning beak. The difference at this time is that during the morning students purchase the tickets and leave to use them afterwards, and at this time, students purchase the tickets to use them right away at the bar.

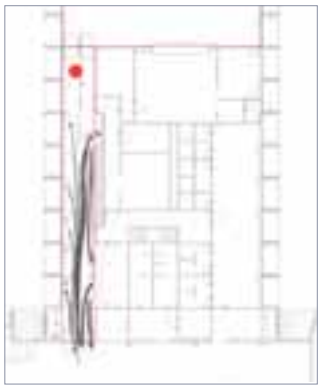


Fig. 231.b) Cafeteria

. the library on the ground floor (1 observer)

Again by this observation, it is clear that it is the younger students who occupy the tables near the entrance by the staff employee, contrarily to the older ones that take up the ones on the middle. The rear end tables are less occupied. There has been noted a significant exit movement at 1.45 p.m., and after classes start there are less entries on the library and a few students who had remained there, studying or playing, also leave after some time. The perceived activities are similar to the previous observations.

Fig. 231.c) Library

. the canteen on the ground floor (1 observer)

As noticed in the preceding two days of observations, the use of this space is very strict in order to provide all the meals and retain order and the well-functioning of such a high-density of users and respective movements. Again, this day proves the same routine: students enter the queue; leave their backpack on the benches, the corners near the entrance, or on the floor; take a tray and their lunch and head towards a table. While the first activities are common for all and are taken on the same spaces, the choice of table may induce different paths according to the place for having lunch. Afterwards, students leave their trays, pick up their backpacks and leave the space. Again at 2.00 p.m. a staff member opens the door to the cafeteria, which was once closed, so that students can more easily exit this heavily dense space. The most specific remark during this observation has been the largest amount of students using it, which was significantly higher than on the previous observations days. Nevertheless, there is also more staff to aid and therefore the queue does not increase with this amount of students, even though the line gets to the exterior of the canteen.

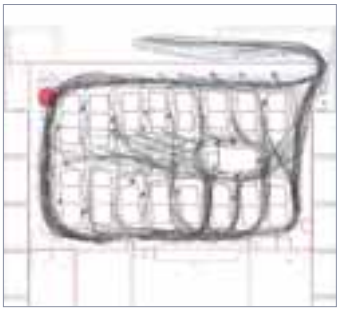


Fig. 231.d) Canteen

. the main corridor of the first floor (2 observers)

During this observation there are no dense flows of people as there were clearly defined previously and, in general, there was a decrease in the amount of users in both the corridor and the niches.

Therefore, as it is a time where this space is less busy, students use the space for a higher production of pedagogical activities in groups, and they choose the benches adjacent to the corridor to undertake them.

Also throughout the corridor, the lack of soundproofing from the music classrooms carries forward the sound from each class to the corridor, enabling a mixture of different sounds, instruments and rhythms, also embodying the artistic ambiance that the conservatory has, that the space provides and that the school inherits from this sharing of spaces. From 1.45 p.m. onwards there is a decrease in movement overall, and the passing of users starts to be more sporadically.

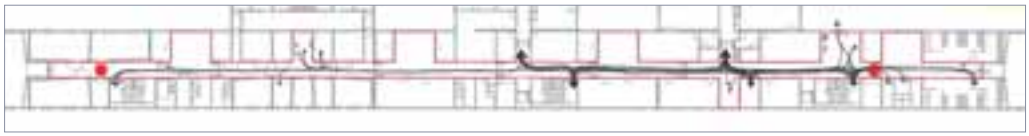


Fig. 231.e) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

During this observation more teachers have been noted on the corridors of the second floor. Several music classrooms were being used for practising and teaching to play music instruments and also a group has left the dance studio after the class. There has been a definite higher use of the east top side of the building compared to the west one, which is clear in the intensity of the drawn movements and activities in the following plan.

The activities perceived have been: using the phone, which is very recurrent throughout all spaces and students, eating a snack for lunch and talking, and there was a staff member visually controlling the space and all the activities from her desk.

Fig. 231.f) Main corridor of the second floor

Fig. 231. Observations 7th February, 1.00 / 1.30 p.m. _ final drawings
(Carolina Coelho)

. 5.00 p.m. / 5.30 p.m.

. the main hall of the ground floor (4 observers)

In this observation, the queue for the card machine near the auditorium was exceptionally long and there were also two staff members near the auditorium entrance because the exterior access is open for the programmed activities that had been occurring in the auditorium related to auditions for an international piano contest.

So, after the break starts a higher density of people is observed towards the exit, but a few moments afterwards the highest location of people is placed near the auditorium, which is explained by the numerous external participants in the contest. This also highlights the relevance of the conservatory towards the artistic teaching of an extended area and the prominence of the auditorium as an urban equipment of higher representativeness, even internationally, as proven by this contest.

This area near the auditorium's cafeteria also aggregates students of diverse age groups and students with parents studying together. The benches where students used to seat during the remaining breaks are now a place to leave their backpacks and go play.

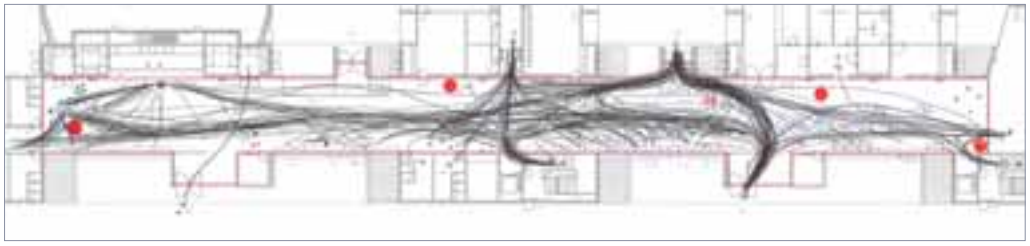


Fig. 232.a) Main hall

. the library on the ground floor (1 observer)

On this schedule it was the younger students that were perceived to be most significant users of the library, probably waiting to be picked up by their parents or waiting for their artistic classes, as opposed to the older ones that can more autonomously leave school.

Several people have been seen going all the way until the end of the space and returning back, probably seeking for someone. This can induce the possibility that the library could be a meeting point for a lot of students and also a space where students usually choose to be during this time of the day. This movement could also be justified for choosing the table that each ones considers to be better placed in space, near a specific furniture, shelf, technological device, or someone. So, by acknowledging the available spots and choosing the one that better suits each person, according to his preferences, the activities to be done, the routines and nearby students, this also generates movement.

Despite this reported movements, the stays are more frequent than the movements. Interestingly, at this time of the day this library acts particularly as a social space rather than a formal studying environment.

Besides the specificity of the choice in location of the younger *vs* the older students, there have also been noticed other differences in spatial fruition and learning processes. The younger students prefer to use physical supports for learning, such as books and magazines, while the older ones often research online on their phones or in the computers. If younger students use the school's devices, probably because they do not have their own computer or do not bring it to school, on the contrary, the older students only resort to the school's computers to check on the library's catalogue of existing books.

The change in furniture display detailed on the previous observation did not influence the activities observed in that lounging space, compared to the remaining observations. That can be a noteworthy conclusion as opposed to what could have been expected, since the previous exhibition had been there for about two weeks and has been replaced for more two sets of sofas that did not bring any more people to that area, even though the seating space had been enlarged.

Fig. 232.b) Library

. the main corridor of the first floor (2 observers)

At this time there is a different perception of movement from the central staircase to the west and the east topsides of the corridor. There have been more isolated movements along the side of the small auditorium, where students and teachers go individually to each of their classrooms. While the movement towards the dance studio has been more noticeable towards the exits, the niches and the lockers. Besides, the dance studio aggregates a significant amount of students near the entrance, the dressing rooms and the nearby niches. As previously regarded, the presence of the parents accompanying their children is more evident during this schedule.

The room conceived as a common living room is strictly used by the students who belong to the Student Association that has won the vote, therefore, others are left aside and simply do not enter the space, which has even its doors closed. It demonstrates clear signs of misappropriation and even some deterioration of the space which could be perceived as overly dimensioned for only the Student Association. This is aggravated by the fact that the school distinctively lacks a common living space for students which from the observations has to be overcome by the heavily use of corridors, the main hall, the lounging space on the library, the corridor of the science labs and the small niches open to the corridors on the first and second floors,…

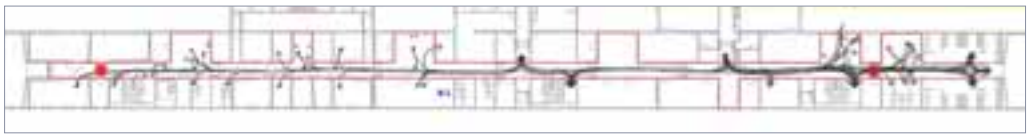


Fig. 232.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

This has been the time where this floor has had the highest density of use, gathering students of all ages, both from the articulated and supplementary teaching regimes. Teachers, students and parents passed by the corridor, there was a frequent movement of entering and exiting the classrooms, social activities were undertaken while waiting for classes to start and students also consulted the information on the displays related to the conservatory teaching.

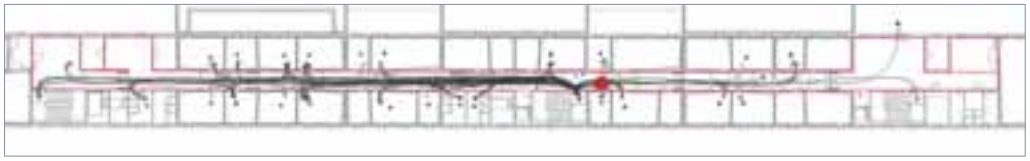


Fig. 232.d) Main corridor of the second floor

Fig. 232. Observations 7th February, 5.00 / 5.30 p.m. _ final drawings (Carolina Coelho)

9th February 2017 (Thursday, exam week)

The final observations day served to validate the previous reports, to confirm the already noticed activities and movements, and to identify the routines from the non-programmed experiences in space.

. 8.00 a.m. / 8.30 a.m.

. the main hall of the ground floor (4 observers)

Besides the regular activities already observed, there have been students undertaking educational activities, namely study for their up-coming classes and/or tests. Additionally, students have spontaneously engaged some of the teachers passing by, asking them some questions on those concerns. But, overall, this observation has proven a similar routine on spatial fruition and it has even become clear that the same people use the same spaces already identified and move in their frequent paths. So, the older students who seat near the library on the benches or sofas, continue to be in this area but stand in a denser and more compact manner. Meanwhile, the younger students that seat on the benches near the central staircase are placed more longitudinally along all the sidewall. The overall accumulation of students near the glass windows can be justified by the lack of benches on the opposite wall and also because of the visibility towards the exterior of the school.

Fig. 233.a) Main hall

. the cafeteria on the ground floor (1 observer)

As seen by the previous observations, this is the time period when the cafeteria is the least used and mostly only by students that head towards the card machine.

During this observation it was able to detail this further and count generally thirty people going to the cafeteria, including staff and students. At 8.00 a.m. two students came to seat in the cafeteria for a previously programmed study time, which might be related to the fact this is a test week and the work overload is higher for students, implying more time spent on pedagogical activities. This is very relevant, concluding that the cafeteria, at this time, precisely because it does not have very much users, can be a place for pedagogical programmed activities amongst the peers and without teachers, also proving that informal spaces are also suitable learning environments.

Fig. 233.b) Cafeteria

. the main corridor of the first floor (2 observers)

This observation come to validate previous conclusions on regard to the activities, the density according to the time period observed and the movements, accesses and direction of teachers, students, parents and staff.

The first ten minutes have no relevant remarks and only detached isolated movements. The most significant movement is central in the corridor, and about half the people using this space move between the central staircase to the central hallway with the teachers' offices and the room for leaving the music instruments. Furthermore, from the overall users of this floor about a third are students carrying large or heavy music instruments and a smaller amount are teachers.

The use of the niches opened to the corridor at this time of the day is generally for social interaction and encounter. Confirming the previous reports, the space nearest to the dance studio is the one which is more vividly used by a larger set of students ready to go on to the dance studio before and after preparing themselves in the dressing rooms.

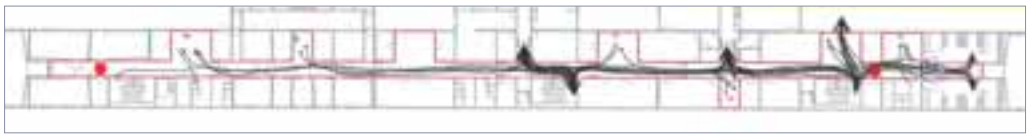


Fig. 233.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

This is confirmed to be one of the least occupied spaces at this time of the morning, proven by the fact that until 8.15 a.m., no one was going through the corridor. It is also set that the students go there for their lockers and come back down. Only two classroom have been used, one for a formal class and another for a student to practice. There is a higher density of people closer to the starting time of the classes, and specifically from the central stair accessing the external pavilions.

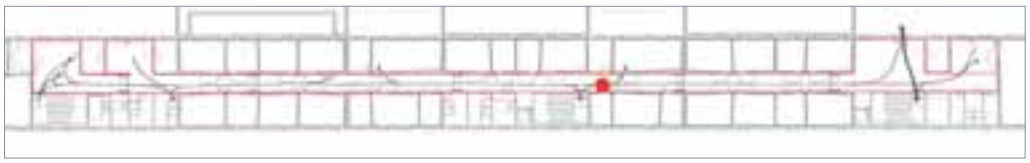


Fig. 233.d) Main corridor of the second floor

Fig. 233. Observations 9th January, 8.00 / 8.30 a.m. _ final drawings
(Carolina Coelho)

. 10.00 a.m. / 10.30 a.m.

. the main hall of the ground floor (3 observers)

During today's observation there has been slightly less students using the card machine at this hour. There has been the same similar activities noted: the people who exit the cafeteria go to the exterior courtyard, to the bench on the centre of the space, or the lateral staircase near the library. Sofas are preferred compared to the benches.

Still, about half time on the observation there was already noticed an unusual gathering of people near the auditorium, which is the side of the main hall which is usually less used at this time of the day and more used during the afternoon. Both students and teachers were seen there and at the beginning users were displaced uniformly throughout the space spreading from that topside to the central staircase. Until the end of this observation people were becoming more and more condensed on this area, arriving from every access and the groups could not be isolated in individuals anymore because they were so compact. Then it was perceived that a programmed educational activity was to be held at the auditorium related to the Portuguese League Against Cancer. This was aimed at students from the 7th to the 11th grades from both the regular and articulated curricula. Therefore, the classes and respective teachers already confirmed for this display entered the auditorium and then the main hall started to be more vacant. This proves that the auditorium is effectively used for pedagogical activities besides artistic ones, and that it has an educational purpose when placed in a school, enabling the gathering of several classes in a whole space rather than repeating the same activity on every class individually. Besides, it also validates the main hall as an adequate space for receiving a large amount of people in an exceptional occasion, besides its regular functioning by the users staying or moving there throughout. The following plan demonstrates the large amount of people reported to be in this space and the unusual path towards the auditorium, which held a programmed pedagogical activity, but not in a regular basis.

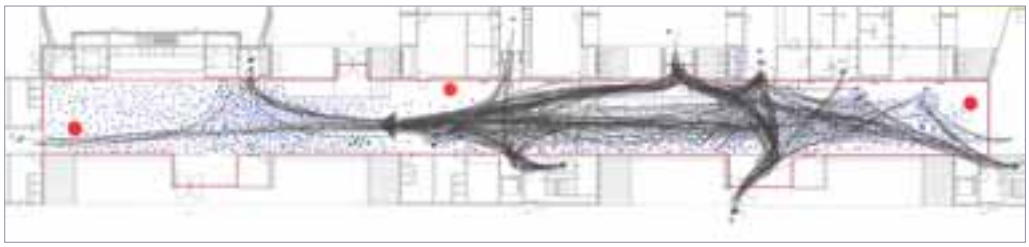


Fig. 234.a) Main hall

. the cafeteria on the ground floor (1 observer)

During this time tables were almost all full of students eating and talking, even though the seating spaces are reduced, but the majority went to the cafeteria towards the card machine. Usually there is a larger group of students at the entrance of the cafeteria where a small niche is created for accessing the exterior, which then was closed. The remaining users were displaced along the line for the card machine and the display of the bar or near the tables.

Fig. 234.b) Cafeteria

. the library on the ground floor (1 observer)

This observation intended to conclude that the main entrance of the library acts as an extension of the main hall, as an informal space in the activities and the spatial fruition, where students talk out loud and engage in dialogues, even though the sofa area is almost not occupied at this time. It has also been conclude that students use the library during the break for quicker activities and errands. After classes restart from the break there are only a few students left in the space.

Fig. 234.c) Library

. the main corridor of the first floor (2 observers)

This is the time when this corridor is most attended in terms of movement and density of people throughout the all space, and also in terms of the variety of uses and directions taken. Although there are artistic lessons all afternoon in almost every classroom, to which the students and parents of the supplementary curriculum are added to the existing users; it is during the morning that teachers and students from the regular and the articulated teaching, mainly in the science lab area and the artistic rooms, make this floor more attended and frequently used by a diverse community with distinctive curriculum profiles.

Again the area near the dance studio and dressing rooms is very used and generates high density of standing people near the entrance to the dressing rooms and the dance studio but also with constant entries and exits from both spaces.

Regular students also use this corridor particularly when they have science lessons and on these occasions students wait for classes outside the classroom doors, on the corridor itself, or on the entrance to that specific transversal side of the building. The students' shop is also a place that aggregates students and creates movement towards it. The artistic rooms, on the other end of the corridor, also generate density of students nearby, particularly by the "small auditorium" (as the orchestra room is commonly addressed), as well as the percussion room, whose usage generally implies the gathering of a group of artistic students rather than the individual lessons occurring in the central part of that floor.

Besides the high density near the rooms where group classes occur for the artistic teaching at the extremities, and the regular curricula students on the science area, some small groups of students have also been remarked standing along the corridor.

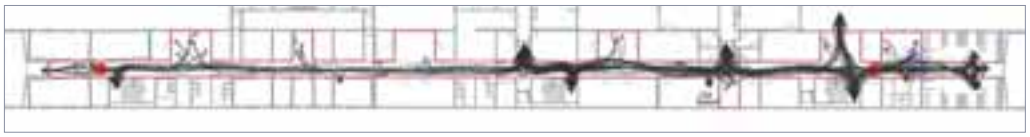


Fig. 234.d) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

There is clearly more people using this space than on the previous schedule, mainly between 10.10 to 10.20 a.m., on the mid-morning break. Besides, the highest density is perceived near the dance studio. Because at this time a dance lesson for younger students was starting, who waited near the studio, playing in the meanwhile. Children ran around from the studio's entrance to the corridor towards the external pavilions, the staircase to that same access, from the stairs to the toilets,… taking very different movements, starting and ending spots.

Students use the classrooms for practice more at this time than in the early morning, which potentiates music sounds from different instruments throughout

the corridor. The staircase on the east side is more frequently used by students to get to their lockers in that area, nevertheless it is the least used one, when compared to the central and the west side stairs near the dance studio. Staff is cleaning the space at this time and the corridor is used by both teachers and students.

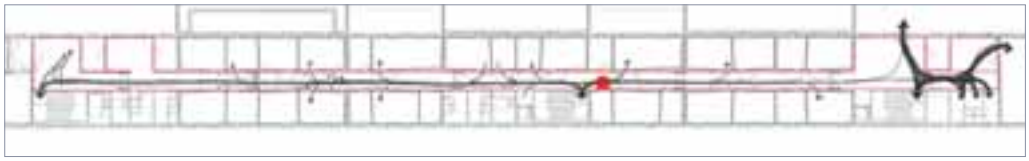


Fig. 234.e) Main corridor of the second floor

Fig. 234. Observations 9th February, 10.00 / 10.30 a.m. _ final drawings (Carolina Coelho)

. 1.30 p.m. / 2.00 p.m.

. the main hall of the ground floor (2 observers)

This observation has brought the confirmation of the informal environment of this space. Children were playing very actively on the main hall in the side that is usually the least used at this time, which is the auditorium side. They were literally running around, whose courses have been drawn in the following plan, validating the hall as more than a social, pedagogical or artistic environment, but also as a place for the regular activities of students of the diverse ages this school has. As already mentioned, it is the younger students that engage in these active games and do it in a very easy manner, demonstrating a sense of appropriation, well-being and belonging in space.

Curiously, on the other side of the main hall there were artistic students singing, which comes to confirm that informality sense and a notion of cosiness in space.

Fig. 235.a) Main hall

. the cafeteria on the ground floor (1 observer)

This observation validates the previous ones, regarding the location of students standing near the tables, the card machine or the bar display and overall, the high frequency of movement rather than stay, due to the narrowness of the space and the limited number of chairs. The dots represent just that – the few people staying, as opposed to the higher intensity of back lines depicting the movements, particularly towards the machine and then the bar.

Fig. 235.b) Cafeteria

. the library on the ground floor (1 observer)

As this week is a test week, the tables are almost all occupied at this time, even though study is paralleled with movement, children running and playing, and some noise from informal and social activities also undertaken in the same space.

Study is generally done in groups by students of all ages and the time for staying in the library has increased. Younger students tend to be more frequently in groups, while older ones can be either in groups or producing individual tasks.

The display of the furniture enables the formation of groups of students bounded by the shelves surrounding each one. This provides a sense of privacy and a certain work autonomy, but also hinders the possibility of full control of the activities done in this space, that in spite of being conceived as an open space, is very partitioned by the furniture layout. This also leads to a expanded use of the space according to each of the perceived occupational niches, from group work, to individual study, to phone games,…

Fig. 235.c) Library

. the canteen on the ground floor (1 observer)

Contrarily to the previous observation day, when the canteen had been particularly full, today has been the day when the canteen was the least occupied. At 1.50 p.m. there was no longer any queue for lunch. The tables near the display where food is served are the ones that are most frequently occupied, and the least used spaces are the ones near the window where the queue passes by.

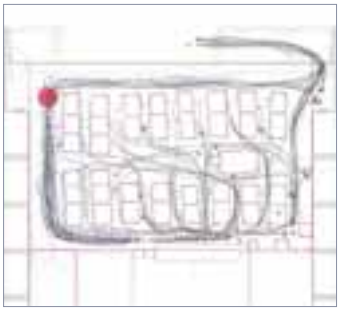


Fig. 235.d) Canteen

. the main corridor of the first floor (2 observers)

Even though there continues to be a more relevant density of people taking the pathways between the central stairs and the central transversal hallway, during this time the movements are more uniformly located throughout.

Interestingly, there is a higher attendance of teachers that move around the space, over students, in which the first represent about two thirds of the users of this space. The younger students use this corridor at this time to play, to run around and occupy the small niches more freely, which is remarked in the following plan. At this time the dressing rooms are not being used and so, the density of occupation clearly decreases from that side of the corridor.

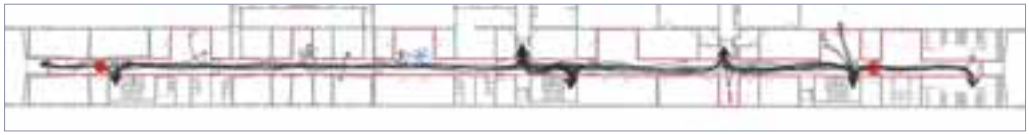


Fig. 235.e) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

During this time there is a generally uniform movement throughout the whole corridor and not a more pronounced direction as opposed to the previous observations during the morning, because at this particular time there are no dance lessons and the previously densely occupied space has now only five people there. Besides, opposite to the previous observations in the morning, at this time the teachers are the ones that more often use this space when compared to students and children who use this corridor for playing during this time period. Classrooms are now being occupied for practising and for formal classrooms, which embeds the corridor with a diversity of sounds from the different classes, and the students that wait to have lessons are seated on the benches on the corridor.

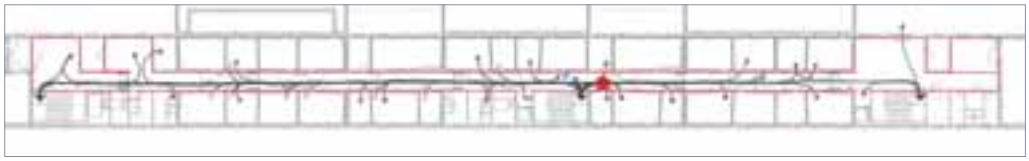


Fig. 235.f) Main corridor of the second floor

Fig. 235. Observations 9th February, 1.00 / 1.30 p.m. _ final drawings
(Carolina Coelho)

. 5.00 p.m. / 5.30 p.m.

. the main hall of the ground floor (4 observers)

As previously reported, at this time the auditorium's cafeteria brings users to this top side of the main hall. There are parents studying in the tables with their children or having a snack with them, there is also a teacher working at a table and people chatting. This is clearly a place for relaxation but also for artistic and pedagogical display, and could even be a place for programmed learning experiences if the studying time with the children is an actual part of the predetermined routine of a family.

From the other side of the main hall students wait to be picked up near the library on the sofas, and use their phones in their spare time. It is also the time when some teachers leave school coming directly from the staircases or from the Direction offices to the exterior exits. Some of the students that remain in school leave their backpacks on the benches and go play elsewhere or simply nearby in the middle of the corridor. Parents and children who arrive for the conservatory classes usually take the central stairs to go to the upper floors.

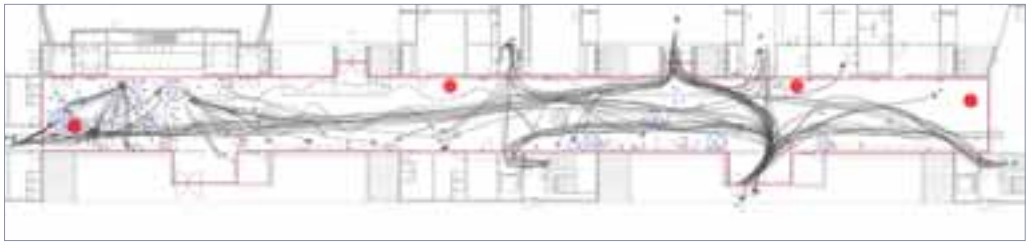


Fig. 236.a) Main hall

. the library on the ground floor (1 observer)

After four observation days the fact that the library holds a more casual but very frequented environment during the afternoon is now established. There are numerous groups of students studying, playing on their phones, talking,… and they are usually younger ones, as it has already been noted in previous observations. At this time the library is completely full and there have been students complaining to the staff for not having seating places to study. Activities, yet diverse, continue to be the same as those remarked before.

Fig. 236.b) Library

. the main corridor of the first floor (2 observers)

This time period has a high variety of movements in regard to the previous observation times, when some paths were quite recurrent. Still, the direction between the central stair to the teachers' offices continues to be significant. But there are more varied movements and, therefore, they are also less condensed. At this time the movements are very specific and individual of each user and directed towards a particular classroom, also because these music classes are generally individual. During this schedule the movements are higher towards the small auditorium and the music classroom on that side. Under the lack of a place to wait until classes start, students stand by the walls near the entrances or seat on the benches on the corridor.

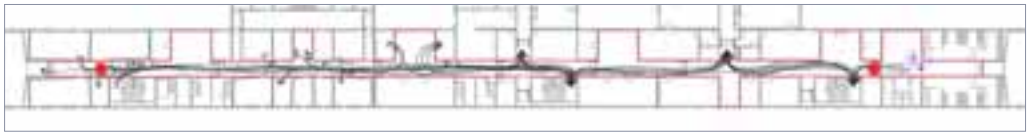


Fig. 236.c) Main corridor of the first floor

. the main corridor of the second floor (1 observer)

At this time students move towards their classrooms, often accompanied by their parents, who take them to the conservatory. There is a significant engagement of the parent with the artistic lessons, proven by the fact that they wait for their children nearby or even inside the classroom, and engage in conversations with their children and their teachers over their performances.

The fact that there is a high intensity of use of the music classrooms during this schedule implies that the sounds get through the corridor. At this time it is the central staircase, as well as the east stairs, that are most frequently used, and not the west side ones like in the morning period.

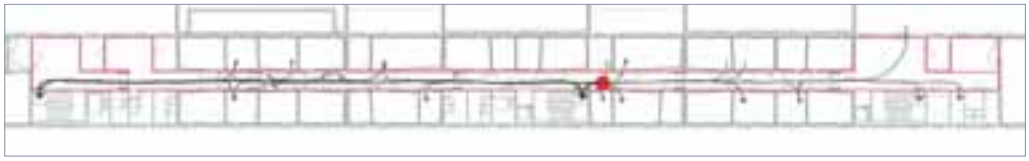


Fig. 236.d) Main corridor of the second floor

Fig. 236. Observations 9th February, 5.00 / 5.30 p.m. _ final drawings
(Carolina Coelho)

Fig. 237. Students waiting for classes (from left to right: the main hall and the science lab corridor) (Carolina Coelho)

. General findings from the observation matrices

After the description of the observed spatial fruition that became more validated with each observation and its repetition in four entire observation days, it is possible to conclude that, generally, the expected results match the observed behaviour and that the initially reports on space use coincide with a spatial experience that is connected to routines, patterns of behaviour and also to social variables, proven by the sketches on the plans that have distinctive similar features for each time period.

The spaces' fruition differs from space to space and also between the schedules chosen, which is even more distinctive according to the teaching regime of the students: either when the space is more used by the regular teaching, or when it is more intensively used by the conservatory students, or by both.

Overall, and lacking a common living room for the students, all spaces either with a more specific or more informal use, can be perceived as spaces to stay during the breaks, more even than it was originally expected. This is the case of the main hall, the cafeteria or the library, but it does not happen in the canteen because it is closed after lunchtime. But also spaces to go by are possible to be considered social spaces or learning environments, where students stay together or individually for studying, talking, practising,… This is the case of the corridors which are supported by the small open spaces near the longitudinal areas and both the corridor *per se* and those niches can be places for students do be in, as reported by the observations. Even the corridor on the science labs' area is used to wait for class, despite its lack of benches and its narrowness (Fig. 237).

Overall the vertical stratification of users is confirmed, due to the specificity of the upper floors in regard to the artistic teaching. When compared, the ground floor welcomes all the school community, the first floor has a teachers' area, the science labs and artistic rooms besides common spaces for all students, such as the students' shop, but the second floor is currently all occupied with artistic lessons.

a)

b)

Fig. 238. a) Corridor on the first floor; b) Students on the second floor
(Carolina Coelho, Maria Catré)

This has also implications on the time periods when these floors are more intensively used. And so, the ground floor is used at all times because it holds the exterior access, even though during the afternoon it also gathers the supplementary students of the conservatory, displaying a more extended community of users. The first floor is used during the all day, but the school teachers start to leave the building in the afternoon, which is balanced by the arrival to the conservatory of its teachers and the supplementary students (Fig. 238a).

The second floor is much less used during the morning and has a denser occupation in the afternoons, with the conservatory classrooms' full occupancy and also with their students standing on the benches and niches on their spare time (Fig. 238b).

This has also repercussions on the users of these spaces, because the external students of the conservatory who arrive after their school classes elsewhere, sometimes with their parents, are added to the regular and articulated students and teachers. Usually the parents accompany smaller children on to their classes, entering the school, something that does not happen during the school day, when entrances are very controlled. These parents also wait for their children inside the conservatory, either inside the class, outside on the corridor, on the main hall, on the auditorium's cafeteria or even on the library, demonstrating a wide variety of informal spaces for all the artistic community to be in (Fig. 239a).

a) b) c) d)

Fig. 239. a) Parents with their children: studying for regular classes and going to the music lesson; b) Main hall in the morning arrival; c) Main hall in the mid-morning break; d) Main hall in the afternoon

(Carolina Coelho)

Spaces

The main hall is the sole entrance to the school and during the morning arrival it gathers all users. Movement is noted longitudinally towards the first floors, namely by teachers and artistic students taking the staircases, and transversally to the exterior towards the external pavilions specially by regular teaching students.

As the canteen and the library are closed, the students stay on the main hall primarily for informal conversations or individual use of the phone, listening to music or similar uses of other technological devices, which clearly hinder any group experience. The access to the card and snack machines is also relevant and gathers a significant density of students. Some pedagogical activities have also been perceived, such as studying, talking about the classes and music practising, even if this is more noticeable during a test week rather than a regular week (Fig. 239b).

But it is during the mid-morning break that the density of occupation of the main hall is higher, potentially because it is the largest break in the morning and students get the opportunity to go to the cafeteria, to get together in the hall, or to go to the library, all at the same time, which enables a high density of people, both moving on the hall to go to some other space, or standing there individually and with their peers (Fig. 239c).

In the afternoon period, the artistic users are more frequent and more evident, considering that the regular teachers and students tend to leave the building (Fig. 239d). As noticed, parents bear a considerable position in regard to the density of people in certain spaces, particularly parents of younger children from the

a)

b)

Fig. 240. a) Library; b) Activities in the library
(Carolina Coelho, Jéssica Barreto, Juliana Ferreira)

supplementary teaching regime, who wait for their children to attend the class, remaining directly on the corridors outside the respective classrooms, on the main hall wondering around, on the auditorium's cafeteria, or even on the library.

Overall, the main hall has moving and staying activities and longitudinal and transversal movements. Activities are individual and collective and bear pedagogical potential. According to the time period, the frequency of each one differs, and clearly the afternoon period has more artistic related fruition particularly felt in a more casual and informal ambiance, from the hall, to the library and the cafeteria.

The library is a controlled environment, even if its furniture, that arranges several smaller partitions, either for groups or more individual activities, may not easily allow it (Fig. 240a).

Yet, it can act as either a formal or an informal space, more even than what had been originally perceived. This is proven by the activities repeated by the observations, some, outside of a more formal experience and portraying an environment of easiness and casualty on a learning space with a widespread potential. This is a particularly relevant place outside the school's jurisdiction: at 4.30 p.m. the school staff leave the library and are replaced by the conservatory staff. Then the library acts as a lounging space, but foremost, a more informal space. It is recurrent, from the observations made, that parents study there with their children and that children get together to study in small groups, informally but with a high pedagogical potential (Fig. 240b).

The auditorium's cafeteria also entices the main hall with an effective spatial experience

Fig. 241. a) Auditorium's cafeteria; b) School cafeteria at the mid-morning break; c) Locker space on the corridor on the second floor

(Carolina Coelho, Daniela Aires)

from which the space is deployed during the morning period, particularly in the east side near the auditorium. From the moment the cafeteria opens at 4.30 p.m. there is a casual gathering of users, namely of artistically related ones, either: teachers, students and/or parents, that stay there in the seating spaces and tables provided. This affords the space with the ability to stay and have group activities, informal knowledge transmission or even casual conversations, that do not usually occur on that side of the main hall, more prone to movement and not staying (Fig. 241a).

Contrarily, the school's cafeteria is not a very intensively used space by the students. Students go there towards the card machine or for a snack, but often chose another location to be or to study. The space is narrow for both standing in line for the bar or the machine, and to stay on the tables, which makes this space more easily perceived as a corridor. Note that even though this space is open at 8.00 a.m. the actual bar is not, which explains the early observations made with only a few people going to the card machine or just staying there, which particularly deployed it of any aggregating factor at the morning arrival. It is during the mid-morning break that the cafeteria holds the highest density of occupation (Fig. 241b).

Corridors have usually longitudinal movement. Their access points are the staircases, mostly the central and the west side ones, even if the east side one is used mainly in the afternoon for the students who wish to get to the small auditorium or to the lockers on that side (Fig. 241c).

As an additional systematisation of the observations from the main corridor on

Fig. 242. Dance students heading towards the dance studios for classes
(Carolina Coelho, Maria Catré)

the first floor concludes that the whole floor plan and its usage, both formal and programmed in the classrooms and informal and spontaneous in movements and social encounters in the common spaces of the corridor and in its niches. This is much more dense during the mid-morning break, where it is used as a pathway. The niches on the corridor are a means to access the lockers or considered as a possible location while waiting for classes. At the lunch break these have other usages, informal and social ones, and even artistic displays for practising music instruments or pedagogical activities such as reading or group working have also been reported.

During the mid-morning break there is a more dense accumulation of people near the central staircase due to the diversity of pathways it crosses. The movement near the staircase closest to the dressing rooms is also intense because they serve both the dance studio on the first floor as well as the effective dance studio on the second floor, which has not been conceived for such purposes and hence is deployed of dressing rooms on that floor. Therefore, students have to do their preparation on the first floor and go to the remaining dance studios for their classes, which leads to routines and scheduled movements (Fig. 242).

The most specific feature of both corridors, on the first and second floors, is the fact that they are not only bounded by a longitudinal layout, but they have open spaces to the corridor, of various dimensions and shapes and with different furniture arrangements. These act as spaces for staying, gathering both moving and standing in both corridors. This is very relevant in the design of the building but also in its fruition, because it enables the gathering of smaller groups with a more private accent to meet, with a different ambiance from the open main hall, the busy cafeteria or the mixed-use library. This can be paralleled with Hertzberger's thoughts on the relevance of smaller spaces that can be considered "spatial units" for smaller groups to proceed with diverse learning experiences:

> "A spatial unit could be described as a space that achieves a certain equilibrium between a sense of seclusion and a sense of community. Where a learning situation is concerned, this mean fulfilling the conditions that enable you to concentrate on your work while at the same time being aware of others and what they are doing." (Hertzberger, 2009, p.11)

These niches deploy the main distribution space of its sole nature as a corridor and can ultimately complement a more formal learning on the morphologically connected classrooms. These facts lead the niches to be considered as active learning spaces of smaller dimensions and socially engaging, also with the potential to convey knowledge amongst the peers. This is again understood by Hertzberger's outlook in regard to school corridors and the need to design and perceive them as effective places for learning as opposed to simple pathways for moving or placing children's belongings:

> "Those corridors that are dominated everywhere and always by rucksacks and odd bits of clothing, and by the endless pulling and shoving, badgering and carping that means they have to be made extra wide, using up a large proportion of what might otherwise be inspirational space, while they could instead be ideal places for meeting others, as well as helping to solve the everlasting problem of cramped classrooms. Completely eliminating corridors and adding corner areas, making the space suitable for communal use by diverse groups of pupils, created greater social cohesion and more places for smaller groups, while whole-class instruction could continue to take place in classrooms." (Hertzberger, 2009, p.9)

The activities observed have been mostly spontaneous, but if studying, working or music performing in a specific niche near the corridor becomes a routine, it could ultimately be considered a programmed activity, recurrent in those students' habits and a scheduled practice. Also, if students usually arrive early to practice before class, either in a classroom or in the corridor, this could also be considered as a programmed activity. So, the continuous observations are the sole means to prove this fact.

During the afternoon the movement is more disperse amongst the whole corridor. The movements towards the niches are more frequent because students either wait for some classes nearby or choose those spaces for their spare time, for social and pedagogical fruition. Reading and practising instruments are the most frequent pedagogical activities, whereas talking amongst the peers is the most common social interaction (Fig. 243a).

The most frequent pathways on the corridors in the morning are usually from the central staircase to the central hallway on the first floor. For the teachers this leads to their common living room. In rainy or particularly cloudy days, regular teaching students also use that same path to go to the external pavilions through the covered

a)

b)

Fig. 243. a) Activities in the corridors' niches; b) Room for students to leave their instruments and the room of the music sheets

(Carolina Coelho, Stephanie Torres, Micael Soares)

corridors that link to the pavilions, mainly to the one on the teachers' hallway. For the artistic students this leads to the room, in that same hallway, where they leave their music instruments (Fig. 243b) and ask for a classroom to practice. Likewise, another noticeable movement is from the staircases to their lockers located on another places near the corridors, so that each student leaves his music instrument before class.

The dance students usually choose to go through the west side staircase near the dressing rooms and the dance studios. So, overall, the movement in the corridors is from the staircases (because the lifts are restricted and not allowed to be used by students) to the classrooms, to the science labs, to the teachers' offices, to the instruments' rooms, or to the dance studios, according to the profile of its many users.

During the afternoon, the corridors usually have students practising music instruments but also studying or conversing in the small adjacent niches. There are also students waiting for their classes outside the classrooms or their parents waiting for the class to end. So, there are more frequent staying activities on the upper floors particularly in the afternoon, as compared to the morning period.

These small niches are used according to their furnishing, where round tables are prone for group gatherings and benches for individual waiting or music practising. Even so, these are effectively used by the students and more frequently for music practising than the main floor, because this floor is more prone to the artistic teaching and students share these same experiences in space, rather than on the lower floor where they meet with the regular teaching students (Fig. 244a).

a)

b) c)

Fig. 244. a) Activities in the corridors' niches; b) School cafeteria; c) Canteen at lunch time (Carolina Coelho, Stephanie Torres, Micael Soares, Daniela Aires)

The school's cafeteria experience in space is hampered by its narrow width that makes it difficult for students to stand while having a snack. So, students usually purchase the snack and eat it on the main hall or, when the weather allows it, on the external courtyard adjacent to the cafeteria. Its significant longitudinal axis entices movements rather that staying and this is proven by the low existence of tables for its few users. The mid-morning break is the time where more movement has been registered, mostly towards the card machine and to the bar display, after which students leave the space that becomes overly loud and crowded with a higher density of people. While at lunch time, there is lesser movement, making students choosing to stand there on the tables. Overall the cafeteria is a space where students go for purchasing a snack and leave, and not for staying. Generally, it is mostly frequented by fifteen-year-old students rather than younger ones (Fig. 244b).

The canteen, on the other hand, providing meals for both the regular and the articulated students, is a very dense space during the opening time. Nevertheless, students are acquainted with its organisational functioning and orderly get their meals, go to a table and have lunch. For the purposes of not duplicating the entrance with the exit in the same space, students arrive from an external spot and exit the canteen near closing time through the cafeteria, accessing the main hall. This proves once more that the cafeteria is mainly for moving rather than for staying. Again, furniture also adds to the organisation of the space and its usage and both accesses and tables are placed in order to avoid the duplication of the queues or any disorder caused by the high-density of students that use this space (Fig. 244c).

Floors

As initially assumed, after the observations it is possible to establish the existence of a vertical stratification of users according to the floor plans. From the morning to the afternoon period the users change and become more prone to the conservatory uses and classes, whereas during the morning there is a higher co-presence of teachers, staff and students from the regular and articulated teaching regimes. As the day progresses these tend to leave the school, and spaces such as the library and the entrance are taken on by the conservatory staff. Besides, when the school's cafeteria closes the auditorium's cafeteria opens, particularly as a gathering space for the artistic users.

Time periods

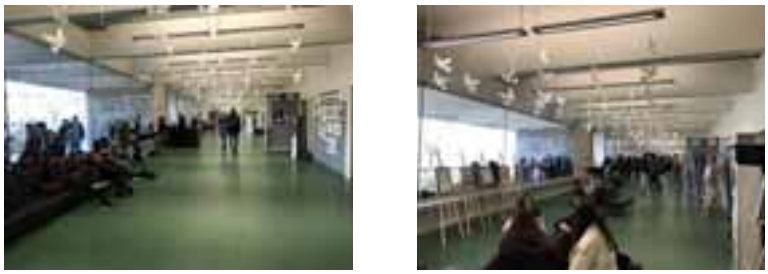
The main hall is used by a variety of activities and displays a high density of people throughout the whole day, even if users may differ as already perceived, according to the fluctuations in the habits and schedules of each teaching regime. The morning arrival gathers all the community that enters at that time, mostly allocated to the school. The mid-morning break is the time where the highest number of people is condensed in this same space for a very short time period, either for crossing it longitudinally or for using it as a space to stay or also for the use of the card machines. The lunch break presents some of the teachers and students to leave the building, which continues on during the afternoon. This is balanced by the continuous arrival of the external students of the conservatory that enter the building after attending their regular classes elsewhere (Fig. 245a). Still, during the afternoon there is a lower concentration of people on the main hall at the same time, because the schedules and breaks differ between teaching regimes.

Simultaneously, as the day progresses the use of the upper floors becomes more intense, because during the morning the students use it mainly as practising spaces when the classrooms are vacant, while in the afternoon all the classrooms are occupied with formal classes for practising music instruments.

Users

Having explained this, students during the afternoon are mostly from the teaching regimes related to the conservatory: the articulated and the supplementary, implying that external users arrive at this space from other schools for artistic lessons. This suggests that these students may be the same age as the ones from the articulated regime, but also older or younger. In this latter case they usually come accompanied by their parents who wait within this space.

a)



b)

Fig. 245. a) Main hall's fruition (from left to right: morning arrival, mid-morning break and afternoon); b) Different seating arrangements on the main hall with and without the exhibitions display

(Carolina Coelho)

Furniture / devices

Furniture is a very important variable to be accounted for when discussing the location of users in space. People also choose the space to stay according to the furniture that space provides, the possible activities able to be done with that furniture and the amount of users that furniture enables.

So, although there are numerous seating spaces in the main hall: sofas, benches and chairs, their positioning near or further away from the entrance, near the library or the cafeteria, sideways to the space or more in the middle, define the choice in the location of the students. Also, the fact that there are chairs and tables in the auditorium's cafeteria enables group encounters and group work, which is specific of this area. Whereas the long benches near the glass windows only enable students to seat next to each other and not face each other, still, its positioning near the windows provides better visibility towards the exterior and the first perception of who is arriving at school. Additionally, if in the first observation day these sofas were aggregators of a group of students, when they were moved back-to-back, that hindered the possibility of larger groups staying together and only enabled pairing of friends next to each other (Fig. 245b).

The displays on the main hall and on the main corridor on the upper floors, besides the exhibitions that occurred both in the library and on the main hall, are aggregators of students who perceive the contents that are being showed, acting as a standing area.

a)

b)

Fig. 246. a) Younger children playing; b) Library's clusters of users (Carolina Coelho)

Likewise, the choice of the niches to stay on the upper corridors is also a matter of furniture: the one with a table may be chosen for group working, while the long benches are more chosen for individual waiting before a class or for practising the guitar.

Clusters of students have also been perceived, not only because of furniture, but because of routines or habits that usually gather friends in groups. This also explains the choice of the benches in the middle of the main hall for younger students and the sofas near the library for the older ones. Besides their choice in seating places, also their activities have been observed to be different from each other. Activities such as using the phones and talking amongst each other are common for all students, while the older students prefer to engage in more individual activities like listening to music and even using the benches side-by-side with their friends, each one using his/her phone individually. Younger students prefer to engage in more collective experiences, playing games, running around and overall have more active and social activities, often dismissing any technological devices. This has been reported in the observations and particularly when noticing on the main hall and on the corridors children, very naturally, running around and playing (Fig. 246a).

The library has clusters of activities, in which diverse activities are possible and students may be pursing them simultaneously each in their space, usually bounded by the shelves in smaller spaces (Fig. 246b).

Also, the fact that lockers are on the upper floors makes the students climb up the set of stairs towards them and only go to their classes afterwards. That determines their main pathways.

Another very meaningful device that aggregates a significant amount of students is the card machine that is a part of the students' routines and also influences their

Fig. 247. The queues generated by the card machines on the main hall (Carolina Coelho)

pathways. Students know that before having lunch or going to the bar, they have to pass by the machine, and that determines their movements, activities and even their spatial usage. Moreover, the long lines generated by the need to access the card machines can even influence people's natural movement in space (Fig. 247).

In his book *Buildings and Power*, which Markus (1993) claims to be "about the meaning of buildings" (Markus, 1993, p.xix), he vividly states: "I take the stand that buildings are not primarily art, technical or investment objects, but social objects." (*ibid.*). In this regard, Markus establishes a possible comparison between the change brought by technological information to the one from the Industrial Revolution, assuming that their respective devices and goods have conveyed changing ways in which to interact in space and the means to do it so:

> "There are parallels with today, when asymmetries of power hinge not on steam power but on systems for handling information. Those who design the hardware and software stand in the position of the entrepreneurs and engineers. Mature colonialism generated a consumption of goods which matches today's consumption of services and media generated by multinational capital; it also created similar political upheavals. All these, both then and now, change patterns of relations and it is the way relations are established in and through buildings which is my concern." (Markus, 1993, p.xx)

So, overall, the devices used in the school, namely the technological ones like the card machines, have also brought new needs by the users and the respective spatial requirements to allocate these devices. Primarily, they represent new aggregation spots, interfaces with the relevance for changing interactions and spatial occupation, meaningful for the social reproduction of space. Hence, the referred change on the "patterns of relations".

This explains the higher density of people near the machines remarked during the observations, that are impelled to be used by all. All in all, it could be argued that these devices, by altering space, also alter the social relations within space, cyclically referring to this intrinsic bond between buildings and society, which holds the foundation of Markus's (1993) book.

Furthermore, in Markus's (1987) elaboration on *Buildings as classifying devices*, it is stated that machines and objects, besides people, can promote a classification of buildings: "There is no building type in which a division of people, objects, and machines, and their spaces, into classes and categories, as the first step towards their organised and purposeful interface, is not of primary importance." (Markus, 1987, p.468). Consequently, these objects interfere with space and, henceforth, with the social relations within it.

Additionally, these changing patterns of spatial use related to technological devices also explain the recurrent usage of the phone, computer or other hardware related to technological information, which is paramount for today's social behaviour, both collective and individual, but foremost in regard to knowledge acquaintance of the utmost relevance in a school building.

Activities

Programmed activities can occur in all of these spaces providing that these are previously arranged. For instance, studying with a child, either on the library or on the cafeteria can be a programmed or a non-programmed activity. It can also be a frequent or more specific activity, if it is a part of the daily schedule or if it happens on a spontaneous manner.

Social activities can also happen on more formal spaces like the library, as explained, and cyclically, formal activities can also occur in informal spaces like corridors, niches, or the main hall, provided that the space has the physical ability to host those happenings, like a formal exhibition as the ones observed in the library but also on the main hall.

All in all, educational activities related to homework have been observed on the library but also elsewhere, in spaces where the students consider feeling well and comfortable. This might mean different spaces: the floor of a corridor's niche or a table of the auditorium's cafeteria. Likewise, informal activities, more related to leisure and socialisation, can also occur in *a priori* more formal spaces such as the library. Therefore, observations led to the conclusion that the location of the activities noticed and their respective nature is a condition of spatial appropriation by the students, besides spaces' features and their schedule and habits (Fig. 248a).

In this case, observations made it clear that the same space is differently perceived by the students according to their activities and routines. Some might prefer to

a)

b)

Fig. 248. a) Educational activities in the niches and social and leisure activities in the library; b) Main hall's fruition and location of students

(Carolina Coelho, Juliana Ferreira)

study in a more formal environment with the support of the school's staff and teachers, while others might choose to be in the cafeteria early in the morning when there is less people there.

Additionally, this choice is also paralleled to leisure and social activities that have the specificity of being possible in this school in a wider variety of spaces, including the ones potentially more formal like the library. So, if some students prefer to use the niches for a more private experience, the main hall is openly used by all and where everyone is seen by the others. Besides, also in the library there are sofas in a small lounging space still more reserved, than the auditorium's cafeteria where everyone gathers around for a collective social meeting of the conservatory's community.

Therefore, dimension is also to consider, because small spaces provide a sense of privacy but diminish the possible number of people in a group. Contrarily, overly large spaces, such as the auditorium, can hamper the comfort of the users namely for auditions, while the small auditorium, with a smaller but still adequate dimension, can be used for auditions without such a formal sense projected onto the space. Furthermore, overly open spaces become very public and so, the placement of people in the middle of the main hall is less preferred. So, even if this a location chosen by most students, mostly prefer to be near the sidewalls (Fig. 248b).

The diversity of students' ages, teaching profiles and interests also potentiates this diversity in choices for developing each of the social, pedagogical and artistic

activities perceived throughout the observations in several spaces. This makes the school very particular both in terms of its users and curriculum, but foremost in terms of the uniqueness of its spaces, its possible appropriation by its widespread community of users, and overall the spatial adaptability to several activities of different nature, proving that educational activities effectively occur in spaces with diverse physical features and conceived for diverse purposes.

The condition on whether appropriation occurs, why and by what means, has already been put forward by Hertzberger:

> "We are not concerned with a visual appearance as a shell around the object, but with form in the sense of accommodating capacity and potential barer of meaning. Form can be vested with meaning, but can also be divested of it by the use to which the form is put and by the values that are attributed and added to it, or indeed removed from it - all depending on the way in which users and form interact.
> What we want to state is that it is this capacity to absorb and communicate meaning that determines the effect form can have on users, and, conversely, the effect of users on form. For the central issue here is the interaction between form and users, what they do to each other, and how they appropriate each other." (Hertzberger, 1991, p.150)

In this case, students provide meaning to each of the spaces that differs widely from student to student, or according to groups of students and their habits. The wide-ranging manner of experiencing space, both individual and collectively, has also been established by Hertzberger, to which he adds the possible change on experiencing space in an on-going manner through time:

> "[...] the reciprocity of form and usage, in the sense that form not only determines both usage and experience, but that it is itself equally determined by them in so far as it is interpretable and can therefore be influenced. In so far as something is designed for everyone, that is a collective starting-point, we must concern ourselves with all conceivable individual interpretations therefore - and not only at a specific moment in time, but also as they change in time." (Hertzberger, 1991, p.92)

The meaning of being on the corridor's floor for doing the homework (Fig. 248a), despite the lack in tables or chairs, is a conscious choice taken due to other assets the students have perceived this space had, like the staff employee nearby for their comfort and well-care, or the privacy generated by this space against others, more open and accessible. Contrarily, the preference in staying on the main hall is also supported by the significance of its accessibility and visibility by all, acting as a meeting point.

Even though in spaces with this openness and width, like the main hall, the canteen or even the library, students have preferences on their placement and clusters of students

a)

b)

Fig. 249. a) Main hall on the mid-morning break before the display on the auditorium
b) Students studying (from left to right: external courtyard, auditorium's cafeteria)
(Carolina Coelho, Daniela Aires)

have been remarked, also revealing group appropriation of space, differently done by each group. This diversity can also be a condition of the groups' activities and the way in which they are undertaken, the way space engages each one and the interaction that each space, its devices, furniture, dimension and partitioning promotes.

All in all, having acknowledged that in all the observed spaces students engaged in learning activities, these observations validate that educational experiences in this school occur throughout the whole school and during all the days of the observations, provided they can be programmed/non-programmed and informal/formal.

In fact, the week days did not generally affect the results from the observations, expect on Wednesday afternoon because there are no regular curriculum classes. Then, another exception has been the observations during the auditorium's exceptional use for an educational activity that gathered multiples classes. This has led to an extraordinary gathering of students and teachers on the main hall (Fig. 249a).

But, as expected, during the final week of observations, which was a specific exams week, students were more often observed studying when compared to the first week, which has been perceived in all observed spaces: the main hall during the breaks or the morning arrival, the niches on the corridors upstairs or even the corridor benches by the classrooms, the school's cafeteria in the morning, or even the auditorium's cafeteria when it is not still functioning during the mornings for a more quite study or even in the afternoon in small groups (Fig. 249b).

Fig. 250. Artistic practice in one of the corridors' niches
(Carolina Coelho)

Likewise, the artistic display has also been perceived amongst the whole school and even if students prefer to perform more in the classrooms or on the corridors, the more easy-going are able to practice on the ground floor either music instruments and singing, surrounded by their peers and by all the school community that enters the school. It is noteworthy that programmed artistic practice also happens in the corridors' niches, as proven by the observation of artistic students which have reported it to be a scheduled procedure, which interestingly does not solely occurs inside formal classrooms (Fig. 250).

In fact, music practice is particularly relevant for the students whose instruments are overly costly, voluminous or heavy to be carried outside the school, which implies the conservatory to have both the instruments and the space for students to practice, besides the general need for formal classrooms, for formal individual and group teaching, evaluation and large public displays.

. Critical interpretation of the general findings from the observations

Overall, in this school it can be concluded that users are very mixed in space, even though each group can have its preferences on which space to be, or where to stand amongst a more general one such as the main hall, the library or the canteen. This has actually been noticed in the observations, where younger and older students showed different locations on those spaces. Besides, also teachers, staff and even parents are gathered on the main hall, corridors and even on the library or the auditorium's cafeteria, where all have been observed.

It has been perceived that, within those spaces considered to be highly sociable, the diverse users are placed both individually and/or in groups and their location can be accorded to routines and habits that each group has already established in

the building. As remarked earlier, the location of the younger *vs* the older students has been considered recurrent, as well as the possible identification of spaces more prone to the artistic or the regular teaching community.

But at the same time, it has also been observed that individuals also consider the corridors and the main hall as spaces to stand and not only to pass by, even though their location may differ amongst the groups and be demarked mostly near the bounding walls of the main hall, near doorways while waiting for something or someone, or simply in one of the seating areas, separated from collective gatherings[791]. This situation can be paralleled to Whyte's (1980) conclusion on New York plazas, that despite its cultural and contextual differences in time and space, its "sociable spaces", public and outside, can be associated to the common spaces like the main hall that acts both as a staying and a moving space. Whyte has concluded that the places where socialisation happens with higher intensity gathers groups of people in many forms but it does not obliterate individuals that also use these spaces more than the less sociable ones:

> "The best-used plazas are sociable places, with a higher proportion of couples than you find in less-used places, more people in groups, more people meeting people, or exchanging goodbyes. At five of the most-used plazas in New York, the proportion of people in groups runs about 45 percent; in five of the least used, 32 percent. A high proportion of people in groups is an index of selectivity. When people go to a place in twos or threes or rendezvous there, it is most often because they have decided to. Nor are these sociable places less congenial to the individual. In absolute numbers, they attract more individuals than do less-used spaces. If you are alone, a lively place can be the best place to be." (Whyte, 1980, pp.17-18)

Another conclusion taken from Whyte's study is that "What attracts people most, it would appear, is other people." (Whyte, 1980, p.19). This seems to be the case from the observation in the main hall, particularly during the morning arrival. The fact that students wait here for their peers, entices the space towards an increasingly higher density of people that continue to arrive until the first classes start. If students stay there waiting for their colleagues, on their arrival the space will be more and more densely occupied. Furthermore, the fact that students stay there may suggest it as a popular meeting point, particularly relevant at these age groups.

Another inference taken from the observations is that this school also aggregates movement and standing activities, as reported, mostly on the corridors on all

[791] Whyte has also reached that conclusion pointing out that: "Standing patterns are similar. When people stop to talk on a plaza, they usually do so in the middle of the traffic stream. They also show an inclination to station themselves near objects, such as a flagpole or a statue. They like well-defined places, such as steps, or the border of a pool." (Whyte, 1980, p.21)

floors, associating pathways with dialogues with pedagogical potential that occur amongst students but also amongst students and teachers, parents and teachers and colleagues. Recognising that this knowledge transmission on pathways has been remarked during the observation, it has also been formerly perceived by Whyte by means of "time-lapse cameras overlooking several key street corners" that noted that conversations occurred on those same pathways:

> "People didn't move out of the main pedestrian flow. They stayed in it or moved into it, and the great bulk of the conversations were smack in the center of the flow-the 100 percent location, to use the real-estate term. The same gravitation characterized "traveling conversations"- the kind in which two men move about, alternating the roles of straight man and principal talker. There is a lot of apparent motion. But if you plot the orbits, you will find they are usually centered around the 100 percent spot." (Whyte, 1980, p.21)

Interestingly, Whyte cannot arrive to an explanation on this happening, even if he argues that: "It is understandable that conversations should originate within the main flow. Conversations are incident to pedestrian journeys; where there are the most people, the likelihood of a meeting or a leave-taking is highest." (*ibid.*). Whyte does not infer an explanation on why people continue on that same flow. The sole assumption pointed out is that: "This does not seem to be a matter of inertia but of choice-instinctive, perhaps, but by no means illogical." (*ibid.*).

Nevertheless, this bears great relevance for our current study, proving that dialogues start on the corridors but may still continue on there, where people meet, ultimately considering them not only containers of movements, but also and more importantly, *educational vessels* for socialisation and knowledge transmission, which enhances their potential as learning environments and containers of pedagogical and social activities. Naturally, that the fact that the main hall holds a higher density of users and has additional width, enables even further the possibility of staying and moving in the same place without disturbing the natural movement.

In regard to furniture, seating spaces are considered to highly weigh on the choices of people to stand. Whyte also points out the relevance of both "physical comfort" and "social comfort" (Whyte, 1980, p.28)[792], which has also been acknowledged by these observations, as students seat in their established spots near their friends and often in groups according to their ages or interests.

Additionally, Gehl highlights that: "Only when opportunities for sitting exist can there be stays of any duration." (Gehl, 2011, p.155). Accordingly, for the design it

[792] "Ideally, sitting should be physically comfortable - benches with backrests, wellcontoured chairs. It's more important, however, that it be *socially* comfortable. This means choice: sitting up front, in back, to the side, in the sun, in the shade, in groups, off alone.
Choice should be built into the basic design. Even though benches and chairs can be added, the best course is to maximize the sittability of inherent features." (Whyte, 1980, p.28)

would be relevant to consider seating areas and previously arranged benches (*ibid.*), as comfortable as they may be, in order to provide for the need to create social areas, but it is also by appropriating space that students define their location on those same areas. Generally, the niches adjacent to the upper corridors, which hold seating spaces in various layout options, are often used, but in what regards the wider choice in seating spaces in the main hall, this is frequently established by students as a habit that is already a part of their daily routine.

Finally, following the statement by Whyte: "Choice should be built into the basic design." (p.28), it is concluded that furniture can aggregate activities and people in space, and the more it is considered early on and the more diverse it might be, the wider the array of activities the space can cope with and, ultimately, the higher the potential choice for effectively using that space in particular.

Niches like the ones on the upper corridors, and overall the existing corners on open spaces, have also been observed to be highly occupied by groups, which is also recurrent from Whyte's observations, due to their prospect for "face-to-face sitting" that induces groups towards those spaces (p.32), as perceived by the frequent observations undertaken, specially on the main corridors of the first and second floors.

Lastly, Whyte recalls the preference for people to be in denser spaces as a way to be a part on the lived space:

> "As we have seen, people have a nice sense of the number that is right for a place, and it is they who determine how many is too many. They do not, furthermore, seek to get away from it all. If they did, they would go to the lonely empty places where there are few people. But they do not. They go to the lively places where there are many people. And they go there by choice-not to escape the city, but to partake of it." (Whyte, 1980, p.100)

This could clearly be related with the high density of users in some spaces of the building, precisely on the main hall as a meeting point for all, as opposed to the minor number of people using other spaces such as the cafeteria, which is proven by all the previously presented observation matrices. Furthermore, Whyte also defends "small urban spaces" as the preferred spaces for people to be in:

> "It is wonderfully encouraging that places people like best of all, find least crowded, and most restful are small spaces marked by a high density of people and a very efficient use of space.
> I end, then, in praise of small spaces." (Whyte, 1980, p.100)

This holds representativeness in a school because it can be associated with Hertzberger's concept of small spaces as "spatial units" (Hertzberger, 2009, p.11), previously defined and its relevance explained.

All in all, and despite assuming the differences between New York plazas and the study on contemporary Portuguese schools, some of the remarks by Whyte have the potential to be comparable with this case study, considered to still be up-to-date and supportive of the findings on groupings and their locations, particularly applied to the spaces that have been considered to shelter "the social life of small spaces" (from Whyte's title), although not "urban" but predominantly pedagogical, like the main hall, assuming that socialisation is a turning point on the reference to learning environments today.

The multiplicity of moving spaces, standing areas and clusters of educational, social and artistic activities for learning may be considered active learning spaces for a whole variety of activities and teaching curricula, used by students of diverse age groups, not only from the school but also from the articulated regime and the supplementary one, which adds extensive diversity to the space users.

Gehl (2011) explores the concept of "integration" for plotting people and activities simultaneously in a space[793]: "Integration implies that various activities and categories of people are permitted to function together or side by side." (Gehl, 2011, p.101). This has been remarked through the observations undertaken. In fact, the need to use different colour markers to explain the nature of the activities and the results brought by the observation matrices indicate an activity assembly and also a high density of people in the same spaces observed. This fact may imply that the spaces promote the integration of activities and people. Contrarily, Gehl agrees on "the rejection of monofunctional areas" (p.107), which for our current Thesis, implies less adaptable areas and areas with low entropy levels, because due to their monofunctionality there is a certainty on the activities they hold.

But Gehl highlights the relevance on gathering activities and people in order for them to stay and not only to go by, therefore, the activities that spaces can shelter are crucial as an enhancer of their staying time:

> "That people and events are assembled in time and space is a prerequisite for anything at all to occur, but of more importance is which activities are allowed to develop. It is not enough merely to create spaces that enable people to come and go. Favorable conditions for moving about in and lingering in the spaces must also exist, as well as those for participating in a wide range of social and recreational activities.
> In this context the quality of the individual segments of the outdoor environment plays a crucial part. Design of individual spaces and of the details, down to the smallest component, are determining factors." (Gehl, 2011, p.129)

[793] Even if his approach is to public spaces.

Fig. 251. Artistic students in the library experiencing both leisure and educational activities, while using the computers, playing on their phones and listening to music

(Juliana Ferreira)

This can be transposable for the design of the school space, by understanding that the activities should hold pedagogical potential and hence promote a staying time in that space that contributes for the students' learning process.

Generally, this diversity of activities and users, and the gathering of movement and standing, social/artistic/curricular experiences in general, in all the observed spaces, provides this school with a very enriched ambiance, where learning can occur throughout, despite the dimension and initial nature of the spaces, and where the community is very prone to both knowledge transmission and acquisition. Space is paramount for this gathering, for mixing users that share common pathways and for enabling that diverse learning activities happen in all spaces, even if not initially conceived for such purposes, such as: the library for informal experience, the niches for formal artistic practice, or the auditorium's cafeteria for the joining of all artistic community with a daily frequency and not only when the auditorium is open for performances (Fig. 251).

This brings extra-complexity to this school space which needs a diverse range of spaces for the diversity of learning activities that currently bear educational potential, in a balance between the wide choice of spaces for students to choose from, the wide variety of ways to learn, the cost/benefit of all these spaces, or its potential redundancy or excessive spatial offer, and the sought cohesion of the building as a whole. This has been systematised by Hertzberger:

> "[…] it [the school] is a place where pupils are more demanding and learning has to be more than just absorbing basic knowledge. In the relatively affluent countries with their increasing dependence on knowledge, the claims on space are getting greater too. Indeed, in the knowledge society differentiation is on the increase and with it comes

> the need for smaller working groups. […]
> And as the interest in more individual-based education continues to increase, so does the spatial complexity of school buildings. Working alone or in groups requires more and more workplaces, though without endangering the view of the whole. This overall view is necessary as a support to the teaching staff, but also for helping pupils to find their bearings in the welter of options open to them." (Hertzberg, 2008, p.8)

Naturally, that management has to be considered an enabler of this spatial usage, for providing the conditions for the space to be experienced in such a widespread manner, the parents to be allowed inside and share their children's learning experiences, and primarily for largely understanding that informality and socialisation can also convey knowledge and a sense of belonging in space, facilitating the welcoming of educational contents within a broader learning experience, by the students and the overall community.

Finally, when stating a direct correlation between the frequency of encounters and the activities, Gehl (2011) is again recalled, indicating that people meeting in space enables other sorts of activity occurrences, namely of social nature. This holds relevance for the design of space that, by enabling interaction and encounters, also provides for a wider range of activities to occur later on[794].

Gehl elaborates on "life between buildings" and its relation to space, buildings and city planning that "influence patterns of activities, to create better or worse conditions for outdoor events, and to create lively or lifeless cities" (Gehl, 2011, p.31). Further on, the assumption of this dichotomy is openly stated:

> "The physical framework itself can be designed so that the desired contact forms are impeded or even made impossible. Architecture literally can stand in the way of desired activity patterns.
> Conversely, the physical framework can also be designed to give a broader spectrum of available possibilities, so that processes and building projects are permitted to support one another. It is in this context that work with public spaces and life between buildings must be seen. Possibilities can be impeded - or they can be facilitated." (Gehl, 2011, pp.54-55)

This is much in tune with our own belief on the relation between space and the *living experience*[795]. The diagram presented by Gehl demonstrates the relation between

[794] "This connection is important in relation to physical planning. Although the physical framework does not have a direct influence on the quality, content, and intensity of social contacts, architects and planners can affect the possibilities for meeting, seeing, and hearing people - possibilities that both take on a quality of their own and become important as background and starting point for other forms of contact." (Gehl, 2011, p.13)

[795] See chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

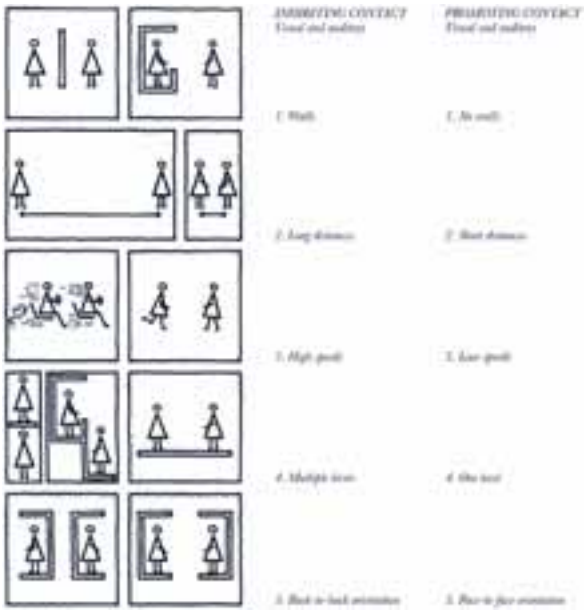


Fig. 252. "Physical arrangement can promote or prevent visual and auditory contact in at least five different ways."
(Gehl, 2011, p.62)

space's configuration and the contact that it enhances or hampers, also graphically supporting his previous statements (Fig. 252). This acknowledgement clarifies how interaction is most likely to occur and which spatial conditions enhance it, ultimately informing the design[796].

This assumption also complements our previous approach on the need to correlate the potential of a space to hold activities - resolved by means of maximising the entropy of that space, and its effective use - perceived through observations, walkthroughs and focus groups.

All in all, the understanding that the conceived design by the architect may imply the possibility of activities to occur in a specific place, is paramount for our current Thesis, but also the acknowledgement that even if a space is provided with the features to cater for a particular activity, ultimately it is the inhabitant(s) that will have the choice on its effective use. It is the current spatial fruition that this last approach intends to perceive: the life made possible by the design and the choice of its inhabitants on how to experience and appropriate it.

[796] Regarding "life between buildings", Gehl states that: "The connection demonstrated between street life, the number of people and events, and the time spent outdoors provides one of the most crucial keys to the way in which conditions for life between buildings can be improved in existing and new residential areas - namely by improving conditions for outdoor stays." (Gehl, 2011, p.79)

4.2.3.2. Walkthroughs _ Idiographic analysis

Walkthroughs, as previously explained, consist on tours to the school, with a specific focus related to the research question, led by the participants of each of the chosen groups, considered to represent the members of the school community who experience that space.

This methodology has been dealt in detail by Duarte, Veloso, Marques and Sebastião (2014) considering it as "site-specific focus groups", in which the interaction between the participants occurred in their own environment, hence its title: "site-specific", implying a visit of the building with a previous and subsequent focus group:

> "The focus groups encouraged high levels of interaction among the groups of pupils and teachers, allowing the analysis of their views of the renovated spaces when visiting them, enabling the development of discussions between the researchers, pupils and teachers in situ. Focus groups took place before, during and after the visit to the schools' spaces. This is what is meant by the term 'site-specific focus group'." (Duarte, Veloso, Marques and Sebastião, 2014, p.2)

Furthermore, in our own procedure and similarly to the referred "site-specific focus groups"[797], there has also been an initial moment for contextualisation of the subsequent "participant-led tour of the school" (Duarte, Veloso, Marques and Sebastião, 2014, p.15) and to enable some discussion on the possible routes chosen by the participants, and there has also been a conclusive moment for additional comments on the tour. Moreover, it has also been guided by a "script" previously composed for that purpose (p.7). So, having been thought as a sequential procedure, that in our research complements observations, both on our own study as in the previously referred paper, these focus groups have been anchored in a generated interaction between representative "social actors" with distinctive purposes, as observations merely state the general interaction and movement (p.6)[798].

Besides this paper's relevance on the state of the art for the specificity of these focus groups, in which participants *walk through* their spatial reality, the fact that it reports to its implementation onto Portuguese schools which have had a recent intervention by the School Modernisation Programme, provides it with deeper significance for our current research, whose case study is in fact a school also under this Programme[799]. And even though this paper lies under "a study about the impact of the renovation of learning spaces on pedagogical practices as part of the

[797] "The focus groups took place in the schools, before, during and after the tour to the schools." (Duarte, Veloso, Marques and Sebastião, 2014, p.7)

[798] "[...] it enables the creation of an intentional situation of interaction, one that is guided by clear goals that are understood by the social actors – which cannot be said of observational methods." (Duarte, Veloso, Marques and Sebastião, 2014, p.6)

[799] See chapter 4.1. Presentation and justification of the chosen case study.

secondary school modernisation programme (SSMP) launched by the Portuguese government in 2007" (*ibid.*), it is also considered of greater relevance for identifying and assessing adaptability in the building on the behalf of this Programme. So, this procedure is sustained to bring appropriate information, particularly under a context in which it has already been put in place, and where it has reported significant findings, also in regard to people's relation to space:

> "The focus groups in this format were particularly important for the research since they facilitated a dynamic of social interaction and the expression of views and opinions among groups of pupils and teachers about the impact of the renovations on education practices. They also highlighted some of the specific aspects of the interaction between the appropriation processes and the object of the intervention, which was in itself object of contradictory interpretations. Further, this technique enables the attainment of a triangulation strategy, central to the study." (Duarte, Veloso, Marques and Sebastião, 2014, p.1)

As for the composition of each of these focus groups, they have been separate, as in our own research, under teachers and students: "those social actors most affected by the education-learning process (pupils and teachers)" (p.3). Nonetheless, due to the complexity of the school's curriculum, for our study, these have been even more detached into students and teachers from both the articulated teaching and from the regular teaching, assuming four focus groups with their specificities and potential differences when implementing this procedure.

Similarly to our study, these "site-specific focus groups" also imply the understanding of people's relation to space, which in our research aimed at understanding how social actors structure their daily routines in space and which activities are held in the built spaces, to ultimately discuss and understand spaces' effective fruition as perceived by each focus group:

> "In research on learning spaces, the establishment of site-specific focus groups represents an important instrument for demonstrating how pupils and teachers give meaning to, make use of and appropriate the renovated spaces." (Duarte, Veloso, Marques and Sebastião, 2014, p.7)

Finally, the referred study has reported having reached its goals:

> "Using this technique, it was possible to achieve various objectives of the study, namely: (1) identification of the more negative and positive aspects of the spaces that were not considered in previous phases of the research; (2) exploration of the different ways the pupils and teachers view the spaces by interaction with one another and with the space; (3) understanding the different ways of appropriating the spaces that had previously been impossible to detect; and (4) priorities attributed

> to some spaces in detriment to others and the underlying reasons for this." (Duarte, Veloso, Marques and Sebastião, 2014, p.8)

Analogously, the procedure applied to our own research is also intended to identify the social dynamics on space, to analyse how social actors report to space, and to understand the routes taken by each group on their similarities and possible discrepancies, as our investigation aims to understand effective spatial fruition in regard to the activities held in each space and the potential social and educational interactions that might occur:

> "The mobilisation of the site-specific focus group technique enables an analysis of how the users engage in dialogue, view, use and appropriate the created or renovate spaces: a reality that is difficult to capture using other techniques." (Duarte, Veloso, Marques and Sebastião, 2014, p.8)

This is stated to have brought "very rich, additional and diverse information, often reinforcing the data collected by methodological instruments used previously" (p.15), as expected from the establishment under this context.

The paper's final remark appeals to the establishment of original methodological procedures on learning environments as a core problematics, which is also one of the expected contributions of our research – under the architectural scope, to think about contemporary learning environments and be informed by them and their ability to cope with up-coming requirements and events:

> "Research on learning environments requires new thinking and the necessity of testing innovative research methods incorporating the space as a central element of the question. This is what we have attempted. It is important to pursue this reflection from the perspective of methodological optimisation and integration. (Duarte, Veloso, Marques and Sebastião, 2014, p.16)

Under the support of literature references and the proven relevance of its implementation, walkthroughs have been established and adapted to our own research question and to the context of our architectural research.

Four focus group have then been arranged considered to represent the students and educators of different teaching regimes and hence, portraying different teaching-learning experiences in the school, with a particular regard on the potential adaptable spaces identified. These were the following:

. teachers of the regular teaching

. students of the regular teaching

. students of the articulated teaching

. teachers of the artistic teaching

The first three have occurred on 3rd February 2017, followed sequentially.

As this procedure had to be previously arranged with all the participants, according to their availability, the initial focus group has been done with the teachers of the regular teaching, because it was a suitable schedule for the four participants.

The focus groups with the students have also been formerly scheduled and previously authorised by their parents, who were given instructions on when to bring and retrieve their children according to the schedule of each walkthrough.

As focus groups and walkthroughs have been gathered according to the same set of four different groups of users of the school and relevant members of the school community, the procedures were undertaken on the same day, following one another, as it was considered the most efficient way of gathering a wide set of people and profiting from their participation without a second arranged reunion that would separate focus groups and walkthroughs in different days. In fact, the preparation of this procedure in two different days for the same group of participants could hinder their engagement for participating, because it would imply: the arrangement of two sets of dates and the possibility of all participants to be present, their parents' availability for bringing and retrieving them, and the team's presence for recording the procedures. The chance of all to be simultaneously available a second time would be very small, since it has already proven to be challenging for only one day. So, both walkthroughs and focus groups happened respectively in:

. teachers of the regular teaching – Friday, 3rd February 2017

. students of the regular teaching – Friday, 3rd February 2017

. students of the articulated teaching – Friday, 3rd February 2017

. teachers of the artistic teaching – Thursday, 9th February 2017

It is noteworthy that on the 3rd February 2017 there has been a staff strike which prevented classes to happen because the school was closed, namely for its students. Therefore, as this was a day in which students already assumed to be in school, they have accepted to be there on that day with their parents' authorisation, and the school and the conservatory have also allowed the establishment of these procedures, even with the staff strike. The fact that the school was not in a regular day and classes were not happening, allowed for the group to stay on the spaces normally used by these participants and to comment freely on them, with more time and without distractions.

As explained initially, teachers of the artistic teaching have been contacted by the Direction of the Music Conservatory to participate in these procedures according to their availability on a day that was considered to be possible for all: 9th February. This day has also coincided with an observation day, which diminished the number of authorisations for all our team for entering the school – which had all to be

previously arranged with the Directions and the staff in everyday we entered the building – and this walkthrough was possible to be set in place between the scheduled observations on the afternoon of that day.

Both focus groups and walkthroughs tried to have a similar number of participants, balanced both in gender and curriculum or scientific areas of interest. These have started to be composed by four people in all groups but it was enlarged to seven in the artistic students' focus group and walkthrough, where all volunteers showed to be very eager to participate and to demonstrate their feelings towards the school space. This also demonstrates the artistic students' sense of belonging in the school and has also provided further information both during the focus groups and in the walkthroughs, because the group was very diverse in age, instruments played and spatial uses.

The volunteers for the focus groups were the same as for the walkthroughs, avoiding further authorisations, logistics and schedule arrangements and coinciding the comments on spaces provided during the walkthrough on the building and the descriptions on each of the considered most relevant adaptable spaces during the focus groups.

Having tried that all focus groups and walkthroughs took relatively the same time, on an average of one hour, some of the groups were more talkative and meticulous than others. This implied a balanced moderation between listening carefully to all volunteers' remarks and also do it during a similar time schedule for all four walkthroughs, so that the detail on each justification might resemble itself and the main aim was accomplished, leaving out possible deviations from the purpose of these tours and avoiding superfluous remarks on the school spaces that might not be of relevance for the acknowledgement of the adaptable spaces from the volunteers' point of view.

Specifically, in regard to walkthroughs, participants were asked to conduct a tour on the main building under study for this current research, whose aim was strictly to display the school's most adaptable spaces according to each of the groups. Walkthroughs had been previously prepared in order to provide information on questions regarding this subject, for further justification of the pathways chosen and the spaces identified. Thus, participants were asked to identify the spaces with the larger number and diversity of activities and people in the main building and to arrange a tour around them. Also, they were asked to focus on which people used the spaces, what activities occurred there, their social, pedagogical and/or artistic nature, and their potential different uses between teachers and students, and between the artistic and the regular teaching.

The tour around the building is especially relevant to be analysed from the point of view of the pathway chosen by each of the groups, which may or may not mimic the groups' more frequently used pathways in a regular school day. Another consideration to be critically reflected upon will be the spaces identified as the most adaptable and its reasoning. Assuming that each group will focus particularly on the spaces that it has a more profound relation with, spaces more often used by

each group and naturally more related to each groups' more specific activities, i.e. music spaces will potentially be regarded in a more profound manner by the artistic community rather than the regular teaching community that does not use them as much. This will be one of the outcomes for future debate. Another consideration is concerned with the choice of the spaces to go by and their potential differences or resemblances amongst the groups, the reasons for indicating them in particular as opposed to others considered least adaptable.

Subsequently, each walkthrough will be individually commented on, according to the sequential procedure in which they have been undertaken, followed by a general conclusion on potential similarities and/or discrepancies amongst the four and a critical assessment on these findings.

The team for accompanying the walkthroughs was composed by myself as team leader and moderator of the way the tour was fulfilling its goals, while leaving the paths open to the groups' choice and balancing the discussion between a focused eye on adaptability and spaces more prone for diverse activities and the uses each space effectively allocated, and the more personal remarks on use or critical commentaries on space that participants might have.

Besides, the team was also composed by other members that contributed to best record the procedure with the following roles: taking all the field notes from the remarks made by the participants and their quotes on the matter; audio recording; video recording; taking photographs of all the stages of the event; and finally another person on the team whose function was to draw over the building's plans the pathways by which the tour was led and the spaces where stops were made and the adaptability rank according to the group's explanations.

Colours were assigned to all focus groups when drawing their pathways onto a general plan, in order to overlap the results in the end of the four walkthroughs and understanding possible differences or parallels.

Overall, the all team for this procedure involved five people that were arranged to better fulfil all the functional needs and that did not participate or got involved in any way in the behaviour and comments of the participants.

The results of each walkthrough will now be depicted in detail. In order to safeguard volunteers' identity, particularly from the students that have participated, who are still minor, volunteers will not be addressed by their name[800]. It is considered that it is not the identity of the person who does the action, which is relevant to indicate, but his/her outlook and the fact that he/she is doing it. Overall, it is the activities and the spaces that are under research that matter, rather than the identity of the participants' involved does not add information for these findings.

[800] As it was previously accorded with the parents and the Directions of the School and the Conservatory, for their authorisations.

. Walkthrough with teachers of the regular teaching - Friday, 3rd February 2017

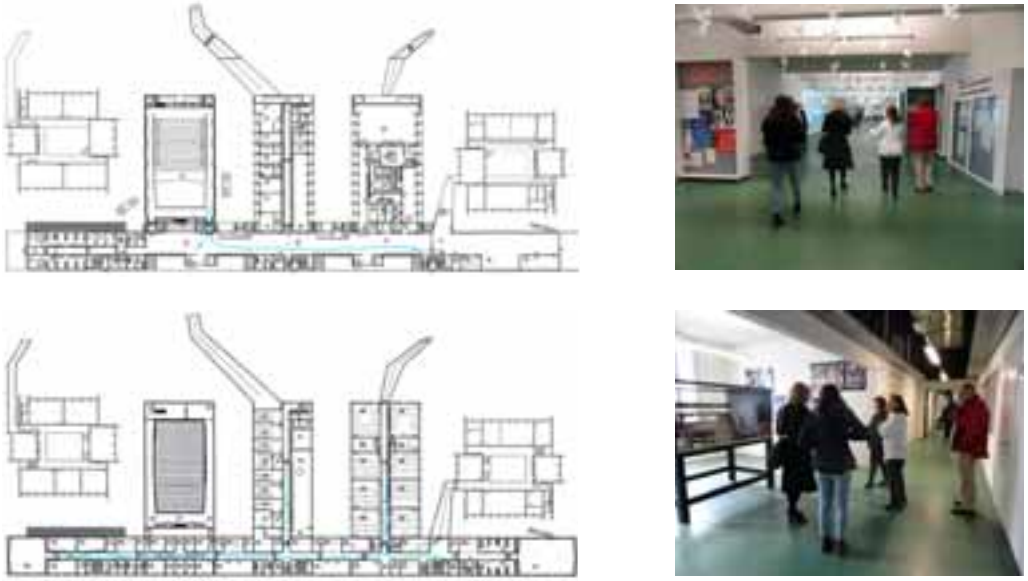
This group is composed of four teachers of the regular teaching regime, three from the mathematics department and one of history of the culture and the arts, who have also participated in the focus group. This tour started in the teachers' hallway, as it was the meeting point arranged, and proceeded towards the ground floor.

As already explained in general, the brief for all four focus groups was that the participants showed the main building of the school focusing on the spaces that they considered to be the ones that effectively allocated more activities and people. For that purpose each group would independently decide what route to take and where to stop, justifying each of the chosen spaces.

This group's route started on the first floor on the teachers' offices, in which it was assumed the significance of the teachers' common living room as a gathering space for this group in particular.

Then, the walkthrough progressed within the main corridor on the first floor, first towards the east side of the building to the small auditorium. When arrived at that extremity, the group returned and went towards the science labs' hallway, since it is also used by the regular teaching and, hence, teachers have a closer connection with that area. Meanwhile, while passing throughout the corridor, the niches were also indicated as spaces the students choose to spend time in. Then, the west staircase, closer to the science labs, was chosen to come down to the ground floor, because regular teachers do not use the upper floor that is dedicated to the artistic teaching of the conservatory. On the ground floor and from that staircase, the tour stopped near to the library, which was highly appraised, and then ended on the main hall. Interestingly, the main hall was considered, by the teachers, as separate parts and not as a whole area, pointing out the area near the library, the central area closer to the central staircase and the auditorium's cafeteria on the main hall, all as adaptable spaces of intense usage by the school community. A plan was sketched reporting the path taken and the spaces identified by that group from their initial brief (Fig. 253).

A closer outlook on the spaces identified is now possible, to critical analyse them and their report to this group in particular and the activities undertaken there. The teachers' living room is a very wide space with their own cafeteria, which is more often used as a leisure and socialisation space but that has also the ability to have workstations, even though work is not usually done there. Teachers also say that it is the room where the Union meetings occur, possibly due to its dimensions that enables a collective gathering specifically for the teachers as their audience.



a) b)

Fig. 253. Walkthrough with teachers of the regular teaching: a) plans; b) photos (Carolina Coelho, Daniela Aires)

The niches on the main corridor have been referred as spaces for gathering small groups of students with a very frequent use. The small auditorium was assumed to be used only for small lectures for about 100 students. It was considered to be a less integrated space that is used for collective gatherings when there is no need to use the main auditorium. Still, it was indicated as the most used space on the first floor for the regular teaching, because the remaining formal ones are more predisposed to the artistic teaching. At this time teachers recognised the effective sharing of the spaces by both teaching profiles and the auditorium as an example of that. On the contrary, the dance studio on the other extremity of that floor plan was seen as less adaptable and much more exclusive, and it was even stated that the adaptability decreases as we progressed towards the dance studio, because the rooms become increasingly more specific of a particular usage or teaching. Still, the niche closer to the studio is widely socially used by the students while waiting for classes to start.

Coming down the stairs the group stopped near the library for explaining its relevance as a space for all: "it is not just a space for the students, it is space for the students and the teachers and for other activities…"[801] In fact, there are activities promoted by the library such as book readings that enable student aggregation.

The cafeteria was recognised to have high "limitations" because students as soon as

[801] Free translation of the original quote in Portuguese, as these procedures have all been done in Portuguese: "Não é apenas um espaço de alunos, é um espaço de alunos, professores, outras actividades..."

they eat, have to leave for providing space for others, and ultimately, these teachers concluded that "it is not adaptable"[802]. When passing by the main auditorium teachers said "it is permanently in use", "it is special" and that it was even "open to the city"[803].

Finally, it was reflected upon the relevance of the main hall as an adaptable space. Teachers recall that whenever there are activities outside the classrooms they occur in the main hall, such as events with external guests. Exhibitions are also shown there, as well as video displays on a variety of subject matters. The possibility of considering the main hall in parts is curious, but it also enables critical reflection because, from the previous observations, even though the space is wide open, it is used in distinct areas by the students, as some will seat near the central stairs and others near the library. This is added to the fact that the auditorium's cafeteria places chairs and tables in the main hall, which also creates an explicit area with a specific seating arrangement. This has been asked to the group, that confirmed the most frequent usage of the benches near the auditorium for the parents and the artistic community, as opposed to the regular teaching students that usually stand near the library or in the centre.

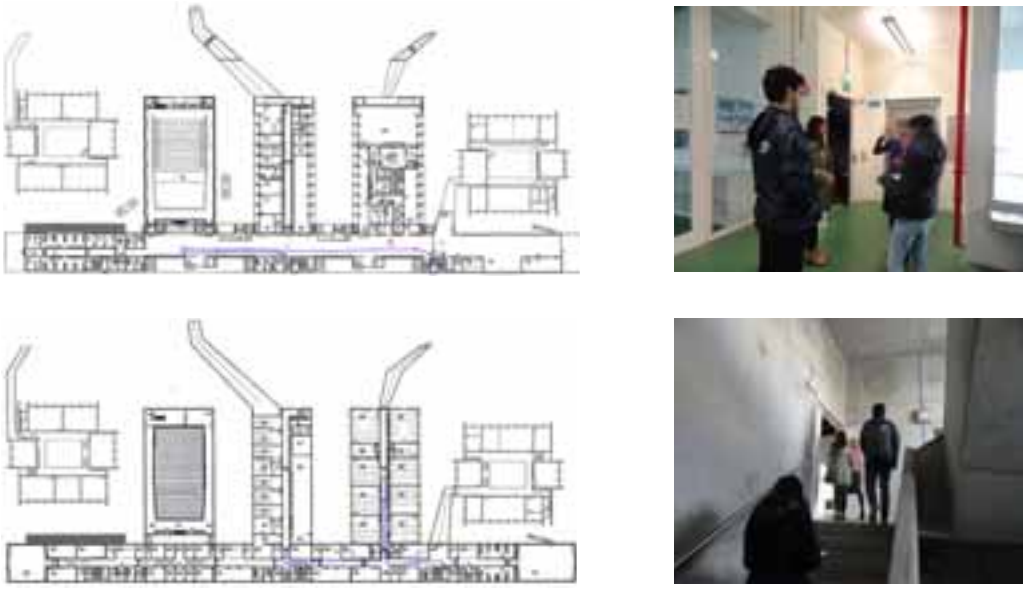
So, all in all, the spaces considered to be most adaptable were the main hall in possible separate areas, the library, the niches on the corridor of the first floor, the small auditorium and, for this group in particular, the teachers' common living room (Fig. 253a).

. Walkthrough with students of the regular teaching - Friday, 3rd February 2017

This group was composed by three female students and one male student, whose ages ranged from 15 to 17 and who attended the 10th to 12th grade. The walkthrough started on the main hall and progressed upwards. The students pointed out the main hall as the most adaptable space (according to the definition given prior to the tour so they could arranged it accordingly) and then the library, although less adaptable than the main hall. Near the library students chose to go up by the closest staircase. On the first floor the group immediately went towards the science lab hallway, because on the opposite direction there was the dance studio they do not use. The tour continued on to the science labs, the area where they effectively have classes on this building. The visit ended on the teachers' hallway, the next transversal wing of the building, where students also informed they use this corridor to get to the external pavilions. In this floor only the niche between the two transversal areas was

[802] Free translation of the original quote in Portuguese: "Adaptável não é."

[803] Free translation of the original quotes in Portuguese: "está permanentemente a ser usado", "é especial", "está aberto à cidade".



a) b)

Fig. 254. Walkthrough with students of the regular teaching: a) plans; b) photos (Carolina Coelho, Daniela Aires)

recognised a possible space for diverse socialising doings and to cater for diverse activities (Fig. 254).

When passing by the cafeteria, the students said they use the entrance area and the vending machine more often or simply purchase snacks and leave towards the main hall or the adjacent exterior space. As observed previously, these students confirm to frequently stand on the benches near the central staircase, more frequently during the morning arrival. Even during the breaks they prefer to stand on the main hall than on the first floor. In regard to the library, these students use it more for its computers or for doing group works.

The first floor's accesses to the exterior are particularly used by them when it is bad weather. The access from the laboratories is mostly used when students have classes there and choose to go straight outside, and the access through the teachers' offices is the most used of them all.

The regular teaching community does not portray a connection to the main building as deep as the artistic teaching community. This is confirmed by the fact that they only use two of the floor plans, and even marginally some of them. From the walkthrough, the main hall has been the space considered to gather the most users and different activities, followed by the library on the ground floor. One niche adjacent to the corridor is often used by the regular teaching students as a space for informal and social activities while waiting for classes to start (Fig. 254a).

. Walkthrough with students of the articulated teaching - Friday, 3rd February 2017

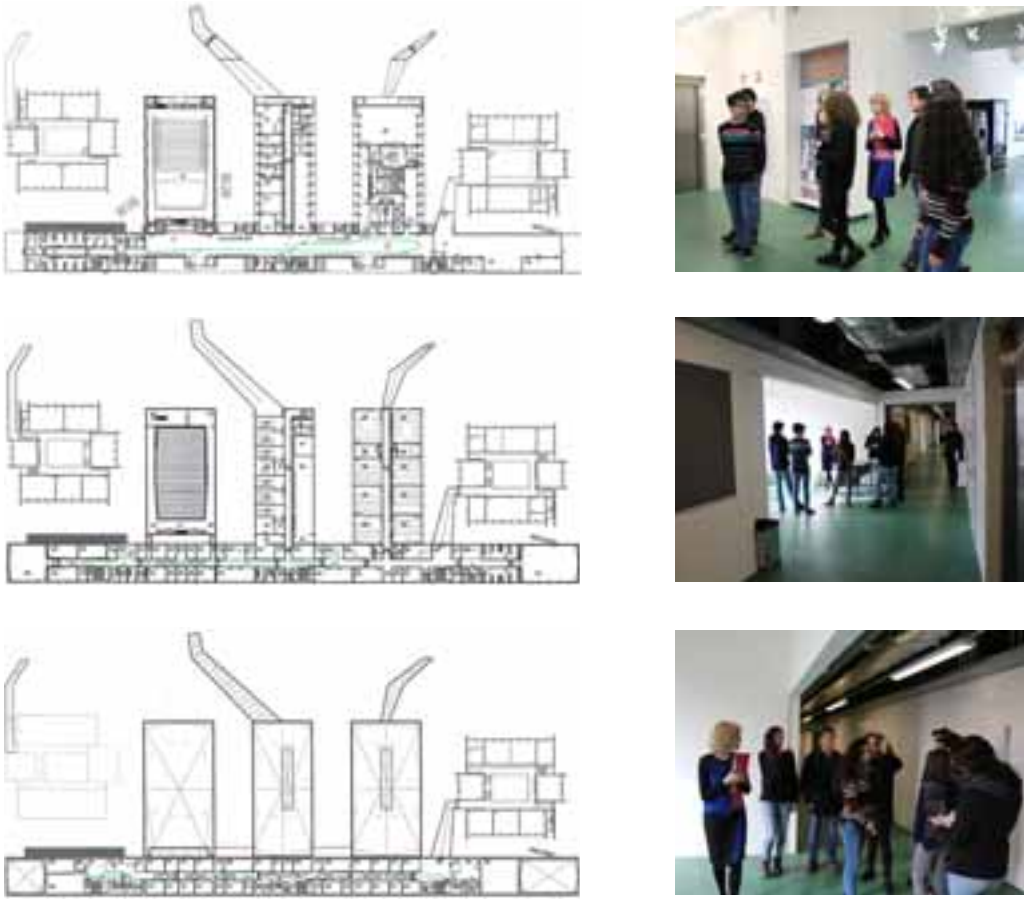
This particular walkthrough was composed by seven students, due to their eagerness in participating and bringing colleagues with them, ranging from 12 to 18 years old and attending the 7th to the 12th grade. These students play the cello, the piano, the harp, the bevel flute and one specialised in singing, which is overall a very diverse group in terms of music preferences and hence of spatial uses, because, as formerly indicated, the classrooms are located according to the nature of the instruments played, which indicates these students use different classrooms for their individual lessons on different parts and floor plans of the building. Also the age difference amongst the participants provided different testimonies on spatial experience according to the classes taken by each student and their schedules, but also their personality or will, either socialise or to be alone.

This has been, in fact, a very significant tour of the school, as it provided additional information on behalf of the students who are the ones that most acutely use all spaces of this building and whose appropriation is more evident. The fact that it was made through the three floor plans and with constant remarks near the spaces, demonstrated the interest and also the critical commentaries students have on a space where they spend so much time, in both formal and informal experiences, collectively and individually.

Although it might be argued that the fact that this group was composed by seven participants, as opposed to the remaining ones with four, could unbalance the answers from this procedure, the final conclusion was that it enriched the debate on the school spaces and the diversity of their potential uses. Each of the participants had a very active voice on their school and had also a very broad perspective of each and every space and on the building overall, as opposed to the regular teaching community that had a more restricted outlook on the building's spaces. Moreover, this also showed a diversity of effective fruition in this building, even informal and spontaneous as it might be, contrasting with the remaining walkthroughs whose perspective on adaptable spaces and frequent routes and uses on this building were quite similar amongst each of the group participants.

All in all, the tour started on the main hall and progressed upwards, ending on the second floor that had not yet been addressed by the previous groups. Artistic students referred to the main hall and specifically to the auditorium's cafeteria as a potential space for a diversity of uses, but then continued on to the main hall area near the library that they found even more prone for a wide range of activities. At this point they also mentioned the library as a relevant space, although less significant on this behalf than the two previously addressed spaces (Fig. 255).

The tour continued by the central staircase, which was preferred by the students. On the first floor, students progressed towards the east side to the small auditorium's



a) b)

Fig. 255. Walkthrough with students of the articulated teaching _ debating on the potential adaptable spaces: a) plans; b) photos

(Carolina Coelho, Jéssica Barreto)

topside. They have immediately overlooked the opposite side leading to the dance studio, because this group does not have any dance student amongst the participants and the top side of the dance studio is effectively very specific of that brief. So, throughout the tour, students frequently stopped on the niches adjacent to the corridor to explain their use while waiting for classes and to established them as potential adaptable spaces for several experiences. Then, near the small auditorium, students chose to go to the second floor by the closest staircase and went through the main corridor on the second floor, elaborating on how they used the space and the fact they used the niches on the corridor's extremities as well as the benches amongst the corridor itself, which could both be considered adaptable and frequently used in several different ways for: artistic practice, social talking or even hastier studying times.

It is relevant again to underline that a simplified concept of adaptable spaces was previously explained to every group. Generally, the spaces with more people were considered to be also the spaces that allowed more activities and that, in the end,

could have simultaneous experiences happening, all leading to potential adaptability. But even though there is a possible correlation, still to be concluded from these procedures, the groups were asked to focus on adaptability and not only on density of people in space. The tour ended near the opposite staircase on the west side of the second floor (Fig. 255a).

After the depiction of the general tour in its sequential stages, we will proceed with a more detailed outlook on each space and on the comments from the students on that matter. Starting on the auditorium's cafeteria, students claim that parents are avid users of this space while waiting for their children. It is also occasionally used when there are events on the auditorium and not necessarily on regular school days or school hours.

In what concerns the general cafeteria, there is the consistent opinion that students use it for as little time as possible, for purchasing whatever they might need and leave, which was already sustained by the regular teaching students.

The main and the small auditoriums have also been mentioned as being "rather good". The small auditorium is most frequently used for auditions with parents and friends because of its size adequacy.

The library is frequently used as social space by these students: "it is very used, but it is more for talking than for just standing"[804]. As for the corridors' appropriation and the previously observed artistic informal displays, artistic students confirm that the colleagues who mostly played on the corridors were the ones whose instruments allowed it, such as guitar and harp players, and that the remaining students with voluminous instruments, that were difficult to displace from the classrooms to the corridors, did not do it as much. They also feel that "playing in public is an habit"[805] and that, in the end, they could even create a much more vibrant environment than what they do. Students have even pointed out that sometimes there are complaints on the noise they are alleged to make, but that they lack on alternatives for spaces for them to be in and to practice: "They complain everywhere from the noise but they don't provides us with any space" [806].

Students confirm to use the central staircase more often with the purpose of going to the room for leaving the music instruments and where the music sheets are kept, which they say: "it is where everyone stops"[807]. This had already been recognised by the observations and will also be sustained by the artistic teachers that confirm to often go to that room prior to their classes.

[804] Free translation of the original quote in Portuguese: "é muito usada, mas é mais para conversar do que para estar."

[805] Free translation of the original quote in Portuguese: "tocar em público é um hábito."

[806] Free translation of the original quote in Portuguese: "Queixam-se em todo o lado do barulho mas também não nos arranjam nenhum sítio."

[807] Free translation of the original quote in Portuguese: "A sala das partituras é onde toda a gente pára."

In what regards the niches on the corridors, these students claim to use them as a staying space, most often when they go to their lockers and decide to stay there, but they also confirm that artistic training also occurs there, as well as pedagogical activities, namely younger children doing their homework with their parents before classes start. And so, the proximity to the locker area is also a reason for choosing that niche in particular, proven by quotes such as this: "I use it very much because of my locker"[808].

Students have also sustained that the use of these spaces also depended on the spatial features and the environmental comfort it provided, as well as the furniture it had for catering for specific activities. In this sense, the niche closer to the small auditorium is one of the preferred spaces by these students because: "it's warmer, it has more sun and a table", on the contrary, a niche that previously had a table and a bench and now it does not, currently deprives the students of going there. They state: "When it had a table and a bench I used it more"[809].

It is relevant to recall that the fact that the corridors on the first and second floors differ in configuration, implies a different positioning and morphological conditions for the niches, and therefore a potential difference in use. Not only do the niches have different sets of furniture, like tables, benches and lockers, as they also have different light conditions and, foremost, those on the first floor are spread around the whole building's length, and those on the second floor are more segregated on the extremities, potentially inducing a lesser usage due to its morphological depth.

Still, the fact that these are further away from the most integrated spaces may lead to a cosier atmosphere and a sense of easiness that explains some of these students' preference for being on the second floor rather than on other, more exposed and denser spaces. This remark from the students is important to be critically analysed, because it may imply that integration is a deviating factor for individual activities, and those activities that involve students to feel at ease and comfortable, like practising as opposed to public displays. Yet, this may change according to the person who undertakes this practice, because during observations students have also been seen singing in the middle of the main hall. So, this idiographic approach also concludes on a degree of subjectivity on the choice of spaces to play in, provided by the subjectivity of the people who are engaged in these spaces. This leads to the assumption that spatial fruition is also a product of personality and individual choice, besides social and cultural contextual constraints, and that spaces are not only chosen according to physical or morphological features.

Overall, the practice on the corridors themselves, near the classes or on the niches, display the already referred artistic ambiance very relevant for motivation, critical thinking and peer interaction: "here we feel the artistic environment, and that is

[808] Free translation of the original quote in Portuguese: "utilizo muito por causa do cacifo".

[809] Free translation of the original quote in Portuguese: "quando tinha a mesa e banco usava mais."

Fig. 256. Walkthrough with students of the articulated teaching _ moving through the school (Carolina Coelho, Jéssica Barreto)

very important"[810]. The collective gathering of the students is also paramount for their learning and also for their social life, they even say they often get together on a specific niche during a break and then split up towards each one's classrooms, as they explained during the walkthrough (Fig. 256).

. Walkthrough with teachers of the artistic teaching - Thursday, 9th February 2017

This group is composed by four teachers of the conservatory: two of them who teach the transverse flute, one the clarinet and another one the trumpet. The walkthrough started on the main hall that teachers considered to be a highly representative space according to the initial brief of this research, explained to them beforehand. Specifically, they focused on the fact that the artistic teachers stay together more in the auditorium's cafeteria, where there are also parents helping their children with their homework, which introduces in this space educational and both programmed and non-programmed activities. The library, according to them, holds more articulated students rather than supplementary or regular ones.

These teachers have also sustained that the central staircase is more used and it was through there that the tour progressed towards the first floor. Then, and similarly to the artistic students' walkthrough, these music teachers went immediately on towards the small auditorium and did not consider going on the opposite direction to the dance studio. Naturally that these routes demonstrate the specific uses and the groups' perspective on space, also according to their experience and inherently, their curriculum and routines in the school associated to the spaces that allocate them. The teachers have also highlighted that situation and confirmed that it was more the dance students and teachers that used the staircase near the dance studios (Fig. 257).

[810] Free translation of the original quote in Portuguese: "aqui sente-se o ambiente artístico e isso é muito importante."

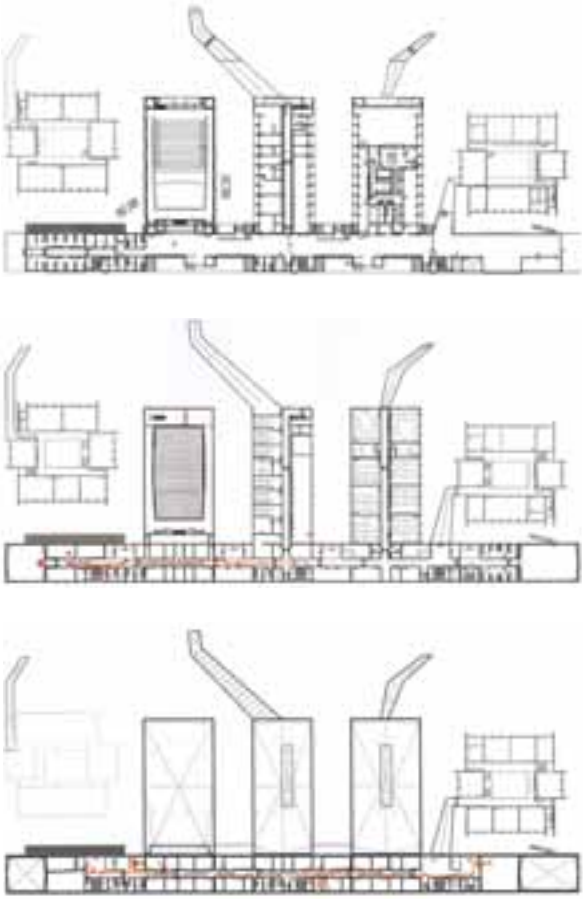


Fig. 257. Walkthrough with teachers of the artistic teaching _ plans
(Carolina Coelho, Micael Soares)

During the tour on the corridor, the teachers explained the relevance of the niches, as spaces for students to say for a little while. They have also identified the composition room as a significant space, where students have collective classes, aggregators of a wide range of students. But their focus was mainly on the small auditorium, highly regarded for a very diverse set of uses, regular and artistic, formal and informal, public and private. Teachers have also explained that the main auditorium also holds frequent events for the regular teaching community.

In what regards the niches, teachers also share the opinion that the placement of furniture, such as tables, promotes its usage in more diverse ways, like collective gatherings and pedagogical activities.

Going up those stairs to the second floor, teachers again pointed out the niches for similar reasons as those on the lower floor, and explained the location of their classrooms, which were all on that floor according to the nature of the instrument they taught. Interestingly, as the sense of belonging is very vivid in these teachers,


Fig. 258. Walkthrough with teachers of the artistic teaching
(Carolina Coelho, Jéssica Barreto)

they made sure their classrooms were open so we could go inside during our tour, because these represented the spaces where they spent most of their time in the conservatory (Fig. 258). The walkthrough ended on the opposite end of that floor plan, on the dance studio, where we did not enter because of the need for special dance shoes, concluding on its high specificity.

. Critical interpretation of the general findings from the walkthroughs

After all four walkthroughs it is possible to overlap the routes taken in all tours and to superimpose the groups' choices for the most adaptable spaces.

As for the routes, only the artistic teaching, both with its teachers and students, have chosen to go to the second floor, as the regular teaching community does not have a close connection with this floor plan and hence, does not have a say in what regards potential adaptable spaces on that floor. That justifies the fact that those walkthroughs with the regular teaching did not go there at all.

Another difference in the routes is the fact that the regular teachers and students have chosen to go through the science labs, as opposed to the artistic community, which did not. This naturally demonstrates that the tour also confirms the spaces to which every group has a deeper connection with, and those which make part of their daily routine. It is from these spaces and the activities each one usually does in them that they could have an opinion about, and not on the remaining spaces.

This also explains the broadness of the tour by the artistic students and their most frequent stops on both formal and informal spaces; the stops made from the artistic teachers, mostly on formal spaces since their socialisation in the building is more circumscribed; and the fact that the regular community has taken shorter routes amongst the spaces used by them, which are only a part of the building overall (Fig. 259).

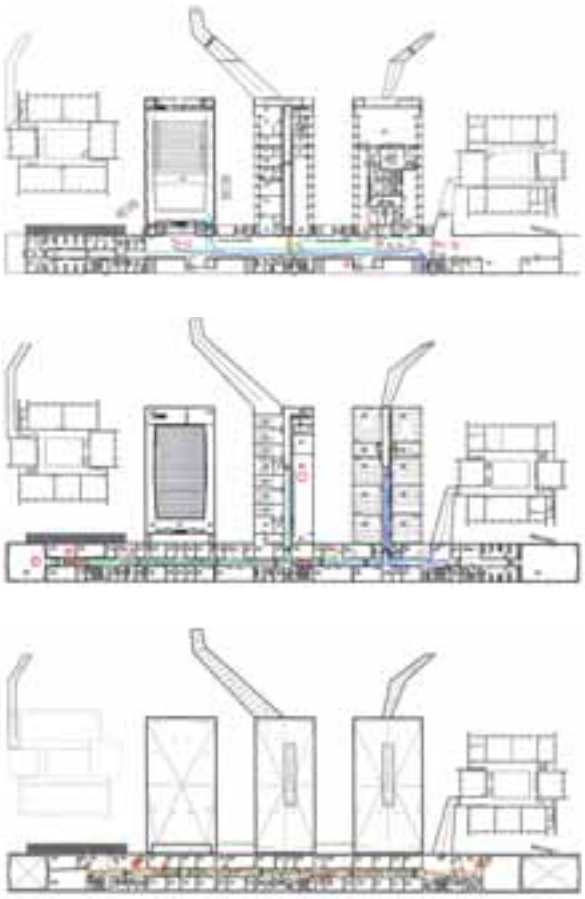


Fig. 259. Walkthrough with all groups _ plans
(Carolina Coelho, Daniela Aires)

Teachers from the regular and also from the artistic teaching have similar pathways in the school amongst themselves, but differently in each group. That is due to the reality they know in the building and that they have explained during the walkthroughs, which conditions the way in which they use space.

The artistic teachers have depicted a rather conditioned use of the space, with little social interaction, set only in their area of acquaintance with their students and nearby teachers, frequently teaching similar nature instruments. Social sets may be the teachers' common living room or the auditorium's cafeteria, which has already been confirmed as highly frequented during the afternoons particularly by the artistic community at large. Still, the fact that breaks are short may impede longer pathways and, as these teachers' classrooms are located on the second floor, all in all, they state the most frequently gathering spot is, in fact, the main corridor, where students wait for class, where sometimes parents of younger children wait with them and where teachers come for a small break. So, the corridor is here understood and experienced as a moving pathway to get to class but also, and very

significantly, a space to stand, to practice music instruments before class, to do homework while waiting, and to socialise.

The teachers from the regular teaching have also confirmed a similar route within the school, but regarded socialisation as a very relevant and frequent happening for both their personal lives and their professional work. This explains the need for such a large teachers' common living room provided with seating areas, workstations and a cafeteria, but also offices for teachers according to their scientific area in particular, implying the frequent meetings and the need to work collectively. Naturally, they have indicated during their walkthrough their living room as an adaptable space, which relates only to them, but that has been explained to hold socialisation, individual or collective work, and even programmed events and meetings also from external entities from the school. This is a specific remark from this group, which adds complementary information to the communal school spaces.

The regular teaching students have also demonstrated a very pragmatic use of this building in regard to the choice in pathways, which is most considered for getting to a destination rather than for socialising *per se*. This might explain their lower sense of appropriating space or feeling free to stay in diverse locations and enjoying social, leisure or pedagogical activities with their peers. These particular students consider the main hall and the library as relevant communal spaces where they meet socially at the morning arrival, and where most of their social experiences in the building occur outside classes.

It was the group with the articulated teaching students that has shown the most informed conception of the whole building and the broadest consideration on potential uses and a higher sense of belonging and appropriating space. Particularly, their creative profile leads them to enjoy common spaces in informal activities, most often spontaneously, but also to easily undertake activities of social, educational and artistic nature in the main hall, the corridors, the niches, the library,… all spaces not initially conceived for such purposes, more for moving or for formal fruition, respectively.

All groups have considered the main hall has a highly adaptable space for a diverse sort of activities, gathering all the school community. It has even been considered by some groups as a space potentially understood in several different spatial areas, due to the adjacency to different spaces, such as the auditorium, the Directions' offices, the cafeteria and the library; with different seating arrangements throughout; and also which held different students according to their usual location there, which had already been perceived during the observations. In this sense, the regular teaching community assumed its preference for the space near the library and the artistic one indicated the auditorium's cafeteria as a potentially more prone space for this group, but they also sustained their frequent use of the informal spaces on the upper corridor, both the corridors themselves and the niches for them to be in.

The niches on the upper corridors have also been appraised as relevant spaces, particularly for all the artistic community, as socially and artistically relevant and with the specificity of a higher sense of comfort for them to stay, due to the smaller dimension of these spaces, the physical comfort it provided and the connectivity with the classrooms in which they have classes. On the contrary, the regular community does not have such an intensive use of these spaces and it uses the corridors mostly as moving pathways or just when waiting for science lessons.

Besides the niches, and also proven by the previous observations, the corridors themselves, despite being deprived of a very large width, are spaces of effective stay, both for regular and artistic study or for social gathering. This is mostly due to their direct connectivity to the classrooms and also their morphological integration, gathering the users of that floor plan and the students from the previous and the forthcoming lessons.

The library, as it also holds social activities besides the most formal ones, is also a space to be referred to according to this brief. It is a space that can cater for all the school community in programmed events such as book readings, formal exhibitions, or informal talking, besides group and individual work with colleagues or with the parents. It is overall, a space that enables, through the space and also through its management, a diverse fruition. The main auditorium is very significant community asset, whereas the small auditorium is used for both the regular and the artistic communities and it holds a greater sense of intimacy. Finally, the artistic community has also referred the small auditorium and the composition room, where collective classrooms happen, also as adaptable spaces. This has been highly stressed by the teachers, which innately are more acquainted with formal events, and the students have referred this space along with the remaining, more informal ones.

4.2.3.3. Focus groups _ Idiographic analysis

Focus groups have the specificity of assembling a group of contributors and to assess a precise problematics:

> "The focus group method is a form of group interview in which: there are several participants (in addition to the moderator/facilitator); there is an emphasis in the questioning on a particular fairly tightly defined topic; and the accent is upon interaction within the group and the joint construction of meaning." (Bryman, 2008, p.474)

Specifically, this process aims at gathering information through participants' interaction for explaining a certain subject matter, which is set by the researcher (Morgan, 1988, p.6). For our current research, it is used under this sequence of methods because it is intended to provide data that might explain, rather than just

depict the perceived social interactions, which justifies its subsequent use after observations and walkthroughs, but in a conjoint manner for the overall findings[811]. According to Morgan (1988):

> "The strength of relying on the researcher's focus is the ability to produce concentrated amounts of data on precisely the topic of interest. This strength was clear in comparison to participant observation because focus groups not only give access to reports on a wide range of topics that may not be observable but also ensure that the data will be directly targeted to the researcher's interests." (Morgan, 1988, p.13)

In this case in particular, focus groups have been formed and asked to comment on a more specific manner, each ones' routines, movements in the school building, activities within that building and a potential justification of the remarked behaviour during the observations. These have been formed in order to provide a better acquaintance of the school's community, to understand in a more detailed explanation the choices made from the walkthroughs and also the frequent uses perceived in the observations, and foremost to elaborate on the adaptability issue in regard to the building by generating interaction within the contributors in their own environment:

> "Focus group research is less artificial than many other methods, because, in emphasizing group interaction, which is a normal part of social life, it does not suffer from the problem of gleaning information in an unnatural situation." (Bryman, 2008, p.487)

As already explained on the walkthroughs description, the focus groups and walkthroughs went hand in hand in completion date and for all the same four different groups of volunteers. Also according to Bryman: "[…] the general point is that increasingly focus group practitioners try to discern patterns of variation by putting together groups with particular attributes or clusters of attributes." (Bryman, 2008, p.482). So, the four groups previously arranged for the walkthroughs have also been the same that have participated in these focus groups, because these are considered the ones who bring detailed data for this research and may have different perspectives on space[812].

The focus groups have been undertaken in the following days:

. teachers of the regular teaching – Friday, 3rd February 2017

. students of the regular teaching – Friday, 3rd February 2017

[811] "In combination with other methods, focus groups can provide preliminary research on specific issues in a larger project or follow up research to clarify findings from another method." (Morgan, 1988, p.17)

[812] "Focus groups take a long time to arrange, and it takes a long time to transcribe the recordings that are made. […] Make sure you are able to justify the number of groups you have chosen and why your data are still significant." (Bryman, 2008, p.479)

. students of the articulated teaching – Friday, 3rd February 2017

. teachers of the artistic teaching – Thursday, 9rd February 2017

This stage aimed at deepening the information related to spatial use and personal data that might inform and clear out some of the most generalised findings from the observations of collective patterns of co-presence and natural movement, to the tour guided by the groups on the walkthroughs. So, at this time the focus groups, intended a closer approach to each person as a representative of a group but assuming each ones' spatial fruition and perspective of the space according to their age, curriculum and interests. Note that even from the previous observations, it has been remarked that students laid in space according to their age groups, from the younger to the older ones, and even according to social denominators guided by common interests in the school and/or in the conservatory.

The time for the focus groups, similarly to the walkthroughs, was intended to be analogous so that every volunteer had the opportunity to provide information for the purposes of our current research but, in a well-adjusted way, without deviations from the purpose on the subject of adaptability, which might have proven to be difficult. Still, as this process intends a closer and more individual outlook on people's relation to space, the time taken for each focus group naturally depends on the profile of the interviewees and their more or less active participation on this procedure.

Each group was gathered and it was explained to the participants the context of this research so that they could understand, in a simple yet precise manner, in what way could they contribute and what was the intention of their contribution, leading the conversation to that subject and attempting to deviate it from further distractions. Naturally that the concept of adaptability might prove difficult for them, so that after explaining the context of the research, this concept has been described and clearly explained in a simple way for all to understand it.

Then, a dialogue was started for getting acquainted with the individuals on their personal profile regarding age and also pedagogically, regarding their curriculum, which might all bear relevance for their spatial fruition according to the classes they attend and their respective location. Then, discussions were led towards spatial usage, access from the exterior and most used pathways, that would explain and potentially provide correlations with the users from the observed movements in the building and also the activities undertaken by the participants, on their nature and location.

Afterwards, participants were asked to individually reflect upon the building's spaces and to provide their outlook on the spaces that, according to their perspectives, would better represent the spaces where the widest range of activities actually occurred and that gathered the most diverse array of people. Focus groups had been previously prepared to answer specific questions on spatial adaptability in the building, foremost which were the spaces each group considered more adaptable

and why, locating them in the plan and explaining the activities that occurred there and the people who actually used it. The "script" included question such as: Can participants rank the spaces according to their adaptability? From the most adaptable spaces, which ones are more related to social, pedagogical and artistic activities and which can congregate them all? Which hold formal and/or informal activities and which hold programmed and/or non-programmed events? Are the corridors considered spaces of relevance for knowledge transmission or just for movement? If so, in what ways and by whom? What is the main route taken by each person and each focus group, and which spaces does each focus group consider to be the most frequented by them and which activities do they undertake in those referred spaces? Are there any spaces lacking in the school that would be relevant for their learning and socialisation?

Overall, focus groups took about one hour, enclosing the presentation of the context of the research to the actual sketching on the building's plans by the contributors, even if this may differ from group to group according to the active participation of the volunteers.

Also, similarly to the walkthroughs, each focus group required a team of people to best record it, intended to be neutral and not participant in the process. So, it was composed by myself as the team leader, for moderating the debate according to the research objective, and the remaining team members with the following functions: registering the audio; registering the video; photographing the experience; writing field notes on what was happening, the sequence of events and the most relevant quotes from the volunteers; and providing the plans and markers for the participants to sketch, in a total of 5 people involved on the team.

From all focus groups, accounts were made on audio and video records of the full experience; field notes were taken; photographs documented the event, either on a general space and on individual participation; and finally, sketches done by the participants on the plans were produced by all volunteers, regarding their most used pathways and their perspective on the most adaptable spaces.

Each focus group will be analysed in its specificity and then general remarks will be concluded on potential similarities and/or discrepancies amongst the four. Although the materials gathered have been extensive, commentaries will be provided on all of them, crossing the distinctive findings, even if only some of the sketches and photographs will be placed here at this point, as a representation of a broader extension, which to reflect upon. Again on this analysis, the identities of the volunteers will not be disclosed, but rather the accounts on their participation, their outlooks on space and their respective fruition. The focus groups will be analysed in the order in which they have taken place.

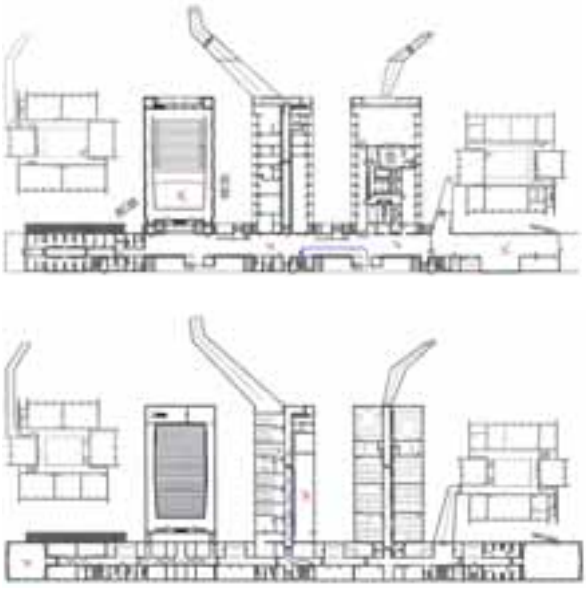


Fig. 260. Focus groups with teachers of the regular teaching _ drawing by one participant (Teacher A)

. Focus group with teachers of the regular teaching - Friday, 3rd February 2017

This focus groups is comprised of the same four teachers of the regular teaching regime that went on the walkthrough. When asked about their regular routes on the school, the answer was similar to all the participants in this group: teachers arrive at the school, choose the central staircase to go to the first floor and then go to their transversal hallway, either to the teachers' common living room or to their scientific group office. From there teachers go through the access on that extremity towards the external pavilions. The floor plan on the second floor has not been used to sketch their usual paths, since it is not used by the regular teaching community.

So, it might be concluded that these teachers do not use the spaces in this building so much, exceptions made for the Direction hallway on the ground floor, the science labs area, and naturally the area of the teachers' offices on the first floor in particular.

In what concerns spatial adaptability, teachers were able to specifically indicate them in the plans they were provided with, pointing out the ground floor as the floor with most spaces on that regard, particularly: the library, the main auditorium and the main hall. Interestingly, the main hall has been indicated as being most adaptable near the library and near the central staircase, leaving out the area more specific of the artistic community near the auditorium. On the first floor, teachers have also pointed out the small auditorium, which they stated to be also used by the regular teaching for smaller gatherings of some classes, and particularly on their behalf,

Fig. 261. Focus groups with teachers of the regular teaching
(Carolina Coelho, Daniela Aires)

the teacher's offices and their common living room. After the analysis on all four sets of sketches, these are all very similar in both the routes used and the adaptable spaces considered (Fig. 260).

Nonetheless, regular teachers have also pointed out the lack of a common living room for students that they missed from the school, as it was before: "the great loss we had with the new school was the loss of a polyvalent space. […] Now there is the ground floor and they use the exterior spaces but it is not the same."[813]. This quote bears an extreme high significance, already confirmed by the observations made earlier on the lack of a common living room for students to be, to talk, to play table football (formerly very appraised), … Teachers have even assumed to have tried to sort that out with the possibility of opening the canteen outside lunch hours, which seemed to be very difficult to put into practice, stating that: "it was not viable".

In regard to the whole space, teachers sustained: "It is very good to be here"[814]. It complements the pedagogical project of the school, it has enhanced their work conditions and their relation to the students. Even for the teachers' socialisation they confirm its adequacy on the teachers' common living room but also on the each scientific group office.

But appraisals were also made to the new school space that has "a higher external presence for the city" and particularly to the changed and plural curricula that has brought "another life to the school". Teachers even argue that: "our school started by being the school of the poor people, the quality of the work here changed that status, but the conservatory came to give a hand… it was the cherry on top

[813] Free translation of the original quote in Portuguese: "A grande perda que tivemos com a nova escola foi a perda de um espaço polivalente. [....] Agora há o piso 0 e eles utilizam os espaços exteriores mas não é a mesma coisa."

[814] Free translation of the original quote in Portuguese: "É muito bom estar aqui."

Fig. 262. Focus groups with students of the regular teaching _ briefing on the aim of the procedure (Carolina Coelho, Jéssica Barreto)

of the cake"[815]. Even though teachers are clear in stating that it was not the space that brought this, that "the activity and energy already existed before"[816], they also confirm the aggregation of a "more educated and informed society"[817] that uses these spaces from the outside, like the library that welcomes outside people to make their works there.

Overall, this focus group helped clearing out the relation between space and the pedagogical project, understanding the enriching ambiance and also its cultural environment and even the educated people it brought for the conservatory but also for the space in general (Fig. 261). It also confirmed, for that regard, the plurality of uses and the spatial, pedagogical and community assets it has conveyed.

. Focus group with students of the regular teaching - Friday, 3rd February 2017

As previously indicated, the participants on the focus groups have been the same from the walkthrough, as a group of four students whose ages ranged from 15 to 17. After briefing them on the context of this research (Fig. 262), students discussed space and their particular outlook on the uses for the regular teaching and the ones that aggregated a wider variety of events.

The usual route taken by these students seems to coincide amongst the four, in which students enter through the sole exterior access towards the main hall and

[815] Free translation of the original quote in Portuguese: "A nossa escola era a escola dos pobres, a qualidade do trabalho que nós desenvolvemos mudou esse status, mas o conservatório veio dar uma pequena ajuda.... foi a cereja em cima do bolo. "

[816] Free translation of the original quote in Portuguese: "Não foi o bloco que trouxe a atividade e energia, ela já exista antes".

[817] Free translation of the original quote in Portuguese: "Uma sociedade mais culta e erudita."

then take the central staircase to the upper floor, reaching the transversal access towards the teachers' offices. There, these students use most frequently the corridor placed on the final end on this hallway towards the external pavilions where regular classes occur. This leaves off the second floor, which is not indicated by these students as a floor plan they actually occupy and that has nothing sketched on the plans provided.

Students have also mentioned that another path was possible, when they did not go to the upper floor and simply went straight from the entrance of building to the exterior access towards the external pavilions, on the ground floor. Nevertheless, this was considered a secondary option, only when weather conditions were favourable.

But even though students have pointed out this route as a moving pathway, they have also indicated it as a space for dialogue and peer interaction throughout the day, but particularly in the mid-morning break. It has also coincided with their answer on which space they preferred to be in their spare time, to which they answered the external space adjacent to the cafeteria, for leisure and eating.

Regular teaching students confirm that they use the main hall and the main corridor on the first floor as spaces to stay. In the main hall, in particular, students have indicated to often use the benches near the central staircase before going up, as well as the benches and the chairs near the auditorium's cafeteria, for socialising and having a snack. On the upper floor, when students have science classes on its respective transversal hallway on the west side of the building, they often use the main corridor benches or its adjacent spaces – the small niches, where staying and socialising is also possible, while waiting for science classes to start. Naturally, that the use of the toilets near the main corridor on the upper floor is also a space that engages students during this time, as represented in the plans where the students have been asked to sketch on.

Only one student has confirmed his use of the library and the remaining have assumed a low use of this space and the urge to produce group works at home rather than in the school. This might indicate a lesser sense of belonging in space than the students from the articulated teaching, who remain there longer, for their artistic classes besides the regular ones.

As for the canteen, students have confirmed they used it for having lunch, but they did not enjoy its entrance straight from the exterior, deployed of some environmental comfort, particularly on bad weather days. Also related to this space, students find it to be over-crowded and even if could be amenable of other activities after lunch, which they would prefer to continue doing there, such as talking amongst each other, it is not possible due to its high frequency of use and spatial need of tables that induces them to leave there straight after lunch.

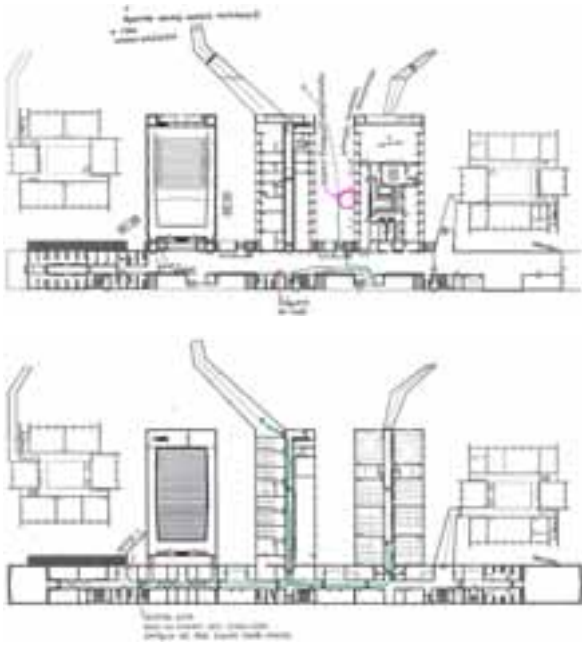


Fig. 263. Focus groups with students of the regular teaching _ drawing by one participant (Student A)

The cafeteria is not at all a space where regular students like to be, which coincides with the observations matrices previously undertaken. These students say they even avoid going there simply for picking up some snacks, and often preferred the vending machines on the main hall than going to the cafeteria to buy them straight from the bar.

During the breaks throughout the regular school day, students confirm their preference for staying in the pavilions, specially when the weather is not favourable to come outside, because they feel these pavilions can also accommodate them during the intervals between classes, rather than coming to the main hall or even to the main building overall (Fig. 263).

After discussing their spatial preferences, main routes and most frequented spaces, students were provided with plans of the main building in which to sketch their main pathways, as already justified, but also to point out the spaces they considered to be more adaptable to more activities and more people (Fig. 264). Although these students did not exactly point out the spaces in the plans according to their potential adaptability rank from their outlook, that was considered possibly too complex for them, they were able to explain in their own words and from their experience in the school where they considered that most activities usually occurred for them. These spaces have actually been identified in the plans, although not designated as adaptable, but after a careful analysis from the records taken and the sketches from the students, the spaces indicated by the students are the ones they have a deeper connection with and the most representative in terms of their time in the school.

Fig. 264. Focus groups with students of the regular teaching
(Carolina Coelho, Jéssica Barreto)

The main hall has been clearly indicated by the regular teaching students as the space where non-curriculum activities usually happened, i.e. activities such as exhibitions, demonstrations from external associations and performances. They have not mentioned neither the main auditorium nor the small one on the upper floor.

. Focus group with students of the articulated teaching - Friday, 3rd February 2017

Similarly to the previous focus groups, this one has also been established with the same participants of the walkthrough for the students of the articulated teaching, previously detailed in its wide-ranging composition, which has proven to be highly informative and aware of the space and its assets. Again students were explained the context of the research and its purpose so they could participate in the most explanatory manner towards the specificity of this study, to which they were very detailed. As these students are enrolled both in the conservatory and in the school, they are more aware of the spaces in the main building as compared to the regular teaching students. Furthermore, and as already explained on the analysis of this group's walkthrough, the fact that all these students have diverse ages and having different music instrument classes, provides them a diverse outlook on the building, according to the location of the specific classroom they attend.

In what concerns these students' main routes in the building, they often use the main staircase in the building towards the first floor and the east topside staircase towards the second floor. This could be explained due to the location of their lockers near that staircase on the second floor. As opposed, the central staircase to the second floor does not lead to any specific common space, and the east one leads to an open space adjacent to the corridors that has an adequate dimension for socialising after placing their instruments on the lockers. So, the plans from this focus group involve the second floor, contrarily to the ones from the regular teaching students (Fig. 265).

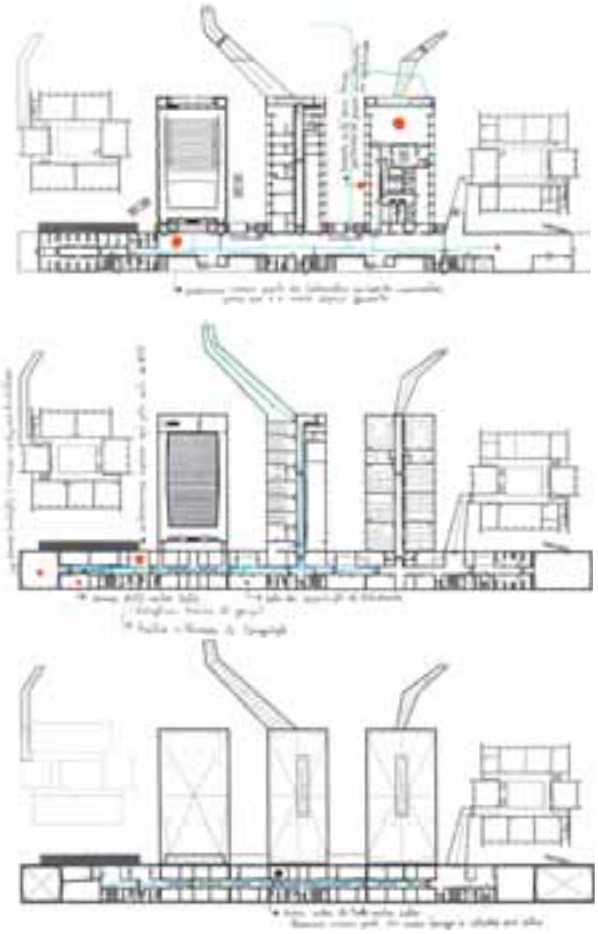


Fig. 265. Focus groups with students of the articulated teaching _ drawing by one participant (Student B)

Still, the diversity of the students' instruments is correlated with their paths on the building, which is proven by the plans they have sketched, indicating their most frequented spaces and movements. This specifies that students can have different habits when moving in space, according to their classrooms' locations and their lockers. So, if diversity has been acknowledged from the analysis of the sketches done by the students, there are also similarities amongst each other and with the regular teaching students' pathways. These are: the common use of the accesses on the ground floor to the exterior, and on the first floor through the teachers' offices' hallway towards the external pavilions; on the contrary, the access from the science labs to the exterior is the least used by all students.

So, for the morning entrance, artistic students generally place their instruments on their lockers or on the room provided for that purpose in the teachers' hallway and depart for their classes. The students whose instruments are kept in school, such as the piano or the harp, do not have to do this detour.

Fig. 266. Focus groups with students of the articulated teaching
(Carolina Coelho)

Not all artistic students claim to go straight to class after arriving at school, and some explain they stay on the main hall for a while, near the central staircase's benches or on the benches near the library, while waiting for their friends. These have already been perceived as highly preferred spaces by the students overall and hence, highly dense at the morning arrival, proven by the observations matrices previously analysed. Throughout the day, these students have diverse movements according to their places of interest and their curriculum.

As already informed, the classrooms for the music teaching are connected according to the nature of the instrument taught there, and so, the wider the variety of instruments, the further the students are displaced on the first and second floor plans of the building for their classes. Naturally that the lack of students from the dance course overlooks the most frequent use of the west wing of the building, where the dance studios are placed and their respective lockers. So, if the music students frequently use the small auditorium for their auditions or performances, the dance students also use the studios on the opposite side of the building for those purposes, both with collective potential either for practice, classes and display. Interestingly, the main auditorium can be used for all, mostly in public and pre-arranged events of higher public representativeness.

The spaces established by this focus group as their favourite for staying, leisure and socialising differ according to their age group (Fig. 266). Older students claim to prefer to stay in the main building throughout the main hall, preferably seating in the auditorium's cafeteria, which is felt as a place of belonging. The younger ones prefer to stay outside, near the external pavilions where they have most of the regular classes, avoiding coming to the main building specifically for their breaks, unless they intend to pursue specific uses such as having lunch, a snack or going to the library.

The library is recognised as an important space for this group, as opposed to the

regular teaching's previous answers. They state their relevance either for studying and undertaking pedagogical activities and also as a space for informal fruition and socialisation, eventually felt as an extension of the main hall. This may be due to the lack of a common living room for students and it is also in tune with the diversity of activities perceived in the library during all the observations.

Similarly to the regular teaching students, the external space adjacent to the cafeteria is also a very favoured space for these students who use it particularly when the weather conditions are favourable. Again, the cafeteria shows to be one of the least used common spaces, as also proven by the observations, and even if some students state their preference for the vending machines, as the regular teaching students had already expressed, the ones who actually go there, often stay for a limited time only for the purchase of snacks. The canteen is also used for these students to have lunch and leave straight afterwards, as also mentioned by the regular teaching students and remarked by the observations.

Naturally that these students refer to the niches near the corridors on the upper floors as spaces to stay, more so than the previous focus group, because of its morphological connectivity to the classrooms and also because they fell rather comfortable in smaller spaces, which they consider to be cosy and physically adequate for socialising and even for artistic informal displays.

In what regards these artistic displays, students claim that they often practice inside classrooms that are vacant, particularly in the early morning or lunch breaks. Still, some may practice on those niches. The harp student, for instance, has said that she would use one of those niches in a frequent way for practising when the classrooms were all being used. This also demonstrates a sense of physical and social comfort for playing an instrument in a common space of the school. However, the cello student states her struggle in playing outside a classroom because this instrument implies to be seated on a chair that is lacking in all of these spaces and that ultimately deprives her from practising outside and compels her to the schedules of the vacant classrooms.

All in all, the practice of music instruments is constrained by the physical features of the spaces and naturally by the ones who play them. In this sense, if there are students who easily play their instrument on the corridors, others confirm their lack of comfort when playing outside. But overall, if during the observations some students have been perceived playing music instruments on the ground floor, the students of the focus group have confirmed their preference for playing on the upper corridors, where they feel more at ease and more amongst their peers. This coincides with the observations that have perceived to have more artistic students in these spaces in regard to a wider general community that uses the main hall. Even though, the piano that is usually placed on the main hall is often used by students to practice or to enjoy themselves, informally, either alone or with their colleagues.

Fig. 267. Moment of spontaneous artistic display during the focus group with students of the articulated teaching
(Carolina Coelho, Jéssica Barreto)

During the focus group, some particularities have been told, like the singing students that, generally, find it interesting to sing in the staircases, for acoustics testing on a most improbable space, conceived for vertical circulation and not for artistic, yet informal and non-programmed, training. These testimonies, overall, demonstrate that this building is subject of appropriation particularly by the articulated teaching students, who find amongst the diversity of spaces, the ones where they prefer to spend time in and to practice their instruments. It also shows that the music ambiance is displaced throughout the whole building and that the profile of these students in particular is rather spontaneous and enriching of the spaces' potential from its early conception (Fig. 267).

Remarkably, students have confirmed that during the Music Day, the conservatory encourages students to be in the common areas of the building playing their instruments and promoting an inspirational music environment.

The profile of these students implies frequent gatherings for practising and discussing music and for learning. This is also proven by the regular meetings on Saturdays only for watching the orchestra in the auditorium or for the collective rehearsals that occur there also on Saturdays. This implies the need for individual learning spaces but also spaces of different dimensions for smaller and larger groups, such as the small auditorium and the main auditorium respectively. Also, public displays are frequent for these students, which usually occur in both the small and the main auditoriums. Besides, students also recognise that some activities with their parents also take place in the library in a more informal manner.

Even though the building lacks an effective students' common living room, since some of the students who have participated in the focus groups belong to the Student Association, they in fact use that room for their particular appropriation.

Even so, students point out that the most adaptable spaces for them are the spaces used by most of the school community, namely the main hall, where most activities are possible to be done, considering it to be a highly innovative space while comparing them to other conservatory buildings they know, specially the prior space of the conservatory that the older students had also known.

. Focus group with teachers of the artistic teaching - Thursday, 9th February 2017

Again, this focus group has also been done with the same participants of the walkthrough, which implies that their spatial use concerns the location of their classrooms and so their closeness to one another is accorded to the affinities on the nature of the instruments they teach[818]. The fact that there are two transverse flute teachers, who have naturally near classrooms for teaching, as opposed to the trumpet and clarinet teachers that have their classrooms nearby one another, potentially implies different spatial routines.

One of the explicit findings of this focus group is the very specific use of space that teachers claim to have, very different from the wide-ranging outlook provided by their artistic students. Teachers, on the other hand, sustain that they reach the school and go straight to their classrooms using the central staircase, or go first to the room where instruments and music sheets are kept and then to the classrooms. Some of the teachers confirm occasionally going to the teachers' living room for a quick coffee break, either at the arrival at school or in the midst of their lessons. In this way, they do not have a very broad fruition of the remaining spaces. As they confirmed: "Our culture as music teachers is more individualistic, we use the classrooms for very long and isolate ourselves there."[819].

Despite the fact that each teacher uses his/her classroom in particular, and so their routes in the school are to and from that space, the artistic teachers all report a similar spatial use and also a similar perspective on the spatial adaptability of the building, realising that the comments all coincide (Fig. 268). Besides the occasional break on the teachers' living room, their communal time is spent near their classroom on the corridors, socialising with the teachers near them and hence, the ones that teach similar nature instruments: "the corridor ends up by being the meeting point for the teachers"[820]. They insist that the building is too long for going to the teachers' common living room that is shared with the regular teaching teachers, or even

[818] Note that each teacher is accorded with a specific classroom and that music classrooms are arranged by the nature of the instruments.

[819] Free translation of the original quote in Portuguese: "A nossa cultura como professores de música é mais individualista, ocupamos as salas durante muito tempo e isolamo-nos nas salas."

[820] Free translation of the original quote in Portuguese: "O corredor acaba por ser o ponto de encontro dos professores."

further away to the auditorium's cafeteria on the ground floor, because they do not have time in their small breaks for going there.

They reveal a critical stand on the large dimension of a building such as this, that may hinder the social contact and family sense they felt in previous buildings, smaller and with less teachers: "the problem with these large buildings is the lack of contact with the others that is missed [that did not happened in the previous conservatory spaces], as even the students, I think, suffer from that" [821]. This might show a more evident criticism and a higher difficulty for adapting to a new environment that implies changing habits and routines, as compared to the students who did not mention these remarks and seem to have learnt how to use the building and to make the spaces fit for their needs.

The main auditorium and the small auditorium are considered adaptable spaces, in which the small auditorium has mainly artistic activities, even though some activities from the regular teaching might occasionally occur there, and the main auditorium has also artistic activities and others of very diverse sort, mainly programmed ones, but also external ones enlarging its influence on the city. Even so, its large dimension may cause some uneasiness from the students and players and so, the small auditorium is often used for pedagogical purposes and also for cost reductions or avoidance of the use of excessive space for a reduced audience. The main hall has also been clearly stated as an adaptable space, even more prone to informal activities besides the possible formal activities that occur there.

The niches on the first floor have been confirmed to hold students while waiting for classes, as opposed to the second floor niches. This could be explained because the niches on the second floor are placed on the extremities and it is actually on the benches that students stay near their classrooms, according to these teachers. The fact that students practice both on the niches and on the corridors has also been confirmed by these teachers, as did the previous focus groups and the observations prior to that, and teachers even say that it sometimes bothers the classes inside.

Another relevant remark made from these teachers, and that had already been confirmed by the artistic students, is the use of formal classrooms for practice, when those rooms are vacant from formal lessons. One of the teachers of the artistic teaching has said: "My classroom sometimes is completely disorganised as if someone has been there, perhaps a quartet or so ,…"[822] This might imply that music classrooms can hold both formal and informal activities of artistic and pedagogical potential, possibly due to its adequate smaller dimension and a sense

[821] Free translation of the original quote in Portuguese: "O problema destes mega pavilhões multidisciplinares é que perdemos um bocadinho o contacto com os outros, mesmo os alunos, penso, que sofrem um bocadinho nesse aspecto." Even though students have shown they use all the building and did not, in any time, made this critic to the fact its dimension might obstruct their socialisation.

[822] Free translation of the original quote in Portuguese: "A minha sala às vezes está completamente desorganizada como se estivesse lá estado um quarteto ou assim..."

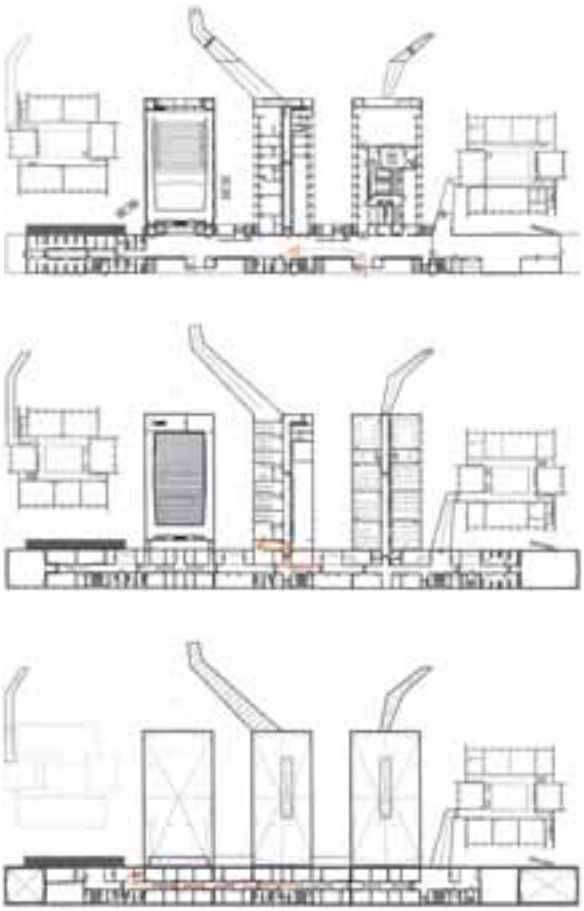


Fig. 268. Focus groups with teachers of the artistic teaching _ drawing by one participant (Teacher B)

of easiness to play and practice, either alone or in small groups. But to note also how deeply rooted the sense of belonging is from the teachers, claiming for *their* classrooms, because of the time they spend in the same space and the fact that the association of an instrument to a space makes them use that same space and not any other, hampering their fruition of the whole school building.

Generally these teachers support the main hall as a space that gathers all the community and that, in some time periods such as the mid-morning break, it is completely full and highly dense, which has also been perceived by the previous observations. But also in the afternoon they confirm students to be on the benches, more sporadically in the middle of the corridor and more frequently near the auditorium's cafeteria for socialising, but also for studying and for practising, by both the articulated and supplementary students that come to the conservatory in the afternoon.

Overall, the artistic teachers share the common indication of the main hall to be very aggregating of people, but also point out the main and the small auditoriums for their frequent use and ability to cater for several different artistic activities. Some


Fig. 269. Focus groups with teachers of the artistic teaching
(Carolina Coelho, Jéssica Barreto)

criticism has been made to the building, regarded to a comparison with the previous spaces where the conservatory has been before. Similarly to the regular teachers, these teachers' routes and routines are near, but there is a higher sense of ownership of the classroom where they teach, due to the long time they spend there, and a lower sense of socialisation amongst the all artistic community, let alone the regular teaching, said to be due to the space's over dimension that does not allow them to go to the common spaces in a short period of time (Fig. 269).

. Critical interpretation of the general findings from the focus groups

Teachers have similar routes on the building, differently according to their artistic or regular classes. It is the students who have a more diversified use of the spaces and, most profoundly, it is the artistic students who spend a very long time there, who most perceive and appropriate space as their own.

Routes on the building also differ according to the final destination of the people involved. The lockers are a very important space for the students to place their instruments, but the room for placing the instruments and where the music sheets are kept is also a common space used by all the artistic community on their arrival. On the other hand, regular teaching students aim at reaching the external pavilions for their classes, either by the ground floor or through the corridor on the first floor, which is used by the teachers, whose offices are placed in that hallway.

The cafeteria is a space not highly appraised by the students, to which some prefer using the vending machines. Instead, the exterior space near the cafeteria is very favoured by all students as a pleasant space to be in good weather. The canteen is a space that only caters for having lunch and, due to its over-crowding, students claim to eat and promptly leave afterwards.

The library is confirmed to be used both formally and informally for studying and socialising, as the observations had already confirmed, particularly for the artistic students who spend more time in the school and use the main building more widely, than the regular teaching students whose time schedule for using it is also balanced with the time spent on the external pavilions.

It is also the artistic students who mostly use the auditorium's cafeteria, being in school at the time it is opened and using all the floor plans of the building. The teachers also confirm its use, but their specific spatial fruition in a regular day is narrowed to the area closer to their classroom.

Corridors are considered to be relevant meeting points for all interviewees, for socialisation and even for artistic practice. Regular teaching students confirm the use of the benches and niches on the first floor, mostly near the science labs; while artistic students enlarge their relevance and sustain their use, both on the first and on the second floors, near their classrooms, on the corridors themselves, or on the niches, for talking or even for practising. This practice of music instruments is very widespread and can be accommodated in more formal music rooms or in the most informal spaces, depending on the people who do it and on the requirements they might have for playing that instrument in particular.

So, artistic activities can be formal and informal. Formal activities are often displayed in the more formal spaces from the music rooms, to the small and the main auditoriums. Still, some formal activities or informal but programmed ones, like the jazz gatherings on all Monday afternoons on the main hall, or the playing of instruments on the Music Day on the corridors by formal directive, can be implemented elsewhere in more informal spaces.

Social activities have also been confirmed to occur on the main hall, the cafeteria, the canteen and also on the library, which has been particularly conveyed by the artistic students and previously confirmed by the observations.

The wide-range of spaces that take on artistic practices may be so because of a potential lack of practising spaces for all the students attending the conservatory, but also the spreading of social activities on all the school building may result from the lack of a common living room, which the main hall is often considered to be.

Not only that, but the main hall also holds formal activities, public displays and formal events of pedagogical potential, which broadens its scope and potential even wider. The main and the small auditoriums are directly pointed out by the artistic community as very relevant spaces for practice and performances. And even if the main auditorium has the ability to accommodate smaller groups, the small auditorium is often preferred due to its more adequate scale size for practising and smaller gatherings.

The specific findings from the artistic teachers' focus group in regard to the identification of both auditoriums – the small and the main one – as adaptable spaces, might have been expected from this focus group because the teachers are naturally more related to formal activities, performances, auditions and enlarged public displays, naturally related to the artistic realm. This can be justified because both auditoriums are spaces where artistic daily activities occur, and because these teachers are much acquainted with these happenings, as opposed to the regular teachers, for instance. Unsurprisingly, for the artistic teachers, the perception of the auditoriums as adaptable spaces can be noticed as natural, as these are spaces they often use and that are enrolled on their daily routines and teaching practices.

The most informative focus group regarding the space use of the building has been naturally composed by the artistic students, because of their broader use that reaches all spaces of the building, individually and collectively, for informal and formal activities, for pedagogical and artistic practices. It is also the group who has openly depicted its use in diverse ways on each space particularly focused on informal and spontaneous activities, often not initially conceived for those common spaces, such as corridors, niches and the main hall.

Regular teachers have identified the lack of a common living room for students to be highly significant and a "loss", has they stated, from the previous school. The artistic teachers have not mentioned this need, perhaps because socialisation for the artistic students may occur in many different places, as spontaneous in their choice as they are in their activities. The main hall does not only comprise informal socialisation, but also pedagogical and artistic displays and, as it is a space used by all and the space that welcomes the community straight from the outside. It is not only for the students, it is for all. It is the place that holds formal and programmed events outside the classroom, and so, because it comprises a wide array of happenings of diverse nature and also a wide range of people and not only students, the students lack a space only for them. As already perceived from the observations, students lack a common living room to be, to socialise, bounded by its walls in a sense of belonging, cosiness and appropriation. The main hall helps fulfilling this lack, and other spaces as well, such as the mentioned exterior spaces namely the one adjacent to the cafeteria that is highly used when the weather is favourable, the auditorium's cafeteria and the library that also permits informal activities and socialisation. This may justify the main hall to be considered by all as highly adaptable to multiple activities and different experiences, from the wide-ranging curriculum of the students and their diverse formal and informal needs. The canteen, on the other hand, is only used for having lunch and leaving because of its dense use and the cafeteria is less used because of its low width.

All in all, the main hall's fruition is a common denominator in all answers, as it is a meeting spot and the common entrance for all the community, regular and/or artistic, which testifies its the diversity of activities. From the jazz happenings that

occur in an informal yet programmed manner on Mondays by the students, to all the informal activities, and also the formal activities mainly referred by the regular teachers and students, such as the exhibitions and other pedagogical events, the main hall is generally considered an adaptable space. The regular students have even said that most of the pedagogical formal activities that did not took place in the classroom would occur in the main hall, demonstrating its clear and already establishment as a functional space for programmed activities and pedagogical activities outside the classrooms. So, although the uses and routines in space may differ, all focus groups have been unanimous in identifying the main hall as the most adaptable space, the space that holds most activities outside the formal classrooms; formal exhibitions, displays and performances; but also socialisation during the breaks, spaces for artistic informal practice and even pedagogical moments; throughout all of its area and during the all school day.

. Final remarks on spaces' appropriation and testimonies from the contact with the Directors

After the nomothetic approach on this case study and how it has been conceived by the architect from an initial stage of the methodology here proposed, the first approach to the idiographic procedure put forward has been a serious of interviews, first informal and then semi-structured, with the Directors of both the Music Conservatory, Professor Manuel Rocha, and the Director of Quinta das Flores School, Professor Ana Margarida Marques[823], whose contacts have been established since the beginning of this current Thesis until its finalisation. These have had the greatest impact on the possibility of performing the observations, the focus groups and the walkthroughs, with their logistic support, professional openness to this process and also the mobilisation and sensitivity of the school community towards it.

Besides, also their input on the building and how the regular and the articulated teaching communities perceive and use it has also been paramount to inform on its effective spatial fruition. Additionally, it is also by management decisions that this school demonstrates a very particular aggregation of both formal and informal activities together, by understanding the nature of their students and the specificity of their wide curriculum, and also the need for socialisation and informal practice for knowledge transmission. This may justify the openness to the community and also the acknowledgement of the artistic practice and socialisation on initially more formally prone spaces such as the library, or circulation spaces likes the corridors near the classrooms.

[823] The openness and support provided by both Direction boards, represented by their respective Directors at this time, has been paramount for the realisation of this following surveys, and also their personal and professional acknowledgement of "life within this school".

a) b)

Fig. 270. a) Project "Há Baixa" with students from the Department of Architecture of the University of Coimbra, explaining their project and displaying a movie projection about their work, 14th February 2017; b) Students entering a session on the auditorium, gathering a set of several classes from different years. 9th February 2017, 10.30 a.m

(Carolina Coelho)

Precisely, in what regards effective spatial fruition, Professor Manuel Rocha has informed us on the current usage of some of the school spaces. The previously entitled "spare spaces" on the final plans, and which have been noted to be more frequently on the second floor plan presented on the 4.2.1[824] of this methodology, are currently used as music classrooms for individual teaching and/or training of music instruments. This is due to the high increase in students and respective spatial needs of the Music Conservatory, keeping all the second floor for the artistic teaching, as opposed to what had been a conclusion from the 4.2.1 stage of the methodology, when focusing on the final plans *per se,* in which spare spaces were determined to have the potential to allocate a more mixed teaching and even to address the regular teaching for a mixed use of this floor plan, which currently does not occur.

When questioned about the activities occurring in the auditorium, Professor Manuel Rocha pointed out the multiple potential activities of different nature that can occur there, some even by external entities to the school, to which the conservatory lends the facilities (Fig. 270a), which was also mentioned by the walkthroughs and focus groups.

Even pedagogically, this is the gathering place of joint reunions for the regular teaching, broadening its scope beyond the artist performances, both by the its students but also externally, to other artistic associations, to collective happenings like the French Film Festival, or academic formal classes for a large group of students from the school, namely a joint class, as it occurred in the last observation day (Fig. 270b). Anyway, the auditorium is considered a formal space and even if it could be sometimes considered over-dimensioned, some activities occupy the stage and not the audience, in a more cosy and smaller environment.

[824] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

Fig. 271. Exhibition on the main hall, 25th January (left) and 7th February (right)
(Carolina Coelho)

Another space that answers these spatial requirements is the orchestra room that is used as a small auditorium, particularly for student auditions or for smaller happenings, but sometimes also of an external nature, even if its location on the first floor might hinder its usage. Note that this small auditorium, as the community entitles it, is often chosen against the main auditorium that has a direct access to the street. Anyway, and despite its lower accessibility, its dimension is considered adequate for smaller groups and makes it a very frequented space not only for the conservatory but also for the school. This might imply that dimension is a very relevant physical attribute in choosing to allocate activities, in which an excessive dimension may cause some discomfort for undertaking certain activities and so, external accessibility is not a decisive factor when determining activity allocation.

Also the main hall holds frequent and very diverse activities. Jazz concerts by students usually happen on Mondays; fairs of very different kinds, such as books or minerals, also take place in the main hall; as well as different scientific exhibitions and projects that are displayed there. This is also proven by the exhibition that was showed there longitudinally along the hall and that gained added materials along the course of the observation days (Fig. 271). By making these displays in the main hall - in a space that welcomes all the community into the building and that also acts as a staying and moving space - it is also a way to make students get acquainted with diverse scientific contents, that could even be outside their own curriculum options, to pass on knowledge amongst all the community and to make them feel they appropriate space for their own interests and activities.

As the main hall has a long depth, near the library, where some seating spaces are placed, there was also another exhibition displayed that was organised during the observations days. This implied the relocation of the seating layout, proving

Fig. 272. Exhibition displayed on the main hall 25th January (right) and its previously layout 23rd (left) (Carolina Coelho)

their possible rearrangements and the effective appropriation of the space whose changes were made for academic purposes (Fig. 272).

The library had also an exhibition displayed on the first observation day that has been taken down afterwards, also showing this space as appropriated by the school community, as a pedagogical facilitator and a learning environment, still with a rather informal layout, particularly on that specific exhibition area with sofas for gathering small groups (Fig. 273a).

Also due to its wide area, the main hall has the auditorium's cafeteria within, that is open after the closing of the regular cafeteria near the canteen. This acts mostly as the cafeteria of the conservatory because it is mostly used by its students and teachers, but even by the parents while waiting for their children to have artistic classes. So, from 4.30 p.m. it represents a resting and social place, mostly for the artistic community, enhancing the living experience and collective gatherings on the main hall from that time period onwards (Fig. 273b).

Interestingly, from 4.30 p.m. the regular classes are lesser and lesser and the conservatory takes the lead in the spatial fruition of the building. This is also proven in the library, where the staff from the school leave and the staff from the conservatory is in charge of this space, allowing higher informality and enabling it as a social student room the school lacks. The seats at the entrance are now almost like a lounging space for students to wait for their parents or to get together. Parents study with their children, both in a scheduled or non-scheduled routine.

The lack of a common students' living room takes us to the Student Association space. It has also been remarked that the students' room is only used by the Student Association and not by the entire student community, which is deprived of a space for gathering and social activities. This is a sore point amongst all the community,

a) b)

Fig. 273. a) Exhibition displayed on the library, 23rd January;
b) Auditorium's cafeteria on the main hall, 23rd January
(Carolina Coelho)

leading to indicate the main hall as the space appropriated as a "learning street", as a students' space in which to study, play, rest, individually or socially engaging in activities and conversations. When questioned about this situation the students in the referred room answer that it was open to all, but it was rather a decision of the remaining students not to attend the space, even if the situation lies in the fact that these students use the room as their own and the students that have competed against them to the Student Association do not use this space (Fig. 274).

Another situation that has been noted by the Music Conservatory is the increasing need for four dance studios. Recalling the final plans presented in chapter 4.2.1[825] there was only one dance studio conceived and located on the first floor. Currently, the studio immediately on the upper floor is also accorded for the dance practice, leaving the choir room, which was previously conceived by the architect, to another room in the pre-existing school pavilions, which have also been rehabilitated. According to the conservatory Director, two supplementary dance studios would be needed to fulfil the dance teaching requirements, which has led to the mobilisation of the architect in conceiving a project of a dance pavilion with four studios, according to these requirements, whose development is still undisclosed.

All in all, this current spatial changes and appropriation that has been occurring in the building from the increasing needs of the conservatory, leads to a spatial mix. Furthermore, it assembles all the school community, teachers, students and staff from both institutions in a whole space, beyond the borders of the new building, but also immersing in the pavilions, bestowing on them both a regular teaching nature but also an artistic one, and spreading an artistic ambiance on the whole school and its students. Recalling Bernstein's (1971) analogy of the school as a

[825] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

Fig. 274. Student Association room. 7th February
(Carolina Coelho)

parallel for society, it would be possible to conclude on the acceptance of different profiles and interests of the users and the synergies that this spatial and curricula mix could provide towards a social and cultural enrichment of the community.

The schedule of the music and dance classes and the occupation of the respective classrooms allocated to the conservatory has been provided by the Director of the Music Conservatory. It is concluded that during the afternoon period all classrooms are occupied and in the morning period, even if some classes also occur, the remaining classrooms are occupied with the music training of the students that request a specific room with the music instrument they play in order to practice, often individually, but also with a piano player and even in small groups. This bears an increased relevance when addressing the teaching of voluminous or quite expensive music instruments that are not possible to be acquired directly by the students, who have to play with the existing ones in the school, namely the harp, the pianos or the percussion instruments. When asked about this situation, students confirm that the morning period and also the lunch break, when music classrooms are not formally occupied with classes, are the time periods they use for practising and that they represent a very important part of their training. Eventually, this has also been confirmed by the artistic teachers during the focus groups, which leads to the conclusion that the music classrooms have both formal lessons and informal practising moments, individually or collectively, in programmed or more spontaneous arrangements.

Another relevant information from the analysis of effective spatial fruition is the music playing of instruments on the small niches in the corridors, particularly on the upper floors, more prone to the artistic teaching. This occurs with smaller instruments, being the most frequent the guitars, in a more spontaneous manner, often when waiting for the classes to start. But it also occurs with instruments

taken from classrooms, which are needed spaces, and brought to the corridors for practising in programmed scheduled times with the students, teachers or staff, as students have informed us. This information holds a high relevance because, in this case, it confirms the conclusions on the academic potential for the music teaching of these informal spaces of the school, linked to the main corridors but without a closed boundary.

Moreover, although the music classrooms have similar physical attributes and therefore similar potential to allocate the teaching of different music instruments, another input provided in regard to effective spatial fruition is that, by appropriation, the classrooms are separate according to the nature of the instruments decided to be played there: stringed, wind, percussion and keyboard instruments, singing, dancing and music sciences. This association is translated onto the schedule of each teacher that lectures in a particular classroom and is associated with the placement of the music instruments according to their category. This spatially originates a separation from the artistic students and teachers according to the instruments played, enhancing more frequent gatherings amongst their direct peers, rather than a joint assembly of different interests. Anyway, as the curriculum implies group classes, and also because informally students often practice in groups, this is overcome by social interaction and effective and intentional collective spatial fruition from the artistic community.

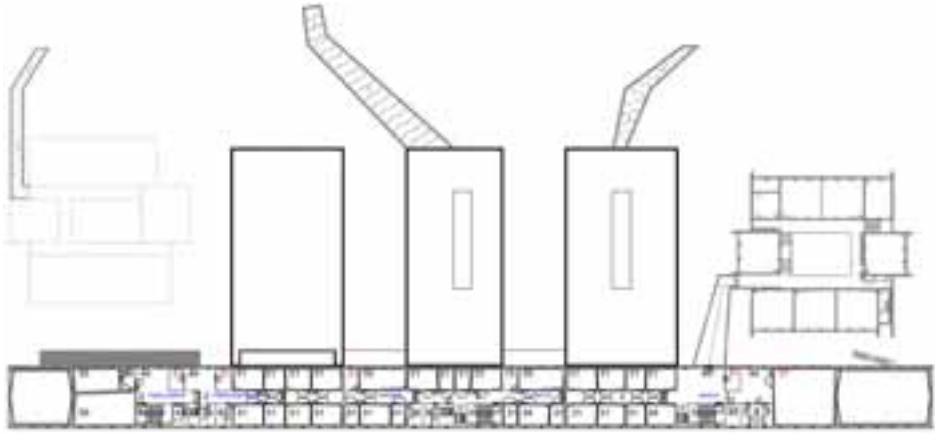
Conclusively, despite the similarity in the physical attributes addressed in chapter 4.2.1[826], appropriation, habits and routines, deploy the space's potential to allocate any instrument and instead present a sense of belonging of both the teachers and the students to a particular classroom, which leads to a potential narrowing of the overall potential of each space addressed in 4.2.2[827], to social and effective constraints brought along by the actual usage in time.

Recalling Lynch (1977), the sense of belonging by students can be associated with spatial appropriation, maintenance and fruition, and the fact that the space has suffered some alteration by the curriculum needs and by social appropriation is also a reflection of a sense of belonging and also of its ability to cope with changing needs and wants by all the community:

> "The children should be living in places that have a clear social and spatial identity, places they can understand and take pride in. They should have a role to play in community maintenance and community celebration – particular functions to perform, particular places for which they are at least in part responsible. " (Lynch, 1977, p.57)

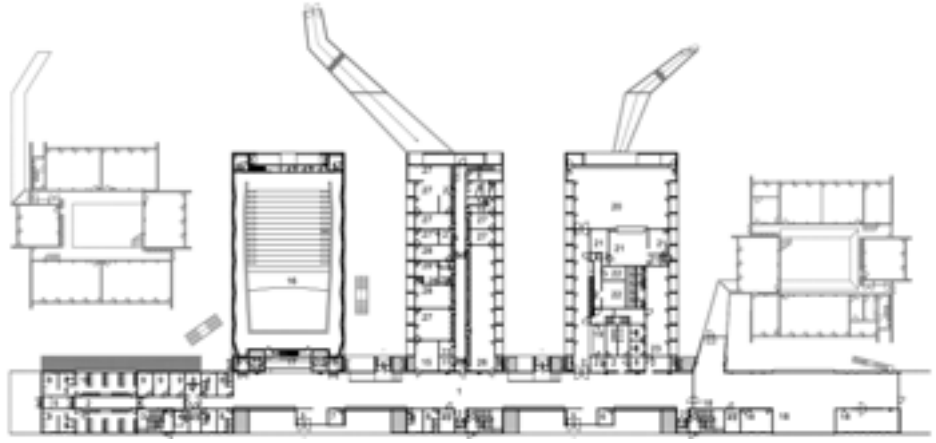
[826] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

[827] See chapter 4.2.2. Description of all possible activity allocations to educational environments



Second floor plan

First floor plan



Ground floor plan

0 10 20 m

1 main hall
2 access–corridor
3 vertical access–stairs
4 vertical access–elevator
5 entrance–outdoor access
6 reception desk
7 ticket office
8 bathroom–toilet–sink
9 dressing room
10 locker room
11 storage
12 indeterminate supportive space
13 spare space
14 vault
15 archive
16 auditorium
17 auditorium's cafeteria
18 library
19 cafeteria
20 canteen
21 kitchen
22 kitchen storage
23 staff room
24 teachers' room
25 students' room
26 secretariat
27 administration offices regular teaching
28 administration offices artistic teaching
29 orchestra room
(small auditorium)
30 music studio
31 music instrument training room (individual or for small groups)
32 choir room
33 singing studio
34 song writing studio
35 specific music training room
36 study room
37 dance studio
38 science lab
39 generic classroom
40 common living space
41 teachers' office
42 teachers' meeting room
43 teachers' office for meeting students
44 students' shop
45 photocopy room
46 parent council room
47 auditorium supportive spaces
48 psychologist's office
49 technical area
50 music instrument storage
51 maintenance room
52 music sheet room
53 special education office

Fig. 275. Plans with the effective spatial usage of the school
(Plans provided by Parque Escolar and edited with captions by Carolina Coelho)

The plan (Fig. 275) displays the changes in program from the initial brief set in the final plans and already analysed at the beginning of this overall methodological application in this school[828] and the changes the building has suffered in regard to alterations on the use of each of its spaces. This can be justified by the increasing needs mainly perceived by the conservatory for more music training rooms that have occupied all previous spare spaces, but also changes in other spaces as it is displayed in the plans and subject of a following critical analysis. It also demonstrates the effective use of the space defined by the school and the conservatory management that have altered the architect's brief, possibility because the initial brief did not met the actual spatial needs or because those needs have changed in time. So, if appropriation, in a more informal manner, has already been analysed by the idiographic approach, it is also relevant to acknowledge the formal changes the spaces can have, and which enable the changing in their functions throughout the building's lifecycle.

As perceived by the plans and duly highlighted in red, the most remarkable change regards the spare spaces and teachers' meeting rooms that are being used as music teaching rooms, due to the increasing need for more spaces on this behalf as Professor Manuel Rocha as explained us. Even if this leaves out the option of more diverse uses on the second floor not specifically related to the conservatory.

Additionally, the need for more dance studios has guided the change of the choir room for a dance studio on the second floor, which led to the possible conclusion of an understated spatial need for formal spaces for both the music and dance teaching that has not been met in the building, or an increasing need that has led to these changes. The latter may be proven by the increase in students from the conservatory from 706 in the school year of 2010/2011 (the first year of the conservatory on this space) to the current figure of 1027 students in the school year of 2016/2017, according to the data then provided by the Director Professor Manuel Rocha. It is noteworthy that this number resembles the number of students of the Quinta das Flores School, which has a total of 1153 students on this current school year, provided also by its Director Professor Ana Margarida Marques. This could indicate a high rise in spatial needs to cope with the demanding increase in students of the conservatory and its specificities in regard to spaces with soundproofing features, for both individual and collective teaching and also for practising, which is quite representative in this school, besides its need to cope with the regular teaching as well, significantly representative[829].

Moreover, in what concerns the lack of more dance studios, the architect José Paulo dos Santos[830] (2017) on an interview conducted for the purposes of this Doctoral

[828] See chapter 4.2.1. Description of the school space and how it supports activity allocation.

[829] Note that the students from the articulated regime are accounted for as conservatory and school students because they are enrolled in the two. Supplementary students are only students of the conservatory and the regular teaching students are only students of the school.

[830] We kindly acknowledge architect José Paulo dos Santos for receiving us in his office and for his availability for the interview, for reviewing its transcription and also for authorising its publication for the purposes of this Doctoral Research. Nevertheless, it has been decided not to include all the interview as an appendix,

Thesis, explains that the brief for this project with the Conservatory and Quinta das Flores School with an articulated teaching regime, only comprised one, even though the initial project for a separate conservatory had more dance studios[831].

It has also been identified the use of the students' living room only for the Student Association and prompting a major spatial lack in regard to a students' space for all with the ability to cope with informal activities of social, pedagogical and artistic nature. As already explained and perceived through all this process, this leads to a more informal use of other more formal spaces *a priori,* such as the library; or the auditorium's cafeteria, open regularly on weekday's afternoons; and the main hall for allocating these activities that are scattered all over the building and even on the exterior spaces when possible.

Another change of high impact is the location of a space that has been frequently mentioned by the artistic community as a meeting point for all at the morning arrival, which is the music instrument storage at the beginning of the teachers' offices' hallway. This is the space where students go to place their voluminous music instruments before going to the regular classes, that explains the large number of cellos and similar instruments. Adjacent to that area there is the music sheet room where students and teachers said to go before classes to pick up the sheet for practice or for the lesson itself. As perceived by the observations this is a very frequented space, a true aggregator of the artistic community, proven also by the repeated entrances and exits from this space.

Other spaces have also suffered some changes on their function, potentially of minor relevance. The students' shop and the photocopy room were placed in one space, leaving the previous students' shop as a teachers' meeting room. There is also the special education room located in that area and the parent council room as well. This could be perceived as rearrangements of the spaces according to the regular teaching needs and dimensions. The ground floor has not acknowledged formal changes, also because the appropriation has a more informal nature and the spaces could still be regarded as their names indicate: cafeteria, library and main hall, which can still comprise numerous functions, even sometimes outside the most common expected uses, such as informal activities.

On the other hand, the second floor that had the potential of gathering other functions and teaching purposes, due to its numerous spare spaces, has seen

even though it has all been transcribed and reviewed by the architect, because it has been done in Portuguese and hence would not be perceived by non-Portuguese speakers. So, the quotes will be enclosed on the Thesis according to their representativeness towards the contents explained and for paralleling effective use with the initial brief and the design. This will be further developed on the following chapter regarding the building's adaptability retrieval.

[831] According to the architect: "In the initial project of the conservatory of Vale das Flores much more complete dance spaces were foreseen and which enable another occupancy." (Santos, 2017)
Free translation of the original quote in Portuguese from the architect's interview: "No projecto inicial do conservatório do Vale das Flores já estavam previstos espaços de dança bastante mais completos e permitia outra ocupação." (Santos, 2017)

them all transformed into music rooms and so, its effective spatial fruition has become monofunctional, or at least specific of the conservatory, rather than the all community[832]. This explains that the focus groups' plans and the tours done by the regular teaching students and teachers did not comprise that floor, because they do not effectively use it. The most relevant changes are perceived in the first floor, also because of the increasing need for music rooms and specific spaces and for a rearrangement of the regular teaching offices.

The need for a dance studio shows the numerous students enrolled in this curriculum option and has displaced the choir room outside the main building. The plans also display information on the arrangement of the instruments per nature: music science, strings, dance, percussion, wind and singing, as already perceived by the focus groups and walkthroughs, and which is formally established on the doors of the classrooms. Finally, the so-called orchestra room is now entitled by all as the "small auditorium", which is sustained to be used by the school and the conservatory for multiple activities, showing the wide possibilities of this space outside the specific formal displays that the previous name might imply.

These changes demonstrate the building's ability to cope with these needs and a clear increase in spatial requirements by the conservatory, most likely due to the growth in the number of its students. This also demonstrates the formal changes, even if informal appropriation may also convey the displacement of the active learning environments to places where this actual community finds it more suitable at that time. And if the plans convey the formal decisions taken by management, it is the observations, walkthroughs and focus groups that have gradually demonstrated its effective and progressively more individually outlook on people in this place, their learning, and generally their *life within this building*.

On the life this building accommodates, a final remark can be noticed on its artistic ambiance, because after this extensive procedure that has been done *in situ*, it has confirmed its effective artistic occupancy, which was an initial requirement from the design. The architect's aim for music spatial fruition spread around the building justifies the fact that "the cells are isolated amongst themselves, but there is a sound dispersion towards the corridors", this is actually reached what was originally intended: "some sound permeability for the public spaces, to feel they have life."[833] (Santos, 2017).

[832] According to the architect José Paulo dos Santos (2017) on the referred interview, these spaces' coating materials differ from the initially conceived as music rooms because the first lack on soundproofing facilities that the music rooms require. As a solution for "cutting costs", these do not have these acoustics requirements. The architect clarified this spaces' function: "The term 'reserve' [from the Portuguese 'reserva' and translated to English as spare space] indicates that it does not have the soundproofing conditioning of the rest, which could be used as a space for instrument storage or study. [...] at any time students and teachers may use them." (Santos, 2017)
Free translation of the original quote in Portuguese from the architect's interview: "O termo 'reserva' indica que não tem o acondicionamento acústico dos outros, que poderia ser utilizado como espaço de guarda de instrumento ou de estudo. […] a qualquer momento podem alunos e docentes usá-los" (*ibid.*)

[833] Free translation of the original quotes in Portuguese from the architect's interview: "No conservatório, as células são isoladas entre si, mas há alguma dispersão do som para os corredores."; "[...] decidimos que deveria haver alguma permeabilidade de som para os espaços públicos, para se sentir que têm vida." (Santos, 2017)

. Overall conclusion from the idiographic approach on effective spatial fruition

After describing the spatial sample and its potential to allocate activities, space has also been perceived in regard to the living experience it shelters, embodying Hill's words: "[…] architecture is not just a building. It is, primarily, a particular relation between a subject and an object [...]" (Hill, 1998, p.7).

Observations derive from the need to assess effective spatial fruition, aiming at registering movement: pathways and directions, and standing activities in coloured dots according to the type of activity considered. Density has been indicated by the thickness of both the lines and the dots.

The spaces observed have been selected from the initial spatial analysis, as the ones with blended activities, namely: the main corridors of the second and first floor, the main hall, the library, the cafeteria and the canteen. Isovists have also led to the positioning of the observers for higher visibility. Each observation took 30 minutes, 8 observers and included the classes' most significant breaks for attending the common spaces: the morning arrival, the morning break, the lunch break and the afternoon school exit.

The niches on the main corridors are effectively used for standing while waiting for a class, socialising or taking up other learning activities, but also for practising on music instruments. This has been recently published in *Domus* magazine: "It is rewarding to see students and tutors rehearsing all over […]". (Domus, 2016, p.66)

Paths diverge according to the users: teachers often go straight to the teachers' offices on the first floor, while regular teaching students usually cross the main hall towards regular teaching pavilions, whereas artistic students and teachers are the ones that use all the building's floors.

A vertical stratification of the users has also been verified, from the ground floor that congregates all the school community, to the second floor that is only frequented by the artistic community.

Observations differ according to each chosen interval. The morning arrival at school holds a high frequency of moving activities. The mid-morning interval has the highest density of movement through all the floors in order to reach spaces such as the cafeteria or the library. It is also the densest interval for standing activities while awaiting the following class. The lunch break is when the canteen is open, aggregating a large group of students. As the afternoon progresses, the frequency of use of the artistic classrooms increases, along with moving and standing on the corridors.

Programmed activities of social nature may very exceptionally occur at the canteen, as opposed to the cafeteria that has mostly social non-programmed activities. The

library allocates programmed and non-programmed learning activities and even social and more spontaneous events at the afternoon, but rarely artistic. The main hall gathers all activities, programmed and non-programmed, social, artistic and learning, supported by its significant width and length, besides its accessibility between the street and the other pavilions, acting as a "communal living-room" of the school (Hertzberger, 1991, p.62).

Finally, rather than observing natural movement (Hillier et al., 1993) in a non-participated manner, walkthroughs sustain an effective understanding of spatial adaptability from the users' perspective, complementing the entropy approach and the observations.

For this methodology, the selected groups were: teachers of the regular teaching, students of the regular teaching, students of the articulated teaching, and teachers of the artistic teaching, all very diverse. Each group has been asked to conduct a separate interpretative visit to the central building of the school, commenting on the spaces' adaptability and justifying it according to the types of activities that usually each of them undertook. Interestingly, from the diversity of individual profiles, there is a similarity in pointing out the main hall, as the most adaptable space, even if the activities that each group performs may differ.

Students have pointed out the corridors on the upper floors as being central to their life in the school, for moving but also for waiting for classes, socialising and for pedagogical activities. Unsurprisingly, the second floor, which is used particularly for the artistic teaching, is considered the students' own space, justifying its higher frequency on spontaneous artistic activities. Both students' focus groups identified the niches on the corridors as being very frequented spaces by all. This is due to the high connectivity that these spaces have with the classrooms and to their global integration as a meeting point for all. But also, this is similarly justified by the proportion of these spaces that bestows a sense of intimacy that does not occur on the main hall, gathering smaller groups for socialisation and for spontaneous pedagogical or artistic happenings. Natural lighting conditions, temperature and furniture also determine the choice of spaces by students, regardless of their similarity in coating materials or dimensions, which implies that the choice on physical features of the space early in the design impact on their adaptability potential further on its use.

. Extensive list of materials gathered for this specific approach

The figures presented during the methodology application are only a part of a more extensive lot of information, drawings, questionnaires, surveys and procedures that have enabled the gathering of the conclusions presented.

Naturally, that this chapter could not hold all the graphic materials gathered and, hence, it has been decided to introduce the most relevant ones, or the ones that held a more comprehensive analysis of the gathered results.

Anyway, all these materials have been a part of these procedures and represent stages of development and application of the methodology in the real case study.

For that purpose, the following list indicates all the materials produced prior to the application of the methodology, the records of its application *in situ* in real time and the intermediate graphic materials produced during all these procedures, that enabled all the final ones that have been already included in the body of this Thesis.

These have been identified according to the procedures under which each one has been done:

. Space Syntax Analysis

. Observation Matrices

. Walkthroughs

. Focus Groups

. **Space Syntax Analysis**

. Axial line map

. Ground floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. First floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. Second Floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. Convex map

. Ground floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. First floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. Second Floor
. Rn
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility
. R3
. Choice
. Connectivity
. Integration HH
. Line Length
. Mean Depth
. Node Count
. Attribute Summary
. Intelligibility

. VGA analysis

. Ground floor
. Rn
. Connectivity
. Visual control
. Visual integration HH
. Visual mean depth
. Visual node count
. Attribute summary

. First floor
. Rn
. Connectivity
. Visual control
. Visual integration HH
. Visual mean depth
. Visual node count
. Attribute summary

. Second Floor
. Rn
. Connectivity
. Visual control
. Visual integration HH
. Visual mean depth
. Visual node count
. Attribute summary

. Isovists

. Observation Matrices

. Formal email addressed to the Directors of the Music Conservatory and Quinta das Flores School, formally explaining the purpose, context and methodological procedure

. Captions provided to all team members, standardising all graphic representations

. All the drawings done by the team of 8 collaborators during all the time periods and on the days already indicated:

. Furniture on the locations observed
. the main hall of the ground floor
. the cafeteria on the ground floor
. the library on the ground floor
. the main corridor of the first floor
. the main corridor of the second floor

. Indication of the artistic classrooms

. 23rd January 2017 (Monday, regular week)
. 8.00 a.m. / 8.30 a.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 10.00 a.m. / 10.30 a.m.
. the main hall of the ground floor
(3 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 1.30 p.m. / 2.00 p.m.
. the main hall of the ground floor
(2 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the canteen on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 5.00 p.m. / 5.30 p.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 25th January 2017 (Wednesday, regular week)
. 8.00 a.m. / 8.30 a.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 10.00 a.m. / 10.30 a.m.
. the main hall of the ground floor
(3 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 1.30 p.m. / 2.00 p.m.
. the main hall of the ground floor
(2 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the canteen on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)

. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 5.00 p.m. / 5.30 p.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 7th February 2017 (Tuesday, exam week)
. 8.00 a.m. / 8.30 a.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 10.00 a.m. / 10.30 a.m.
. the main hall of the ground floor
(3 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 1.30 p.m. / 2.00 p.m.
. the main hall of the ground floor
(2 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the canteen on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 5.00 p.m. / 5.30 p.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

9th February 2017 (Thursday, exam week)
. 8.00 a.m. / 8.30 a.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 10.00 a.m. / 10.30 a.m.
. the main hall of the ground floor
(3 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 1.30 p.m. / 2.00 p.m.
. the main hall of the ground floor
(2 observations in draft with notes + final drawing)
. the cafeteria on the ground floor
(1 observation in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the canteen on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. 5.00 p.m. / 5.30 p.m.
. the main hall of the ground floor
(4 observations in draft with notes + final drawing)
. the library on the ground floor
(1 observation in draft with notes + final drawing)
. the main corridor of the first floor
(2 observations in draft with notes + final drawing)
. the main corridor of the second floor
(1 observation in draft with notes + final drawing)

. Walkthroughs

. Formal email addressed to the Directors of the Music Conservatory and Quinta das Flores School, formally explaining the purpose, context and methodological procedure of both the walkthroughs and focus groups.

. Formal email addressed to the parents asking their authorisation so the under-aged students could take part in the procedure, added by a letter explaining the purpose and context of the research and the procedures of both the walkthroughs and focus groups.

. Authorisations signed by the guardians of each student, proving the acquaintance on the situation and their approval for their children to participate.

. Drawings that represent the pathways chosen by each group and the spaces considered the most adaptable.

- . Students from the articulated teaching regime (3rd February 2017)
- . Students from the regular teaching regime (3rd February 2017)
- . Teachers that lecture regular teaching subjects (3rd February 2017)
- . Artistic teachers (9th February 2017)
- . Joint plan with all the results

. Focus Groups

. Drawings done by every participant according to their respective group

- . Students from the articulated teaching regime (3rd February 2017)
- . Students from the regular teaching regime (3rd February 2017)
- . Teachers that lecture regular teaching subjects (3rd February 2017)
- . Artistic teachers (9th February 2017)

Besides all this material, extensive notes have been collected in notebooks and plans and also sound, video and photographs have been taken, recording these proceedings in-depth. Besides the hours of sound and video recorded, we can account for the following personal photographs:

- . 44 photographs of the school taken on the 25th November 2011
- . 776 photographs of the school taken on the 29th August 2013
- . 626 photographs taken from the observations on the 23rd January 2017
- . 1623 photographs taken from the observations on the 25th January 2017
- . 162 photographs taken from the observations on the 7th February 2017
- . 189 photographs taken from the observations on the 9th February 2017
- . 189 photographs taken from the walkthroughs and focus groups on the 3rd February 2017
- . 123 photographs taken from the walkthroughs and focus groups on the 9th February 2017

4.3. Systematisation of the results: Description of the potential correlations and retrieval of the school's adaptability

> "Society must be described in terms of its intrinsic spatiality; space must be described in terms of its intrinsic sociality." (Hillier and Hanson, 1984, p.26)

The current educational paradigm suggests a wide scope of activities with pedagogical potential held in different active learning environments, which impact student achievement[834]. Adaptability as the physical ability of a building to cope with changing activities and requirements, is paramount when regarding artistic schools, lecturing the regular and the music and dance courses.

This research has focused on the relevance of adaptability to educational spaces, which are requested to answer the current spatial needs and reciprocally to enhance the possibility of learning amongst the whole system and individually in each space, most reflecting Hillier and Hanson's quote above.

Therefore, its aim has been to present an original methodological approach on assessing the adaptability of contemporary artistic schools, as a specific and complex case study on both the activities and spaces to consider. Its purpose is to assess the schools' ability to cope with the pedagogical and social evolving needs and to conclude on the design attributes that potentially enhance adaptability, for a more lasting and effective building performance (Fig. 276). For achieving it, it has introduced procedures from different epistemological provinces, for a more supported retrieval of its adaptability, sequentially as follows:

1. Description of the spatial sample, functional and morphological, informs on how it supports activity allocation. A space syntax analysis regarding convex spaces and axial lines, as places and pathways for learning, will provide a thorough understanding of the sample's morphology and conclude on the relevance of global and local syntactic measures towards activity allocation, spatial cognition and the overall "social logic of space" (Hillier and Hanson, 1984).

2. Description of all possible activity allocations informs on the pedagogical potential of each educational environment, matching all possible activities to

[834] See chapter 2.3. Adaptability for contemporary learning practices and environments.

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 276. Description of the methodology and identification of the current milestone IV. (Carolina Coelho)

the spaces in a feasibility matrix. It considers maximising entropy, informing on the uncertainty of an activity allocation to both convex spaces and axial lines (Coelho and Krüger, 2015).

3. Description of effective events informs on behaviour and appropriation, holding higher relevance in this artistic ambiance. This stage corresponds to an idiographic approach on singularities, while the latter to a nomothetic approach on regularities (Windelband, 1894).

4. Description of the potential correlations amongst each stage, enables the retrieval of the school's adaptability, understanding a potential correspondence between integration, entropy and behaviour.

This methodological framework was expected to be a contribution to knowledge advancement, identifying adaptability in this particular contemporary context and combining distinctive study fields[835]. Also, for the practice, the acknowledgement of the spatial configurations with higher representativeness towards adaptability could be informative to future designs.

As explained from the beginning, the methodology was applied to Quinta das Flores School that went through an adaptive-reuse process by the Portuguese School Building Modernisation Programme and whose spatial rehabilitation went along with a curricular transformation, in which the Music Conservatory has been added to the Basic and Secondary School.

Pedagogically, it now has an "articulated teaching regime" in which students attend both the artistic and regular classes, besides the regular students and the external students that only attend the music and dance classes at the conservatory. Therefore, the students' and teachers' profiles are diverse, holding a wide array of activities. Spatially, this signifies spaces with assorted spatial features and the sharing of common areas and services, which favours group dynamics, social cohesion and a transmission of competences from each teaching regime. Specifically, the methodology will be applied to the central building that represents the school's entrance and where the

[835] The first results correlating space syntax to entropy were presented in the *10th International Space Syntax Symposium*, in 13-17 July 2015, London. These have also been published in the Conference's proceedings as: Coelho, C.; Krüger, M. J. (2015). Towards a methodology to assess adaptability in educational spaces: An entropy approach to space syntax. In Karimi,K; Vaughan, L.; Sailer, K.; Palaiologou, G.; Bolton, T. (Eds.). *Proceedings of the 10th International Space Syntax Symposium*. p.17: 1-20. London, UK: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
Besides, an initial explanation of the adaptability methodology developed in this Thesis has been explained in the *3rd International Symposium Formal Methods in Architecture*, in 30 November - 2 December 2016, with further publishing of the paper on which the communicational was based. It will be published as: Coelho, C. (in publication). A Gathered Methodology Towards Enhancing Adaptable Learning Spaces. In D. Viana, F. Morais, J. Vaz (Eds.). *Formal Methods in Architecture and Urbanism*. Cambridge: Cambridge Scholars Publishing.
Afterwards, a subsequent study comprising all stages of the methodology, has been presented in the *11th International Space Syntax Symposium*, in 3-7 July 2017, Lisbon. It has also been published in the Conference's proceedings as: Coelho, C.; Heitor, T. (2017). Adaptability Retrieval In Artistic Learning Environments. In T. Heitor; M. Serra; J. Silva; M. Bacharel; L. Silva (Eds.). *Proceedings of the 11th International Space Syntax Symposium*. (pp. 7: 1-19).
All presentations and publications validate these contents and the methodological application by the academia, which have been developed amongst this current Thesis and whose correlations will be presented in this chapter.

Fig. 277. Different ways of experiencing the artistic school spaces (from left to right: the auditorium's cafeteria, the dance studio, the main hall, open space onto the corridor)

(Carolina Coelho)

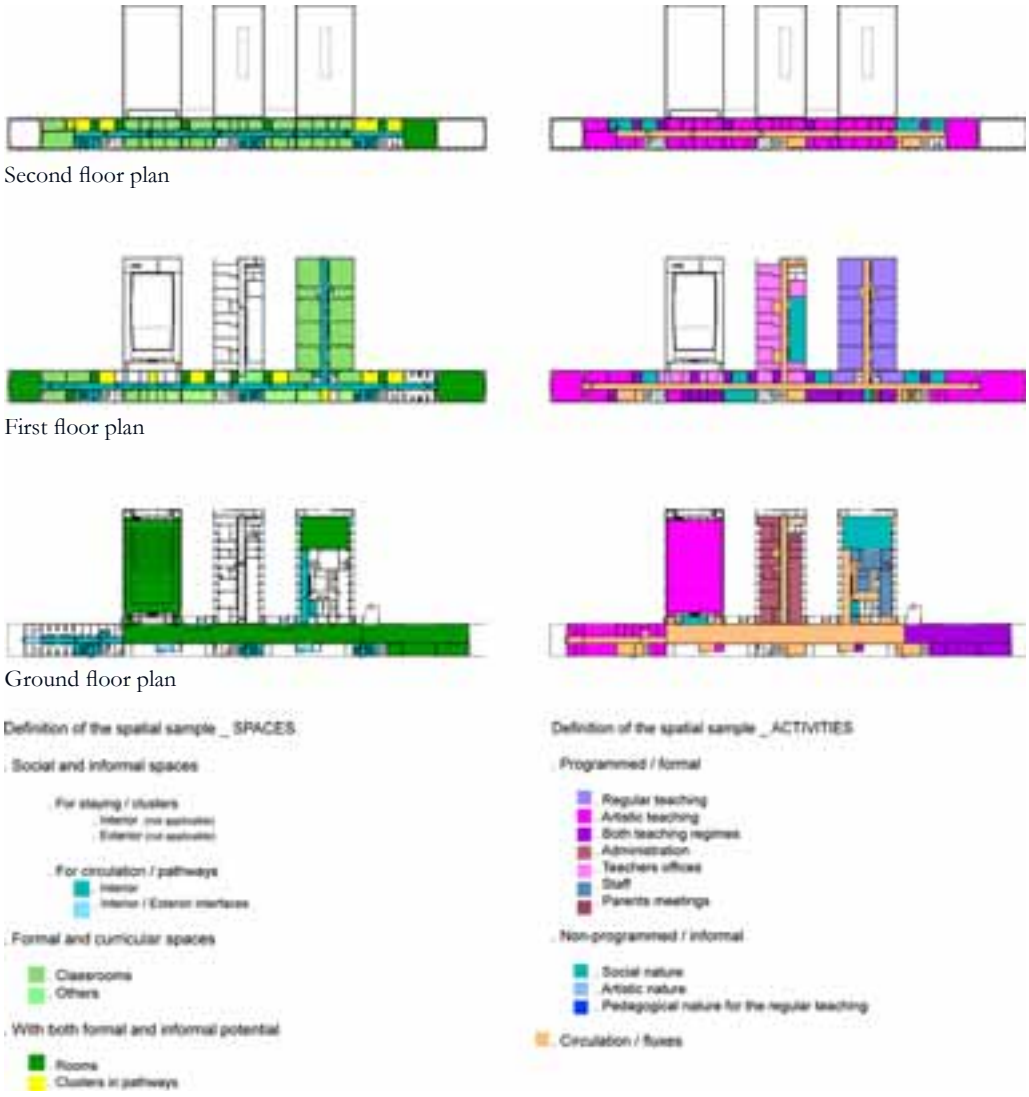


Fig. 278. Quinta das Flores School _ Spaces and Activities

(Original plans provided by Parque Escolar, edited and colour assigned by Carolina Coelho)

social and pedagogical blend is significantly higher (Fig. 277).

This initial milestone comprised a description of the spatial sample, informing on its ability towards activity allocation. Primarily, it analysed the spatial sample according to its spaces, activities and attributes, functionally describing how and by what means does the space allocate learning activities. Subsequently, and still under the first milestone, a morpho-syntactic analysis provided an in-depth understanding by the analysis on convex spaces, axial lines and visibility.

The initial step consisted on identifying the existing spaces and assigning them with coloured hatches for a graphic interpretation on the positioning and density of active/supportive learning environments, informal/formal spaces, moving/standing areas, spaces assigned to each teaching regime,….

The coloured schemes presented (Fig. 278) displayed a general colour mix that indicates a respective combination of teaching profiles, formality and informality, circulation and standing, already providing an insight on the adaptability potential of these "multi-option spaces" (Ader, 1975a).

The analysis focused on the school's spaces and its initial provision, during the design, in order to hold an extensive assortment of learning activities required by this school's mixed curriculum. This overlapping between a wide set of spatially demanding activities and the spaces to cope with them, could only be accomplished accordingly if the spaces were provided with intrinsic attributes that enable them to accommodate the very diverse activities that occur in the school, but also, to possibly accommodate future changes on those same activities in each of the spaces identified from the sample.

After analysing Quinta das Flores School under a morpho-syntactic approach, it was concluded that, the most integrated space on the ground floor is the main hall, which welcomes all the users, enabling spontaneous encounters and which also promotes social gatherings and pedagogical events for an enlarged school community (Fig. 279). Whereas on the upper floors, the main corridors are also the most integrated spaces, but as they are narrower these enable mostly circulation rather than static activities.

The analysis of syntactic integration indicates that, besides the specificity of the second floor's layout with the main corridor holding an extremely high integration that differs from all the rest, the ground floor's axial map holds a higher value of integration rather than the analysis of the same floor done by means of a convex map that inherently shows the highest values in mean depth. Therefore, the axial line that gathers all the longitudinal spaces is more representative of the whole system than the corridor alone as a convex space.

Afterwards, intelligibility scattergrams, as a second order measure, can be achieved by correlating integration and connectivity and understanding which floor's layout

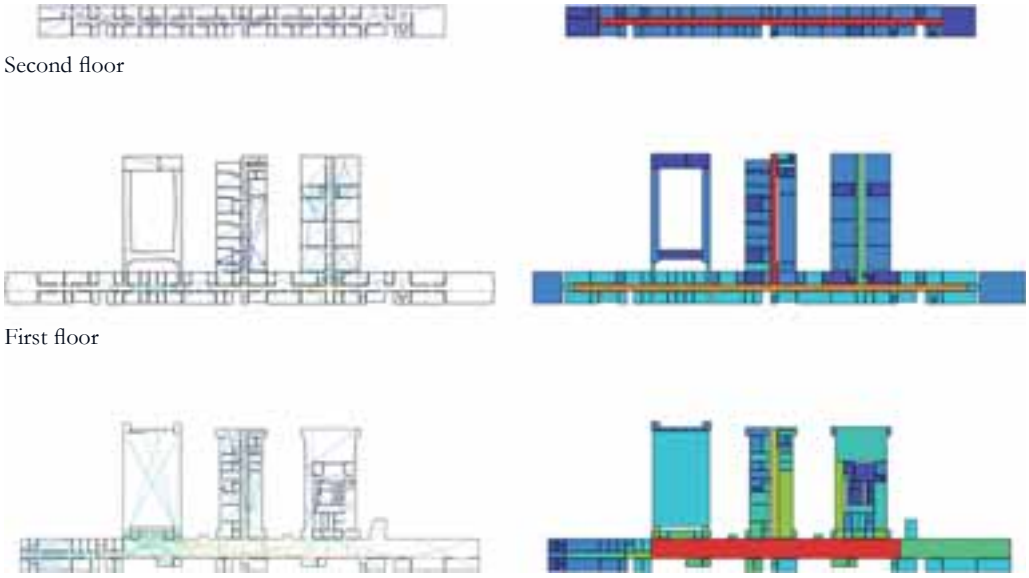


Fig. 279. Axial line (a) and convex space map (b) for integration
(Carolina Coelho)

is best comprehended and less "labyrinthian" (Hillier, 2007[836], p.94). In this case and again besides the straightforward layout of the double-loaded corridor of the second floor, it is the ground floor's axial line map provides also very high levels of intelligibility proven by the scattergram's regression line and determination coefficient. This is fairly significant since this is actually the floor used by all users, as an interface between inhabitants and visitors in circulation pathways towards each one's destination and purpose in the system.

So, if the first milestone identified the spatial sample, the spaces comprised and the activities that were meant to occur in this school in particular, in order to acknowledge how these could correspond, the second milestone considered the precise allocation of the activities to the spaces, in order to fully understand the space's potential to shelter the extensive list of site-specific activities that occur on this school. It was considered that the more detailed the list of spaces and activities, the closer it would depict this case study and context in particular, which explains the complexity of the analysis and the wide list of variables regarding the spaces and the activities.

After all the explained procedures under the entropy calculations, conclusions can be drawn regarding not those just results *per se*, which have already been subject of reflection on that chapter, but on the potential correlations between milestones one and two, meaning the space's description on a morphological approach and its respective physical potential to allocate the activities that occur in this school, ultimately, to understand a potential overlapping between entropy and integration.

[836] Consulted edition from 2007, original edition from 1996.

. Critical interpretation from the correlations between the morphological approach by Space Syntax and the nomothetic analysis by Entropy calculations

The methodology for assessing adaptability engaged space syntax and entropy and considered both convex spaces and axial lines from the first and second milestones of the overall procedure. The data gathered from this research, provides information on both the correlation between convex spaces and axial lines per approach and the potential correlation between the two approaches. This adds further input on a space where both moving and standing, as well as formal and informal activities, are possibilities to learning and actively trigger moments of information exchange amongst all inhabitants.

Hence, the results from their correlation aim to provide a more complete outlook on educational spaces and the possibility to triangulate partial results, in order to reach a more supported overall conclusion on the potential relation between space syntax and entropy, and ultimately how this potentially affects adaptability in schools.

To reach the entropy results, activities and feasibility matrices were produced that traced the allocation potential of each space to a range of activities. The matrix acknowledged the learning process under the current paradigm, considering non-programmed activities also with the potential to be curricular. It regarded a wide range of activities according the school's pedagogical specificities and it additionally added relevance towards a wide community and the locality, which naturally support external use and performative activities, either programmed and non-programmed.

When applying the entropy formulation for convex spaces, it was possible to rank them according to the final results encountered, pointing out the ones with higher and lower entropy values. Two different distributions were considered, concluding that the most disaggregated one provided higher levels of entropy, although the hierarchy between spaces was fairly similar between them both.

For the case study, the spaces with the highest entropy are spaces that hold several features that provide them with the potential to shelter both programmed and non-programmed activities, group and individual practices, of external and internal uses, such as: the library and the main hall; artistic spaces like: the music studio, the auditorium, the orchestra room and the choir room; and generic spaces like: the common living spaces. On the contrary, the spaces ranked with the lowest values of entropy are strictly monofunctional and generally support effective learning spaces (Fig. 280).

Another significant conclusion, while comparing both distributions, was the tendency for the entropy stabilisation after about 20 activity allocations to a space, which considers that the level of entropy varies very little for spaces with a potential

VALUES RANK

ENTROPY CALCULATIONS

Domain III		Domain IV	
space	value	space	value
18 library	**1,746**	18 library	**2,720**
30 music studio	**1,745**	30 music studio	**2,696**
13 spare space	**1,732**	16 auditorium	**2,681**
16 auditorium	**1,729**	29 orchestra room	**2,681**
29 orchestra room	**1,729**	32 choir room	**2,681**
32 choir room	**1,729**	40 common living space	**2,661**
43 teachers' office for meeting students	**1,705**	1 main hall	**2,647**
38 science lab	**1,684**	13 spare space	**2,643**
39 generic classroom	**1,615**	17 auditorium's cafeteria	**2,478**
37 dance studio	**1,611**	19 cafeteria	**2,476**
40 common living space	**1,6**	20 canteen	**2,475**
1 main hall	**1,578**	43 teachers' office for meeting students	**2,398**
25 students' room	**1,386**	39 generic classroom	**2,287**
35 specific music training room	**1,381**	37 dance studio	**2,228**
17 auditorium's cafeteria	**1,379**	35 specific music training room	**2,213**
19 cafeteria	**1,378**	31 music instrument training room	**2,098**
20 canteen	**1,376**	33 singing studio	**2,098**
31 music instrument training room	**1,373**	34 song writing studio	**2,098**
33 singing studio	**1,373**	36 study room	**2,098**
34 song writing studio	**1,373**	38 science lab	**2,095**
36 study room	**1,373**	25 students' room	**2,079**
24 teachers' room	**1,33**	24 teachers' room	**2,023**
41 teachers' office	**1,33**	41 teachers' office	**2,023**
42 teachers' meeting room	**1,33**	42 teachers' meeting room	**2,023**
48 psychologist's office	**1,055**	2 access - corridor	**1,735**
23 staff room	**0,693**	3 vertical access - stairs	**1,735**
27 administration offices - regular teaching	**0,693**	4 vertical access - elevator	**1,735**
28 administration offices - artistic teaching	**0,693**	5 entrance / outdoor access	**1,735**
44 students' shop	**0,693**	48 psychologist's office	**1,609**
45 photocopy room	**0,693**	26 secretariat	**1,551**
26 secretariat	**0,69**	23 staff room	**1,386**
2 access - corridor	**0,637**	44 students' shop	**1,386**
3 vertical access - stairs	**0,637**	45 photocopy room	**1,386**
4 vertical access - elevator	**0,637**	6 reception desk	**1,099**
5 entrance / outdoor access	**0,637**	7 ticket office	**1,099**
6 reception desk	**0**	8 bathroom-toilet-sink	**1,099**
7 ticket office	**0**	47 auditorium supportive spaces	**1,099**
8 bathroom-toilet-sink	**0**	9 dressing room	**0,693**
9 dressing room	**0**	10 locker room	**0,693**
10 locker room	**0**	11 storage	**0,693**
11 storage	**0**	12 indeterminate supportive space	**0,693**
12 indeterminate supportive space	**0**	14 vault	**0,693**
14 vault	**0**	15 archive	**0,693**
15 archive	**0**	21 kitchen	**0,693**
21 kitchen	**0**	22 kitchen storage	**0,693**
22 kitchen storage	**0**	27 administration offices - regular teaching	**0,693**
46 parent council room	**0**	28 administration offices - artistic teaching	**0,693**
47 auditorium supportive spaces	**0**	46 parent council room	**0,693**
49 technical area	**0**	49 technical area	**0,693**

Library

Orchestra room

Music studio

Main hall

Fig. 280. Entropy rank of convex spaces
(Carolina Coelho)

to allocate more than those activities. This information can be introduced in future designs as operative input for the architect, while pondering between the cost and benefit of the design solutions.

By establishing a correlation between integration and entropy for both convex spaces and axial lines it is possible to conclude upon their compared results[837]. Within this procedure, and in order to compare the convex and axial results on both their integration and also on their entropy, the concepts of "axial line entropy" and "average axial line entropy" were also introduced as a novelty, specifying entropy results to axial lines.

For the study of the correlation between integration and entropy for convex spaces, the entropy values encountered by the calculations were cross-referenced with the integration HH values provided by the software for r_n, because it is a global measure that is considered to best describe the system overall and that has already been detailed in the chapter regarding space syntax and compared to the local measures.

Spaces for specific activities, whose uncertainty degree in activity allocation is very low and hence with the lowest entropy, were recognised as fairly integrated and connected, mainly on the ground floor. This can be explained by their functional utility, because although spaces such as the entrance, ticket office, reception desk, restroom and vertical accesses are supportive spaces, their proximity is required so that the main active learning environments can be productive. Particularly in this school, spaces that support external events need to be integrated and intelligible for the external user.

Specific spaces with recognisable values of entropy also represent some of the most integrated and connected ones and the most significant for users when experiencing space, such as the library and the main hall, respectively spaces with high entropy and high integration. This supports a potential correlation between activity allocation, integration and appropriation, and ultimately towards adaptability.

Conversely, corridors are a particular case study where the correlation between integration and entropy is not high. Especially on the upper floors, corridors are very integrated convex spaces that are connected to much other spaces on the system. However, when analysed alone, they do not have high levels of entropy, considered the restriction of activity allocations in a pathway that does not have the most suitable features to cope with extra-curricular activities or simply standing for doing some of those activities. Only when the axial lines, placed on those same corridors, intersect other spaces connected to them, with high entropy, does the correlation increase. This could immediately indicate that axial lines' integration has

[837] The correlation between space syntax parameters and entropy has already been presented in the *10th International Space Syntax Symposium* (Coelho and Krüger, 2015), in which the full explanation of this complex and extensive procedure is explained in detail. Besides proving the correlation between convex integration and entropy for adaptability, that paper has also established the concepts of "axial line entropy" and "average axial line", within 'An entropy approach to space syntax'.

a higher correlation to entropy because it involves several spaces and not only the activity allocation possible in one single space, that could be central to the system, but could also be more significant for circulation and leading towards the high entropy spaces than their possible allocation *per se*.

This is not the case of the ground floor, because there the main corridor, identified as main hall, can be both a moving pathway and also a place for standing. This space has even the utmost asset of being long and wide and also be very accessible from the exterior, which increases its activity allocation in regard to the potential to cope with extra-curricular activities, curricular activities such as external displays and also external activities overall, besides both programmed events and non-programmed happenings. So, as a convex space of high integration it also corresponds to a high entropy space. Moreover, if axial lines' entropy are examined that intersect not only this space but also spaces connected to it, the correlation increases because several of those spaces are also common use spaces for all the school's users and that can accommodate a very wide array of activities, namely curricular and extra-curricular but for all teaching types, such as the library and the auditorium also with very high entropy.

For all the following scattergrams explaining "how the variables *x* and *y* are related" (Hayslett, 1981[838], p.132), correlations have been studied based also on both their determination coefficients (R^2) and respective regression lines, as well as their probability values (*p* values[839]), which indicate respectively how the dependent variable is correlated with the independent variable, and also how statistically significant is the hypothesis set forward by each correlation. Understandably, the higher the determination coefficient in each scattergram, the stronger the correlation between both variables. In this sense, the data from the dependent variable are more accurately explained according to the independent variable. Furthermore, the *p* value is also meaningful, as evidence on the "hypothesis-testing" (Hayslett, 1981, p.100), that proves the statistical significance of the outcomes achieved and specifically, that the alternative hypothesis (H_1) set by the correlation is not achieved by random data or pure chance, as the null hypothesis (H_0) might argue[840]. Indeed, if the *p* value is recognised to be low, which is customarily defined by default below 0,05, this will enable to robustly reject the null hypothesis, and it will also demonstrate that the alternative hypotheses set by the correlations are statistically significant, confirming the positive and valid relationships between the correlated variables.

The correlation between integration and entropy for convex spaces is scattered and the regression line not significant, but according to the same conclusion for

[838] Consulted edition from 1981, original edition from 1968.

[839] According to the APA style used in this Doctoral Thesis, "*p* value" is orthographically written like so.

[840] Hayslett (1981, p.102) explains the difference between these hypotheses: "More generally, the hypothesis that is being tested is called the null hypothesis, and is denoted by H_0. The hypothesis that the experimenter is willing to accept if he does not accept the null hypothesis is called the alternative hypothesis, and is usually denoted by H_1."

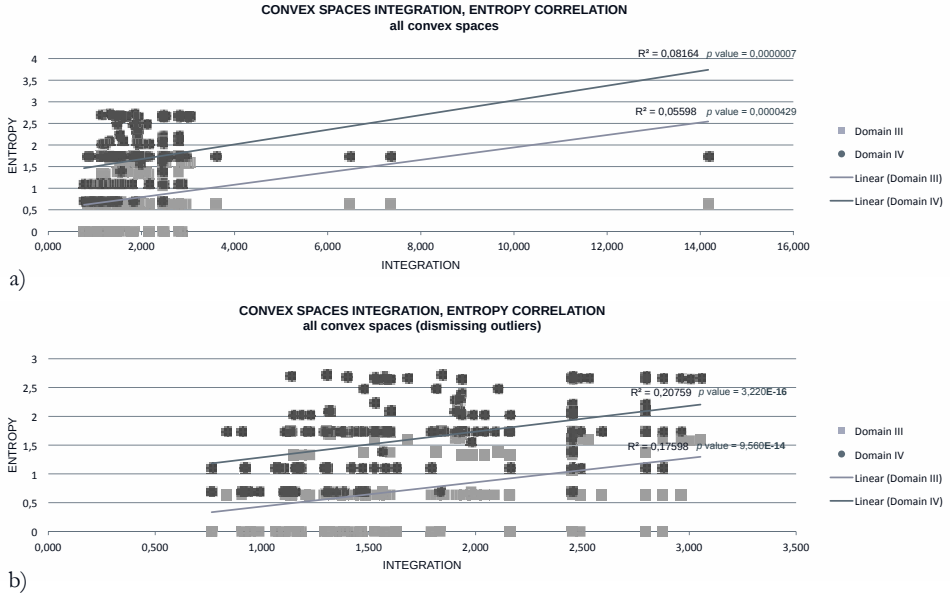


Fig. 281. Convex spaces correlation scattergram _ Integration, Entropy
All convex spaces (a) with all values, (b) dismissing outliers

(Carolina Coelho)

the entropy approach, the domain IV's distribution presents a higher correlation than domain III's , with a determination coefficient (R^2) of $R^2 = 0{,}08164$ and $R^2 = 0{,}05598$ respectively (Fig. 281a).

After an examination of the correlation between all convex spaces and their correlation to entropy, the scattergram did not established a significant link from the regression line. So, it was considered to dismiss the outliers that held three very divergent values of integration, to assess whether the correlation could be enhanced (Fig. 281b). After this procedure, the determination coefficients raised to $R^2 = 0{,}20759$ and $R^2 = 0{,}17598$.

The fact that the correlation for convex spaces is not straightforward occurs because it links spaces identified by function with spaces identified by their position in an overall system. Hence, spaces identified in the entropy approach as restroom, generic classroom, or storage (in e.g.), which are frequent and placed differently in the building, will present diverse values of integration. This leads to an equivalence of the same entropy to multiple integration values that justifies a more vertical dispersion.

If the correlation is made with just a binary match between the highest value of integration HH r_n of each convex space from each floor plan, then this reduces the number of values to correlate and the scattergram in a less complex set of variables. Doing this implies that the highest integration space is chosen to represent all the remaining ones with the same caption: e.g. convex spaces have been labelled as toilets on the ground floor which naturally are placed on different locations within the system

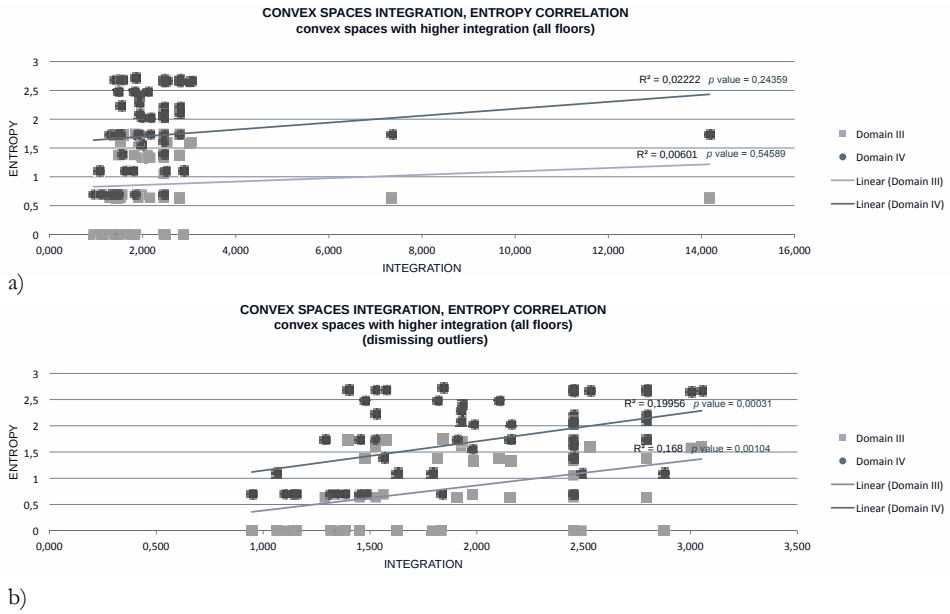


Fig. 282. Convex spaces correlation scattergram _ Integration, Entropy
All convex spaces with higher integration (a) with all values, (b) dismissing outliers

(Carolina Coelho)

and hold different integrations. All of them have been considered for the previous scattergram. In this following scattergram, the toilet with the highest integration from each floor has been chosen to represent the remaining ones, dismissing the others for a sharper analysis of the correlation (Fig. 282a). Even so, the correlations are significantly lower, particularly for domain III's distribution, with determination coefficients of $R^2 = 0{,}02222$ and $R^2 = 0{,}00601$ respectively for domain IV and III.

So, it was also considered the possibility of dismissing the outliers (Fig. 282b) so that a more detailed analysis can be perceived from a less disperse distribution. This procedures has increased the determination coefficients to $R^2 = 0{,}19956$ and $R^2 = 0{,}168$, respectively for domain IV and III, in which domain IV continues to hold higher values of integration and also of correlation.

All in all, even after all these procedures and respective critical analysis, the highest correlation is between all convex spaces identified from the space syntax approach, dismissing the three outliers that hindered the increase of the determination coefficient. The scattergram that only comprised the highest values of integration to each convex space identified with a number from the sample list did not establish a clear correlation and even after removing the outliers the determination coefficient on both domains were similar but still lower when compared to the first scattergram with all convex spaces.

This fact leads to the conclusion that the correlation is higher when different values of integration are enclosed in the distribution, potentially because this last distribution

allocated the highest integration encountered for that space to its entropy. In some cases, that might make the correlation less clear because supportive spaces, such as toilets or storage rooms, may be shallow in the system and be connected to high entropy spaces, but still have a single function. So, when choosing, for example, the toilet with the dressing rooms with the highest integration and allocating it to its naturally low entropy, then the correlation is not meaningful. On the contrary, on this case, if a lower value of integration was chosen, then potentially the correlation could be more accurate on the low centrality of the space towards a small activity allocation potential. The widespread distribution reveals that there are spaces that are frequently placed on different locations of the building, having diverse values of integration, that could also be higher if supporting a high entropy space that holds several different activities, which justifies its potentially high integration.

Therefore, it is concluded that a distribution with all convex spaces is more accurate in describing the system and it is also concluded that it is the most correlated distribution as well, so far.

It is now possible to detail the convex integration and entropy correlation between floor plans, locating the spaces according to the floor in which they are placed and according to their convex integration from the space syntax analysis. This will provide an in-depth knowledge on the more and less correlated distributions regarding floor plans and disaggregation, from domain III and IV. At that point, conclusion can be drawn on whether spatial configuration influences this correlation because, as already examined in the first milestone of this methodology, the three floor plans analysed have very different configurations, vertically from a more to a less scattered layout. Besides, the locations of the spaces within that same configuration may also impact the correlation, which can also be considered as a conclusion of this detailed analysis by floor plan (Fig. 283).

After the analysis of the scattergram by floor plans, it is concluded once more what the previous overall scattergram already suggested: the fact that the convex integration and entropy is not straightforward and the determination coefficients are not significant. That conclusion has already been achieved by the previous correlation that enclosed all convex spaces within the spatial sample. After the study on the separate scattergrams by floor plan these provide input towards that conclusion, particularly on this school because the floors are configurationally very different amongst each other and so, conclusion can be drawn on the application of the methodology and the correlation of its results on different spatial layouts.

As proven by the scattergrams, all three floor plans have led to different correlations. A conclusion can be taken at this point which regards a generally higher correlation between domain IV's distribution rather than domain III's for the same floor and overall when all spaces are comprised in the same distribution. This again

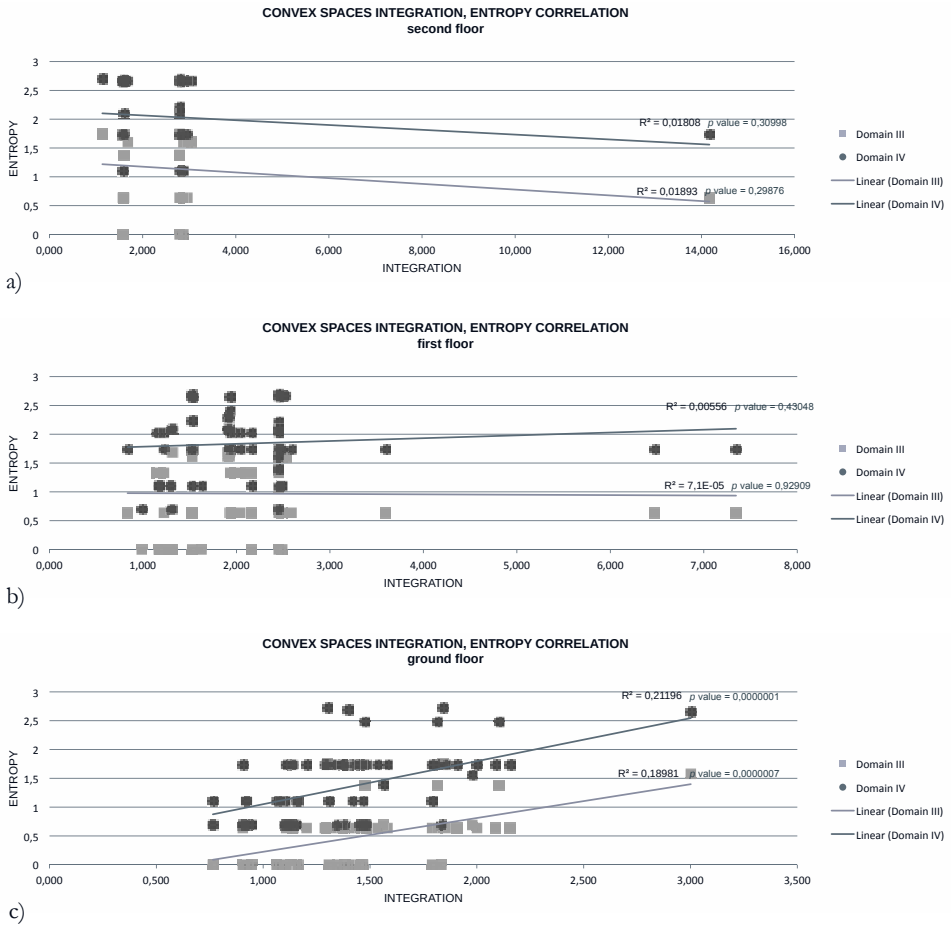


Fig. 283. Convex spaces correlation scattergram _ Integration, Entropy
By floor plans (a) second floor, (b) first floor, (c) ground floor
(Carolina Coelho)

acknowledges that the most disaggregated distribution is the one that better depicts space and better corresponds entropy to integration.

When analysing the distributions by floor plan, they are indeed very significant. The ground floor holds the most significant correlation with determination coefficients already of a certain relevance: $R^2 = 0{,}21196$ and $R^2 = 0{,}18981$, respectively for domain IV and domain III. These results change completely when separately analysing the first and the second floor's distributions with the highest determination coefficient of $R^2 = 0{,}00556$ and $R^2 = 0{,}01808$ respectively, which are very low and non-meaningful for establishing a potential correlation. As these latter results are very low it could be argued that they also decrease the overall correlation when all spaces are analysed, because the ground floor when analysed separately holds a higher correlation than the overall spaces in the system with the highest $R^2 = 0{,}08164$.

From this analysis it can be better understood the source of the outliers earlier

dismissed from the correlation to all convex spaces. So, after dismissing the outliers, which are all from the upper floors, for a more in-depth study of the closer variables, the correlation for all convex spaces increases significantly for R^2 = 0,20759 and R^2 = 0,17598, respectively for domain IV and III (Fig. 281b), even if the overall higher correlation remains equal because the outliers are not from the ground floor.

After a separate detailed analysis and through a comparison of results, the ground floor's significant correlation over the remaining floor plans distributions can be explained by its configuration, which vastly differs from the upper floors, and that best associates high entropy to high integration spaces in the system. Specifically, the ground floor has a more scattered development, with three very intricate transversal hallways with an extensive set of spaces, whereas the second floor holds a more cohesive configuration that is strictly established by a main corridor with spaces on opposite sides.

The building's design has been explained by the architect José Paulo dos Santos (2017) that claimed his preference for "single-loaded corridors" that were not possible to be accomplished on this brief, which have led to the final design of the main corridor with rooms on both sides and the largest rooms on the ends:

> "In schools I like what the English call 'single-loaded corridors', which is a corridor with only one-sided classrooms. I do not appreciate the hallway in the middle. In the project of the conservatory of the Vale das Flores[841] we had music rooms for classes in simple corridors and the rooms for instruments with a corridor in the middle (double-loaded corridor). In Quinta das Flores the program was defined with the instrument rooms with a corridor in the middle and since there was no hypothesis, in this linear development, to conceive such corridors as simple, we had in the east and west tops of the Conservatory's building the program that required a larger surface."[842] (Santos, 2017)

So, the built space is a product of the design and the brief and naturally influences the actual building's use and adaptability potential. In this case the choice for locating the larger spaces on the extremities of the floor plan increase the axial entropy in regard to the convex entropy and provided a higher correlation between the entropy and integration when the building is analysed by axial lines. Furthermore, the option for "double-loaded corridors" provided similar integration values to different entropy ones, because not only are the instrument classes together but

[841] The architect is referring to the first project for the Conservatory separate from the school.

[842] Free translation of the original quote in Portuguese from the architect's interview: "Nas escolas eu gosto do que os ingleses chamam de 'single-loaded corridors' que é um corredor com salas de aula só de um lado. Eu não aprecio corredor ao meio. No projecto do conservatório do Vale das Flores tínhamos salas de conjunto em corredores simples e as salas de instrumento com corredor ao meio (double-loaded corridor). Na quinta das Flores o programa foi definido com as salas de instrumentos com corredor no meio e como não havia hipótese, neste desenvolvimento linear, de colocar os tais corredores simples, dispusemos nos topos nascente e poente do corpo do Conservatório o programa que requeria maior superfície." (Santos, 2017).

also supportive spaces and other space with different, more separate activities[843].

Besides, the additional hallways transversal to the longitudinal development have also been explained by the architect as a solution for spaces with different structural and modular dimension:

> "The conservatory brief was developed to north and near the street, with the main brief of the classrooms established on the first and second floors (above the street level); adjacent, and to the south, it had the Auditorium for hundreds of people. Initially the area for the administration / faculty, and the cafeteria / labs were separated from this hallway of music. Parque Escolar has asked to join these areas to the linear development of the building. Conceptually I preferred to have only the body of the auditorium joint together, but later we joint these two bodies that needed a different metric."[844] (Santos, 2017)

Naturally, that the joining of the two transversal hallways establish a more scattered distribution of the spaces for the ground and first floors, especially when these have spaces for more specific functions as the architect explains and, hence, specific allocation potential. The analysis by axial lines may, therefore, provide a more in-depth examination of the space as a whole and not of separate spaces *per se*, analysing in a more aggregated manner spaces such as the main corridor to the extremities, or the longitudinal body of the building and its transversal developments, as environments and not individually bounded spaces.

[843] The richness of the spatial solutions is a subject matter that the architect claims to be interested in and that may have influenced this design from the symmetries and asymmetries of the 'Hôtel Particulier' that the architect claims to have influenced him very much, to Adolf Loos's interior richness of the circuits and Louis Kahn's volumetric control.
According to the architect José Paulo dos Santos full quote from the interview: "There are recurrent compositional aspects that come from the 'Hôtel Particulier' and its axes of symmetry and asymmetry. [...] I have visited many works and I have really only been moved with some, for example with many of Kahn's works. With Corbusier it's a more mental thing, with Kahn it is not.
With Kahn I am affected by the control of the volumetry and with Loos it impresses me the inner richness of the rigidity. He created very rich interior spaces. In Loos, the skin does not affect me much, but this inner richness and the circuits do. I like that part of the concept. [...] I interpret Loos as having condensed all of the time from the Muthesian houses that he visited around the Raumplam." (Santos, 2017)
Free translation of the original quote in Portuguese from the architect's interview: "Há aspectos compositivos recorrentes que provêm do 'Hôtel Particulier'e dos seus eixos de simetria e assimetria. [...] Visitei muitas obras e verdadeiramente só me emocionei com algumas, por exemplo com muitas obras do Kahn. Com Corbusier é uma coisa mais mental, com Kahn não.
Com Kahn afecta-me o controlo da volumetria e com Loos impressiona-me a riqueza interior da rigidez. Ele criou espaços interiores muito ricos. Em Loos, a pele não me afecta muito, mas sim essa riqueza interior e os circuitos, gosto dessa parte do conceito. [...] eu interpreto o Loos como tendo condensado o tempo todo das casas Muthesianas que visitou à volta do Raumplam." (Santos, 2017)

[844] Free translation of the original quote in Portuguese from the architect's interview: "O programa do conservatório desenvolveu-se a norte e junto ao arruamento, com o programa principal de salas de aula desenvolvidos nos pisos 1 e 2 (superiores ao nível da rua); adossado, e a sul, tinha o Auditório para centenas de pessoas. Inicialmente a ala da administração/corpo docente, e do refeitório/laboratórios estavam separadas desta ala de música. A Parque Escolar pediu- para adossar estes corpos ao corpo linear. Conceptualmente preferia só ter o corpo do auditório adossado, mas depois adossámos estes dois corpos com necessidade de uma métrica diferente." (Santos, 2017)

The following analysis will focus on the correlation between integration and entropy for axial lines, once more applied for both distributions corresponding to domains III and IV. Following the previous demonstration shown on how to calculate the axial line entropy and the average axial line entropy, this has been applied to all axial lines recognised by DepthmapX, through the identification of the convex spaces each axial line intersected, identifying the entropy of each separate space, and then estimating their axial entropy for each axial line.

This has been done by the identification of all the axial lines used from the previous space syntax analysis[845], by the reference number, and then associating their axial integration. After the identification on the integration map, then it was possible to superimpose it onto the final plans and on the plan that defined the convex spaces also considered from the space syntax analysis, in a three layer drawing that enable to associate the line and its location on the plans and to list the convex spaces intersected. As explained, for the axial line entropy calculation the spaces used are those considered from the convex analysis and already analysed in their specificities in the space syntax approach. They are not the spaces from the captions because some of them are not convex, particularly in the case of a conservatory where the layout of the music spaces cannot be convex due to the acoustics performance. Besides, the analysis identified the axial lines from the space syntax previous procedure, so it was considered more valid to identify the spaces intersected by those same lines listed from DepthmapX, as well as the convex spaces used under the same approach.

Again, and similarly to the procedure for estimating axial line entropy and average axial line entropy for all axial lines identified by DepthmapX, from the previous entropy approach, another future development could be the creation of a software that layered the axial lines with the convex spaces and that enabled to introduce the convex entropy, so that the axial entropy could be estimated, automatising this time consuming process.

Then, a chart and scattergrams were produced plotting the axial line entropy against integration, to study their possible correlations (Fig. 284). This calculation established that these values changed according to the sequence of spaces and their respective individual entropy.

Some spaces with high entropy values are not necessarily the most integrated in the system *per se*, but when analysed within an axial line, that correlation is meaningful. Overall these values can reasonably be higher than spaces alone if the axial lines intersect relevant entropy spaces. This is the case of spaces that are placed on the extremities of the upper floors' longitudinal development that hold significant values

[845] For the correlation to be most accurate the axial lines and convex spaces have to be exactly the ones considered from the previous space syntax analysis in order to associate the previously recalled convex and axial integration with their convex and axial entropy.

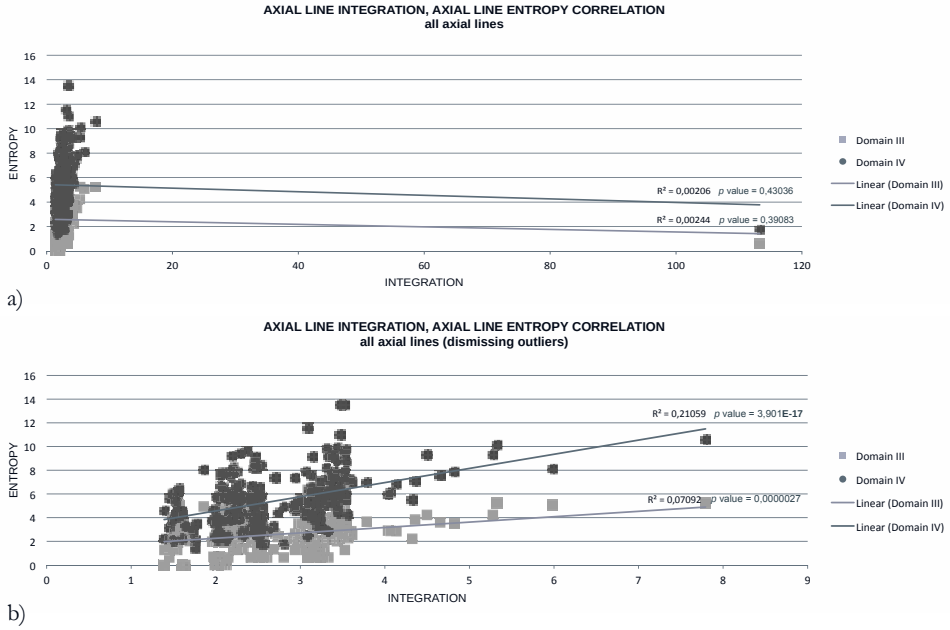


Fig. 284. Axial line correlation scattergram _ Integration, Entropy
Distributions according to floor plans and domains (a) all data, (b) no outliers
(Carolina Coelho)

of entropy, namely the orchestra room and the music studio, and are intersected by some of the most integrated axial lines for that floor, therefore presenting a strong correlation between syntactic integration and entropy.

The correlation between all axial lines' integration and entropy is not meaningful from the start because it has an extremely far-reaching outlier that hampers the correlation, which relates to the axial line integration from the second floor[846] (Fig. 284a). Note that this value has already been considered an outlier from the previous space syntax analysis and so it can be for this correlation. Therefore, another scattergram that holds all axial lines' except this one, considered to be an outlier, presents a correlation in which the determination coefficient is evidently higher for domain IV than for domain III's distribution, as it was for the convex correlation (Fig. 284b), respectively with $R^2 = 0{,}21059$ and $R^2 = 0{,}07092$.

While comparing these values with the previous convex correlation that hold determination coefficients of respectively $R^2 = 0{,}20759$ and $R^2 = 0{,}17598$ for domain IV and for domain III's distribution, also after dismissing the outliers, despite the latter's closeness between domains, there is a higher correlation between integration and entropy for axial lines rather than for convex spaces, proven by the regression lines and respective determination coefficients of both graphs for domain IV. Pedagogically this is crucial, because it supports the fact that this school

[846] Outliers from the space syntax analysis had already been dismissed for a more in-depth analysis in the remaining distribution of values when pursuing that analysis. See chapter 4.2.1.2. Space Syntax _ Morphological analysis.

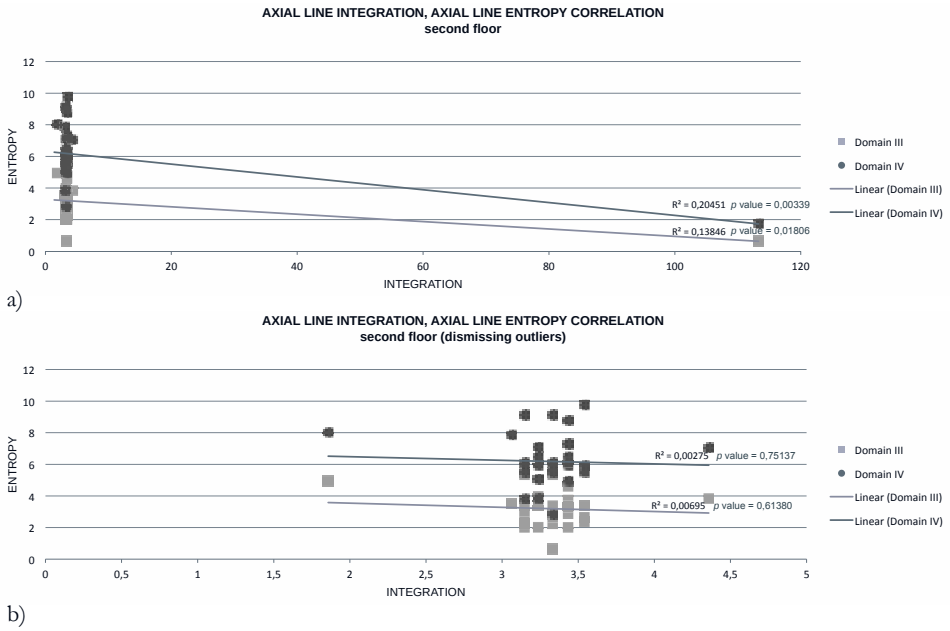


Fig. 285. Axial line correlation scattergram _ Integration, Entropy
By floor plans: (a) second floor with all data; b) second floor with no outliers
(Carolina Coelho)

considers not only formal learning spaces, but also spatial sequences as potential moments and environments for active learning.

At this point, separate scattergrams can be made for each individual floor plan, for acknowledging whether its configurational display can impact the correlation (Figs. 285 and 286). The fact that the three floor plans analysed are different amongst themselves, from a configurational perspective, is relevant because separate scattergrams can provide data on the highest and lowest correlation according to the configuration. Naturally, this plays a relevant role because space syntax focuses on the spaces' morphology and therefore the results from convex and axial integration between floor plans may also differ.

From a closer examination on the separate scattergram per floor plan and per domain, the highest axial correlation is between the ground floor, with a very representative determination coefficient: $R^2 = 0{,}34104$ for domain IV and $R^2 = 0{,}26214$ for domain III's distribution, far more significant than the remaining correlations (Fig. 286b). The first floor holds $R^2 = 0{,}15154$ and $R^2 = 0{,}00774$ for domain IV and III respectively, which is lower than the ground floor. Finally, the second floor does not have meaningful determination coefficients to support a correlation with $R^2 = 0{,}00275$ and $R^2 = 0{,}00695$, again for domain IV and III, even after dismissing the outliers.

It could be concluded that it is the second floor's distribution that is hampering a stronger correlation overall between all axial lines, because the ground floor analysed

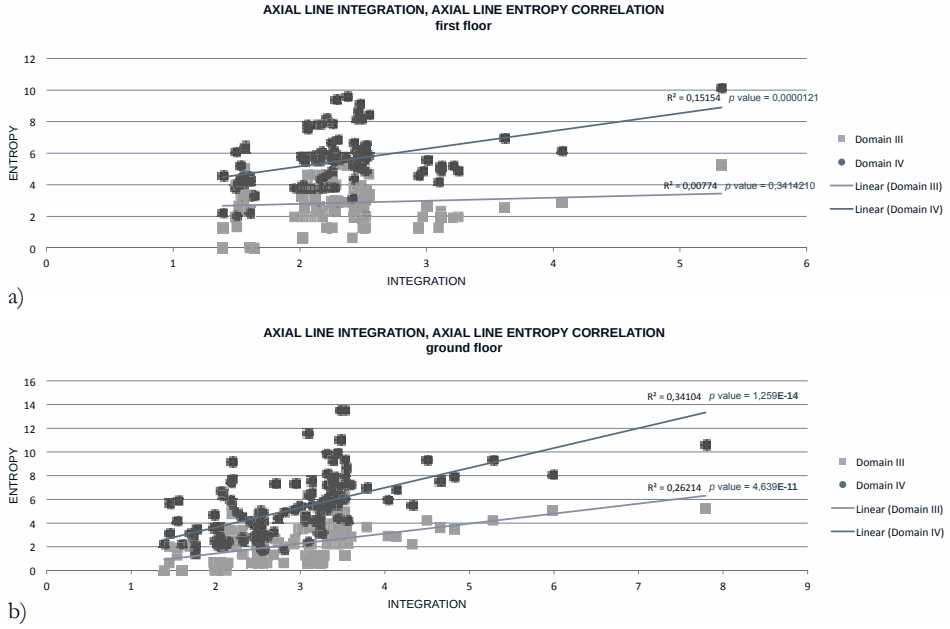


Fig. 286. Axial line correlation scattergram _ Integration, Entropy
By floor plans: a) first floor; b) ground floor
(Carolina Coelho)

separately holds a higher correlation than the scattergram that plots all axial lines from all floor plans with $R^2 = 0,21059$, which is significantly lower than the ground floor's individual correlation with $R^2 = 0,34104$ for domain IV.

The second floor has a very clear distribution of axial lines that are transversal to the building's longitudinal development and that cross it from a space on the north to a space on the south side, intersecting the corridor. So, those axial lines' entropy is generally calculated with three values: the entropy of both opposite side spaces and the entropy of the corridor that connects them. Therefore, their axial line entropy relates to the entropy of the spaces that are crossed by that line, so if the entropy between them varies significantly, then their final results on axial line entropy will describe that difference. This will also bear significance for the average axial line entropy, because it divides the values of the axial line entropy by the number of spaces accounted for in the calculation, and so their final result will also vary to an average number between both values of the entropy of those spaces individually assessed. Consequently, if one of the spaces is a supportive space, it will decrease the end results for both the axial line and the average axial line entropy, and contrarily if it crosses a space of high entropy *per se*, then it will increase the final results.

The average axial line entropy is less related to the integration than the axial line entropy, because many of the spaces analysed have zero or non-meaningful values of entropy, which diminishes the average axial line entropy, but there is also a higher correlation on the ground floor than on the upper floor and for the entropy

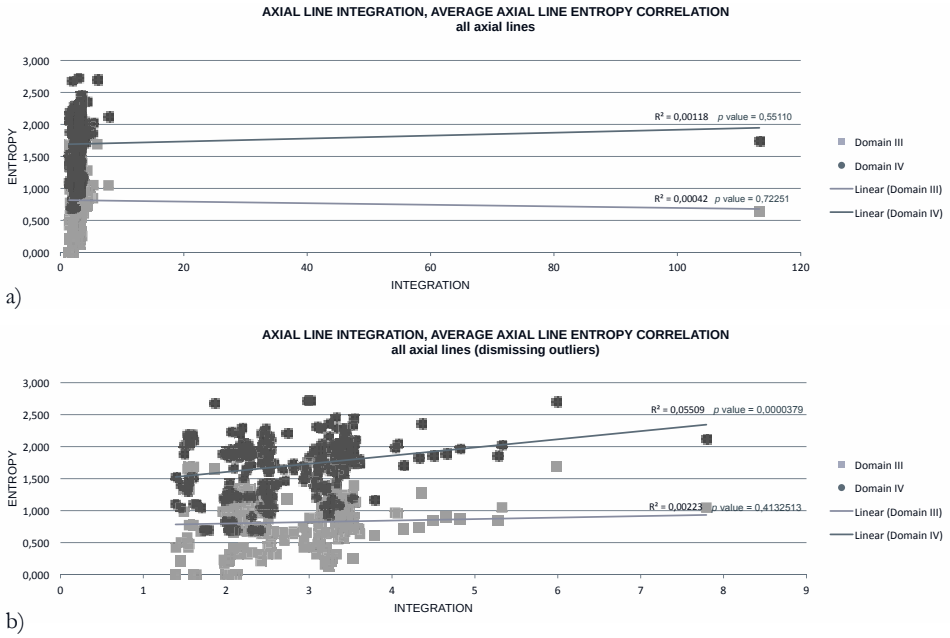


Fig. 287. Average axial line correlation scattergram _ Integration, Entropy
Distributions according to floor plans and domains (a) all data, (b) no outliers
(Carolina Coelho)

distribution for domain IV rather than for domain III.

Naturally that according to the calculations of the axial line entropy, the results are high if spaces of high entropy are enclosed in the same axial line. If that axial line has also high integration in the system, then the correlation is logically higher, which is more frequent on the ground floor than on the upper floors, because, as it has already been explained, the most integrated convex spaces are generally the main corridors that connect to the other spaces, and their entropy alone is located relatively in the middle of the rank, for either entropy results of both domain's distributions or for the feasibly matrix's activity allocation.

Another influential variable on these calculations is the number of convex spaces intersected, which implies that spaces with higher entropy increase their axial line entropy, but also if an axial line intersects several spaces then its final value is potentially higher because it is incremented by several different plots of values. So, the average axial line is a measure that can balance these results according to the number of convex spaces intersected by that axial line.

Thus, the average axial line entropy has been plotted against the axial integration to critically analyse the compared results to the axial line entropy *per se* (Fig. 287). When estimating the correlation with all axial lines it does not prove to be relevant, as it occurred with the previous axial line entropy, due to the outlier. So, the correlation can be estimated if the outlier is dismissed, which holds $R^2 = 0{,}05509$ and $R^2 =$

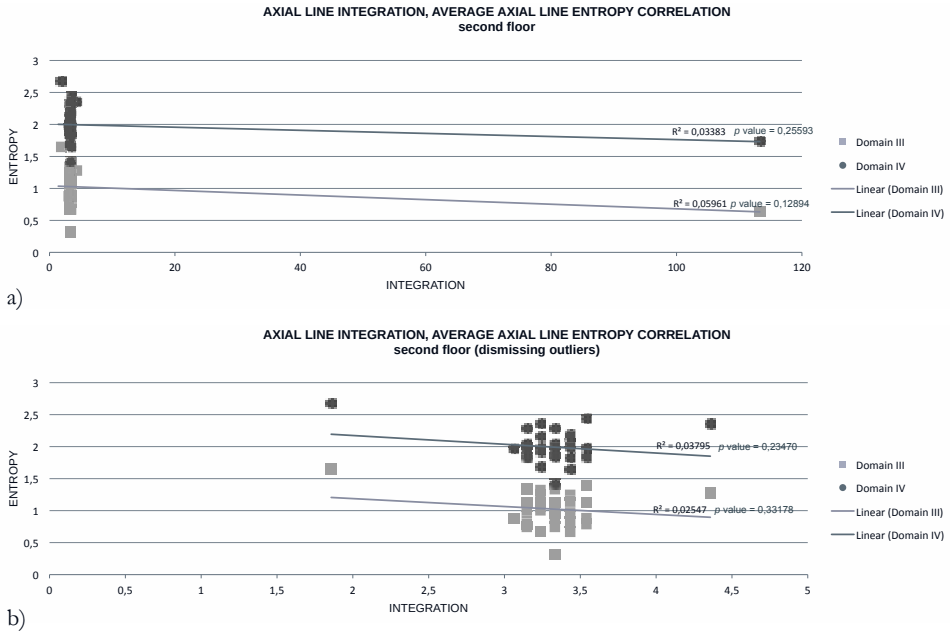


Fig. 288. Average axial line correlation scattergram _ Integration, Entropy
By floor plans: (a) second floor with all data; b) second floor with no outliers
(Carolina Coelho)

0,00223. These values are lower than the axial entropy that had R^2 = 0,21059 and R^2 = 0,07092 for domain IV and III. This is, in fact, the lowest correlation that plots all variables, even compared to the convex correlation.

It is also possible to analyse the scattergrams per floor plan and per domain in order to conclude on whether these prove to have similar distributions when compared to the axial entropy or not (Figs. 288 and 289).

Like it happened for the previous analysis, it is also the ground floor's average axial entropy distribution for domain IV that holds the highest correlation for this measure with R^2 = 0,27218, followed by the same floor's domain III's distribution with R^2 = 0,18353. This can be perceived as reasonably high, particularly when compared to the remaining values, but it is still lower than the R^2 = 0,34104 and R^2 = 0,26214 for domain IV and III's distribution for the axial entropy.

Both the first and the second floor do not prove to have correlations between their average axial entropy and their axial integration. For the first floor the correlation with the average axial entropy is significantly lower than with the axial entropy that reached R^2= 0,15154 for domain IV and, in this case, the regression line is almost flat, not reporting a correlation. The second floor has non-meaningful determination coefficients for either distribution on regard of its average axial entropy, even after dismissing the outliers.

Then, scattergrams were produced that correlated syntactic integration with entropy

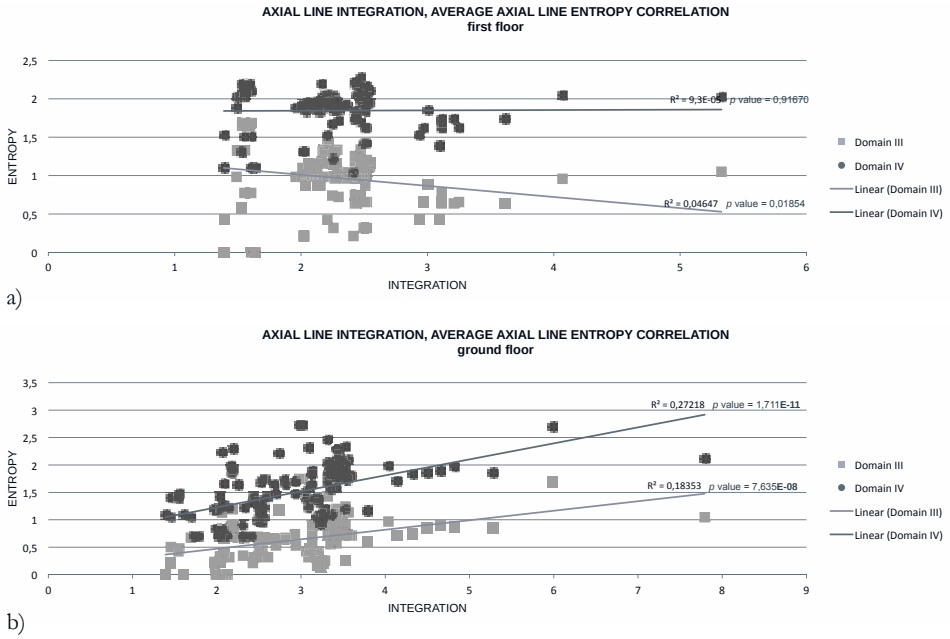


Fig. 289. Average axial line correlation scattergram _ Integration, Entropy
By floor plans: a) first floor; b) ground floor
(Carolina Coelho)

calculations for both convex spaces and axial lines, overlaying all six distributions by floor and by domain for each of these possible correlations, which lead to distinct results (Figs. 290, 291 and 292).

From the distributions that hold all variables, the highest correlation belongs to the axial line entropy when plotted against axial line integration for domain IV. Although it is fairly lower for the same distribution when estimated for domain III, it also displays a high correlation when convex spaces are concerned. Nevertheless, the average axial line entropy is the one that demonstrates the lowest correlation when all axial lines are comprised after dismissing the outliers. So, overall the most accurate association is between axial lines and their entropy, rather than individual convex spaces, even though the correlation can also be significant.

Generally, correlations are higher for domain IV than for domain III's when analysed for the same distributions, similarly between convex and axial correlations. This informs that a more in-depth distribution is best associated with the entropy of that particular space or axial line, which is potentially more accurate and detailed in activities, leading to a closer depiction of the actual case study in terms of activities when plotted against its effective integration.

An analysis by floor plan is possible and required because all three describe different configurations, vertically from a scattered to a more cohesive configuration where no transversal hallways have been designed. This clear impacts the results because

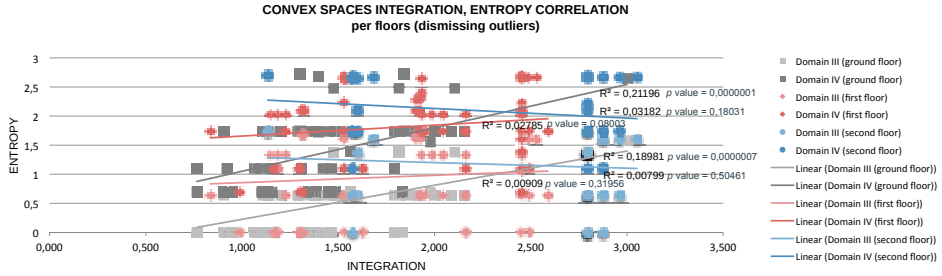


Fig. 290. Convex spaces correlation scattergram _ Integration, Entropy Distributions according to floor plans and domains, dismissing outliers (Carolina Coelho)

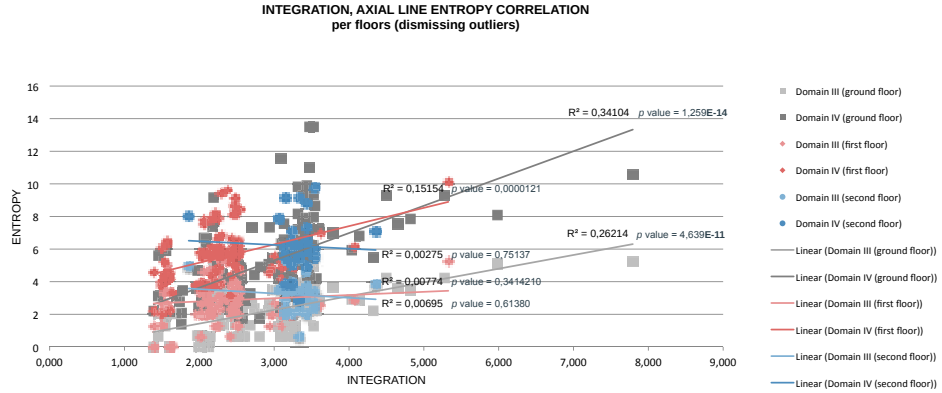


Fig. 291. Axial line correlation scattergram _ Integration, Entropy Distributions according to floor plans and domains, dismissing outliers (Carolina Coelho)

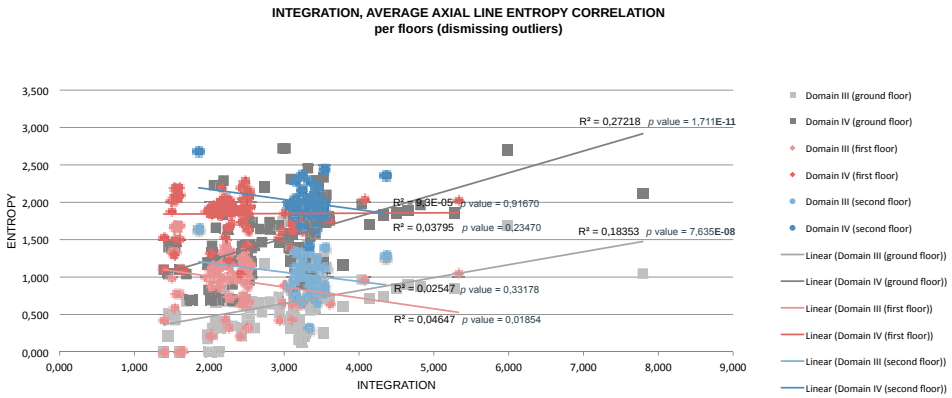


Fig. 292. Average axial line correlation scattergram _ Integration, Entropy Distributions according to floor plans and domains, dismissing outliers (Carolina Coelho)

the ground floor has fairly more significant correlations than the upper floors for all measures under comparison. The correlation slightly tends to decrease vertically towards the second floor, with low correlation amongst all measures.

From the higher ground floor correlation it can also be remarked that for similar values of integration there were corresponding values of entropy, which implies that the ground floor spaces with analogous functional purposes are placed in analogous positions on the school's layout, than they are on the upper floors, with lower correlation between integration and entropy.

Due to their configuration, the first and second floors have common values of integration for different spaces that have different values of entropy because they are related to very different functionalities. As their main configuration lies within a main corridor that connects to the spaces on both sides, then different function spaces, and hence different entropy spaces, have similar values of integration regarding the system's morphology. This explains the more visible vertical tendency of the distribution for the second floor, because for the same integration values correspond different entropy levels, associated with different allocation potential. This translates into a lack of hierarchy of the spaces according to their entropy and a similar centrality in the system for spaces with more or less active learning purposes.

From the analysis of the scattergrams there are two linear trendlines that can be perceived: an oblique and a vertical one. This could be understood from a more immediate interpretation as a potential stabilisation of the integration. But it is not the situation that this trendline describes. Actually, from a closer observation of the integration of the system and from its overall configuration, there are several spaces with different spatial features and also with different activity allocation potential that are located in similar topological positions on the system. Nevertheless, this is due to the fact that same values of entropy are associated with different syntactic integration values, which occurs because spaces have been identified from the captions over the final plans and so, according to their main function on the building. Still, if some of the spaces are site-specific such as the auditorium, the library, the choir room or the orchestra room, others are not, and are very frequent on the whole building. This implies that the same space considered for the same function, such as the music studio, the science laboratories, or even supportive spaces such as toilets or stage rooms, occur more than once and hence, have different integration values on the system regarding their different locations. So, this connection may not be univocal for spaces that have more than one integration.

This is very clear on the second floor, where the immediate configuration of the system with a main central corridor that connects to the adjacent spaces, with different functions closer to one another. On the remaining floor plans, namely on the ground floor, that is more scattered, there is a more diverse range of syntactic integration values and their binary matching to an entropy value is more distinct. So

the vertical trendline is clearer on the floors that are morphologically more cohesive and less noticeable on more scattered morphological configurations.

As seen, for equal values of integration there are variable values of entropy. This implies that topologically, equal spaces in the system have different allocational potential. Therefore, there is not a hierarchical disposition of the spaces as far as its adaptability is considered, because that would imply the least amount of topological steps for more adaptable spaces, and in this case there are supportive and monofunctional spaces very integrated in the system.

This fact can be justified by the need of supportive spaces connected to high entropy spaces with wide spatial and functional requirements, which is particular relevant for the artistic activities. For example, performances in the auditorium need lockers rooms, dressing rooms and bathrooms connected to it. So, if the auditorium holds a relatively elevated integration on the system to be easily accessed from the outside and to be central in the building, then its supportive spaces close-by will naturally also have reasonably high integration values. More so, if the analysis is made by axial lines than by convex spaces, because those axial lines may intersect other high integrated spaces besides the auditorium itself.

This is also the case of toilets that have low values of entropy but that have a very frequent use by all and imply a relatively high frequency of locations and also some need to have high integration, to be effortlessly accessed by all, despite the users' original location.

Consequently, high entropy spaces often hold high syntactic integration like: the main hall, the library and common living spaces, because they are both central to the system, morphologically and functionally. Other high entropy spaces are not so integrated as convex spaces because the architect has chosen to place them on the extremities of the upper floors, such as the music studios, the orchestra and the choir rooms. Nevertheless, when analysed by axial lines, that integration is higher because they are often intersected by the most integrated axial lines, like it happens with the auditorium, the choir and the orchestra rooms. The contrary to this is not always the case, because high integration spaces, do not always have high entropy, which has already been explained by the need of supportive well-connected spaces to others more relevant towards learning.

Furthermore, the existence of outliers adds to this vertical trendlines, because when there is an outlier of extremely high integration, such as it occurs on the axial integration of the second floor with 113,294, very different from the remaining ones, then the distribution of the other variables is closer together and perceived as more vertical in regard to a further value of 113,294.

So, if the integration values are less disperse amongst each other and outliers are

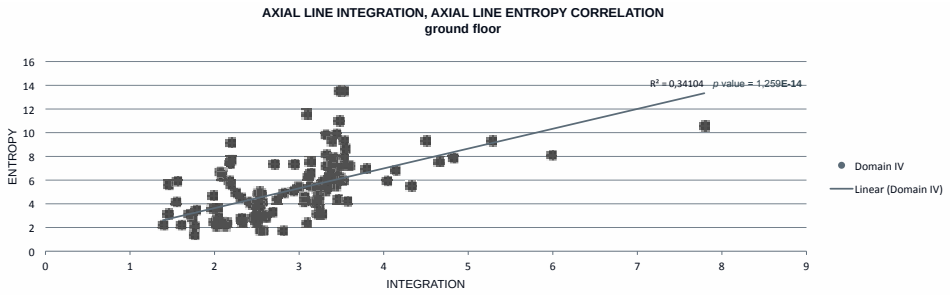


Fig. 293. Scattergram of the most representative correlation:
Correlation between axial line integration and axial line entropy for the ground floor's domain IV (Carolina Coelho)

considered, then the correlation between those values and their entropy is more vertical. The most vertical distributions are logically the second floor's, because it is where more spaces and axial lines have the same integration values when compared to different entropy levels, due to this floor's configuration, where a corridor accesses most spaces on opposite sides. Contrarily, the less vertical distribution is the ground floor's because the integration is more specifically related to a value of entropy and there is not such a wide range of spaces with the same or very similar levels of integration. This is due to the more scattered configuration of this floor plan. Under the possible correlation by means of convexity, it is therefore concluded that it is also the ground floor plan, with a more scattered configuration and more diverse values of integration from the analysis that holds the higher correlation, fairly different from the remaining floor plans.

All things considered, the highest correlation between integration and entropy was found on the axial line map for the ground floor, with the most significant R^2=0,34, fairly distant from any of the other values (Fig. 293). This implies that integration, as the independent variable, explains in 34% the entropy values in the *y* axis. This is also the distribution with the highest syntactic intelligibility, besides the specificity of the second floor's double-loaded corridor layout. Hence, the ground floor is a more representative interface for interaction and learning, by acknowledging more adaptable spaces, with higher entropy and which also has more syntactic representativeness in terms of axial lines.

With regard to the level of significance of the correlations, it might be concluded that for most of the studied ones, the *p* value supports them to be statistically valid. Similarly to the determination coefficient, also the *p* value has shown fluctuations amongst the correlations between the observed variables, to be subsequently discussed.

When convex spaces integration is plotted against entropy for all convex spaces, the *p* value is near zero (*p* value = 0,0000007 for domain IV's and *p* value = 0,0000429 for domain III's distribution, respectively). The situation is added when the outliers

are dismissed, generating *p* values specified by scientific notation near zero. This concludes that the correlation between the variables is statistically valid and has a high level of significance.

When analysed in deeper detail, by floor plan, the *p* value does not provide such strong evidence towards the proposition on the correlations. Thus, it might be argued that all the entities observed together as a whole are very strong in suggesting a valid hypothesis, while this is not as robust when the correlation is scattered in smaller samples by floor plans. Still, the ground floor's correlation between convex spaces integration and entropy is indeed very strong, respectively with *p* value = 0,0000001 for domain IV and *p* value = 0,0000007 for domain III's distribution, assuming their high statistical significance.

As for the scattergrams that correlate axial line integration and axial line entropy the *p* values prove the strength of the evidence for assuming the hypothesis of their effective correlation and vividly reject the null hypothesis that the results might have been subject of fair chance. In fact, when dismissing the outliers for the scattergram between axial line integration and axial line entropy, *p* value = 3,901E-17 and *p* value = 0,0000027, respectively for domain IV's and domain III's distributions. As these values are near zero, this indisputably concludes on the strength of this correlation.

Correspondingly to the latter correlation between convex spaces integration and entropy, also when the axial line integration and entropy correlation is detached by floor plans, the *p* values computed are not as meaningful. But analogously to the previous correlation for convex spaces integration, the ground floor also specifies, respectively, *p* value = 1,259E-14 for domain IV's and *p* value = 4,639E-11 for domain III's distribution. This again proves the correlation to be statistically valid and significant. Furthermore, this correlation is even more robust, since *p* values are also low, for the second floor without dismissing the outliers and also for the first floor domain IV's distribution.

Finally, the correlation between axial line integration and average axial line entropy, for all axial lines when dismissing the outliers is also meaningful to be discussed, since *p* value = 0,0000379 for domain IV's distribution, despite the low determination coefficient. Even so, this is particularly more relevant when the correlation is detached by floor plans, where the ground floor is proved to be quite significant in terms of both R^2 and *p* value.

Generally, it might be concluded that the correlations are proven to largely be valid and statistically significant, reaching *p* values near zero and even some of the times specified in scientific notation, which is paramount for concluding on the validity and significance of the hypotheses brought by these correlations. Besides, it is the ground floor that transversally holds the strongest values when compared to the other floor plans.

All things considered, it is paramount to acknowledge the most significant correlation, associating a very low *p* value that assesses the strength of the hypothesis of the correlation to be statistically highly significant; along with the highest determination coefficient, supporting that the correlation between the variables is strong. This occurs in the correlation between the axial line integration and the axial line entropy for the ground floor, when analysed for domain IV, whose determination coefficient is the highest and that holds a very low *p* value, near zero (*p* value = 1,259E-14), rejecting the null hypothesis (H_0) of this correlation to happen fairly by chance.

Conversely, because the null hypothesis does not describe the obtained results that reveal a non-arbitrary distribution, it leads to an alternative hypothesis (H_1). In fact, by rejecting the null hypothesis, it provides evidence in favour of a counter one. Hence, this correlation sets the alternative hypothesis that the syntactic integration and the entropy are more strongly correlated by their axial lines on the entropy's most disaggregated distribution, and this is particularly strong for case study's ground floor. Thus, this constitutes specific strong evidence that this correlation, here examined in detail, is "statistically highly significant" [847] (Buchan, 2017) and that the hypothesis set, assuming that both variables are effectively correlated, is robust.

Therefore, according to the *p* values achieved from all the correlations, and especially from this most significant one, strong evidence against the null hypothesis is presented, concluding that the correlation between the variables is statistically valid and has a high level of significance.

Conclusively, having explained the methodology and its application, the choice in the case study and having produced a critical analysis of the data gathered, on the individual approaches and on their potential correspondence; spaces and axial lines with the highest values on both entropy and integration were identified and subsequently the correlations on the distributions. Although for this school the results have been somehow scattered, one distribution has proven most significant. This implies a deeper bond between morphology and activities on the ground floor and when analysed with respect to the teaching regimes, which values this school's relevance towards external use, artistic and regular teaching. Having also proven a higher correspondence to axial lines than convex spaces, this also bears significance at a pedagogical perspective because the spaces are more representative for this analysis when considered as a whole, which associates adaptability with the concept of active learning environments, rather than individual spaces. In fact, the overall data gathered and the conclusions support the impact of the school space on the teaching methodology as well as the learning processes as it happens in the overall spatial system (Hilllier and Hanson, 1984).

[847] According to (Buchan, 2017): "Most authors refer to statistically significant as P < 0.05 and statistically highly significant as P < 0.001 (less than one in a thousand chance of being wrong)."

. Critical interpretation from the correlations between the idiographic analysis and the remaining approaches

> "Educational space needs are designed primarily around patterns of human interaction rather than the needs of particular subjects or technologies." (Worthington, 2007, p.17)

This idiographic approach, divided into three procedures, intends to relate the school space with the effective use it holds. Thus, it resorts to the people, who use it to better report how the learning process occurs throughout the whole school building. Besides, all of these procedures have also been accomplished by people, non-participant observers, that recorded in several manners all of the events that inform the overall findings. So, recalling Neuman words: "Social research is for, about, and conducted by people." (Neuman, 1996, p.16). Nevertheless, these methods taken from social sciences research aim to provide that information, as a qualitative approach to spatial fruition, used to provide operative and complementary data for an architectural research on space and its ability to allocate activities, both formally and informally. This acknowledges the procedures' disciplinary scope under architecture because, ultimately, it will inform architectural research.

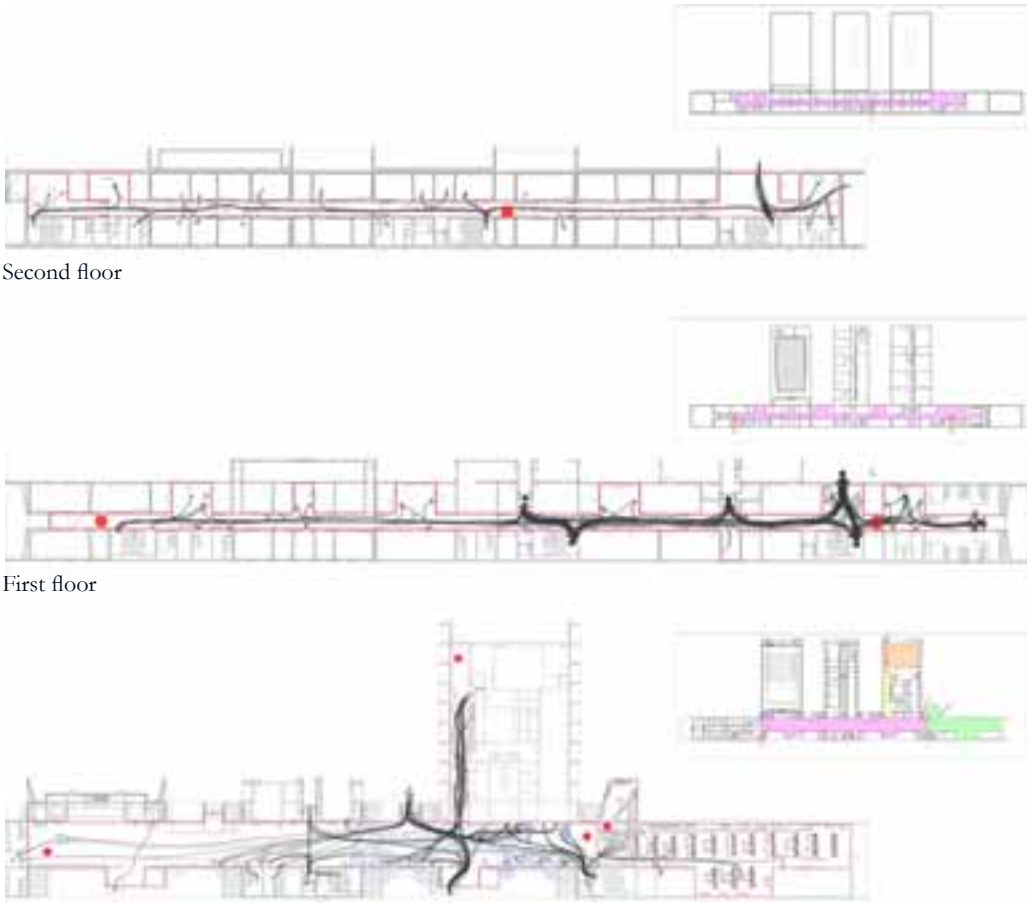
Furthermore, at this stage of the methodological application into the case study, it is concluded on the relevance of each of these three procedures and also on the high significance of its sequential establishment, in a triangulation approach that aims to integrate the contribution of several methods[848] (Bryman, 2008, p.379). Assuming that each procedure will bring additional contributions towards the conclusion, a conjoint methodological approach will potential be more extensive in the acquaintance and explanation of the reality in regard to the learning processes in space:

> "Each method, thus, reveals slightly different facets of the same symbolic reality. Every method is a different line of sight directed towards the same point, observing social and symbolic reality. By combining several lines of sight, researchers obtain a better, more substantive picture of reality; a richer, more complete array of symbols and theoretical concepts; and a means of verifying many of these elements. The use of multiple lines of sight is frequently called *triangulation*." (Berg, 2004, p.5)[849]

Observations enabled a more thorough understanding of the patterns of co-presence and natural movement in space, the highest and lowest density spaces and the activities that produced that density. Having provided this general outlook on a collective use, after frequent observations on the same spaces and schedules, a more detailed description on space use was able to be depicted, namely on the nature

[848] "*Triangulation* entails using more than one method or source of data in the study of social phenomena." (Bryman, 2008, p.379)

[849] Italics from the original quote. Consulted edition from 2004, original edition from 1988.



Second floor

First floor

Ground floor

Fig. 294. Observation matrices _ Morning of a regular school day
(Carolina Coelho)

of the activities done and on the people who did them on that space and time periods. After a critical analysis from the drawings and by plotting the dots and lines representing people standing and moving, along with the field notes on similarities and exceptions from each of the observations, to which it has also been added the video and photograph recordings; it was possible to establish some conclusions on the effective spatial use, on the densities of that use in each space according to the time intervals of the observations, and potentially correlating them to classes' schedule and the week overall timetable of both the school and the conservatory communities and lastly to spatial features (Fig. 294).

The walkthroughs and focus groups, separated into four, each with a specific curriculum affinity, provided a very specific outlook on space from each particular group. This has been studied and analysed, assuming a diversity of outlooks on spatial adaptability according to the groups interviewed but also some similarities amongst the four.

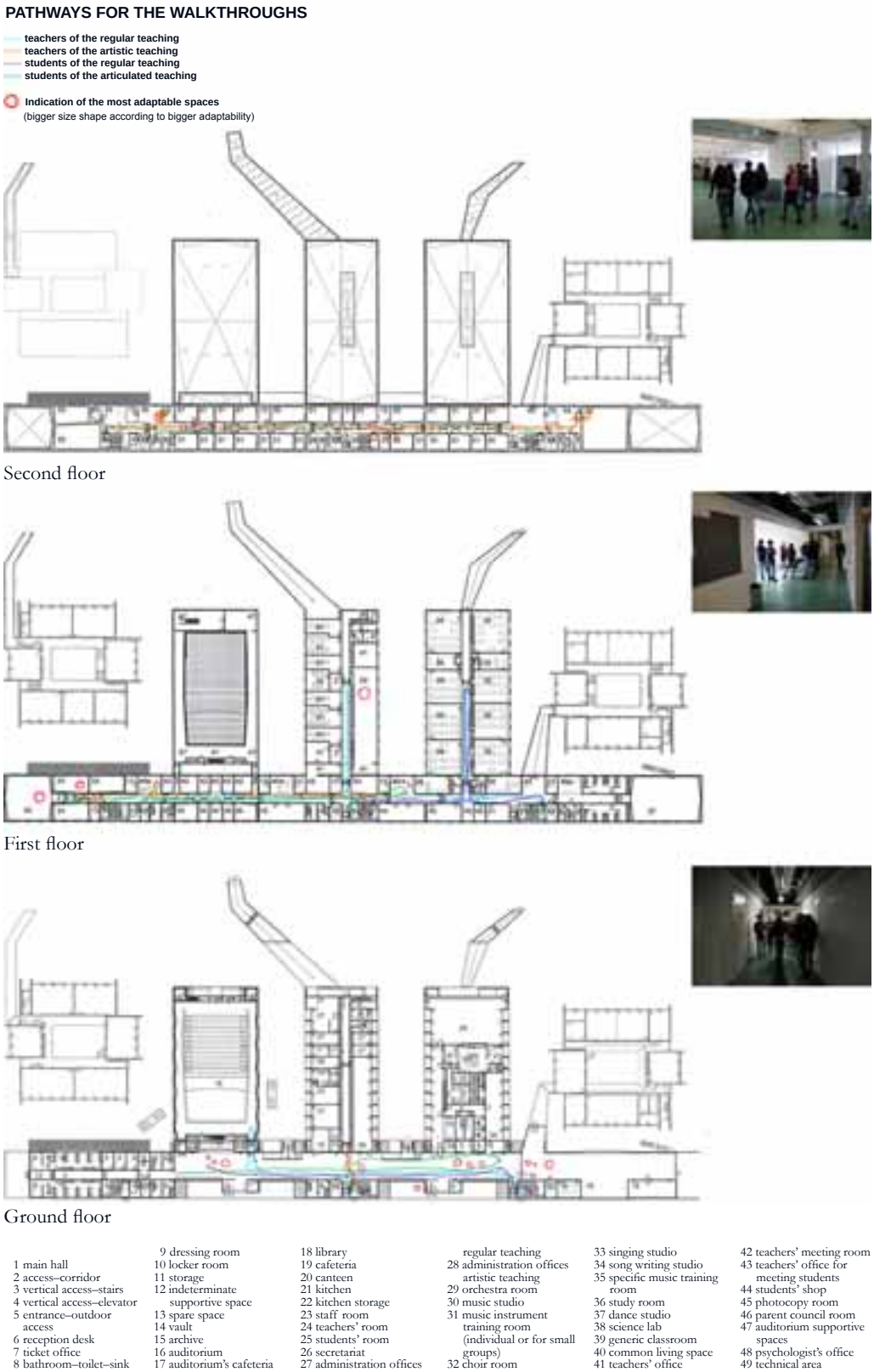


Fig. 295. Walkthroughs _ Photos and plans with the most adaptable spaces identified (Carolina Coelho)

These have confirmed the previous conclusion from the observations in a more general fruition, but they have also enabled some clarification and justifications of those happenings[850], and specifically they have also provided a fine-grained portrait of spatial usage and life within this space as a whole, in regard to: how each group perceives space, how and why they use it in such a way, and specially what activities do they undertake in the building and, from there, which can be associated with the same space for considering it an adaptable one.

Primarily, the lack of a specific students' common living room enables dispersion of the informal and social activities throughout the whole school, which has been confirmed by the three procedures, and which demonstrates the building's ability to hold those activities elsewhere in other spaces, but also the students' adaptation to those constraints. This has been overcome by the artistic students that are keen on spontaneous happenings in diverse spaces, even the least expected ones, but not so much for the regular teaching students that use the school in a more formal and previously arranged manner, demonstrating a lesser sense of appropriation and belonging to the building.

This final overall conclusion does not aim to repeat itself from the previous intermediate ones, process-specific and more detailed. On the other hand, it aims to acknowledge this process overall as an holistic approach to space that provides information from a more general to a more detailed account on spatial fruition on this case study in particular. Naturally that the individuals' accounts from space have to be perceived amongst an holistic approach to the building and the general community that lives within it, but it also reports a cultural and social context which is paramount in this building for justifying the specificities and even the unexpected outlooks remarked during these procedures. So, the more specific the outlook from each of the contributors, the less it represents an overall perception of space use, but this does not deploy it from relevance, since it helps portraying a community on its informal and social activities, and correlates them to the spaces where they are in fact undertaken, which is the aim of our current research and which would not have been understood and brought for the findings if a methodological approach on effective spatial fruition and appropriation had not been accounted for.

And if some conclusions have been reached in regard to the identification by all the community of the main hall as a space that gathers all of the school users and also a very wide range of activities, others may also be disclosed and their correlation to the previous findings from the former milestone can also be analysed (Fig. 295).

Observations have remarked, and focus groups have confirmed, the fact that artistic students practice in very different shaped spaces, from formal classrooms when

[850] "[…] the main goal of focus groups is not to gather opinions, representations or perceptions about any particular theme, but rather to understand the processes that lead to these opinions" (Duarte, Veloso, Marques and Sebastião, 2014, p.4)

vacant, to the small niches on the corridors, which is very relevant because it is a specificity that does not occur in the regular teaching classrooms – students do not go to the classrooms to study in an informal or non-programmed manner, as they do in the artistic teaching. Artistic teachers on the focus group have even confirmed that students would gather themselves in groups and went to a vacant classroom to exchange ideas, knowledge on instrument playing and to play together as a group. Not only that but, it has also been assumed by the artistic teachers that students also get together in these music classrooms for sharing ideas and discussing some music works they have individually seen before online and wanted to show to their colleagues on an online streaming, using the wi-fi network of the school, and then discussing its artistic value all together.

This proves again that socialisation is also a way for information transmission, in this case, for the students to present to their colleagues what they have seen, but also for debating, critical thinking and ultimately knowledge creation, very meaningful for the artistic teaching. It indicates their will to learn from each other and to create knowledge and artistic displays by themselves, and not only to have information strictly passed on by their teachers. This is a very specific feature of these students in which creativity, motivation, willpower and critical thinking is most relevant for their profile and for their curricular path on the conservatory.

The difference on activity allocation on this matter is particularly relevant and subject of critical analysis. Since both regular and artistic classrooms are prepared for both informal and formal teaching, the fact that their actual use differs and that only on the artistic teaching do students use their classrooms for informal study, may be accorded to the physical dimension of these rooms which are quite smaller and enabler of a sense of belonging and comfort than a larger room may not convey. But it can also be conditioned not just by spaces' ability to cope with those activities, or by management decisions, but by personal options on practising there rather than elsewhere. So, social and individual preferences, namely under the profile of the artistic students – rather spontaneous and expressive, is keen on making the choices on activity allocation.

Ultimately, effective appropriation is a product of the physical features of space and the building's morphology, but also from the people's profile, individual and collective, who appropriate it, either by changing the space to provide for their needs, or by using it in ways not initially conceived in the design. The fact that regular students do not appropriate space as far as artistic students do, and that artistic students may engage in artistic and informal displays in numerous common spaces deployed of the best physical features for music performance, induces the fact that their social profile makes them take those creative and spontaneous decisions on space use, differently from their regular teaching colleagues.

So, it might be argued that adaptability is correlated with the community that uses the

space and their cultural and social context, who chooses on how to use the school space and where to learn more informally and in non-programmed manners. But it is also correlated with a sense of belonging in space and, if that occurs, students will use all the spaces of the school as potential active learning environments, because in all of them people may learn by observing, by practising, by discussing with their peers and with their teachers. In a school such as this, where formal and informal, individually and collective spaces are integrated and closely connected, and where corridors and common spaces are used by all and act as conjoint spaces, this is an environment prone to learning, in the most varied ways as it might be.

The comments from the artistic students' focus groups in regard to adaptable spaces, also demonstrate that each space has a high potential for coping with activities as it has been previously conceived, because these students understand its potential from even the most unlikely spaces, or even spaces lacking physical features that would better account for music display. So, all in all, by appropriating space, some activities may be done in spaces deprived of the best physical potential for it. This may lead to an under-development of these activities, but that does not immediately avoid it from being used. From this finding, the entropy approach that uses a feasibility matrix for allocating spaces to activities potentially leaves out spaces that, in fact, hold actual pedagogical, artistic and social activities. Singing in the stairs, as some artistic students have mentioned doing in the informative discussion during this focus group, is an example of an activity which is not expected to be done in this space deprived of the best physical conditions for it.

That is why the input from the approach depicting effective spatial fruition complements the previous ones, informing how the spaces are actually used from all possible activity allocations from the former entropy approach. All in all, if students start practising singing in the staircases, or playing music in the corridors, these can be considered active learning environments, even informal and for non-programmed events, but prone on pedagogical potential.

The fact that the main hall is identified from these findings as an adaptable space, correlates its high effective fruition to high integration, realised from the previous morphological analysis by space syntax. Nonetheless, students from the articulated teaching have also explained their preference for using the upper floors precisely because of the lower densities these hold and their more specific users related to the conservatory. This might imply that spaces with higher mean depth and lower integration, as they hold lower density of people in space, can be preferred to proceed with social and informal activities, mainly accorded to the artistic practice, precisely anchored in a sense of cosiness and social comfort. Even so, the fact that the main corridors are favoured as staying places when compared to the niches, particularly on the second floor, where the niches are located at the extremities of the building and so, with higher mean depth and lower integration, makes them frequent spaces to be in, even if they are not the most suitable places to be

in a collective manner. In this case, the high connectivity of the corridor to the classrooms weighs more in choosing the space to be in.

On the interview conducted with the architect José Paulo dos Santos (2017), when asked about a common living room and the diverse use of the main hall, the architect confirms that "the school (faculty and students) uses these spaces in a diverse manner"[851] (Santos, 2017), and that the whole space comprising the main hall and the transversal corridor towards the canteen, were used as a living space and no specific room was provided for that purpose:

> "As far as I could tell, either the main hall on the ground floor or the corridor leading to the canteen, which passes through a cafeteria including the canteen (this one to be used outside mealtimes), this T was used as living room."[852] (Santos, 2017)

This is also possible due to high connectivity of the main hall towards several other spaces such as: the auditorium and the auditorium supportive spaces, the administration hallway, the cafeteria and the canteen and the library. But the architect, when asked about the main hall's representativeness as a potential learning street and the high density of its use, highlights its connectivity not only to the interior spaces but also the exterior courtyards, which in fact coincides with the observations undertaken that have remarked the high frequency of movement between the main hall and the outside spaces[853].

This enables the establishment of a parallel between the design and the effective space use that can be depicted by observations, focus groups and walkthroughs. Even if the canteen is not used outside of the lunch schedule as it was initially perceived[854], the area from the canteen transversally towards the main hall and the main hall's longitudinal development are used to cope with the need of a common living space with both curricular and extra-curricular activities of diverse nature, as the architect acknowledges.

[851] Free translation of the original quote in Portuguese from the architect's interview: "A escola (docentes e discentes) utilizam estes espaços de forma diversa." (Santos, 2017)

[852] Free translation of the original quote in Portuguese from the architect's interview: "Tanto quanto me dei conta, quer o vestíbulo do piso zero, quer o corredor de acesso ao refeitório, que passa por um bar incluindo o refeitório (este para ser utilizado fora das horas de serviço de refeições), esse T, era usado como sala de convívio." (Santos, 2017)

[853] According to the architect regarding the main hall: "[…] is not only the vestibule that gives access to the auditorium's dressing rooms, to the auditorium, to the administrative area and the secretariat, to the canteen and to the library, but it also gives access to the outer courtyards to the south. The courtyards to the south are like interstices that there were always present in Quinta das Flores between the pavilions."
Free translation of the original quote in Portuguese from the architect's interview: "não é só o vestíbulo que dá acesso às zonas de vestiário do auditório, ao auditório, à zona da administração e da secretaria, ao refeitório e à biblioteca, mas dá também acesso para os pátios exteriores a sul. Os pátios a sul são como interstícios que sempre houve na Quinta das Flores entre os pavilhões." (*ibid.*)

[854] According to the architect: "The canteen should always be able to be used outside meal schedules."
Free translation of the original quote in Portuguese from the architect's interview: "O refeitório deveria sempre poder ser utilizado fora dos tempos de refeição." (*ibid.*)

Therefore, spatial fruition and morphology are correlated, as proven by the high-density spaces which are also the most integrated ones, both for standing and for moving towards a specific direction. Even so, from the focus groups and walkthroughs it has been perceived that this was particularly recurrent for the regular teaching community rather than for the artistic users. Artistic students, in particular, use the whole building: the spaces for the school, for the conservatory and the shared spaces, and therefore are better acquainted with all the spaces provided. In this manner they are able to choose from a wider variety, the ones they feel more at ease to be in, according to the activities. They also convey a sense of spontaneity and creativity that enables informal activities to happen everywhere, even if individually done and not by larger groups. In this sense the spontaneous, and sometimes unexpected activities, in informal spaces can be an urge of the moment or even a repeated happening but do not represent a whole community. What does, in fact, represent the whole community are the higher patterns perceived in the observations. Nonetheless, the understanding of the specificity of this community, bounded by informality and creativity, bears significance for their choice in spaces and so for activity allocation.

Therefore, if analytical assessments have proven their relevance from the initial stages of this methodology and are correlated to the patterns for staying and moving taken from the observations and also from the focus groups and walkthroughs; these latter enable a fine-grained acknowledgement of the spatial usage that might explain some of the exceptions observed on the first procedure or even complement additional uses from spaces initially not understood for such purposes:

> "[…] focus groups give voice to individuals, with the added value that they take place within social contexts in which the social relationship framework is focused by the researcher's choices." (Duarte, Veloso, Marques and Sebastião, 2014, p.6)

Even so, if informality bears great relevance for the current learning experience, for the artistic students it bears even more, because the artistic practice implies it and also because the artistic profile of the students also bestows that. So, this reflects upon the choice of spaces to be in and, overall, into activity allocation to spaces, considering spaces that were previously disregarded from this analysis as active learning environments for this particular community, in this particular building.

As remarked by these latest plans regarding effective use[855], the conceived use by the design differs from the effective use on some of the spaces, implying that the building had to cope with upcoming requirements, but with these changes it is still able to answer all the pedagogical and social needs.

The entropy approach that provided an analytical allocation of activities to spaces

[855] See chapter 4.2.3. Description of effective events and experience in the school.

has been widened to the allocation of those same activities to spaces deprived of the best physical features, but that convey others, perhaps more socially and individually related, considered to be more significant for some of the users. Therefore, the spatial fruition approach did not narrow the allocation of activities to spaces from all of the possible ones to the ones that effectively held those activities, as it might have been expected, but it ultimately *enlarged* it because of the high informality of this building's ambiance and curriculum, which allocates learning activities to spaces that were not initially considered potential active learning environments.

Having already established a correlation between space and people, and ultimately students and learning spaces, at this point this is recalled: if the building conveys how the learning process occurs, it is also the people within it that determine how the learning process is perceived and where does it take place, mostly in informal situations. This has been proven to be particularly relevant for artistic schools and even more for those whose curriculum options convey multiple choices, uses and activities. Thus, adaptability, as shown by individual accounts, but also by frequent observations of informal uses of the space, is also a reflection of the community in space and their sense of appropriation, informality and creativity in associating activities to learning environments.

. Retrieval of an artistic school's adaptability _ Final considerations

> "This process would depend on the mechanism of description retrieval discussed earlier, that is the ability of human being to retrieve an abstract description of spatiotemporal events and use it as a template for further action." (Hillier and Netto, 2001, p.13)

After proceeding with the overall methodology it is concluded that all procedures bear relevant significance for assessing adaptability and their sequential application provides data on different aspects that weigh on the adaptability potential, comprising Schön's (1993) "reflection in action".

From the analysis of the building's technical drawings and particularly of the more detailed ones, the choice of the materials can be generally described as plaster board for technical acoustics performance, floating oak flooring or epoxy on the floors, concrete wall finishes or hard maple for the walls. The architect José Paulo dos Santos (2017) explains these options in regard of the choice of the materials:

> "Almost the whole school has epoxy applied to the pavements. In the music area, the acoustics technician had suggested me to use solid wood because he likes the sound with a certain quality. Here we use the floating oak floor [...] in the instrument rooms. In the auditorium,

> by contrast, it is 'hard maple' wood. The liner had to have a certain acoustic characteristic and at that time, in Lisbon, the acoustics technician Commins had suggested to me the 'hard maple' as one of the most acoustically suitable woods ...
> I've always liked hard maple. In Northern Europe it is used with regularity, not being used so much here [...]. I found it opportune to line the auditorium with hard maple, from the floor to the various plates / acoustic linings of the skirting boards and ceilings."[856] (Santos, 2017)

Naturally, these spatial features are related to the end results on adaptability because they enable activity allocation, which has been analytically supported by the entropy approach, associating activities to spaces according to their physical potential. Nevertheless, the effective use of space is also determined by individual or collective preferences or routines that can overlap the potential of spaces with similar physical features. This is why each of the focus groups has particular movements and activities in specific spaces, as demonstrated by the observations and walkthroughs.

On a more critical analysis of the results, entropy calculations informed which activities the spatial sample depicted from the first milestone can allocate from an extensive list regarding this case study's curricular specificities. It established which spaces have a wider or lower allocation potential for either the regular and the artistic teaching regimes, as well as external uses, curricular and extra-curricular, programmed and non-programmed activities.

The results identify the spaces with the highest results as the ones that hold the largest range of possible activities and furthermore, the most widespread allocational potential amongst the different domains. The library is ranked at the top as a space that can cater for most users and curricular and extra-curricular activities in the school. It is followed by the music studio, which is a medium size space that can allocate activities not only for the artistic teaching but also for the regular teaching. The auditorium, the orchestra and the choir rooms are large size spaces that have also the potential to gather smaller groups, and similarly to the music studio, that are provided with soundproofing requirements for the conservatory classes but that can also cope with the less spatially demanding regular classes. It is concluded that over-provision increases the adaptability potential of the spaces, which can be compared

[856] Free translation of the original quote in Portuguese from the architect's interview: "Quase toda a escola tem aplicada monomassa nos pavimentos. Na ala da música, o acústico tinha-me sugerido usar a madeira maciça, porque ele gosta do som com determinada qualidade. Aqui usamos o soalho flutuante de carvalho (...) nas salas de instrumento. No auditório, pelo contrário, é madeira de 'hard maple'. O forro tinha de ter uma certa característica acústica e na altura, em Lisboa, o acústico Commins tinha-me sugerido o 'hard maple' como uma das madeiras mais adequadas acusticamente...
Eu sempre gostei do hard maple. No norte da Europa usa-se com regularidade, não se usando tanto aqui (...). Achei oportuno forrar o auditório com hard maple, desde o soalho às diversas placas/forros acústicos dos lambrins e tectos." (Santos, 2017)

to its effective use. During the focus groups and walkthroughs contributors have confirmed that large overly-dimensioned spaces were avoided for smaller events, for cost-efficiency purposes and also for a sense of cosiness and easiness of use. So, in these cases, when the entropy results are overlapped to the effective fruition, the over-provided spaces narrow down its effective use to the most adequate situations in which their specific requirements can cope with. For others, less demanding, other spaces are often chosen as compared to these. This explains, for example, the more frequent choice of the orchestra room as opposed to the auditorium for performative events and/or external displays with smaller audiences.

Additionally, other spaces like the main hall and the common living spaces have also been identified with high entropy values. This is due to its openness in accommodating very different activities, curricular and extra-curricular, programmed and non-programmed. These spaces' results can actually be correlated with effective spatial fruition, that from all three procedures undertaken have pointed out these niches adjacent to the main corridors as highly used for a variety of different activities and by different people, and especially the main hall as the space that holds the widest array of different events, formal and informal, individual activities and group gatherings, curricular and programmed as well as extra-curricular spontaneous or non-programmed activities. This is, in fact, the space that has been more clearly pointed out from the effective spatial fruition procedures as the most adaptable and that also holds a high entropy result.

From the space syntax analysis, the convex spaces with the highest integration are the main hall and the main corridors, which coincide with the effective spatial fruition from the observations, as the spaces used by all. When paralleled with the entropy results for individual spaces, the corridors have average entropy from the overall rank, because their activity allocation potential is narrowed down to interaction and circulation. Nevertheless, when comparing the main hall's results from all three analyses, it is a space with high entropy that is very used by all the community and that holds a very high syntactic integration.

There are also other spaces to be considered as integrated spaces such as the library, which is the space with the highest entropy, and also the cafeteria and the auditorium's cafeteria that are also placed on the entropy's rank on a high position.

From the information gathered from the effective spatial fruition, the library is a space that, in fact, accommodates a very wide range of activities from curricular to extra-curricular events, programmed and non-programmed activities, from group gatherings to individual study for the artistic as well as for the regular teaching curricula, and also from social interaction to small lectures. So, the correlation between the three approaches is confirmed.

On the upper floors that overlapping has to be careful analysed because the

main corridors are also confirmed as being highly used and highly integrated, but particularly for the second floor, there is a similarity on the integration of several spaces with different allocational potential and hence, with different entropy. This occurs on the first floor for the students' room, the music studio, the specific music training room, the study room, the teachers' meeting room, the students' shop, the photocopy room, the parent council room, the psychologist's office, spare spaces and dressing room. The cohesive configuration of the second floor better describes this situation, in which the music studio, spare spaces, the music instrument training room, the singing studio, the song writing studio and the specific music instrument training room, all have similar integration levels. This is due to their adjacency and the fact that the floor's configuration is based on a highly integrated main corridor that distributes the spaces for the two opposite sides.

Consequently, this configuration infers that the correlation between integration and entropy is consistent for some of these spaces such as: the music studio that holds the second highest entropy overall, also for the common living spaces that even hold higher integration than these spaces, besides the spare spaces. Still, in some cases the entropy is lower and the correlation is less meaningful. This can be explained by the configuration of the floor plan that does add a significant centrality to the active learning spaces as opposed to the supportive ones, and also by the fact that some active learning spaces imply supportive spaces to be one topological step away.

Furthermore, the choice for placing the supportive spaces on the first floor such as the teachers' meeting room, the students' shop, the photocopy room, the parent council room, the psychologist's office, especially accessed from the main corridor, also decreases this correlation because this floor allocates, in quite similar syntactic circumstances, curricular and extra-curricular activities and especially active and supportive learning environments, from artistic formal learning spaces to informal rooms' for the students.

This explains the higher correlation between syntactic integration and entropy for the ground floor as identified and reflected upon earlier, even if some spaces on the upper floors also describe this correlation. Furthermore and as already studied in detail, there is even a higher correlation when the integration is analysed by axial lines rather than by convex spaces because the first may comprise spaces that were former deep spaces placed on the building's extremities, and when analysed by axial lines they are intersected together with some of the most integrated ones.

The spaces that coincide with the highest values and that from the observations, focus groups and walkthroughs have also been identified as being highly used and, ultimately more adaptable, then these are the ones that are considered more adaptable overall, according to the proposed methodology. This is the case of the spaces already mentioned such as the library, for its possibility of gathering very diverse activities in a formal and informal environment and also its large dimension and

adjacent spaces that enable the simultaneity of different nature activities. Besides, its high network connectivity and all the technological devices it holds as well as the pedagogical materials like books and magazines make this space an aggregator of users. The diverse placement of tables for individual and group gatherings, near the bookshelves or closer to the computers, also provide users with different possible uses. It is also a very accessible space from the outside, which enables parents with a more easy access for studying with their children, as it has been perceived from the observations, but during the week day it is also a space for both prolonged and short stays, because students rapidly access the library for a doubt, for staying on the sofas, for using the computer, for spending time in general after school, or for a more specific task. As far as environmental conditions are concerned, it is a space that is comfortable, well lit and with adequate insulation, it is also exposed to the exterior courtyards of the school as well as towards the exterior and so, with generally high visibility towards other spaces which may enhance encounters and interfaces with the peers.

The general cafeteria and the auditorium's cafeteria are spaces that hold high integration and entropy, but differ in regard to their physical features that provide different spatial appropriation situations. The auditorium's cafeteria is placed on the main hall, as the inside space that welcomes all users and this makes it very accessible to all the community, that is also welcome to use this space, as an interface for teachers, students and parents. It is also a space where artistic students were perceived to be practising in groups, but in more quite moments of the day such as the time before the classes start in the morning. It is also a space considered by the students for individual study and also for peer interaction, but socially that can also lead to information transmission and learning amongst peers. Contrarily, the general cafeteria is not a space where most students like to stay, because it is overly narrow and too long, so its proportion resembles a corridor more than a space for standing. This has been acknowledged by the observations that have concluded that most students purchase the items and often proceed to the outside spaces or go indoors towards the main hall, leaving the space for their peers also to purchase their items. Students seldom use the cafeteria as a space for study or extra-curricular activities connected to learning because of the overcrowding of the space on the breaks and its narrowness that hinders group gatherings, and also because of its dimension that could be considered small, particularly for the most important breaks, hindering a more extended stay. So, even if accessibility is considered on this space, its dimension and configuration impede a more adaptable effective use, as it has been perceived in the observations and more specifically described in the focus groups.

It has also been perceived that artistic teaching spaces have the potential to hold other users and situations, like the regular teaching that is less spatially demanding. This explains the high entropy of conservatory's formal curricular spaces such as the specific music training room, the music instrument training room, the

singing studio, the song writing studio, but foremost the music studio that has an average size and can accommodate smaller classes for the regular teaching besides the individual and group classes and programmed or non-programmed study practice of the conservatory's students. It can also be used as a formal class for external use lectures or occasional external displays for a smaller audience or an additional single-time class. From the effective spatial fruition approach, it has been perceived that these spaces are in fact used in extra-curricular situations and very frequently for both programmed and non-programmed artistic practice, either in groups or individually. This has been supported by the focus groups information. Nevertheless, appropriation bears relevance for these spaces' effective fruition and the regular teaching students and teachers do not perceive these spaces as their own or the possibility of their use. So, the artistic students use these spaces in very diverse manners and often in very spontaneous activities, as well as all the upper floors' spaces, because they are mostly allocated to the conservatory, as they are acknowledged by these students as spaces that enable their spontaneous uses and informal appropriation. On the contrary, these are not used for formal nor informal regular events and activities, and it is the main hall that is mostly perceived by the regular students as a space for potential appropriation and study practice.

Similarly, the auditorium is a space that is very significant from a pedagogical perspective for the school and for the conservatory, but also for external uses and overall for the community and the city. It is a space that is in fact used in a very broad way, for diverse activities and not just artistic ones, but that holds great relevance as a music hall for international performances as well as a space for curricular displays. This has been stated by all the focus groups and also noticed from the observations. It is also an integrated space and with high entropy.

This is a space that is provided for specific performances, public displays and events with a large audience. Besides its acoustics and environmental comfort, it is also a large space in regard to its dimension that enables an audience and a stage from a configurational perspective. Its hard maple coating is very specific for acoustic purposes and it is also a very accessible space for the school community and also from the exterior, connected to the main hall and also with a specific entrance on performance days. This has also been noticed during the observations, when an international piano contest was taking place in the auditorium and international contenders were using it for practising and for performing, entering on the building by its specific entrance that is only opened in such situations.

From the focus groups and walkthroughs, contributors have stated the relevance of the auditorium for large displays. But for cost constraints and foremost for a more comfortable environment, either for the audience and also for the performer, the orchestra room on the upper floor was more frequently used than the auditorium if its intrinsic attributes allowed the allocation of the activities, according to the size of the audience and the spatial requirements of the events. Students and

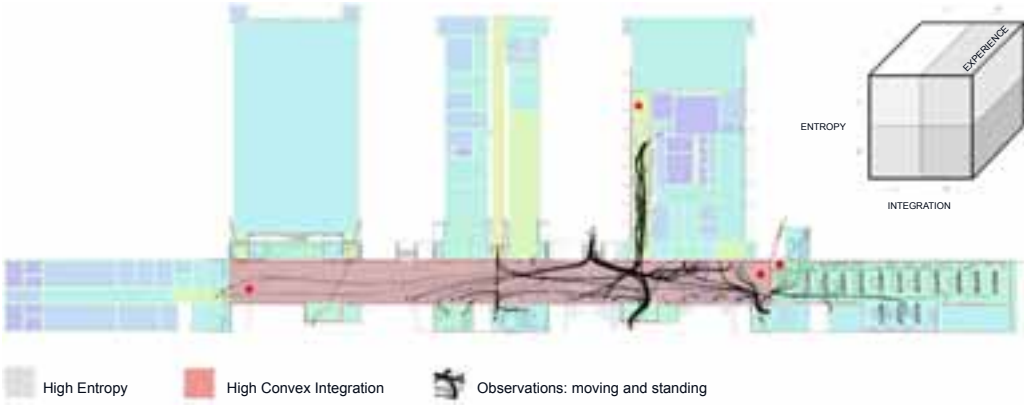


Fig. 296. Analysis of the correlations between
Integration, Entropy and Experience from the methodology
(Carolina Coelho)

teachers confirmed their preference in using the orchestra room, which they entitle more commonly as "small auditorium", to gather a class for a specific lecture, for welcoming an external guest, for smaller music displays and even for music evaluations and performances according to the size of the participants and the nature of the activity.

So, even if the entropy proves the auditorium to be highly adaptable, the effective use also considers the orchestra room to be of particular relevance as an adaptable space. In this case, the methodology has proven consistent in which the last approach, regarding effective use, has led to more specific and qualitative conclusion in the quantitative higher adaptability of the auditorium when compared to the orchestra room. So, in terms of adaptability, the two comprise high entropy and axial integration which is most correlated to entropy, but in terms of affective usage the last approach of the methodology has proven that the auditorium is in fact very representative and often used, but its ability to allocate smaller groups is not accomplished and instead these are accommodated, for cost and comfort reason, in a smaller space, also provided with soundproofing requirements.

All in all, the findings on every approach coincide with the choice of the main hall as the space with the highest diversity of activities and the main aggregator of users, considering it to be the most adaptable space, due to its physical attributes and to the high entropy results (Fig. 296).

It is a space with an adequate configuration for allocating activities and also as a circulation, in which students have been perceived to be moving from the exterior access to all spaces in the school but also longitudinally between indoor spaces. But it is also large in width and length to enable standing on benches and also around small tables for diverse activities, acting both as a high integrated convex

space and comprising some of the most integrated axial lines. Besides, from the analysis of its attributes it is also a space that is very integrated in the system, whose accessibly from the exterior is immediate and also highly connected to high entropy spaces such as the library, the auditorium and the cafeteria, which are spaces of common use, both formal and informal. It has network connectivity that enables the extensive use of technological devices, as noted during the observations and it also provides comfortable environmental conditions for standing there. So, all in all, the choice of intrinsic attributes provides it with an extensive allocational potential that is described in the feasibility matrix. Overall, its open configuration and also its width enable students to use it effectively as a common living space from which the school is deprived. Moreover, due to its accessibility it is also the space that is most used for external curricular displays and extra-curricular as well. The same reason justifies it as an interface and a meeting point for the students to engage in social interaction. Besides, the fact that it acts as a main circulation increases its effective use and thus, its potential as an interface and a space for knowledge transmission.

All these attributes are consistent with an extensive list of possible activities that this space may accommodate, and therefore, its uncertainty in which activities may be occurring there, determines its higher entropy in regard to other spaces, where there is more certainty on the activities' occupation and that, inherently, are more specific. Likewise, conclusions from the effective use's approach have also established overall the main hall to be the most adaptable to a wide assortment of activities for all the school community.

After a review on the most adaptable spaces from the building, as the ones that hold higher results when correlating integration, entropy and effective use, the focus will be on the main corridors and also the common living spaces and some spare spaces, for further development. Besides the main hall, the main corridors are also the most integrated even if their convex entropy is low. Still, these have high axial entropy, which is the measure with the highest correlation to integration. As previously concluded, and not intending to replicate prior remarks, axial lines are paramount for identifying and assessing adaptability because students move in pathways that can be comprised not solely by the corridors but also by very adaptable spaces, when both the pathways and standing spaces are gathered, either as a space that enable both, such as the main hall, or in axial lines that intersect the two. In these cases, the correlation between integration and entropy is higher, and so is the possibility of allocating more activities and users, and hence, the higher adaptability. That explains the high values of the main hall for all approaches and also its validation as an adaptable space from an effective use perspective, and also the axial lines' higher correlation when compared to individual spaces. This also concurs with the concept of active learning environment as a whole, that enables learning through an assortment of activities that are possible by separate spaces with that higher potential but also when those spaces are connected. When that connection is more

disaggregated, enclosing active learning in a formal and informal manner, through curricular and extra-curricular activities, programmed and non-programmed and for all teaching regimes, for moving and for standing, then the entropy of that axial line/environment overall is higher, and so is its adaptability in coping with activities of different nature where learning is the common denominator.

This is the case of the main corridors on the upper floors that are very integrated and, thus, that are central in the system. So, these are used for all as a pathway to reach specific spaces according to the users. Because these spaces are connected to common living spaces, as niches open onto the corridors that enable informal activities, non-programmed study, social interaction and also artistic practice, when the corridors are analysed as a whole with their niches, then their adaptability rises because together they represent a very integrated active learning environment that holds a large potential for allocating a wide array of activities. This frequent and diverse effective use coincides with the expected used from the design, because when the architect José Paulo dos Santos (2017) was asked whether the school brief could acknowledge the assets of active learning environments outside the formal classrooms and the possibility of learning on the corridors, the architect has confirmed it for its design of this school building, stating that:

> "I think this is recurring since ever. Students have always met outside the classroom, on the corridors, or in 'niches'. [...] In these spaces / rooms that come out of the corridors on first and second floors of the Conservatory hallway, the intention was for them to be used. Though on the ground floor the space is a passageway / of distribution and also of usufruct, of encounter."[857] (Santos, 2017)

This is quite relevant because it overlaps design and use, expected and effective spatial fruition, and it also demonstrates that active learning environments were assumed from the design as spaces that are possible to be considered externally to the classrooms and, cyclically, that learning activities were supposed to be undertaken on these spaces. Additionally, these spaces have a functional purpose, as the architect considers these niches as "spaces of release and that allow natural light and cross ventilation" [858] (*ibid.*), but they also complement with potentially standing spaces, the longitudinal configuration of the main corridors for its single function as a long moving pathway.

Moreover, because the configuration of these upper floors has a main corridor that

[857] Free translation of the original quote in Portuguese from the architect's interview: "Eu acho que isso é recorrente desde sempre. Desde sempre que os alunos se encontram fora da sala de aula, nos corredores, ou em 'nichos'. [...] Nestes espaços/salas que saem fora dos corredores nos pisos 1 e 2 da ala do Conservatório a intenção era que fossem usados. Conquanto no piso zero, o espaço é de passagem/distribuição e também de usufruto, de encontro." (Santos, 2017).

[858] Free translation of the original quote in Portuguese from the architect's interview: "Os nichos no corredor são espaços de desafogo e que permitem luz natural e ventilação cruzada." (*ibid.*)

connects to most spaces, then the more formal and programmed events are also connected to this more informal and social environment. So, the consideration of the environment as a whole, with the niches as common living spaces as well as the formal music studios near-by, enhances the simultaneity of learning activities, and broadens their nature and the array of users, ultimately increasing the adaptability of the school.

Overall, the high integration of both formal and informal spaces for multiple activities and their connectivity are essential to acknowledge the learning environments of a school with activities of different nature that all contribute to the learning process. This is particularly relevant in the artistic teaching because practising is very demanding and frequent and so, students resort to a wide array of possible spaces in the school building for studying, which can also be done individually or in groups. Music instrument practice can be located in more formal spaces such as formal music studios, which are very adaptable because they accommodate practice, lecture and evaluation, individually and in small classes. But it can also be undertaken in more spontaneous and non-programmed activities in the common living spaces near the corridors, particularly when these are highly integrated and hold a high visibility. If this is the case, students choose those spaces because they are interfaces for encountering their peers, ultimately potentiating group study and knowledge transmission or artistic improvisation and experimentation. But the fact that these are highly integrated also increases their adaptability, because students can practice near the classroom where their programmed classes occur, and so, practice and lecture, formal and informal, programmed and non-programmed and also individual and group activities can all be related, and spatially connected, as a whole learning environment. Therefore, it is concluded that the environment that gathers all activities is potentially more adaptable.

Besides, the more disaggregated the activities from an extensive list and the more diverse they are – in users, time frequency and in nature - the more adaptable the space that can allocate them. Even more so, if that space is considered as a whole gathering of several individual spaces, all with different learning potential and allocational purposes, because from the gathering of different nature spaces the more adaptable the learning environments to a wider assortment of learning activities. Their integration and connectivity overall enables that the spaces can be considered as a whole, for high local connectivity between them and higher global integration. From the effective fruition approach this has been identified as an argument that supports effective use, because students tend to use spaces with higher integration, where encounters and interface are possible, and they also tend to stay in spaces where interaction is possible and knowledge transmission can occur in between formal activities and therefore, these spaces are preferred when they are connected to formal classrooms and music studios.

Individually, the library and the main hall may act as active learning environments

per se, because of their large size, adequate configuration and proportion between length and width that allow moving and standing, but they also enable formal and informal activities, programmed and more spontaneous events, and because of their integration are very accessible and central spaces in the system.

Space syntax is paramount to support the understanding of these results, because it identifies the space's morphology that can be associated with the users' choices for activity allocation and the patterns of co-presence and natural movement in space. Actually, similarly to the surveys, the morpho-syntactic analysis has also identified the main hall, along with the main corridors as highly integrated, besides the library, the auditorium and the cafeteria.

General integration is therefore a determining factor for the gathering of a broader community, proven by the main hall as both a convex space but also by all the axial lines it comprises. Besides, its intensive effective use also validates it to be a space that caters for different activities with pedagogical potential and also a highly dense pathway for vertically accessing other floor plans, and longitudinally other spaces of the school, as well as transversally towards exterior spaces outside the central building.

Furthermore, the axial line results have proven to be more comprehensive for this particular brief, for comprising a set of convex spaces as a whole active learning environment. Hence, this process concludes that spaces with the ability to have both moving and standing activities, considered highly integrated convex spaces but also with high axial integration, are the most significant as active learning environments, as spaces of informal knowledge transmission amongst peers. This is particularly frequent in the corridors' openings that hold small staying spaces, highly connected with formal classrooms.

This leads to the conclusion that informal spaces bear higher pedagogical potential when connected with more formal ones, whose mean depth is smaller, because students lay in a more inclusive space, embedded with formal and informal, programmed and non-programmed activities, pedagogically facilitating their learning in several different situations and spaces, under the current learning approach. Naturally that spaces with higher mean depth only aggregate a smaller fringe of students that move there for more specific purposes, and are hence less aggregators of a more general student community.

Additionally, for this case study, appropriation enhances these conclusions, because the main hall is considered the most adequate space for holding extra-curricular activities such as external displays and also programmed and non-programmed events to showcase all the students' work in their many forms and from the diverse curricular options. The library, on the other side, also enhances informal activities and also social interaction more than a formal library comprises, which is understood by the conservatory's management, which also increases its adaptability in regard to

informal and non-programmed activities. On the lack of a common living room, both spaces play a relevant role either for formal activities and informal and social interaction, but all with learning potential, as diverse as it can be.

Naturally, that if the two are considered together, because of their high integration and connectivity, then it can be concluded that the ground floor is an active learning environment of high adaptability potential and that has been actually effectively proven by its effective spatial fruition and ultimately the appropriation of space by the school community that considers it their own and changes it for different events and situations. When this happens the school environments can be paralleled to the social construction of society recalling Bernstein's studies (1971, 1973, 1975, 1990).

Finally, this case study is considered to have adaptable spaces and foremost adaptable environments, which lead to its consideration overall as being adaptable to the very assorted activities that its extensive curricular options imply. For this school it implies the ability to change and to continue to cope with the changing requirements, which has been confirmed by the architect as being an initial account, in the recent interview conducted: "Teaching today is very rigid and normative, and in the future it may be less normative."[859] (Santos, 20017). Besides, the detailed conclusions achieved by the sequential procedures to assess adaptability coincide with the formal documents on the school regarding the main hall[860] and the library[861] as favourable spaces for effectively accommodating a variety of events from both teaching regimes that the rehabilitation of the school pedagogically implied, also agreeing with the architects' intentions and the original brief[862]. This associates design process and space use, possible activity allocation and effective spatial fruition, all as moments of the building's lifecycle for acknowledging and providing for adaptability.

[859] Free translation of the original quote in Portuguese from the architect's interview: "O ensino hoje é rígido e normativo podendo ser que num futuro venha a ser menos normativo." (Santos, 2017)

[860] "There is a great dynamism in organising scientific, sporting and cultural events, followed by exhibitions, musical demonstrations, dissemination of activities from the different courses and from the Student Association, among other initiatives, within the School hall." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.8)
Free translation of the original quote in Portuguese: "Existe um grande dinamismo na organização de eventos de natureza científica, desportiva e cultural, sucedendo-se exposições, demonstrações musicais, divulgação das actividades dos diferentes cursos e da Associação de Estudantes, entre outras iniciativas, no átrio da Escola." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.8).

[861] "The library is a large space, endowed with important material resources, and with a diversified interventions' project. The activities that it promotes, support curriculum development in the field of information literacy and in an extra-curricular scope, make it sought and valued by students and teachers." (*ibid*, p.9)
Free translation of the original quote in Portuguese: "A biblioteca constitui um espaço amplo, dotado de importantes recursos materiais, e com um projecto de intervenção diversificado. As actividades que promove, de apoio ao desenvolvimento curricular, no campo da literacia da informação e de âmbito extra-curricular, fazem com que seja procurada e valorizada por alunos e professores." (Delegação Regional do Centro da Inspecção-Geral da Educação, 2011, p.9).

[862] Full quote in English: "The brief proposed by Parque Escolar aims at providing Quinta das Flores Secondary School with functioning and comfort conditions compatible with the present and future times, as well as the integration of the music teaching within its campus." (Santos, 2008)
Free translation of the original quote in Portuguese: "O projecto proposto pela Parque Escolar visa dotar a Escola Secundária da Quinta das Flores de condições de funcionamento e conforto compatíveis com os tempos presentes e futuros, bem como a integração no seu campus do ensino da música." (Santos, 2008)

5. CONCLUSION

5.1. Revision of the concept of adaptability for contemporary school buildings

> "It is necessary to be constantly aware of what needs to be done before we can guide the changing pattern of training, and the task of research is increasingly to expand the scope of our understanding. […]
> What I am suggesting is that education should be directed towards a more concrete end. That end should not be an abstraction, such as the ideal conception of the architect, but the general problem of seeing the overlapping needs of living as a whole and opening up, whenever we can, new possibilities and choices for the future. That is an objective in which all architects should feel themselves vitally involved." (Martin, 1968, p.361)

This conclusion aims to recall the research question placed at the beginning of this Thesis and to reflect upon the study undertaken, in order to critically review the concept of adaptability and the possibility of its assessment under the proposed methodology.

This research proposes a methodology to identify and assess adaptability, particularly applied to artistic learning environments as the case study, for which it is particularly relevant. Krüger defined adaptability as: "the ability of the built form to maintain compatibility between activities and spaces, as those vary" (Krüger, 1981a, p.1169). Overall, this definition of adaptability is confirmed to be current and the concept of adaptability has been considered to better report this condition on contemporary artistic schools, by the increasing diversity of activities and spaces, technical requirements, variety and sizing, conforming with the need for spatial adaptability in regard to activity allocation.

Recognising that adaptability's literature recalls several authors, as it was noted on chapter 2.1.[863], and that it also carries adjacent concepts whose approach may differ or fluctuate between each one, this research considers Krüger's (1981a) definition as a current and adequate one in regard to the school brief and the contemporary context.

In fact, the Secondary School Modernisation Programme undertaken on Portuguese contemporary schools had the ability to rehabilitate the existing physical built spaces and provide them with an adaptive reuse process for coping with the learning

[863] See chapter 2.1. Adaptability: definition and adjacent concepts.

practices as they are perceived today. The case study of Quinta das Flores School, presented and justified in chapter 1.5.[864], has been physically and pedagogically rethought under the scope of this process, by the rehabilitation of the existing pavilions, as well as by the construction of a new building. This has been the case study in which the proposed methodology has been firstly applied, because it holds the common spaces shared by all the school community, it also accommodates formal and informal spaces for curricular and extra-curricular activities, either programmed or non-programmed, all bearing with pedagogical potential.

The choice of this case study is, hence, justified by its adaptive reuse process that recognises it as a contemporary school building with a pedagogically enriched curriculum that is also a reflection of a contemporary paradigm implying spatial requirements, which the rehabilitated school had to comply with under this modernisation process[865].

Therefore, adaptability is recognised as a very significant spatial feature, not only for contemporary school buildings, but particularly for this school that involves a wide array of possible subjects and curricular options, but also of extra-curricular activities. These comprise not only an extensive set of different student' profiles but also of ways in which to proceed with the curricular and formal classes and lectures and also with the study practices, external displays and non-programmed events this school has been noted to hold, as active learning activities that can be accommodated in several different spaces of this building.

Additionally, not only is the learning paradigm not foreseeable in the future, with such a variety of subjects and curricular profiles, but also how can it be undertaken and in which spaces. Thus, the need for considering adaptability is paramount to provide this school with the ability to still continue to cope with the upcoming social, pedagogical and physical needs, as unforeseeable as change can be. Therefore, adaptability as it has been understood, is considered as the suitable concept and its definition is acknowledged as contemporary and adequate, considering the high cultural, economic, environmentally sustainable, urban and pedagogical needs of the recently rehabilitated school building to still be compatible with future learning activities, in the ways these could be undertaken and recognising these may change in a not foreseeable manner, without future physical changes of large magnitude. This ultimately also resorts to another definition of adaptability from the 1970s by OECD (1976) that coincides with the first and that can be understood under its application onto this case study:

> " […] the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition in respect of either the constructional elements, services or the finishes of the building - essentially large magnitude/low frequency change." (OECD, 1976, p.10)

[864] See chapter 1.5. The case study.

[865] For the relation between the school building and the learning process see chapter 2.3. Adaptability for contemporary learning practices and environments.

5.2. Assessment and validation of the methodology

After a critical revision on the concept of adaptability in regard to the school brief and its representativeness towards the case study, the methodology to assess it can be validated.

As established from the beginning of this Thesis[866], it aims to identify and assess adaptability in school buildings and not to evaluate Quinta das Flores School *per se*. The aim of the application of the methodology has been to test it and to validate it when applying it to a school building, assessing the results provided between each approach and the potential correlations amongst them all. Therefore, after the application of the methodology to the case study in the former chapter[867], the conclusion of this Thesis will lie on the methodological approach between the early intentions and the end results. So, the conclusion will address the validation of the proposed methodology and its approaches on how to assess adaptability, particularly when applied to contemporary school buildings.

As seen on chapter 3.2[868], the state of the art on assessing adaptability particularly leads back to the 1970s. Then, models took a relevant role for adaptability, providing straightforward results for abstractly portraying a reality by the relationship of its variables. Echenique (1972) bears particular relevance for the state of the art on models in architecture, by "[trying] to establish some definitions to facilitate the building of a framework or model that will make the observation-description process useful and partial studies possible." (Echenique, 1972, p.164).

Considering models as a man-made construction they could be regarded as an "artifice" from Simon's (1996[869]) *The sciences of the artificial.* Artificial systems resort to techniques to reduce error and uncertainty in decision-making and to simplify the complexities of the external environment and the internal structure of the system. These are capable of simulation, namely through the simplification or abstraction of components and functions, or the simulation of the external environment in which they will enter and establish the interface, using models.

In the case of architecture, techniques for simplification are also ways to represent the existing and the solution, but especially they act as tools for thought and design. The architect must therefore know the internal structure of the building, but also the constraints and parameters of the external environment and the constraints and requirements of the brief.

The split into components in the architectural design process is also a way of inferring information from specific studies under a particular scale, that will have a more significant value as part of a whole, which is the building. Nevertheless,

[866] See chapter 1.4. Research objectives.

[867] See chapter 4. Application of the methodology in the case study.

[868] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[869] Consulted edition from 1996, original edition from 1969.

changes of scale raise questions on the design process and the sequential reference to all ideas that make it a coherent whole.

Fawcett's (1978) Doctoral Thesis, supervised by Lionel March, is a very significant contribution on literature's state of the art for a methodological approach for modelling adaptability, that responds to a "mathematical elaboration" (Fawcett, 1978, p.i.) on the probability of allocating activities to spaces and, ultimately, relating adaptability to a "quantified measurement" (p.54).

The approach to analytical frameworks represents a very relevant line of thought for architectural research mostly present in the 1970s. The forthright identification of the variables and the accuracy of the conclusions were goals when modelling the problems, which intended to surpass what was still considered previous "empirical" approaches on research questions. Therefore, assuming the specificity of this topic, it is significant to mention the previous studies undertaken on this matter, that were particular predominant in the 1970s, but also to review them on their potential contemporaneity or the way in which they could be transposable to the second decade of the 21st century. Even though these models were intended to act as a "working tool" (Fawcett, 1978, p.220), it is also relevant to conclude on the results sought at the time, and their significance and outcomes for today's learning spaces and learning process or, ultimately, for the architectural design as it is now perceived.

For our current Thesis, the context plays an important part in addressing and defining the patterns of activities and spaces. And if in the 1970s Fawcett reaches a "general theory of adaptability" (Fawcett, 1978, p.54) that is studied throughout his Doctoral Thesis in school buildings, because of the interchangeability of the spaces and activities in the timetable, today this research when applied to schools gains an even higher complexity and pedagogical relevance, as it has been justified earlier[870]. Although the British Ministry of Education had already recognised in 1957 the growing range of subjects and the consequent need for adaptable spaces in post-war schools (Ministry of Education, 1957, p.15), today the wide educational provision and the diverse curricular options for the students, introduce a deeper need for accommodating a wider array of activity states in the same physical and static spaces. Besides, not only have the subjects multiplied, but also the teaching procedures have been widened in the form of informal moments of knowledge creation and acquisition, in an also widened range of learning spaces in the schools. So, the pairing of activities and spaces has increased in terms of more spaces and spaces with different spatial features, and also more activities and a higher spatial demand from those activities.

Besides, the changing rate on activities, spaces, but also on the pedagogical curricula, boosts the changes in spatial requirements from people for whom the building has to answer through time.

[870] See chapter 1.5. The case study, and 2.3. Adaptability for contemporary learning practices and environments.

Information technology plays a relevant role in this change, because it influences the decentralisation of the learning process from the teacher and from the classroom, the alteration on the supports and methods of knowledge attainment, and also the spatial requirements for sheltering pedagogical activities.

So, besides introducing complexity in potential models of adaptability, the contextual variables regarding each case study on the schools' curricula, spatial features and community, will also constrain the approaches to this question. In fact, the scope of activities and spaces will have to be considered accordingly, recognising that each school has its own framework. Moreover, the dichotomy between formal and informal activities and spaces also introduces a determining factor which the methodology to assess adaptability today will have to enclose.

Furthermore, not only does the learning process take place outside the formal classroom, but it also can be accomplished outside the fixed spaces. "Learning in lines" and in "learning streets", most acclaimed by Hertzberger, has become a general assumption and a possibility of pedagogical potential.

Foremost, the wide possibilities of learning enhanced by a wider educational provision and learning moments, in which movement and informality are enclosed, carry subjectivity for the learning process, but generally for spatial fruition. Thus, individual specificities, besides general patterns of grouping populations will have to be accounted for.

This will identify adaptability not just as an abstract measure, but rather a closer one to the context, that potentiates encounters, movements and a broader spatial fruition, subject to quantitative and qualitative interpretation.

Lionel March (1998), in the *Environment and Planning B Anniversary Issue*, reviews the contributors and the contents of the previously published papers, whose inputs to knowledge advancement have been extensive in distinct areas of research. Inherently, Krüger[871] (1979a, 1979b, 1980, 1981b, 1981c) and his summarised remarks from his Doctoral Thesis at Cambridge, Fawcett[872] (1977, 1979a, 1979b) and his papers on activity schedules, Hillier's widespread works on space syntax (Hillier, Leaman, Stansall and Bedford, 1976) and Benedikt's (1979) studies on isovists, are mentioned for their work, along with different research subjects and approaches such as those of Stiny and Gips, Steadman, Cooke, Knight, among many others. March even admits his "bias" towards some to finally underline the relevance of all valid contributions:

> "From a scholarly viewpoint that imbalance is to be regretted. There is too little serious work being undertaken in architectural and design scholarship to be partisan." (March, 1998, p.12)

[871] "Mário Krüger brought together space syntax ideas and entropy maximizing in his study of built form and the urban system." (March, 1998, p.14)

[872] "The same issue contained a paper by William Fawcett on activity systems in schools, in which lattice theory was used to represent the problem. Fawcett also teaches at Cambridge and is a founder member of Cambridge Architectural Research, a consultancy which provides technical and computing support to some of the leading UK architectural firms." (March, 1998, p.12)

This assists to demonstrate that knowledge may advance before diverse inputs and study fields and, ultimately, that different research cultures may be reconcilable towards a common purpose which ultimately lies within architectural research.

On the paper *The man-environment paradigm and its paradoxes* Hillier and Leaman (1973) identify different theories and perspectives on the relation between "organism" and "environment", assuming their divergences. Yet, addressing that "the man-environment paradigm" cannot be understood in separate parts or "piecemeal" perspectives and implies the recognition of the whole, because organisms and environments are not "mutually exclusive" [873]:

> "There is no reason why the assumptions of man-environment mechanism should necessarily be taken over piecemeal as the conceptual apparatus of the subject, although this appears to be what has happened." (Hillier and Leaman, 1973, p.509)

For this current research on adaptability this is very representative and a clear support to the Thesis that has been constructed along all the previous chapters. Acknowledging adaptability involves introducing it in the brief, providing for it in the design and its fulfilment along the building's lifecycle. According to the methodology here proposed, it comprises the description of the built space, the description of its allocational potential and the description of effective spatial fruition. These are thus, different approaches that encompass different methodologies and procedures, whose gathering is intended to inform, in a comprehensive manner, the adaptability of that building and to demonstrate that adaptability is a feature that is impacted by different approaches from the design, to the activities bounded by the pedagogical curriculum of the school, by its management and by the community that appropriates space. All of these involve diverse methods to assess them but, when acknowledged in an overall methodology, the final results are potentially more informed and supported, depicting "the ability of the built form to maintain compatibility between activities and spaces, as those vary" (Krüger, 1981a, p.1169), in an extensive description of the building's physical ability, the list of activities and the possibility of change.

The gathering of different approaches to a common subject matter and to approach the same problematics is considered to be very significant and a relevant conclusion of this Thesis, which considers adaptability to be a common denominator for both analytical models and surveys on spatial fruition.

Recalling again March (1998, p.16), he states that analytical models can inform on the distribution of all possible patterns of movement and that those may differ from observations. He exemplifies this with the choice of route to go from a departure to a destination point, and explains that "an a priori distribution of trips" holds all possibilities that may be wider than the observed ones.

[873] "The fault is in the underlying paradigmatic notion of a division into a mutually exclusive world of subjects and objects, organisms an environments." (Hillier and Leaman, 1973, p.508)

Therefore, on the final conclusion of this Thesis, it is established that if the two approaches provide different outputs, namely of distinctive nature, such as figures and qualitative information, then its critical analysis and comparison is relevant to conclude on informed and comprehensive results that are supported by both. In the case of March's example, from all possible routes, an analysis on behaviour may inform on which routes are more frequent, and conclusions for space can be established regarding the overlapping of the partial results. This is what is intended with the space syntax, the entropy and the following effective spatial fruition analysis on the final systematisation of the results.

The proposed methodology has been supported by the identification of space use assessment methodologies and the specificity of adaptability assessment methodologies on the prior chapters[874] and reflected upon their contemporaneity and relevance for adaptability and for the specificity of this case study. Then, chapter 3.3.[875] explains in detail the construction of the proposed methodology in order to apply it in chapter 4.[876] to the case study. As the critical results of this application will be dealt in the following part of the conclusion, at this point the proposed methodology from chapter 3.3. will be crucially reviewed and validated.

By and large, recognising that the adaptability of a school building regards the community's uses on a more regular and collective basis and also on individual dynamics and appropriation, the methodology to assess has to acknowledge both. So, the concepts of *nomothetic* and *idiographic* used by Windelband in his *Rectorial Address* (1894) are here interpreted for identifying both the invariables of space use and the unique and context-defined events, which are considered to have been operative for the definition of the sequential approaches and to each one's individual assessment.

So, this methodology comprehends the *nomologic* approach to all uses that the spatial sample may enable under the scope of all possible activities that can occur in each space, to the effective spatial fruition that was expected to be closer to reality and to better depict the actual activities the space accommodates, on a *idiographic* approach to the assessment of adaptability.

In general, the proposed methodology embraces four milestones in a sequential application of the procedures each one involves, as such:

I. Description of the school space and how it supports activity allocation

II. Description of all possible activity allocations to educational environments

III. Description of effective events and experience in the school

IV. Description of the potential correlations and retrieval of the school's adaptability

[874] See chapters 3.1. Space use assessment methodologies, and 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[875] See chapter 3.3. The methodology for identifying and assessing adaptability in learning environments.

[876] See chapter 4. Application of the methodology in the case study.

The first milestone intends to describe the school space so that conclusions can be achieved on its functional and morphological description. For that purpose it describes the spaces according to their primary function and expected use as social and informal, formal and curricular and with the potential to be both. Then, it also describes the activities, as programmed and non-programmed and concerning circulation. Both analyses regard informal and spontaneous activities to bear learning potential and active learning environments potentially outside the formal classrooms. The attributes that have been provided in the design are also described focusing on: dimension, configuration, coating, networks, environmental conditions and accessibility, because they will weigh on the allocational potential assessed on the succeeding milestone. These partial results will impact the following approach on all possible activity allocations of that space prior described, to the activities listed in a feasibility matrix.

Next, under the same approach on the description of the school space, a space syntax analysis is undertaken, for convex spaces, axial lines and visibility, and for global and local measures, in order to provide results on its morphology, which can impact the patterns of movement and standing and also encounters and, ultimately, enhance or hinder space's use, either potential and effective.

The second milestone aims to describe all possible activities that can be allocated to space and resorts to the concept of entropy as a final result for this approach that can be paralleled to adaptability, as Fawcett establishes:

> "The pursuit of adaptability can be seen as maximising the looseness of the fit of the known activity schedule into the first-build physical schedule […] Thus the concept of entropy seems likely to be a very helpful tool." (Fawcett, 1976b, p.7)

This procedure comprises a series of stages that can be separately assessed but that finally reach the entropy calculations for all spaces considered. This involves a spatial analysis and a list of spaces and their main attributes conveyed from the initial milestone, but whose information is significant for the following stage. Then, an extensive activities sample is listed acknowledging the activities that can occur on those spaces. These activities are associated to spaces according to their capacity constraints, presenting a feasibility matrix that establishes the activity allocation potential of each space.

This also relates to Krüger's studies on maximising adaptability that accounts it to a combinatorial process of associating the activities and spaces with the highest number of possible matches on the feasibility matrix (Krüger, 1981a, pp.1171-1172).

These results can be interpreted *per se,* but further calculations lead to the entropy of each space, which encompass the construction of an allocation and a distribution matrix according to the degree of aggregation intended. Finally, the entropy formulation can be applied from the last matrix, in order to reach the final results on the spaces' entropy, which can be horizontally compared amongst each other and also vertically compared to other figures and data from previous or succeeding approaches of this methodology.

So, this approach ultimately relates adaptability to a "numerical value" (Fawcett, 1978, p.55) that could be subject of future correlation to other figures from prior milestones, but also of spatial qualitative interpretation from a precise and forthright outcome. This figure reports to the "absence of information or the degree of uncertainty"[877] (Krüger, 1984, p.1700) of an activity allocation to a space from the previous combinatorial process, which Fawcett entitles of "loose-fit" (Fawcett, 1978, p.27):

> "An adaptable design is one which allows the activities to take up a variety of states and which is minimally specific to a particular activity state. In this context the term activity state refers to a state of allocation, and the variety, or number, of ways of allocating the activities to spaces of a building can be considered as a measure of its loose-fit adaptability." (Fawcett, 1978, p.166)

This assumption, which is also taken to this current proposed methodology, approaches entropy to adaptability, as the uncertainty in the activity allocation to a space. Based on Krüger's and Fawcett's previously examined studies, these are considered to still be adequate for the consideration of adaptability in a contemporary context and also for applying it to the school brief.

As the previous space syntax analysis considers axial lines and convex spaces, so do the entropy calculations. Thus, after its calculation to individual spaces, the "axial line entropy" and the "average axial line entropy" have been originally studied, as an unprecedented form of approaching entropy to space syntax, which is particularly relevant in school buildings that, surpassing the concept of formal spaces or spaces circumscribed by their physical boundaries, consider learning environments where knowledge acquisition occurs. So, the introduction of these concepts and their respective formulae enable to calculate the entropy of each axial line previously identified and assessed by the space syntax analysis and to reach conclusions on the higher and lower values in regard to the individual spaces' entropy.

All approaches can be examined from a more general scale on the activities and spaces, to a more specific association of both. In fact, space syntax, the entropy analysis and the effective spatial fruition surveys range from a broader and more general analysis to a more detailed one that, in each procedure, aims at providing a more in-depth report on the adaptability of that particular case study.

[877] This embraces a more wide-ranging combinatorial process using macro and microstates that has been simplified for the purposes of the current Doctoral research in architecture that is already considered to hold mathematical procedures qualitatively interpreted, under the scope of architecture, for reaching significant results on this subject.
The full quote is here provided in English: "The determination of the most probable macrostate described in terms of the number of microstates associated to it is expressed, in statistical mechanics, by entropy, the absence of information or the degree of uncertainty. Thus, the most likely macrostate is the one with maximum entropy. Hence we can say that maximising the entropy of a system to estimate the most probable macrostate is the same as estimating it as a function of the maximisation of the number of microstates it contains." (Krüger, 1984, p.1700)
Free translation of the original quote in Portuguese: "A determinação do mais provável macrostado descrito em termos do número de microestados que lhe estão associados é expresso, em mecânica estatística, por entropia, ausência de informação ou grau de incerteza. Deste modo, o mais provável macrostado é o que apresenta entropia máxima. Daí podermos dizer que maximizar a entropia de um sistema para estimar o macrostado mais provável é idêntico a estimar este em função da maximização do número de microestados que o mesmo contém." (Krüger, 1984, p.1700)

SYNTHESIS OF THE METHODOLOGY

I. DESCRIPTION OF THE SCHOOL SPACE

Description of the school space and how it supports activity allocation

I.I DEFINITION OF THE SPATIAL SAMPLE functional analysis	. Spaces . Activities . Attributes
I.II SPACE SYNTAX morphological analysis	. Convex spaces . Axial lines . Isovists

II. DESCRIPTION OF *ALL* POSSIBLE ACTIVITY ALLOCATIONS

Description of all possible activity allocations to educational environments

II.I ENTROPY ANALYSIS nomothetic analysis	. Feasibility matrix . Convex spaces' entropy . Axial lines' entropy

III. DESCRIPTION OF *EFFECTIVE* EVENTS AND EXPERIENCE

Description of effective events and experience in the school

III.I OBSERVATION MATRICES **III.II WALKTHROUGHS** **III.III FOCUS GROUPS** idiographic analysis	

IV. DESCRIPTION OF THE POTENTIAL CORRELATIONS

RETRIEVAL OF THE SCHOOL'S ADAPTABILITY

Fig. 297. Synthesis of the methodology
(Carolina Coelho)

The entropy approach involves the construction of a feasibility matrix that has several domains in a tree-shaped scheme (Figs. 134 and 199), which introduces more detail in each one from the former. As this feasibility matrix associates the list of existing spaces from the sample to the possible activities that each one can shelter, the more exhaustive the list of possible activities, the more specific the analysis on the space and the depiction of its possible activity allocation. Furthermore, maximising the entropy of each space involves a further calculation using domains. It has also been determined that the choice for the scale of the distribution also impacts the results, because the more disaggregated the distribution, the more extensive the calculations, but also the closer these report to the actual feasibility of each space on that particular context.

Thirdly, from all possible activities that can be accommodated on that space informed by the functional and configurational analysis of the first milestone and associated to the feasibility matrix from the second milestone, the succeeding milestone describes what are actually the effective activities that occur in each space and overall in that school building. This approach also comprises a wider description of the results to a more specific understanding of the actual experience in the school. This entails this proposed methodology to range from the qualitative recognition of the uses and the most noticeable patterns of movement and encounters in space, to a more fine-grained analysis on single fruition and the variability these can have. If both are assessed, then the description of effective space use is more profound and closer to the actual context, critically reviewing the quantitative results previously obtained.

This milestone introduces three procedures that inform on general uses to more group-specific or individual fruition. Observation matrices on several spaces of the building describe general patterns of natural movement and the most frequent activities and associate them to spaces and time schedules, for the more representative time periods and during a meaningful number of days. Walkthroughs and focus groups describe more detailed and specific information on space use and provide feedback on adaptability according to the users within the groups, that are considered to be more significant to the school.

Lastly, a critical interpretation on the prior results is undertaken and correlations are made in this last milestone in order to compare partial results, to infer data on the overlapping of the higher and lower results and their association with the spaces, and to acknowledge correlations between the methodological approaches (Fig.297).

For this purpose, comparing both axial lines and convex spaces' results of both space syntax analysis and entropy calculations enables a straightforward identification of the higher and lower correlations and suggests a critical reflection upon the final results regarding spaces' configuration[878] and physical provision for activity allocation.

[878] According to Hillier and Penn (1991) configuration is defined as such: "Configuration is defined as being more than mere relations, since a complete account of relations can be given in terms of a series of dyadic relations between pairs of spaces. Configuration, however, is defined as, at least, the relations between two spaces taking into account a third and, at most, the relation between all spaces in a complex taking into account all others. In other words, configurational analysis must take account of many relations at once and express

Furthermore, if the latter provides quantitative information that can be followed by a critical qualitative assessment, the surveys for effective spatial fruition can also be paralleled to general behaviour, to prior information on the school configuration, or on the activity allocation, in order to achieve more general and comprehensive results.

This sequential process introduces Hillier and Hanson's (1984) "description retrieval" mechanism into two slip component: the description of the space and the activities in more abstract procedures, and the retrieval of the adaptability that their relation provides when applied to the case study as a "complex reality". This represents a subsequent process informed by the first but that can cyclically embody more abstract information to future developments (Hillier and Hanson, 1984, p.204)[879].

After reviewing the concept of adaptability and applying the methodology for which it has been proposed, then conclusions can be taken from the adaptability assessment and what does it comprise:

- **The acknowledgement of adaptability ranges from design to use**, throughout all the building's lifecycle. It involves an expected use from the architect and the actual spatial fruition from the built space, because it has to be considered from the design when providing the intrinsic attributes of the space to accommodate the future expected activities, under the expectation of a more extensive and lasting space use.

- Besides, **adaptability's actual assessment also ranges from the design to its use**. The first intends to describe those attributes and evaluate their capacity constraints towards activity allocation and the latter to evaluate whether they impact these initial design choices or whether they enhance the spaces' adaptability.

- **According to the definition of adaptability considered, it relates activities to spaces,** in regard to which activities can be allocated in each space, either in the present or in the future when change alters the expected or actual spatial use, and which ones effectively can or cannot.

- **The assessment of adaptability engages abstract models of the reality that describe a relation between variables,** in this case all possible activities and all spaces comprised in the sample. The more detailed the model, the closer this relation will be described and the more specific the results on the case study's assessment.

them in numbers. It is configuration that space syntax analysis seeks to express in numerical and model form." (Hillier and Penn, 1991, p.30).

[879] "Description retrieval is a process by which abstract laws are derived from real space-time events and are subsequently embedded into further actions." (Psarra, 2003 p.2)

- **Adaptability is approached to entropy** in the sense that its acknowledgement provides an outlook on the uncertainty of an activity allocation to a space: the higher the entropy, the higher the uncertainty, and ultimately, the higher the adaptability of that space. Because if a space has a wide range of possible activities to allocate, then the assumption on what activity is taking place is lower and, therefore, the more adaptable it is to multiple and diverse activities.

- **Adaptability also relates to effective spatial fruition** because from all possible activities that each individual space can accommodate, their actual allocation can be either narrowed down or enlarged by users when appropriating space, both collectively or individually. This implies that adaptability is socially and culturally constrained according to the fruition that each community endorses to the space and can differ between communities and individuals for similar physical attributes and allocational potential.

- **Providing for adaptability is providing for change** and the ability to accommodate that change, which is still unforeseeable. From the definition of adaptability, a highly adaptable space can cope with changing requirements and activities, which may differ from the expected use perceived in the brief and accounted for by the design.

- **Adaptability assessment ranges from broader approaches to more specific ones** and within each approach it can also be addressed from a more collective perspective to a more in-depth scenario. The more detailed the outlook the closer it will be to the actual case study.

- **This methodology considers adaptability assessment as a sequential procedure**, with different outlooks on space provided by study fields prone on approaches of distinctive nature, that can be triangulated for a whole, extensive and comprehensive information on possible and effective activity allocation to spaces and overall, on spatial adaptability. Also, the broader the approaches and its gathering, the more supported the results. Likewise, the more developed each stage, the more informed the final outcome on adaptability and the more extensive the possible correlations between partial results.

- **The proposed methodology for assessing adaptability acknowledges a triangle with three different approaches for describing the relation between activities and spaces, in order to finally retrieve the space's adaptability.** The methodology comprises the following milestones: I) Description of the school space, II) Description of all possible activity allocations, III) Description of effective events and experience. IV) The correlation between the approaches also demonstrates how do the former have weighed on the following, and generally impact the final outcome on adaptability as an overall outlook on the three.

5.3. Critical analysis of the results and potential future developments

For the practical application of this methodology, it was applied to a case study with a wider range of spaces and users, due to its innovative curriculum and deeper need for the space to be adaptable to the current diverse activity schedules and to the potential future changes the curriculum might have. Moreover, the fact that it had recently undergone a process of adaptive reuse may also add further data to this research. Nevertheless, the results encountered from each previous procedure, as well as the conclusions from the subsequent correlations, correspond to the application of the proposed methodology on the case study, and may possibly differ when applied to other schools with different morphology and curricular and extra-curricular activities. Hence, the correlation between integration, entropy and effective fruition may vary in buildings with different results on one or all of these approaches.

The end results relating to the actual spaces of the school have already been examined in detail in the previous chapter[880] and for the purposes of this Thesis and at this point, the conclusion will focus again on the methodological approach to adaptability, in order to conclude in a more holistic manner according to the initial objectives laid for this research.

Krüger (1992) suggests that two criteria should be considered for the building performance evaluation of complex buildings[881]: the study on cost/quality of adaptability regarding construction and maintenance, and an estimate on the circulations regarding the flows of people that these create. This estimate, when associated with spatial integration, might inform on non-programmed activities and the interface between peers and all users for knowledge acquisition (Krüger, 1992, p.10).

In fact, the proposed methodology in this current Doctoral Thesis takes up these two criteria, when assessing the spaces' morphology and ultimately spatial integration, and likewise identifies over-provision as a potentially enhancer of adaptability, but it also considers effective spatial fruition to conclude on its effective use and hence on the cost/benefit of introducing some physical features.

It has been recognised that the intrinsic attributes of spaces regarding dimension, configuration, coating, networks, environmental conditions and accessibility provide for specific activity allocations which lead to their individual entropy. Nevertheless, it has also been concluded from the entropy approach that after the allocation of around twenty possible activities to each space, its entropy tended to stabilise and so, the cost/benefit of introducing further attributes in order to maximise the entropy of a space was not significant as it was for the initial feasible activities on that space.

[880] See chapter 4.3. Systematisation of the results: Description of the potential correlations and retrieval of the school's adaptability.

[881] In this case particularly applied to higher education buildings.

The study on integration describes how the spaces are related and therefore, how is the allocation potential spatially displayed on the building and, finally, the study of effective fruition describes why and by what means are the spaces used. If a different assortment of intrinsic attributes describes different "thresholds of feasibility" (Fawcett, 1978, p.63), the gathering of different spaces as a whole - either by axial lines that comprise movement and standing, or as an environment[882] overall that can comprise learning activities of different nature - acts as general aggregator of activities and users and is hence, more adaptable to a wider range of activities with learning potential.

The outcomes achieved imply that there is, in fact, a correlation between all three procedures – the description of the school space, the description of all possible activity allocations and the description of effective events and experience - because the results sequentially complement themselves and also meet on the spaces with higher results from all approaches, conclusively considered to be the most adaptable.

These inputs have proven to be relevant for the adaptability assessment of space because the description of the spatial sample and its morphological features impact activity allocation and entropy. Additionally, effective spatial fruition acknowledges whether those intrinsic attributes cope with the actual spatial requirements and in what way and how far is the spaces' allocational potential effective.

The sequence of approaches has also been supported by the procedures, because it is only after describing the sample that its potential towards activity allocation can be perceived, when plotting the spaces' features to the activities' requirements. Besides, axial line entropy and average axial line entropy can only be calculated after the identification of the axial lines on the space syntax initial approach. Finally, effective spatial fruition identifies the spaces' potential uses from the entropy results to their effective appropriation that can be subsequent subject to comparison.

Furthermore, correlations have also been confirmed from an analytical manner with a critical reflection upon the results and also from a cultural, social and pedagogical point of view, supported by the literature's authors of reference, the specific knowledge on this case study and its effective acknowledgement from its actual living experience within space.

Analytical correlations were possible to be established upon compared values provided by individual results, from space syntax's morphological analysis and the integration (as the syntactic measure that best describes the space on that regard), with entropy results from the application of the entropy formulation.

[882] Hillier and Leaman (1973) define environment as follows: "Like most scientific terms the concept environment does not exist in isolation. It is part of a complex of ideas. Its most immediate neighbour is the concept of the 'organism'. Together they constitute the paradigmatic notion that realities involving living structures could best be looked at in terms of the relations between 'organism and environment'." (Hillier and Leaman, 1973, p.507)

As possible future developments on this methodology, other values could also be compared, such as local measures of space syntax as connectivity and mean depth, to the entropy of each space and possibly also for axial lines. Besides, intelligibility, assessed from the space syntax analysis and which informs how easily is the system perceived by the users, can also be correlated to entropy and critically reviewed when related to the input from the walkthroughs on the path chosen by each group. Naturally, other variables from each milestone of the methodology that have even been assessed in separate approaches, could be critically analysed in regard to the remaining milestones of the methodology.

However, the aim of these correlations has always been to assess space's adaptability, identify potential differences amongst floor plans and critically review them. Furthermore, these correlations are also intended to test the methodology and to analyse whether the approaches can be compared or if they add additional information regarding the space's adaptability. So, they have always been done with those very defined purposes and although other comparisons could be made, these are considered to resort to the most representative measures within each approach as the most straightforward manner to compare and validate the methodology and the separate results of its application onto the case study.

The correlation that has proven to be stronger is for the most scattered floor plan's layout, which is the ground floor, that has high individual values of integration, when correlated to entropy. When compared to the remaining floor plans, particularly with a more cohesive spatial distribution, the correlation is less significant and projects a more vertical distribution trend, which implies that similar values of integration of similarly located spaces on the system have different values of entropy, due to their specific functional purposes.

The correlation is also stronger for axial lines rather than for spaces individually assessed, because axial lines join together several spaces that become acknowledged as a whole. Hence, axial lines have been confirmed to hold particular significance for the school brief, because the building is interpreted as a whole system and this highlights the importance of the adjacency of the environments. In this case, the activities that occur on those spaces also bear relevance for the school building as a whole active learning system. As axial lines cross several spaces, their analysis brings further data to this research, because it refers to several potential activities in sequential natural movement for a time unit, thus gathering formal and informal activities and analysing them as a spatial and pedagogical whole. Besides, axial lines also provide data on "shapeless", informal and indeterminate spaces, rather than the formal and defined classrooms, that also hold pedagogical potential not to be neglected, but whose adaptability analysis was not in other ways as deepen.

Consequently, in terms of relating integration with adaptability, it is possible to conclude on the potential of learning in lines rather than in circumscribed spaces, much remembering Hertzberger "learning street":

> "There are school buildings where learning and instruction are not confined to the classroom, where there is as much going on outside the classrooms as inside […]" (Hertzberger, 2008, p.113).

This is in tune with the concept of active learning environments and reaches the highest correlation when the axial lines intersect spaces with different activity allocation possibilities in a more disaggregated array of activities from different domains of the distribution, associating formal and informal activities, all with pedagogical potential. Ultimately, these results value the school overall as an active learning environment, whose morphology and sequential layout play a relevant role towards adaptability and ultimate learning in the diverse ways considered today.

Thus, the gathering of both analyses – entropy and space syntax, in both approaches – convex spaces and axial lines – provides a triangulation of results that individually adds data to a general conclusion on a potential corresponding between entropy, integration and ultimately adaptability.

Additionally, this idiographic approach using observations, walkthroughs and focus groups has complemented the analytical approaches previously undertaken, in a whole, informed and more detailed acknowledgement of the school space, the living experience and, largely, the learning environments. This identified the actual occupancy of each space from a wide range of possible activity allocations listed in the previous entropy approach. This is the case of over-provided spaces that despite their physical ability to cater for diverse activities, when they are extremely over-dimensioned they are not actually chosen for accommodate them on behalf of cost-efficiency, but also of physical and emotional comfort. This concludes that high entropy can be associated with lower spatial feasibility by individual appropriation and management.

However, spatial fruition has also enlarged the allocation potential of some spaces from the prior results because, by appropriating space, users may change its expected use. This has actually been remarked in this school, particularly for the more spontaneous and creative students of the artistic teaching profile, often for informal music instrument practice that may occur in several different spaces of the school, according to each students' preferences and routines.

Additionally, physical provision regarding furniture itself and its arrangement, devices, environmental comfort and lighting conditions are also spatial features that condition spatial allocation bounded by individual preferences on the choice of space to be in regard to others, associating design options to effective use, namely for informal and non-programmed activities.

Therefore, spatial fruition and appropriation have proven to add further information on the building and its adaptability to accommodate learning activities, as diverse as they can be considered. Another conclusion taken from this reported situation is

that adaptability is socially and individually constrained and not only a product of the building's physical provision.

So, the individuals, the groups and also the management, in a more formal and official manner, may condition the activities allocated for a space or, on the other hand, enlarge the spaces' possibilities in regard to spatial happenings. This is particularly relevant for informal and non-programmed events that are currently part of the pedagogical curriculum and a relevant part of the learning process on contemporary schools, particularly in artistic ones, as perceived, because these kind of uses have been more openly expressed by the artistic students rather than the regular ones.

Two remarks may therefore be taken from this: the fact that the profile of the community that uses the space determines the frequency of informal activities, their density and their allocation, which could be more or less expectable. Secondly, according to this community's choices, activity allocation may not be related to better spatial provision or morphological integration, but also be subject of individual judgments and personality preferences, which might weigh more in the decision-making process of choosing a space to practice or to engage socially.

High connectivity to formal spaces and high axial and visual integration in the system are potential triggers of encounters and assets that also weigh on the choice of space to stand, either in groups or individually, for programmed and non-programmed activities. Furthermore, from the observations, the spaces perceived as the densest for natural movement and informal standing are also the most integrated spaces in the system. Ultimately, this correlates space syntax and integration to spatial fruition and experience, and can even provide more detailed information of specific uses or specific users' rapport to space from the more general observations to the more distinctive comments from each focus group and walkthrough.

The connections between these three approaches have also been understood socially and pedagogically, because the third one of the procedure does not involve quantitative data possible to be compared analytically. It provided conclusions based on the drawings, sketches and recordings of spatial effective use and users' feedback on space that can only be assessed in a qualitative manner and then compared to the quantitative outlooks from the previous stages. Still, and as already explained, it has achieved similar results regarding the main hall as the space considered to be most adaptable to different situations and activities, but also other spaces with high entropy have been identified such as the library, amongst others.

The stronger correlation with a more disaggregated and specific distribution for the entropy milestone of the methodology can also be paralleled to the effective spatial fruition procedures that start with observations regarding the most frequent

movements and activities, to a fine-grained analysis of behaviour in space by resorting to walkthroughs and focus groups. This sequence of procedures involves a sequentially more in-depth detail on the activities that the space can accommodate and that the space effectively holds, that can finally reach more specific conclusions, such as the ones regarding differences by floor plans, different uses according to the contributors on the focus groups, and foremost the activities not immediately associated to spaces, but that by appropriating space occur within them.

After the correlation of the results from the three approaches, it has been found that the most disaggregated distribution from the entropy calculations provided higher correlation to integration. This is very significant because this is the distribution that involves an enlarged detail on the activities and so, the one which better depicts the actual case study in a less abstract way.

So, for the purposes of future developments on this methodological approach to adaptability, the feasibility matrix could also be specifically approached in its following applications. The fact that correlations between entropy and integration are generally stronger for a more disaggregated distribution, as was the case of domain IV's when compared to domain III's distributions, leads to the conclusion that the more extensive the activities sample on the specificity of the activities listed and the more widespread the domains for calculating entropy, the closer it describes the actual case study, but also the higher the complexity of the calculations of both the entropy and the following correlations.

Therefore, revising the feasibility matrix and the degree of disaggregation of the distribution for the entropy approach could also be considered in regard to possible future developments of this methodology and the case study in which it will be applied or the main purposes of that application.

So, future developments lie naturally on the application of this methodology to other case studies. That could be established for the purpose of assessing another artistic school individually, or compare it to this current case study that, as it has been noticed, is very singular on the curricular options it conveys. Others could also be assessed in order to understand their spatial differences and uses when compared to an articulated teaching regime school such as Coimbra's, where the regular and the artistic curricula communities share the common spaces of the building. This school, as already recognised, implies a more adaptable requirement of the spaces that need to cope with both teaching regimes' spatial needs and which are specific of either one, in regard to formal but also to informal activities.

This school has also proven to have an intense appropriation of informal spaces prone on non-programme social or extra-curricular activities, as a frequent routine that is embedded with learning potential. Not only do the corridors bear the representativeness of an interface for the gathering of the peers or all the users,

but so do the niches open onto those corridors, which functionally enable cross-ventilation and lighting, as the architect (Santos, 2017) has explained, but that also act as convex spaces for standing, complementing the corridors' circulation and enlarging their learning potential. Both corridors and niches, when thought together represent active learning environments for moving and standing that are very significant for the students' social interaction and even study practice, as it has been observed. Furthermore, the fact that these are very integrated in the system, as the space syntax analysis has proven, determines that higher integration and connectivity between informal learning environments and formally established spaces, such as classrooms, embodies an even more enriched environment with a more diverse nature of the learning activities and that ultimately gathers more users in a conjoint space perceived as a whole.

Therefore, as studied throughout the application of the methodology to the case study[883], this school holds a high need for adaptable spaces to cope with different activities, curricular and extra-curricular, programmed and non-programmed, in which the latter are also very significant for the learning as it is understood today, as a creation of knowledge that surpasses the sole knowledge transmission within the classroom, to informal spaces and activities between peers that hold a more active and independent student profile, as seen on chapter 2.3.[884]. This is very noticeable in this school, particularly for the artistic students prone on spontaneous displays and study practice wide-spread throughout all the school space.

Thus, other artistic schools could also be assessed, particularly regarding the comparison with other conservatories, or to buildings whose spaces are separate between the conservatory and the school. At first, the need for adaptable spaces exists, but along with the spatial segregation of the teaching profiles comes also a potential segregation of users and activities and hence, the need to cope with specific requirements will possibly lie only on each teaching regime and not on the congregation of both on the same spaces. Still, the application of this methodology to integrated teaching schools could possibly support this immediate idea with the actual results brought with the methodological application.

Moreover, even for this particular school in which the methodology has been firstly applied, can the methodology be operative again. In fact, if this school could hold a future physical or pedagogical intervention, the application of the methodology regarding the association of activities to spaces according to the changes carried on by that intervention could be assessed, identifying whether the building is continuing to cope with those social, pedagogical and spatial requirements or not.

Finally, this methodology could also be carried out in regular secondary schools,

[883] See chapter 4. Application of the methodology in the case study.

[884] See chapter 2.3. Adaptability for contemporary learning practices and environments.

individually or in a collective manner, if applying it simultaneously to a set of schools in order to conclude on the most adaptable. That conclusion would naturally bring further information on whether it is the activities that are less site-specific or spatially demanding that can be allocated to several spaces, or if there are spaces that can accommodate a wider array of learning activities. Besides, as it has been understood on the final retrieval of the final results on the Quinta das Flores School[885], the final adaptability outlook on the school is subject to the building's configuration and physical provision, the briefs and the activities it shelters as widespread as they can be, and is also subject to individual and collective appropriation and management options. Naturally, if the methodology was to be applied to several schools and different outcomes would be achieved, than the assessment of individual results on the schools would bring further information on how did they differ and why, and whether those differences impacted the final adaptability of those schools or not. This ultimately, represents the "description retrieval" mechanism that is assumed to cyclically bring more generalised outcomes from a previously studied reality.

All in all, the outcomes aimed to be achieved may also lead to future developments of potential future applications of this methodology. A more or less extended and comprehensive procedure is guided by the cost/benefit balance on the time consuming and intricacy of the methodological application and the final detailed results obtained. In fact, as it has already been explained, each milestone initiates with a more general outlook on the space and reaches a more in-depth acquaintance, which can be adaptable to several situations and objectives according to the number and nature of the future case studies and the objective of future researches.

Specifically, the results will be more or less extensive and time consuming or in need of more or less people to undertake them in future research projects, depending on: the introduction of specificities of other schools onto the activities listed on the feasibility matrix, or on the degree of aggregation of the domain by which to calculate the entropy; the more or less detailed morpho-syntactic analysis; and even the number of contributors, focus groups, spaces and schedules to proceed with the observations.

Accordingly, further applications of this proposed methodology could use a more abstract matrix of activities to compare several schools' adaptability, or could use the same one to compare other schools with both artistic and regular teaching regimes. All in all, it is acknowledged that further developments could be perceived by introducing the specificities of other schools if applied to them, or in a more general manner, using a less disaggregated matrix by restricting it to the initial domains, could be done in order to compare several schools in a less detailed way.

[885] See chapter 4.3. Systematisation of the results: Description of the potential correlations and retrieval of the school's adaptability.

Conclusively, this research considers that high adaptability enables a wider variety of social relations and inhabitants, potentiated by the attributes introduced in spatial design and the spaces' morphology, but it also considers the users and their spatial fruition to define the effective potential variety of social relations in space and, in this case, of activities with learning potential, in their wide array of contemporary possibilities. Ultimately, this reports to an early assumption by W. R. G. Hillier, in a conference in 1969 on *The people/artifact interaction*:

> "There are some interesting differences between the 'physical system' and the 'experience system'. In the first place, the physical system is subject to normal process of entropy (the tendency towards disorder or formlessness), in that it decays if it is not subjected to a programme of action aimed to prevent this.
> The experience system does nothing of the kind. Often its tendency seems to be in the opposite direction. Once basic stresses are removed, a given physical system, partly through action on it, and partly through adaptation in experience itself, becomes an increasing source of life enhancement by becoming a tangible framework for associations, social relationships, memories and perhaps also a very fundamental kind of stability." (Hillier, 1970, p.28)

Hence, adaptability could be understood from design to space use and overall throughout all the building's lifecycle, because it is the intrinsic attributes accounted for during the design that provide the building with the physical ability to cope with the activities and the more diverse these activities are, the more adaptable it can be to changing situations and circumstances.

The need for adaptability is perceived during the building's use, overlapping what is its ability to cope with the activities, to what those activities effectively are at that moment, and how they might change in the future. This justifies this methodology's sequential approach in subsequent milestones: from the morphological description of the building as it has been conceived by the architect in the design, to the allocational potential that the design provides, to its effective spatial fruition and the identification of how and by what means is the space being used. So, it correlates design and use, under adaptability as a building's feature that impacts its lifecycle and the life within it during that time[886].

From the beginning of this Thesis a research question has been presented[887] which has guided the methodological approach to adaptability, the contents to inform on its state of the art, the nature of the approaches that inform the proposed methodology and its application onto a case study, considered to be an original

[886] This ultimately also justifies the title of this Thesis.

[887] See chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

choice, representative and adequate for this research:

> By acknowledging that, from the current pedagogical practices derive the current spatial requirements of the schools, which influence the learning process, how is the concept of *adaptability* defined in the secondary schools of the 21st century, and how can it be considered throughout the building's lifecycle – translated into the design process and enhancer of the spatial usage?

As the conclusion of this Thesis, it considers to have answered this question, which will be examined in detail and responded overall at the end. Current pedagogical practices and their rapport to space have been approached on a specific chapter[888] that intended to project that bond between space and learning as a stage but also as a potential enhancer of the activities, formal and informal, that it could hold within a school and that bear significance towards the teaching-learning process.

This bond between space and social form in "places of science" has been approached by Hillier and Penn (1991) in the paper *Visible Colleges: Structure and Randomness in the Place of Discovery*. This is applied to "visible colleges" as defined by the authors as: "the collective places of science, the places where the "creation of phenomena" and theoretical speculation proceed side by side" (Hillier and Penn, 1991, p.23)[889]. Nonetheless, it is argued that space holds a "social logic", insofar as "social encounters have their own spatial logic" (p.27):

> "To understand their spatial form, we must understand first how buildings can structure space to both conserve and generate social forms" (Hillier and Penn, 1991, p.23).

The relevance of adaptability towards this bond has also been explained regarding spatial provision with the ability to cope with the potential changes on the learning processes, spaces in which it is considered to occur and the practices and contents to convey, in the present and in the future.

After a wide-ranging approach to adaptability in school buildings in the past and how has it been materialised in the built space and by what means[890], regarding the evolution of the learning practices and the spatial implications, the following chapter intended to approach the contemporary learning practices, focusing also on the concept of active learning environments, potentially exceeding the formal classroom to other more informal spaces, not necessarily bounded by definite walls but bearing learning potential as places for knowledge acquisition, creation and communication between peers. Naturally that this bears relevance when considering

[888] See chapter 2.3. Adaptability for contemporary learning practices and environments.

[889] Hillier and Penn recall Hacking's (1983) "creation of phenomena".

[890] See chapter 2.2. Adaptability in school buildings: approaches for growth and change.

school space today, in the sense of what are the spaces in which learning activities could be held and what is the broad nature of those activities.

Having recognised the current practices and the considerations of educational spaces, from the acknowledgement of several potentially closer concepts to adaptability and also several definitions of adaptability *per se*[891], it is regarded as a spatial feature that supports that bond even further, because it bestow on space the ability to cope with the changing activities with pedagogical potential within a school.

After the identification of the concept of adaptability and how could it be translated onto the school brief and the contemporary context, the following chapter intended to also provide an also explanatory outlook on approaches to space use[892] and particularly to adaptability assessment[893], in order to critically review their potential application onto the proposed methodology and context. Recognising that these study fields and approaches are widespread and have been tackled differently by distinctive authors, naturally that the previous chapters aim to provide an outlook on diverse manners so that the proposed methodology could be supported and enriched by an informed process of research. Nevertheless, and recognising that this Thesis displays a broad array of contents and authors, its aim is considered to be clear and these are presented with the purpose of contributing to inform on the Thesis's specific approach to adaptability, applied to the case study, and particularly to a methodological approaches on how to assess adaptability in a contemporary school context and not to overly detail each contribution to the state or the art, neither on the concept of adaptability, nor the adaptable schools of the past, nor on the possible assessment methodologies.

Chapter 3.3 proposed the methodology to be applied to the contemporary school brief, considering the previous information on how the school is perceived today and what it comprises in terms of activities, spaces and users. It also involves the previous research on the concept of adaptability taken from chapter 2[894] and the possible methodological approaches to assess it from chapter 3[895].

This methodology conceives adaptability as a spatial feature to be thought during the design process, for the definition of the building's configuration and relation between spaces, which is assessed by a morpho-syntactic analysis by space syntax. It is also during the design that the building is initially provided with the intrinsic attributes that define its ability to allocate activities according to each one's spatial requirements.

[891] See chapter 2.1. Adaptability: definition and adjacent concepts.

[892] See chapter 3.1. Space use assessment methodologies.

[893] See chapter 3.2. Adaptability assessment methodologies: reviewing previous approaches.

[894] See chapter 2. State of the art and critical revision of the concept of adaptability.

[895] See chapter 3. Construction of the methodology.

Then, adaptability is assessed on the potential it has regarding activity allocation and on the degree of uncertainty on which activity is occurring in space, that is higher if the space can allocate several ones. This is assessed by means of a feasibility matrix and entropy calculations and resorts to analytical models to derive the adaptability of each space from the sample, considering adaptability as a relation between activities and spaces.

So, as the previous models are naturally abstract, despite their potential degree of specificities that can approach the case study with more detail from the abstract model, then adaptability is also assessed during effective spatial usage. So, the third milestone of the proposed methodology comprises the assessment of the effective spatial usage, in order to compare it to all potential activities that the space can initially accommodate and that have been perceived from this former milestone, this will conclude on its narrowing or enlargement, as it occurred in Quinta das Flores School.

In fact, the application of the methodology has shown that activity allocation is subject to individual and collective appropriation, besides management decisions, which could associate activities to spaces not initially remarked from the feasibility matrix. This is due to the profile of the students that this particular school holds, who were perceived to be very creative and resourceful during the observations, walkthroughs and focus groups. Furthermore, these students have shown a sense of belonging in the school that also enables this more spontaneous appropriation of spaces, because they feel it as their own, being at ease to choose where more informal and non-programmed activities are held, often related to study practice, external displays and artistic performances, and that have been noted in all of the school's ambiance from the classrooms to the corridors.

Indeed, the concept of *ambiance* plays a very significant role in artistic schools because it confers music to the whole school. The ambiance also enables the acknowledgement of the learning spaces as learning *environments* prone for the teaching-learning process and surpassing the individual spaces. The spread of the artistic practice throughout the school is also a matter of the design option, which in this case has deliberately provided soundproofing between the classrooms for their acoustics performance, but that projects the sound laid within the classrooms for the very central corridors, where all the school community circulates, engaging them by music. Besides, also management is accounted for the artistic milieu, because of the options to enable socialisation and a rather informal environment on the common living spaces.

From spatial provision to student appropriation, adaptability is encompassed by a widespread range of stakeholders on the process and moments to acknowledge it. Therefore, so has to be the methodology to assess adaptability, intending to assess it in all the moments that bear significance for the definition of adaptability in that

space. If adaptability is provided in the design and is experienced on the spatial occupancy, potentially also defined again by the appropriation, management and pedagogical and cultural options that guide space use, then the methodology has to be involved in all those moments, individually assessing the results for a final gathering of them all.

This coincides with the research question, when it joined the design process and the spatial usage by adaptability and stated adaptability as an *enhancer* of spatial usage. This also has been stated from the fact that adaptability enables the activities to be accommodated: if activities are wider in nature and undertaken by different users, even when these change, an adaptable space can accommodate them in their diversities and specific requirements. Thus, an adaptable space enhances the building's use for longer, for a broader set of possible activities to occur on that space and by diverse users with different profiles and appropriation, which has been remarked between the regular and the artistic teaching communities.

Therefore, adaptability is in fact, and as the research question put it, "considered throughout the building's lifecycle", because it is considered in the design process and it continues to be assessed throughout its use, before all the changes that the school can have and that can pedagogically or culturally change the spatial requirements of the activities, for which adaptability is considered to be resilient.

By and large, adaptability's assessment is a conjoint process that relates all the moments of the building's lifecycle, the people/contributors involved in the definition of space and what does it contain in every moment. So, study areas and methodological approaches on each of these bring a specific outlook on space, that ultimately can be triangulated for a more supported assessment of the building. It is a comprehensive thinking about the space's lifecycle, the people involved, the activities to be held and the potential changes that might come, in which adaptability is acknowledged from the beginning, but continues to play a relevant role in providing for the people and for their actions continuously and in a lasting, pedagogically, culturally and functionally performance for the changes that are unforeseeable at the design.

This research also concludes that the hypothesis placed at the beginning of this Thesis, after presenting the research question[896], have also been recognised as supported and valid throughout the Thesis. Consequently, the definition of adaptability is considered to still be appropriate, suitable and contemporary when applied to the current school brief, as this conclusion has started by clarifying. Furthermore, and according to what has been stated, adaptability involves the design process as a moment for providing for adaptability and the space use that it enables, and it also enhances the building's ability to shelter activities, even if they

[896] See chapter 1.3. The research question: Adaptability as a form of engagement between Architecture and Life.

have changed from the expected to the effective spatial fruition.

Besides, the methodology proposed and applied to the case study is recognised to be robust in the three initial milestones that it engages for providing information gathered from different procedures and whose overall results is, thus, more informed, unbiased and comprehensive for the triangulation of methodological approaches it involves and for the critical review it entails in the final milestone on the building's adaptability retrieval. It is also considered to be adequate to the school brief on its contemporary acknowledgement and it specifically recognises the activities and the spaces that the current learning process engages. The final outlook on adaptability that the methodology provides can be considered valid and, as it has been examined in detail, the potential correlation between the milestones enable to identify what impacts adaptability and this can be operative information to future designs embracing change, space use, appropriation and management, as variables that weigh on adaptability. Recalling the initially proposed general and also the specific objectives and the specific objectives regarding the approach on the case study[897], these are embedded in this conclusion's final outlook on the research and are also considered to have been answered.

Overall, as it had already been established at the beginning of this Thesis, this methodological framework is expected to be a contribution to knowledge advancement, identifying adaptability in this particular contemporary context and combining distinctive study fields for its assessment. Also, for the practice, the acknowledgement of the spatial configurations with higher representativeness towards adaptability can be informative to future designs, but foremost by informing on the variables that potentiate adaptability. It does not aim at providing design guidelines or any rigid design solutions, which are considered not to cope with all these variables. Indeed, if the methodology has proven that adaptability is not a product of the design provision but also of appropriation, then the physical attributes are relevant for potentiating an adaptable building, but its effective use may change according to the context and the community who uses the school. So, as adaptability is verified also by effective spatial fruition, this methodology intends to recognise both design and use as variables that impact adaptability and recall that adaptability might change within the same design if it is used by another community, with a different pedagogical curriculum or another students' profile.

So, this methodology intends to identify the variables that are associated to adaptability and that influence the overall results and the ability of the building to accommodate those changing activities, by resorting to approaches of different nature that may ultimately inform on the diversity of those variables and on their final potential correlations.

[897] See chapter 1.4. Research objectives.

It is highlighted that the aim of this research is a methodological approach to adaptability that enables its identification and assessment for contemporary school buildings. Therefore, not only does it aim to be a contribution to the practice of architecture, while informing on the variables that enhance adaptability to be potentially recognised in the design process, but it also intends to act as a relevant contribution to the academia. As it regards milestones with different approaches, then it relates all of them to adaptability and amongst each other for the final retrieval of the results.

It is also noteworthy the originality of the overall methodology towards entropy and its sequential processes such as the feasibility matrix, the distributions for the calculations, the estimation of the average and axial line entropy and the correlations presented and critically analysed, besides the actual results from this case study. Besides, also the possibility of their association with spatial fruition and the use of observation matrices, walkthroughs and focus groups for the assessment of spatial use in the school, under a closer approach to the context and the real scenario, is also an original methodological approach and it concludes that adaptability involves both realms of study.

Therefore, the analytical models are associated with fruition and experience in a gathered methodology that holds design and use. So, abstract models and quantitative results are interpreted with qualitative information on individual and collective behaviour in space. This is intended to be a contribution to the different studies fields within architecture and for the academia overall, acknowledging that different research cultures can be associated and, when associated, provide more robust and complete results.

Therefore, as this Thesis's objective has been clearly placed onto a methodological approach to adaptability, then it is naturally informed by many study fields and authors, for an original methodological proposition that is considered to be contemporary and that originally also assembles in a comprehensive manner different research cultures. Its originality lies also within the subject matter of adaptability when applied to school buildings and naturally, even more so, when it is specified for the artistic schools and the Portuguese reality, for a more a critical comprehension of what is around us. Recalling again Nuno Portas' quote from a communication at the Department of Architecture of the University of Coimbra, for the Doctoral Course, in October 2011:

> "Research has a lot to do with the context, it is not a sum of events, it has to create complicities, it has to show that it is useful." [898] (Portas, 2011).

This research, as contemporary as it intends to be, has been embedded by its context

[898] Free translation of the original quote in Portuguese: "A investigação tem muito a ver com o contexto, não é uma soma de acontecimentos, tem de criar cumplicidades, tem de mostrar que é útil." (Portas, 2011).

on rethinking the current learning paradigm and how can spaces enable it. In 1968 Leslie Martin in his paper *Education without walls* was discussing that growth and change, urban development and land use had to be accounted for when considering an education building:

> "We recognize new forms of teaching and study these in the closest detail. We then build as tightly as we can around this. We can, of course, by this process build in and make permanent a particular educational pattern which itself is liable to change. And by this process we frequently complicate the technical method. The point to be recognized about programmes is that there can be no detailed programme for the future." (Martin, 1968, p.360)

Amongst several considerations, Martin recognises change, the unknown urban patterns of growth in the future and the also unknown programme of education, particularly for universities. Martin discloses that research has to consider them, opening new prospects. The initial quote used in this conclusion has recognised the need for the architects to be aware of the "new possibilities" and to be engaged, so these are studied and understood as opportunities:

> "What I am suggesting is that education should be directed towards a more concrete end. That end should not be an abstraction, such as the ideal conception of the architect, but the general problem of seeing the overlapping needs of living as a whole and opening up, whenever we can, new possibilities and choices for the future. That is an objective in which all architects should feel themselves vitally involved." (Martin, 1968, p.361)

This involvement with the contextual needs and changes and the engagement in the reality has also been very deeply embedded as a motivation for this Thesis and as an objective to contribute to the knowledge advancement in architecture, recalling Portas: "to show that it is useful" for the reality surrounding us, which involves architecture and to which architecture has to answer. Leslie Martin has recognised that in 1968, assuming change and the need to consider it in the architects' education, and also the specificity of the changing education, that was becoming an emergent subject to which architecture had to answer:

> "At the level of actual building, the consideration of the framework within which we build could open up new opportunities and new objectives." (Martin, 1968, p.361)

Moreover, when addressing future change, Martin assumes its lack of anticipation and its unpredictability:

> "A starting point in any planning for growth and change must be, I

> think, that no one can accurately predict what that change will be. It is the developing use that will cause change to happen and will establish its areas and its extent." (Martin, 1968, p.360)

Consequently, Martin considers that "to build for a variety of uses in the variety of forms that these will demand" represents "a new set of priorities" (*ibid.*). Under a close agreement with the recognition of providing "for a variety of uses" as a "priority", this Thesis restates its relevance when applied to its case study on a contemporary manner with a critical review from previous considerations, such as Martin's 1968 paper.

This Thesis is recognised to be explanatory and wide-ranging, but with a common denominator that leads to the end conclusion on the validation of the proposed methodology. It is informed by the wide-ranging literature on the definition of adaptability, on the broad possible space use assessment methodologies and followed by the application and testing of the proposed methodology that has been produced in abstract to a real case study, in order to be validated to future developments. This has been the guideline of this Thesis, embodied in the table of contents and which intends a very definite goal, acknowledged from the beginning and supported in the conclusion. It has also been informed by a widespread literature of reference, critical thinking in regard to its adequacy and contemporaneity to this context and to the brief, and supported by the actual practical application of an extensive methodology on a real scenario. Overall, all these procedures enable to consider the methodology informed, valid and potentially able to be applied to other case studies.

It also resides in the assumption that those research cultures that it engages could be intertwined for triangulated results and not biased to a specific approach, author or perspective. But foremost, its originality is represented by the methodology that has been constructed from scratch, all the associations of the sequential processes on each milestone and the correlation of the several milestones, in order to produce a methodology that specifically responds to the subject matter and is applied to the context under study.

Consequently, this proposed methodology aims to be well-defined, supported by the previous studies on the state of the art on this issue, but carrying the specificities of contemporary school buildings, for activities, spaces and spatial fruition towards the learning process. It also intends to provide valuable results to inform on that school, for future interventions, as well as potential management decisions later on, but also to other schools as input to report to the architects when thinking about the school brief. So, all things considered, it does not aim to be analytical nor qualitative, but to consider a reality that is complex and whole. It is intended to simplify it so it is possible to analyse it without over-complexity, but likewise, to recognise the variables to identify that particular school space and to portray that particular learning environment.

The approach to the context has been pursued in each milestone. From the description of the spatial sample in its specificities, to the establishment of an adequate list of activities that is correlated to the identified spaces from the sample and also to the evaluation of effective spatial fruition according to the more representative focus groups for providing feedback on space use and the choice of spaces and schedules.

Naturally, that all approaches can be more or less extensive and specified according to the cost/benefit brought by the results and also the purpose of each research. For the purposes of this current research, it was intended to provide an assessment of the case study's adaptability that effectively depicts the space, its users and the activities that can be, and effectively are, held in space. Nevertheless, its extensiveness and detail have also been balanced with methodological options that enable the research to feasible, supported and effective, and that could be undertaken under the scope of a Doctoral Thesis, in regard to an individual work that deals with a wide set of variables, from the time consuming procedures, to the need to arouse the involvement of others as contributors, particularly to the surveys approach and the formal authorisation of all the people involved and Direction boards or other entities. On the other hand, the more analytical approaches that are accomplished by means of models, also require an adequate modelling of this case study. The end results provide a specific description of the space's adaptability in regard to the activities that it holds and has the potential to accommodate later on, supported and focused, and not overly widespread in partial results, in an adequate scale of detail for the results intended.

Recalling Fawcett's first sentence on its Thesis summary: "The relationship between activities and spaces may be analysed at many scales" (Fawcett, 1978, p.i), we also acknowledge different levels for assessing adaptability, in its relation to people and spaces, and we also aim for a methodology neither "deterministic" nor "empirical" (*ibid.*). Nevertheless, within an inclusive approach, this current research does not only aim at the connection between "activities" and "spaces" as Fawcett's, but foremost its relationship to "people" - whether in a more general grouping (as Fawcett considers them), but also as individuals that relate to activities and spaces in a specific sensorial and intellectual relation, when occupying space and undertaking each of the identified activities[899].

Consequently, it is here assumed the relevance of the combinatorial ensemble as a methodology that enables general, prompt and accurate outcomes. But besides the inputs from a mathematical elaboration, also the combination of inputs from other study fields, more prone to the social sciences, provide a more comprehensive outlook on "the social logic of space" (Hillier and Hanson, 1984) and will displace data from a broader range of dimensions on "the living experience" and the spaces' features, that will consequently produce a more extensive outcome on understanding

[899] See chapter 1.2. Motivation and background: Architecture and Life - conceiving forms of engagement.

people's relation to activities and spaces, as a whole and as individuals.

People modify spaces and it is the people that undertake the activities identified. So, they become the subject and the object of the research on the allocation of spaces to activities: they are the common denominator and the main character. This connection will become evident from the design of the space itself - the spatial, material and functional conditions that it provides - to the management decisions, and the engagement of the inhabitants to the space, which determines the formal and informal activities on each space, previously envisioned by the architect, as Fawcett had already put:

> "An adaptable building allows many alternative states of allocation. This type of problem is relevant to building management as well as design." (Fawcett, 1978, p.i)

So, this current research would add that it is the people, by management decisions and their own appropriation of the space, that confirm a *lived* building, functionally and culturally along the building's lifecycle. Recalling Cowan and Watson's[900] (1961) quote from *The Architects' Journal* in regard to the significance of bond between architecture and people for architectural education:

> "Buildings begin with people. Architecture should not be a formal or production-derived solution imposed upon the users, but a growing together of human needs and the industrial equation. Somewhere a synthesis occurs; at this point stands someone – call him architect or what you will – reconciling not leading – creating not directing – not an amateur of other disciplines, but a profession in this task. As our knowledge of human physiological requirements deepens, creative design becomes easier. The multi-disciplinary team is the organisation, research is the tool, and science the discipline which will push our vocation forward in the second half of this century. Buildings end with people." (Cowan and Watson, 1961, p.744).

[900] Peter Cowan and Newton Watson at the Bartlett School of Architecture formed a panel with other contributors from different schools.

BIBLIOGRAPHY

SPECIFIC BIBLIOGRAPHY

. BOOKS AND PUBLICATIONS IN BOOKS

. PERIODIC PUBLICATIONS AND ARTICLES

. PUBLICATIONS REGARDING ARTISTIC SCHOOLS

. PUBLICATIONS REGARDING THE CASE STUDY

GENERAL BIBLIOGRAPHY

PERSONAL PUBLICATIONS

As presented throughout all the corpus of this Thesis, the overall research derives from an extensive scope of contents, because precise bibliographical references on adaptability in contemporary artistic school buildings are scarce due to their specificity. Nevertheless, this also supports the originality and the contemporaneity of the research and its potential relevance towards knowledge advancement within the discipline of Architecture.

Therefore, this Thesis derives from diverse established fields of architectural research for a more supported and comprehensive approach, transposing them onto this approach and considering their potential in order to answer the main research question of the Thesis.

Thus, distinct areas have been recognised as relevant to inform this subject matter, namely: new teaching practices – and the way they impact the space in which they happen; contemporary educational facilities; the state of the art on schools and specifically on artistic schools - as a way to document the case study; adaptability and particularly focused on adaptability in schools - as a way to report the evolution of this concept; space use evaluation processes and space use evaluation processes on schools - as a way to analyse experience and uses that take place there; literature related to experience with the built space and also to analytical approaches on use. Despite being from specific study areas, these contents are believed to be interrelated by this research and to inform it, in order to produce a more inclusive, informed and unbiased outlook on the matter and to acknowledge its general significance.

This wideness in scope is also present on the broad time frame that the following references comprise, with a particular emphasis on literature on schools and also on adaptability's state of the art. Besides, contemporary literature is also extensive, particularly on teaching practices and on the bond between educational spaces and knowledge transmission, which again proves its current relevance.

Thus, assuming that this subject matter introduces contents from different areas that seek to convey the concept(s) of adaptability with the spatial needs of contemporary schools and spatial assessment methods, this explains why the bibliographical references presented in the following pages are recognisably extensive and widespread.

Accordingly, it was considered relevant to present the bibliography by dividing it into *specific* and *general* bibliography. Where the first refers to contents that were specifically introduced in the Thesis throughout its development under explicit chapters on those issues, and the latter lists more general references, which are related to the research question overall and present an awareness towards issues concerned with use, appropriation and the bond between design and experience on more general terms.

Although it was pondered not to divide the bibliography it into possible sub-themes on different reference areas, because of its variety and also the acknowledgement that they are implicitly related, the specific references are subdivided on *books and contributions in books* and *periodic publications and articles in periodic publications*, due to its difference in nature and format. Besides, and assuming that references on artistic schools are scarce, the bibliography has a section that lists all the publications consulted on *artistic schools* and another on the *case study* itself, which is very specific.

At last, the *personal publications* produced during the process of this research are also presented, proving the academic interest and significance of this issue by peers in a wide scope of academic communities and contexts, such as Space Syntax, Formal Methods in Architecture, Sensory Environment Research and Mathematics and Architecture.

Finally, the following list presents the references in APA style (American Psychological Association). It was chosen to present the full bibliographic list rather than just the references quoted in the text because, for the purposes of this Doctoral Thesis, the information used lied not only on the cited works, but also on a broader list of works, books, chapters in books, academic works, periodic publications, … that have comprehensively informed the contents previously presented as implicit knowledge and not just the ones which have been quoted.

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https://www.bartlett.ucl.ac.uk/space-syntax

The Bartlett UCL
http://www.bartlett.ucl.ac.uk/graduate/programmes/postgraduate/mscdiploma-advanced-architectural-studies

11th International Space Syntax Symposium, Lisbon
http://www.11ssslisbon.pt

10th International Space Syntax Symposium, London
http://www.sss10.bartlett.ucl.ac.uk

Post-occupancy evaluation
https://postoccupancyevaluation.com

Center for Building Performance and Diagnostics
http://www.nsf.gov/pubs/2002/nsf01168/nsf01168u.pdf
https://soa.cmu.edu/cbpd/

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