

## **Immersing into Architecture before Architecture:**

The potentialities of Virtual Reality as an architectural representation

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*"leap and the net will appear"*  
- Professor Julio Bermudez

The image presented in the cover of this dissertation is an edited version by Ana Moreira Bento from the original image: *Diagram extended field of vision* (Herbert Bayer, 1935), retrieved from: [www.opusklassiek.nl](http://www.opusklassiek.nl).





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Pergunto-me, quantos arquitetos se terão perdido por não saberem desenhar?

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## **A b s t r a c t**

The objective of this dissertation is to characterise and explore the potential of Virtual Reality (VR) in Architecture. At a technical level VR is seen as a type of architectural representation for architecture designs. When looking at the application potentials that VR brings to Architecture, four different directions were identified: a way of assessment and verification of the designs, a way to preserve architectural heritage, a way to create VR architectural fiction environments and a way to develop virtual portfolios for architects. The development of this last point, led to a draft H2020 proposal for creating a network of VR-labs, at an European scale, that would stay under the management of the architecture schools. This proposal will allow the organization of VR architectural exhibitions, which will take place simultaneously in all the VR-labs across Europe. The impact that may be achieved with this proposal has been identified as the following: increase the efficiency for sharing new architectural solutions and trends inside the European Union (EU), closing the relation between architecture schools and the European public and also to give Architects a faster access to the EU market, with particular relevance for young Architects.

**Keywords:** Virtual Reality . architectural representation . architecture schools .  
VR Laboratories . immersion





## **R e s u m o**

Esta dissertação tem por objetivo caracterizar e explorar o potencial da Realidade Virtual (RV) na Arquitetura. A nível técnico, a RV é entendida como um tipo de representação arquitetónica para o projeto de Arquitetura. Sob o ponto de vista das potenciais aplicações que a RV traz para a Arquitetura, quatro diferentes direções são identificadas, como: uma possibilidade de aferir e verificar o projeto, de preservar o legado arquitetónico, de criar ambientes arquitetónicos fictícios e enquanto possibilidade para arquitetos de poderem desenvolver portefólios virtuais. O desenvolvimento deste último ponto levou à apresentação de um projeto, enquanto possível proposta de submissão ao H2020, ambicionando a criação de uma rede de laboratórios, à escala Europeia, que ficasse sob a gestão de escolas de arquitetura. Este projeto permitiria a realização de exposições de Arquitetura num formato de RV, que teriam a possibilidade de decorrer simultaneamente nos vários laboratórios de RV da Europa. Os impactos que poderiam ser atingidos e que foram identificados com esta proposta são os seguintes: aumentar a partilha de soluções arquitetónicas dentro da União Europeia, estreitar a relação entre as escolas e o público Europeu e facilitar o acesso dos arquitetos ao mercado Europeu, com um enfoque particular sobre os jovens arquitetos.

**Palavras-chave:** Realidade Virtual . Representação arquitetónica . Escolas de Arquitetura .  
Laboratórios de RV . Imersão



## **Introduction**

The evolution and expansion of Virtual Reality (VR), in the recent years, have placed VR as a serious potential contributor to Architecture. Taking this aspect into account, this dissertation constitutes an attempt to systematise the impact of VR, as a type of representation in Architecture and to assess the development in the relation between VR and Architecture.

The opportunity to be involved in the subject of this dissertation had its origin in an internship at the Finnish VR laboratory of SeAMK, under the ERASMUS+ program, during the summer of 2014. In the scope of the internship, a three dimensional (3D) digital modulation of the *Lotta Svärd museum* (1924-26) designed by Alvar Aalto was performed intended to be displayed in a Cave Automatic Virtual Environment (CAVE) from SeAMK. In the scope of this internship there was an opportunity to autonomously learn a computer-aided design (CAD) software, ArchiCAD. The work developed during the internship was recognised as a case of interest and an article was written on the Finnish magazine ArchiMAD (Bento, 2014).

This was a first experience to get in contact with VR and to evaluate some of its potentials. Various contacts were established during that period with technicians and architects interested in VR, with significant relevance for the research work under the scope of this dissertation. The motivation for this dissertation was raised from this experience, along with the following question: What are the potentialities of VR as a representation tool in Architecture and how will they evolve?

The approach to this work started from a broader observation, recognising a need for systematise the understanding of this subject, given its extension and the lack of a clear definition, which is related with the fact that it is not yet a well-established area inside Architecture. Along the development of this dissertation it started to become clear, as it is disclosed, a more focused and synthetic perception of this subject. The contact with different contexts that has been established during the research phase, is present at this dissertation.



The information analysed was extensive, with diverse contacts being established, contributing to the awareness of the complexity involved in this subject. Besides, the viewpoints about the subject have diverged according to the different positions that have been experienced – as a student of an architecture school and as an intern in VR lab. All these aspects have demanded a comprehensive and coherent treatment of the subject unfolding the analysis in two levels.

Therefore, two general objectives had instigated the development of this dissertation. The first was integrated in a descriptive analysis, and intended to understand the technical contribution to Architecture from the specific characteristics of VR. The second was an interpretative analysis, where hypotheses for potential applications are assessed, pursuing the expansion of that contribution. One of those hypotheses was the possibility to introduce VR as type of representation in architecture schools.

In order to develop these objectives, beyond a bibliographic research, there was the need to develop also a field research. The approach followed consisted on collecting the opinions of students, professors and technicians about the relevance of VR, in the context of architecture schools. The research was based on various case studies - six schools and also the two architecture offices that were visited in two different countries - that were the reflection of the contacts established, stressing the necessity to analyse the real practical impacts of VR and to comprehend its practical implications, as a type of representation for architecture. Therefore the different contexts experienced and the contacts already established, justified the choice for those case studies, as part of the research developed under the scope of this Master Dissertation.

Apart from this main document was also created another one, named as: *Appendix of Immersing into Architecture before Architecture: The potentialities of Virtual Reality as an architectural representation*, that contains all the information collected during those visits. This research was carried out on six schools of Architecture in Finland and Portugal, based on interviews to professors and inquiries for students. The schools of Architecture visited in Finland were: the Oulu School of Architecture - University of Oulu, the School of Architecture - Tampere University of Technology and the School of



Arts, Design and Architecture - Aalto University. In Portugal there were visited: the Architecture Faculty of the University of Oporto, the Architecture Faculty of the University of Lisbon and the Department of Architecture of Sciences and Technology Faculty of the University of Coimbra.

In order to complete the aims of the field research, also extra interviews, previously scheduled with professionals of the area of VR and architects, were accomplished. The visits included the first Finnish architecture office, which has adopted the use of a CAVE in the methodology of their work: *Uki Arkkitehdit* from Oulu and a Portuguese architecture office that uses HDM in their work: *18:25*, from Lisbon. One VR Laboratory (VRLab) in Seinäjoki, a Research Centre in Helsinki, were also visited.

The research carried out in the three public schools of Finland took place during a one week dedicated journey. For this reason, there was one single day assigned to each of the three schools. In order to follow this same methodology, this procedure was also reproduced in Portugal, in three public schools that were related with a personal motivation. The journey to Finland was made in April: Oulu's school on 13th April, Uki Arkkitehdit and VRLab on 14th April, Tampere's school on 15th April and Helsinki's school and the Research Centre on 18th of April. While, the Portuguese schools were visited during June: Oporto's school on 3rd June, Lisbon's school on 8th June and Coimbra's school on 9th June. All these visits were made during the academic year of 2015/2016.

Each visit aimed at non-scheduled interviews to professors and also an average of ten surveys per student from each academic year - from the first to the fifth. In the first approach, interviews were attempted to be scheduled by e-mail. Although, given the absence of replies, this turned out to be an inefficient way. Instead, a direct approach to the interviewees revealed to be more efficient and therefore became the chosen method to be applied in every school. Students and professors were picked randomly inside their schools, namely in the libraries, canteens, computer's workrooms, design project's room, auditoriums, offices and some other places inside the school. As an introductory approach they were asked whether they could be inquired about some questions on Virtual Reality





and it was noticed a greater resistance by professors than by students. Altogether 316 student surveys and 12 interviews to professors were achieved.

All the information that could be collected along this research work, bibliographic and the one resulting from the field research, was systematised and structured in accordance to the scope of this dissertation and it is presented in the following way:

*An intersection point: Architecture & computer science*, appears as first chapter, with *When Architecture meets computers science*, *One more tool for representing* and *Represent(action)* as the subchapters, where VR starts to be presented from a technical position, as a type of presentation in Architecture.

In the second chapter, *An action point: Virtual Reality*, the characteristics, evolution and proliferation factors of VR are presented along with the systematization of its contribution to Architecture. The four subchapters: *Beyond the keyboard and the mouse*, *Experiences with VR devices*, *Spreading and evolution of VR* and *Four fields of approach* discuss the potentialities of VR beyond the other types of representation and the last subchapter, starts a conceptual position, systematising the contribution of VR to Architecture. Different directions are pointed out, in this subchapter, as opportunities in Architecture: *Technical verification and validation of the design through VR*, *Preservation of the Architectural Patrimony through VR*, *Creation of virtual architectural environments through VR* and *Creation of architectural portfolios through VR*.

Finally, in the third chapter *A new point: a proposal* it is expanded this conceptual approach, developing one of those directions pointed out on the previous chapter. This last chapter is divided in three subchapters: *From the idea to the field research*, *From the field research to the project* and *The European VR lab network project*. A draft of a project proposal is presented, envisioning the creation of VR labs inside architecture schools across Europe. The project is interpreted as a possibility to evolve the contribution of VR to architects and future architects.

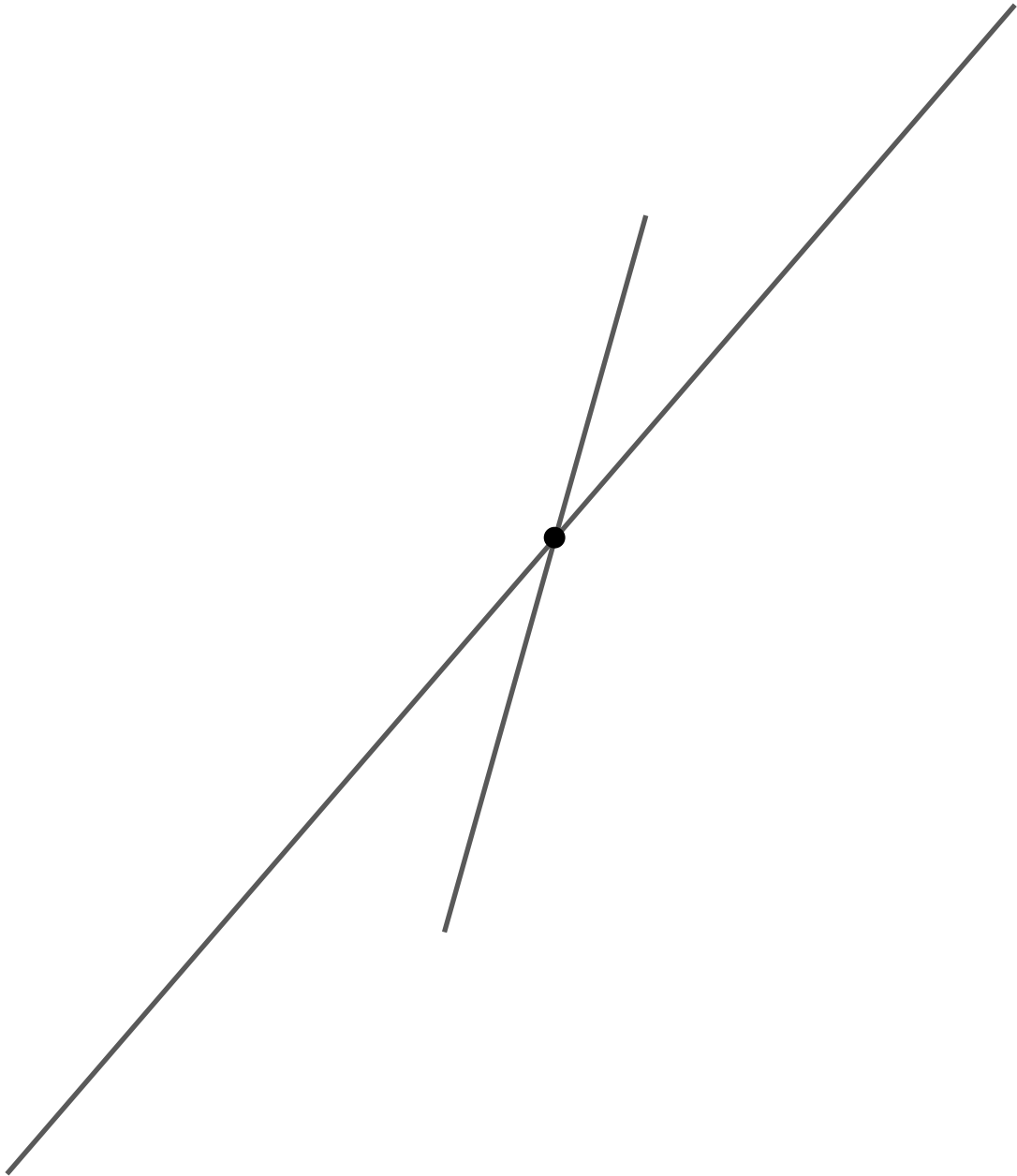
It makes part of a personal motivation to write a document in English language, which aspires the maximum visibility of the addressed contents and that reflects the engagement



of diverse identities in the scope of this work. For this reason, the citations from the Portuguese interviews were translated to English, while its original version is presented on inserted footnotes.

This document is written following the bibliographical norms from the American Psychological Association (APA). It is written in English language, as used in the United Kingdom.





# 1. An intersection point:

Architecture & computer science

Je suis un



Figure 1 - Set of shots from the film *L'école de Siza* from Richard Copans and Stan Neumann

Source: [https://www.youtube.com/watch?v=6Tg\\_RiKIRPo](https://www.youtube.com/watch?v=6Tg_RiKIRPo)

## **When Architecture meets computer science**

As one of the oldest professions, into the academic scope, Architecture went through centuries of evolution, intersecting other areas, absorbing their novelties and also attending to its own development. The discussion of this dissertation is settled in one of those intersecting moments as an opportunity to reach other directions in the Architecture scope:

[...] This is essential: every architect is forced to provide answers to functional problems. But Architecture, with a capital A, begins when the development and the project attain a capacity of freedom. Free of all constrains, able to take flight and develop in other directions. (Siza, n.d.)

From those intersections with other areas - as Engineering, Anthropology, Archaeology, Geology, Mathematics, for instance - rises the opportunity for architects to be sensitive to numerous aspects. This might contribute to complete and enlarge its field of action, giving him autonomy and interdisciplinary and also promoting other ways of thinking and developing Architecture. The results from those relations can be observed either in the architectural design or in the physical structures *per se*.

This dissertation lays on one of these confluent points that Architecture shares with other area or discipline, intending to discuss the potentialities of VR and the evolvement of its contribution in the scope of Architecture. To pursue this intention it is necessary to identify the origin of this relation between Architecture and VR. In this sense, a preceding event of intersection between Architecture and computer science constitutes a triggering event for this relation, as it will be exposed in this first chapter.

Since the relation is currently happening, therefore still wide and vague, there is the opportunity to analyse its developments and to identify some of the resulting benefits. In first place, there is the need to understand which factors have influenced and promoted this connection between them, in order to realise the pertinence of this joint.





Before the digital revolution, Architecture was essentially based on hand-made and physical representations. A very tight association between Fine Arts and Architecture could be established, since there was only the possibility of a close physical relation between the artisan and the produced artefact. The hand-designing of plans, sections, façades and axonometries was - and still is - not so far from doing paintings and drawings. Producing models may not be far from producing sculptures either. The difference is the purpose of that production, which in the case of Architecture is assigned also to technical requirements. Models and drawings make part of the technical language of the architect. In Portugal, architecture schools of Oporto and Lisbon were once integrated in Fine Arts schools, for example. With the introduction of the digital into Architecture, promoted by computers, other way of representing the designs appeared. Therefore a different type of relation between the architect and the representations turned up, revealing other method of production, less physical, more intermediated by interfaces. In 1979, in Lisbon and Oporto, Architecture went apart from Fine Arts schools seeking an independent position. Curiously, that event is coincident with the proliferation of computers and their commercial purchase.

Shortly, the evolution of computers provided various possibilities into the Architecture scope and one of those was the generation of VR environments. Therefore a linear description about the origin and developments of computer is not the purpose of this dissertation. Some events and figures will be detached in order to illustrate the contact established by architects with computers, justifying the introduction of VR as a possible contribution for the work of the architects. Digital revolution promoted the origin and development of VR and at the same time expanded the representation tools in Architecture. Computers influenced and promoted this connection between VR and Architecture, therefore a few moments about it must be identified.

One of those events happened in the year 1941, a seminal mark of computing science with the conception, for military purposes, of the first computer in History- *Colussus* by Alan Turing (Alesso & Smithaut, 2008, p.174). Several upgrades were made to these new devices and along the years it has gone beyond those purposes. Already in the 1950s IBM



Figure 3 - Ivan Sutherland on MIT Lincoln Labs' TX-2 computer  
Source: [www.designworldonline.com](http://www.designworldonline.com)



Figure 2 - Timothy Jonhson designing with CAD software  
Source: [www.designworldonline.com](http://www.designworldonline.com)

started to deviate from this military origin, developing computers for commercial purposes (Alesso & Smithaut, 2008, p. 85). This opened a new field of opportunities where companies like Intel and Apple, among others, had emerged. Some ideas about the potentialities of this equipment were discussed in avant-garde coteries where some architects were included (Feijão, 2011, p.7). In 1959, the Mechanical Engineering Department and Electronic Systems Laboratory of the Electrical Engineering Department of MIT were jointed in a project promoted by the US Air force named “Computer-Aided Design” (Alesso & Smithaut, 2008, p. 37). Ivan Sutherland was a PhD student of MIT and even though he did not make part of that project, he gave a tremendous support to it (Yares, 2013). Sutherland submitted his thesis in 1963, as a description of his work in creating a program named *Sketchpad*, which is recognized as: “one of the very first interactive CAD systems” (Yares, 2013).

*Sketchpad* was an interactive program that enabled the possibility to draw directly from the screen of the computer, using a light pen and some input buttons. This program was thought by Sutherland to be extensible, and shortly after his creation Timothy Jonhson presented his Master thesis as a 3D version of it - *Sketchpad III*. (Yares, 2013) Almost at the same time Lawrence Roberts launched *Sketchpad 3D solids*, which included sets of solid and real-time meddling. (Yares, 2013) About this advances Genevieve Greenwald-Katz said that this program “made it possible for the architectural designer to input pictorial data into a computer by drawing on an electronic tablet.” (Greenwald-Katz, 1976, p.315). Considering this aspect, in 1964 it was held by the First Boston Architectural Centre Conference, a discussion with the theme *Architecture and the Computer*. The first approach of the architects to computers started before any notion of designing with one (Abrahams, 2013, p. 2). Therefore these issues were more discussed than actually applied into the architectural scope.

A striking moment of intersection between Architecture and computers took place in 1967. Under the direction of Leslie Martin, was founded the research centre of the Architecture Department of Cambridge University the *Centre for Land Use and Built Form Studies* (LUBFS). Lionel March, director of LUBFS, encouraged by Martin,

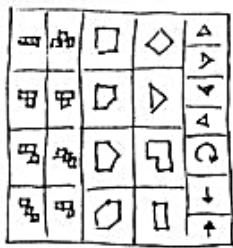


explored how the work of the architect could be influenced by the advances in Mathematics such as computing and artificial intelligence. (Abrahams, 2013, p 2) March started to pursuing researches using computers to develop graph theory to adjust the disposition of rooms in a building, generating unexpected adjacencies in domestic layouts, modelling pedestrian flows and making maps of population distribution in urban areas (Abrahams, 2013, p.4). Lionel March wrote in the magazine *Architectural Design* from May of 1975 about all these type of experimental analyses that computers promoted to Architecture:

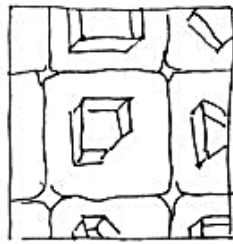
We do not consider computer graphics to be very important: although the facilities are at our command should we need them. Making computers do what architects do and think today is like using a steel frame to support a mock gothic building. Fundamentally computers will not change design methods but theory will. (March cited by Abrahams, 2013, pp.4)

March used the computer as an optimization tool that could provide the architect some functional information, satisfying functional requirements. He disregarded the look of computer designed buildings, yet detached the usage of computer as a possibility to answer to functional problems of the design. It is interesting that this first approach to the computer did not aimed at a digital representation of buildings, but rather to a generation of graphics to investigate the use and disposition of space. The ability to analyse spatial adjacencies and flows of traffic was one of the major regards. (Abrahams, 2013, p. 4)

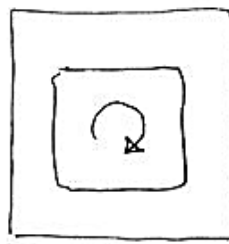
This event describes one first contact established between computer science and Architecture. LUBFS had an interesting contribution in the embracement of this new kind of technology, promoting the academic research as a complement to academic education (Krüger, 2005, p.76). This first look over the functionalities of computers, into the architectural scope, shown a conciliatory way of embracing a brand-new device. Its potentialities were analysed, identified and applied. Attitudes of aversion or elation due to technology may condition the usage of it, as it will be discussed ahead. Whereas, this approach taken by LUBFS represents a pragmatic temperance assigned to new technologies: neither too much enthusiastic nor too sceptical. After these first



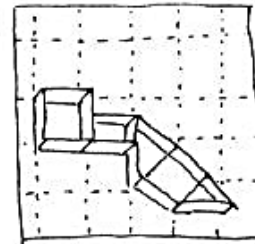
YOU HAVE TO WRITE USING A SPECIAL KEYBOARD



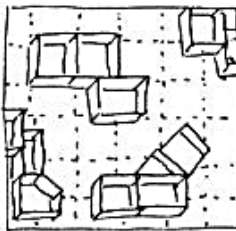
THE KEYS ARE REPRESENTING ROOM-SHAPES



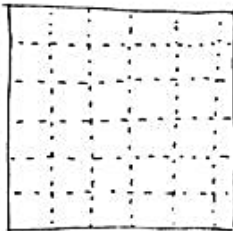
WHOSE POSITIONS CAN BE ROTATED WITH A SPECIAL KEY



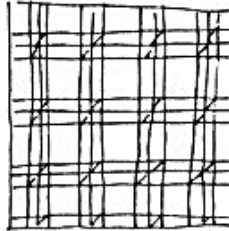
A "WORD" TYPED WITH THESE KEYS SHOWS A STRING OF ROOMS



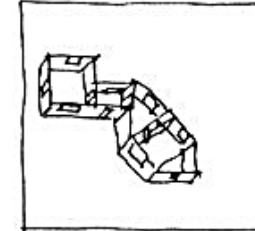
A "TEXT" IS A SUITE OF "WORDS": YOUR FLOOR PLAN AND THAT OF YOUR NEIGHBOURS



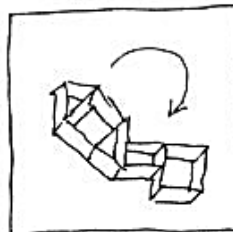
THE "WORDS" ARE TYPED ONTO A "GRID"



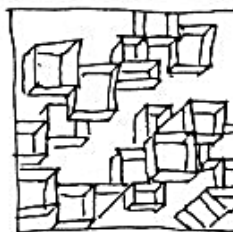
THIS "GRID" REPRESENTS THE "INFRASTRUCTURE" INTO WHICH THE PLANS ARE FITTED



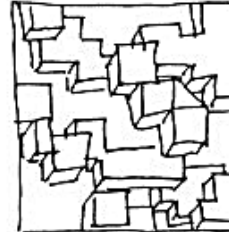
OBVIOUSLY YOUR FLAT HAS TO BE DETAILED: DOORS, WINDOWS, EQUIPMENTS (BATH, KITCHEN, WC ETC.)



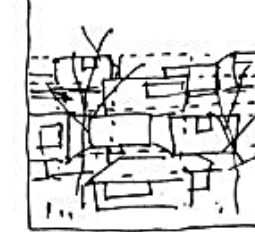
AND YOU HAVE TO DECIDE FINAL ORIENTATION ROTATING THE PLAN



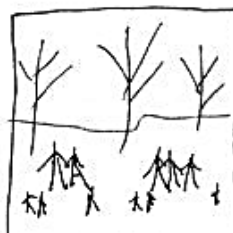
THE "TEXT" CAN BE OF SEVERAL "PAGES": EACH "PAGE" IS THE PLAN OF A DIFFERENT FLOOR



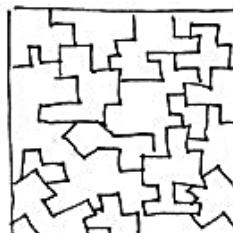
A "TEXT" TYPED BY MANY PEOPLE PRODUCES THE PLAN OF A NEIGHBOURHOOD



A CITY IS A COLLECTIVE "TEXT"



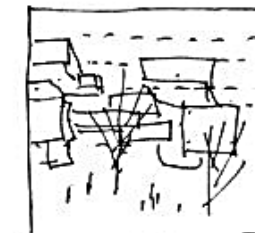
"TYPED" BY THOSE WHO WANT TO LIVE THERE



THE "TEXT" TYPED ON THE FLATWRITER



IS NOT THE COMPLETE CITY PLAN BUT RATHER A "WISHING LIST":



THE FIRST STEP TOWARDS HAVING YOUR TOWN BE AS YOU LIKE

Figure 4 - Flatwriter concept, Yona Friedman, 1971

Source: <http://www.matoffice.com>

applications, instigated by March and Martin in Cambridge, computers started then to be used as supports for planning and designing in the United States (Abrahams, 2013, p.5).

In the 1960s, predictions about the wide use of computer into the architectural profession began to appear in articles of architectural journals and magazines. (Greenwald-Katz, 1976, p.315) These predictions pointed out the next decade patterns.

A decade later, in 1970, in the International Exhibition of Osaka, Yona Friedman presented the “flatwriter”, a device similar to a typewriter that allowed the generation of architectural designs of dwellings. Through a fifty three buttons keyboard, assigned to various types of blocks, it was possible to arrange those blocks and to design a house (Bandeirinha, 2007, p.33). The intention of Friedman was to provide a possibility to the users of planning their own house. Every person would be able to “write” his own house within a total of approximately ten millions of possible estimated combinations (Bandeirinha, 2007, p.33). Each design, when finished, could be associated with the other proposals already defined in order to gradually setting a city plan. (Bandeirinha, 2007, p.33)

In LUBFS’s case, the computer was used to help the architect to understand and to give an answer to functional problems, as a tool for designing. On the contrary, Yona Friedman pointed out a device that was able to surpass that helper position of computers, suggesting that the role of the architect could be extinct by the users’ contribution through this device. (Bandeirinha, 2007, p.33)

Despite the predictions of the 1960s, in the 1970s, Greenwald-Katz described that the use of computers by architects in the United States was already a reality (Greenwald-Katz, 1976, p. 316). However, the approach was not as wide as it was expected. In his article *Computers in Architecture*, Greenwald-Katz describes that a decade after, the tone of the articles started to be less enthusiastic. Some articles even started to consider that perhaps architecture and computers were totally incompatible (Greenwald-Katz, 1976, p.316). From the data presented in his article it is possible to observe that around 57081 architects existed in United States in 1970. He adds that 40% of the architectural firms were smaller





ones and 90% of them employed six people or less. The *New York Times* statistics from 1971 estimated that from the 15000 design firms in the country only 200 used computers. Statistics from the American Institute of Architects shown that from 1969 to 1973, the employment levels dropped 75%. The architectural commissions were also declining 50% per year in the period from 1972 to 1974 (Greenwald-Katz, 1976, p. 316). The author explained that the computer may have helped to solve some professional issues, since the role of architects was starting to be questioned. Greenwald-Katz referred that:

Architects are still designing buildings by hand-row upon row of people bending over drafting tables draw the details of each building. [...] In situations where resources are limited, the architect must be able to explore alternatives to building, to financing and to forms of energy utilization. With costs escalating, he must solve problems that are more complex and solve them faster than he ever has before. The architect must recognize these new needs and adapt his skills to solving these new problems. (Greenwald-Katz, 1976, p. 315)

In the opinion of Greenwald-Katz, the integration of computers in the field of Architecture was happening slowly and for good reasons. He detached three reasons:

1. The difficulty in introducing new techniques in a complex and old profession. He described that “computers people” wanted computers to be used by architects, but they did not know the main requirements of architecture (Greenwald-Katz, 1976). As a discipline that covers various fields it became difficult to establish which parts would lead to computerisation. Also they had no idea how computers could affect architectural offices showing an inattention to how the architects actually design, as the author says: “the computers people have not understood the architect” (Greenwald-Katz, 1976, p. 319)
2. On the contrary, some architects knew why they needed and wanted computers, pointing aspects like: the methodology behind the use; the need to process amounts of data in a short time; the approach to a new way of working yet not so explored; and the fascination about the use and feeling it as a future direction (Greenwald-Katz, 1976, p. 317). These reasons show that architects had interest in learning about this technology.



The author explains how architects feel about different tasks of their work, explaining how computers could suit each one, such as the “*things an architect cannot do or cannot do well, but which he is interested in doing*”- like producing representations where the materials and people could move through a building; “*things he does not want to do*” – as the calculation in structural analyses; “*things he does not want to do, but has to do*”- like codes compilation and specification writing; “*things he does well in which he does not need any help*”- like drawing (Greenwald-Katz, 1976, p. 319).

3. And finally, the investments on the equipment and the learning process by the architectural community. The author explains how large firms, smaller firms and schools experience computerization. This kind of technology decreased its costs about 1/3 to 1/5 in 10 years, coasting in 1976 the equivalent to a sports car. (Greenwald-Katz, 1976, p. 319) Once this equipment was acquired, a large involvement of money and learning process had to be taken even though the costs were decreasing. The larger firms may had the money to invest, however the role of computers into the office was limited. Computer usage revealed to be shortly used in the office work routine. While in smaller firms, the computer played a major role and the whole office worked from it. Besides this offices usage, computers were more used in the university scope, since Greenwald-Katz explains that some of the advances made in schools about it did not reach the work of the offices. He justified that the academic environment is more linked to the understanding of the discipline of Architecture, rather than in advancing its practice. This suggests, that schools are identities apart from the job market experience, since they have different objectives from the offices.

The author justifies: “students are only remotely aware of how architects offices work” and so they have less constraints in experiencing new technologies. (Greenwald-Katz, 1976, p. 316)

This description from Greenwald-Katz, in 1976, shows that the use of different tools – as computers, in this specific case – can help the architect to give an answer in a useful time to various requirements assigned to the design or to the pressures of the market. The author explained that despite the crises in the architectural profession, in the 1970s some



firms were expanding their offices. He did not strictly associated this expansion to the use of computers, but also to the ability “to learn new skills” (Greenwald-Katz, 1976, p. 315).

For this reason, the architect might need to know the different tools available and consider if their characteristics can be useful to be integrated in his work. Also, schools may promote the opportunity to identify new tools and methodologies exploring them.

Beyond these assessments from Greenwald-Katz, a comparison can be established with the current time. Nowadays, schools often provide the first attempt for young architects to contact with architecture challenges. To answer to those challenges, students are taught to use some tools of work for thinking, planning, and communicating the designs. In most cases, these learning moments are inaugural for students, so they may not have any constraints in make explorations and researches about the methodologies of work. On a contrary, in the offices upgrading the tools of work may require an adapting process that can provoke losses of time and money. In schools there is a heterogeneous environment composed by architects, professors and students that can promote the access to knowledge related with new possibilities of work. Besides, students are most of the time open, willing and sensitive to learn technological novelties, as it is currently happening with VR.<sup>1</sup> In schools of Architecture, an experimental environment may allow an investment about different approaches of the design. Whereas in the architecture offices there are various factors that may discourage the architects to explore new approaches, as it was previous described. However, those constraints might not necessarily inhibit the offices to adapt the methodologies of work.

Greenwald-Katz suggested: “It will be interesting to see if in moving into new areas, the architect accepts the new technology.” (Greenwald-Katz, 1976, pp. 317). This suggestion is coinciding with the intention of this dissertation, where, in this particular case, the relation between architects and VR is discussed.

The slow and weighted pace about the introduction of computers, into a largely hand-made environment in the 1970s, contrasted with a different scenario about the 1990s,

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<sup>1</sup> This aspect is developed in the third chapter.



depicted by Julio Bermudez and Kevin King. “An increased abandonment of analog tools in favour of the new, in fashion digital systems of production” was the paradigm presented by the authors (Bermudez & King, 1998). As described by Greenwald-Katz, architects recognized the importance of computer in various aspects: as an optimization tool for researching architectural issues, to archive and process amounts of data in a short time and space, as also for the design process. Besides, computers had started to play a strict role, as an analysis tool in March’s attempts, sooner other functions were added to it. Those functions pursued the objectives of the creation of *Sketchpad* and the introduction of CAD into the design process was becoming a reality. The influence of computer at the representation level became an important aspect for the enlargement of the possibilities of creation. Digital representations affirmed its position into the design process. Thereby, as a tool, computers began to be an essential part of the design process. Bermudez and King reported a reconfigured workspace in architectural offices:

The past five years have witnessed an astonishing shift in the way architecture is produced. Visiting any architectural firm reveals a working environment dominated by rows of desks filled up with computer workstations and printouts. Gone or pushed to hidden corners are the tables with drawing and modelling instruments. The old chaos of handmade production has been replaced by a highly pristine and hygienic productive territory. The noisy murmur of people interacting has been substituted by silent cyberspace communication and isolated machine–operator dialogues. (Bermudez & King, 1998, p. 8)

The descriptions from Greenwald-Katz about the failure of the large mediatisation of computers into the architectural scope in the 1970s, was being subverted twenty years after. A new generation of architects was markedly replacing the analog hand-made ways of working by the new digital ones. This situation affected the work in office and also the learning process at schools changed according to Bermudez and King (1998, p.8). In the 1970s, schools were described as forefront identities by Greenwald-Katz, where the usage of computer was more evident than in the job market. Students were instigated and taught to use the computer, although the offices were not so computerized. However in the 1990s the paradigm changed:





Academia has reacted to this trend by moving to the full integration of computers into their curricula. The results stand in sharp contrast with the path that offices have taken. Instead of doing away with the analog tools that have driven architectural production for centuries, schools continue to embrace a strategy of convivial and tolerance between old and new systems of architectural making (Bermudez & King, 1998, p. 8)

The authors describes that in schools a more moderate environment between analog and digital was being developed. They also referred that this phenomenon was not mainly promoted by professors or administrators, but rather from students' proactivity (Bermudez & King, 1998, p. 9). This dialogue between analog and digital tools explored at schools was contrasting with the digital work environments installed in architectural offices. The attitude from the employee generation of architects, described by Bermudez and King indicated a euphoric stand about the use of digital tools and also an attempt to replace traditional practices for the new digital ones.

As said, euphoria and aversion behaviours may divert the architect from a fair exploration of tools, suggesting a mismatched approach. Besides that phenomenon, the authors remind that "Architecture is grounded, defined, born on materiality, tectonics, embodiment, and presence." (Bermudez & King, 1998, p.8). These inherent characteristics of Architecture "will always demand some direct reference to the analog world", apart from the sophistication of digital tools (Bermudez & King, 1998, p. 8). The extinction of analog devices on behalf of digital ones is an obsolete issue, since analog media is gravely assigned to Architecture. The authors predicted:

Integrating computers in architectural design means to negotiate between centuries-old analog design methods and the new digital systems of production. [...] once the dust of novelty and the mass hysteria of unreflective digital conversation dissipate the unmatched and thus unreplaceable qualities of the analog medium will become obvious and inevitably call for its coming back into the office. (Bermudez & King, 1998, pp. 7, 8)

The challenges that emerged in the 1990s did not reflect the expectations and concerns from twenty years earlier. In the 1970s the main efforts were in order to assure a relation

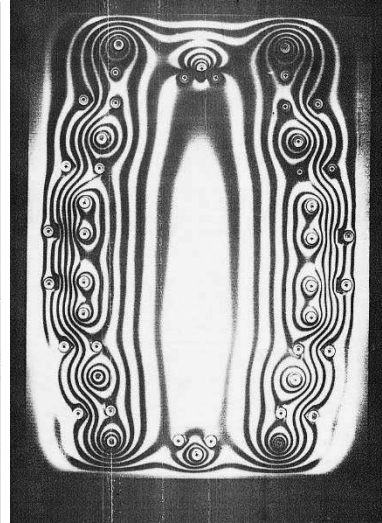
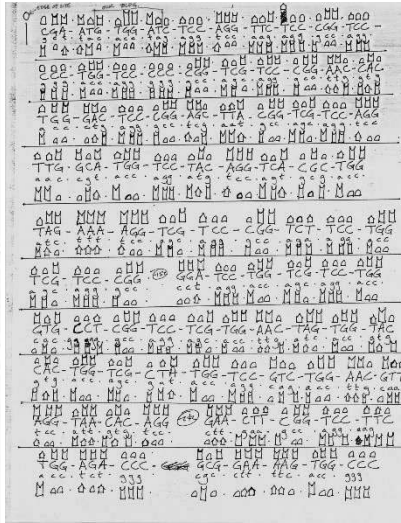
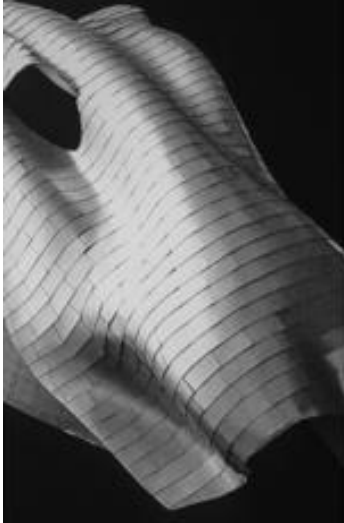


Figure 5 – [above, left] Part of *Lewis House* design (1989-95) by Frank Gehry Source: [www.cca.qc.ca](http://www.cca.qc.ca)

Figure 6 – [above, center] Detail of a schematic representation of a DNA sequence for the *Biozentrum*, Biology Center for the J. W. Goethe University Frankfurt (1987) by Eisenman/Robertson Architects Source: [www.cca.qc.ca](http://www.cca.qc.ca)

Figure 7 – [above, right] *Galaxy Toyama, Gymnasium*, Imizu, Toyama, Japan: Experiment of photoelasticity for the roof, (1990-1992) by Shoji Yoh + Architects Source: [www.cca.qc.ca](http://www.cca.qc.ca)

Figure 8 – [below] Expanding *Geodesic Dome*, (1991) by Chuck Hoberman, Hoberman Associates. Source: [www.cca.qc.ca](http://www.cca.qc.ca)

between architects and computers, as Greenwald-Katz said: “Under the impetus of becoming extinct, there will be architects who, with the help of computers will finally make it into the 20<sup>th</sup> century.” (Greenwald-Katz, 1976, p. 319).

Rather, in the 1990s the concerns were about reminding the importance of analog tools back into the workplace. Therefore, the commitment for the turning of the century lied on the conciliation between the analog and the digital. This was one premise for the beginning of 21<sup>th</sup> century in the Architecture scope.

This premise lead this outline to a latching state: new tools of work do not replace old ones. Architecture lies on this imbibing capacity where various fields, issues, approaches, methodologies or tools can live together. This coexistence allows the distinction of potentialities from each tool. The main concern might be about the opportunities that the architect has in getting to know different tools of work. The availability of tools, the identification of each one and the capacity to distinguish the potentials from each other can be thoughtful. Also the ability to assign a specific tool to the particular requirements of a project should integrate those concerns, taking the benefits of each tool in favour of the design requirements.

### **One more tool for representing**

In 2013, an exhibition called *Archaeology of the Digital*, at the Canadian Centre for Architecture, aimed to critically analyse the origin of digital Architecture. Rather than making future predictions about the impact of computers, a period of time was recalled to be the origin of digital tools usage to reach otherwise inaccessible results in Architecture. (Zardini, n.d.) The term *archaeology* is assigned to a model of exploration by reading, recording, compelling, rewriting, scrutinizing and inspecting various layers of archives and projects that was used to this exhibition. This *excavation* occurred in a moment when there was “a wider cultural need to accept the reality of digital design: to understand it as a cultural reality rather than as an empty promise of utopia.” (Abrahams, 2013, p.4).



The curator, Greg Lynn, highlighted four projects produced between the late 1980s and the early 2000s. Each revealed a unique potential of computation as: Peter Eisenman and the Biocentrum project (1987); Frank Gehry and his Lewis Residence (1989-1995); Chuck Hoberman and the expanding Geodesic Dome (1991); and Shoji Yoh and his Galaxy Toyama Gymnasium (1992). These four architects had different needs and their approaches towards the computers promoted four different strands into the evolution of Architecture (Abrahams, 2013, p.7).

Eisenman was interested in creating a morphological diagram, based on the DNA structure in order to achieve “a key organisational principle which can be repeated and adapted [...]” (Abrahams, 2013, p.7). Gehry looked to computers as a way to achieve better constructive results in his buildings. Besides all the physical models and drawings the architect was feeling disappointed to find inconsistencies in the final result (Abrahams, 2013). Hoberman was exploring animated structures which could generate shape variations. He was using AutoLISP, an expression editor of AutoCAD that could represent how moving parts would interact with other moving parts. (Abrahams, 2013, p.5) This attempted to explore ideas using digital tools had software consequences, as Hunter described: “Together the three of them have influenced the subsequent creation of FormZ, the architectural applications of CATIA, an animation software now used by Hollywood.” (Hunter, 2013, p. 2). This attitude enounces a possibility to the architect of creating a tool that satisfies the needs of the design process in order to add anticipation of the final result. Possibly more relevant, is the fact that one single tool can variate his function and found multiple expressions depending on the usage. This later stage may be more important than the previous, because the architect not always has the opportunity to create a tool assigned to his own issues, as did these three architects. However he often has the possibility to distinguish the ones more effective in the execution of the design needs, from the universe of tools available.

Gehry is an example of an architect who settles an idea and reach the tools to develop it. This architect is detached by some authors, as a case of coordination between the idea and the performance of the tools used. Also his appetite to explore his ideas in a media interaction environment, between analog and digital tools is outlined. His *Barcelona Fish*



Figure 9 – Set of shots from the video interview to Frank Gehry by Greg Lynn  
Source: <http://www.cca.qc.ca>

(1989-92) is one of these cases where it is clear the continuum between the potentialities of the software and steel production (Abrahams, 2013, p.9). Abrahams confirmed: “It is nigh on impossible to say what comes first: the lustre in the graphic interface of the digital surface or the metal surfaces that would invariably clad the steel substructure.” (Abrahams, 2013, p. 9). About *Lewis House*, the expression “native computer” is used to describe how the house seems to be a result of the software’s potentialities. (Abrahams, 2013, p.9) Paul Goldberger, architectural critic, also refers that besides the use of computers Gehry reveals his own way of work mediating the “old-fashion” procedures with the new possibilities. Goldberger adds “He [Gehry] has always designed in his head, put his ideas down on paper, and developed them further by playing with wood and foam models” (Goldberger cited by Malnar & Vodvarka, 2004, p. 275).

Along with these architects, other experiences were made in the 1990s from CAD. Schools, which often had a daring and forefront participation, as described, were also attending to the introduction of CAD. One of the main revealing moments about this introduction, took place in the Graduate School of Architecture, Planning and Preservation in Columbia University (Gil, 2008, p. 45). In its Digital Design Laboratory arose the project *Paperless Studios* which aimed at the students’ experiences with digital tools in the design process (Gil, 2008, p. 45). Animated software were introduced to students expecting the possibility of releasing creativity, but instead a recognisable style was created identified as *blob*.

The differences between these experiments and the ones already described are considerable. Many critics were made to these works - blob - as an uncritical repetition of experiences, misunderstanding of the values of digital and an achievement of amorphous geometry. In the cases presented in the exhibition at CCA, different approaches were achieved even though similar tools or software were used. While in this *Paperless Studios’* case, the opposite scenario occurred: an identifiable style arose from the incomprehension, repetition and conformist way to explore a CAD software, as Gil referred (2005). As the author claims:





The potential of the software resides in the critical intelligence with which one leads the software. The formation of the architect whilst future actor of the digital is crucial. The more disregarded the interface between the user and the software will be, more indomitable it will be. (Gil, 2005, p. 45)<sup>2</sup>

Mathew Allen also makes his critical appointments into these two different events and referred that there was an “important difference between curves that go *whoosh* versus those that go *doink doink doink*.” (Allen, 2013) This description does not reflect strictly the different shapes of the buildings designed, but rather the attitude and implications behind its design process. “*Whoosh*” curves suggest the continuity presented in Ghery’s work, for instance, as an implication of movement that smoothly expresses the intentions of the architect into a design. (Allen, 2013) His intentions were related to constructive desires which required digital tools to design them. On the other hand “*doink doink doink*” curves reflect an isolation from the intentions of the design, as Allen called it an “index of a generation” (Allen, 2013). When Peter Eisenman was called to comment some these *Paperless Studios*’ work, he called it “jungle” (Eisenman, 2003, p. 35). Peter Eisenman described:

Recently I found myself facing the work of a paperless studio at Columbia University [...] The studio project proposed a spatial theory that moved the virtual world closer to something that resembles a “jungle”. [...] The students thought they were dealing with a benevolent jungle and were completely enthusiastic about it, but they had not considered the jungle in terms of a type or a set of principles. [...] they never questioned the value of their concept, what have created it, and how this new jungle might be organized. [...] We must not limit ourselves simply to producing new spatial relationships and images for them. (Eisenman, 2003, pp. 35, 36)

One of the interesting points of the four projects of CCA’s exhibition was the ability to establish a continuum correspondence between their theoretical intentions and the practical ends. Digital in these four cases was the vehicle that scrolled along the path between the idea and the practice and it makes it reaches results. This is the consequence of the fair

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<sup>2</sup> Translated from portuguese: “O potencial do digital reside na inteligência crítica com que se domina o *software*. A formação do arquitecto enquanto futuro actor do digital é crucial. Quanto mais descurada estiver a interface entre utilizador e *software*, mais indomável ele se torna.” (Gil, 2008, p. 45)



application of tools to their challenges and also the skills of the architect to manage them. Digital tools have as many potentialities and inabilities as analog ones. Architects might produce design with “no dialectic” or with no “plane of reference”- as Eisenman described the *Paperless studios*’ works - also using analog tool. The problems of the design is not directly linked with the tool to representing, but with the attitude of the architect behind them. The critical intelligence that Gil referred<sup>3</sup> in order to lead the digital tools, has to be also aimed at analog tools. The formation of the architect facing the tools of work is essential in both cases. Two things need to happen to reach satisfactory results: the architect must be aware of the different tools and especially he must have an intention to use them:

Maybe it [the tool] should not really impact the result, because it is not the tool that should design the building for us. The design should be made in our heads and the tools should only be resources to reach that goal. [...] I find it very important for the students to understand that we should not only focus on the tool again, we should focus on the design. The tool is just a tool. To be able to show your design you need to know how to work with the tool. It is also very important that the students are active. As in old school days, when you learnt how to draw, you did it a lot by yourself, because that is how you learn your way of drawing. I think using modelling, or digital, or VR tools you need to find your own way of how to use it and how to work with them, because otherwise you will get the same kind of style as everybody. (Vikberg, 2016)

Otherwise tools will lead the ideas - as in the Paperless Studios blob results- instead of ideas leading the tools – as in the CCA exhibition cases. A third stage is also possible to reach: a close relationship between ideas and tools can result in a mutual situation. In that case ideas lead tools and tool lead ideas in a reciprocal and cycle way:

Of course any tool will do. These days, the tools may include a computer, an experimental model, and mathematics. However, it is still craftsmanship – the work of someone who does not separate the work of the mind from the work of the hand.

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<sup>3</sup> Quoted in the previous pages.

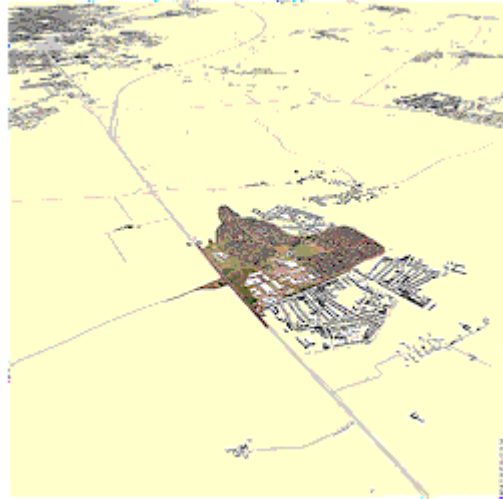
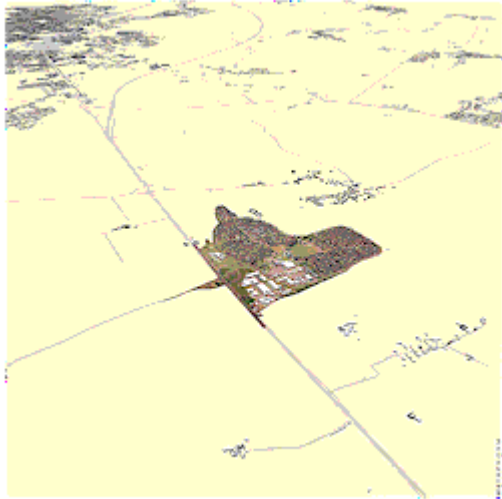


Figure 10 – 3D models, two of the seven scenarios of *Cambridge Futures* from CCC and Crown  
Source: <http://www.cambridgefutures.org>

It involves a circular process that draws you from an idea to a drawing, from a drawing to an experimental, from an experiment to construction, and from construction back to an idea again. For me, this cycle is fundamental to creative work. Unfortunately, many have come to accept each of those steps as independent. (Piano, 1992, p.14)

Different design may suggest different planning strategies, those different planning strategies may imply different types of representation and different types of representation may imply different tools of work. Therefore, certain types of representation might be more indicated for certain designs.

An example of that issue was a project of urban requalification for Cambridge, *Cambridge Futures* (1997), managed through digital representations. This project combined the local power, the academic environment and the business world to develop and support the creation of proposals about the evolution of the city. (Durrant, 2005, p. 173) The aim was to think how Cambridge should grow considering the demographic growth, the implementation of new scientific research and industry parks, the necessity of improving public transportation, considering a green belt which was limiting the historical centre ([www.cambridgefutures.org](http://www.cambridgefutures.org)). This project was open to everyone that wanted to participate and was established in the Martin Centre - previous LUBFS ([www.cambridgefutures.org](http://www.cambridgefutures.org)). Seven scenarios were developed using digital models of the city and the assigned proposals. Also a video with graphic design was made to present all the hypotheses to the public. To Jonh Durrant, major of Cambridge in 1997 and enabler of the project: “[...] it became possible for the common citizen visualize the changes and not just trust the words and diagrams of professional planners.” (Durrant, 2005, p.173). Some resistant anti-change movements have vanished and the communication between all the stakeholders prevailed. This was a relevant example of the application and the impact of a living lab<sup>4</sup> urban experience using digital architectural representations,

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<sup>4</sup> “Living labs are defined as user-centred, open innovation ecosystems based on a systematic user co-creation approach integrating research and innovation processes in real life communities and settings.” ([www.openlivinglabs.eu/FAQ](http://www.openlivinglabs.eu/FAQ))

Living lab is a research concept aiming at the development of something by approaching and involving the final users in the process. The methodologies used to achieve the feedback form the users include simulation of scenarios and situations, co-creation and experimentation, for example.



including 3D simulations of the proposals. An effort to establish a fair communication between all the stakeholders - especially with common citizen - can be identified by Durrant's previous words. Also, since digital representations allow a simultaneous exhibition of designs, through a digital platform – the site of the project –, it was possible to access to that information.

All the types of representation could be suitable to the work of the architect, once he recognises their potentialities. This relationship with tools may imply the architects' attention, since all these aspects may affect his position into the professional field. This stand denies a hierarchy of tools, where ones prevails above others, yet this supports a palette of tools equally at the disposition of the architect, assigned to different functions in his work. Also there are different stages in the design process that might have different needs in what comes to representing ideas and which would benefit from different strategies of designing. One of those stages is the conception of the idea and other is its communication. The characteristics of each stage may also require different types of representation. The representations used into the conception stage may not reveal efficient into the communication stage. All in all, a distinction and characterization from the array of tools should be made in order to define their importance into the representing act.

### **Represent(action)**

The transposition of an idea from the mind to the *real world* is assured by what will be called as representations:

Representing is the replacement of the thing that is being represented. In the absence of the own thing, we reach for representations. (Arenga, 2016)<sup>5</sup>

Mainly, representations are physical expressions of ideas and for that reason they are dependent from tools that allow their execution. Models, drawings, images, paintings are some of the physical expressions of ideas, and thereby they can be considered representations. All of them depend on tools to be executed: as pencils, computers, paints,

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<sup>5</sup> Translated from portuguese: “A representação é a substituição da coisa representada. Na ausência da própria coisa, recorreremos a representações.” (Arenga, 2016)





rulers and printers, for example. Speech is also a way of representing ideas that architects often use. However speech does not necessarily depend on physical tools, it might only depend on the own architect to be expressed. Since this discussion is focused on tools for the representation of ideas, speech will not be integrated into the discussion.

The architect needs to represent ideas so he can develop and show them to others. Representations might inform its viewers about an idea or about an element that already exists, but they can also be an anticipation of the own element that is being represented – like in the case of plans before construction.

Representing has these two slopes: the conception of ideas - by capturing, working, developing and rethinking ideas - and the communication of them to others- by exposing, presenting and explaining them. Even if the tools are the same for both stages, the intentions might be different, and may imply different representations to achieve two different purposes.

For the conception stage, the architect needs to express suitably the intentions assigned to the design, so that his own representations can be understood by himself. This process can be compared to a monologue that the architect establishes with himself. In this type of monologue, words can be released punctually in order to express some main intentions, yet not constituting exactly a phrase. Following this monologue metaphor the architect produces elements of representation just suitable enough to assure its development. When others observe the elements produced, they may just see messy lines, pieces of materials, or schematic graphics. The language is more particular, specific or abstract, still operative by its own:

It can be simple tables, charts, and even simple line drawings will do. Because the architect can visualize easily, it is not necessary for an object to be colored and shaded before he finds it meaningful. Because the embellishments are not essential [...]. (Greenwald-Katz, 1976, p. 319)

While in the stage of communication a wider and more inclusive language is required, depending on the information to pass on and also on the receptor:



Unless an architect is able to listen to people and understand them, he may simply become someone who creates architecture for his own fame and self-glorification, instead of doing the real work he has to do. Listening to and knowing how to understand other people is a vital quality in an architect – every bit as important as technology, ability, and competence. (Piano, 1992, p.12)

Architecture is truly dependent on communication since that it is not an individual experience. Despite the need to get in touch with clients, there is the unavoidable share of tasks with other professionals and technicians that also requires communication. The dialectic system of emitter > message > receptor (as users, clients, stakeholders, laypersons) is crucial for the understanding process of intentions:

If we start to design and make architecture [...] we have to understand really what the need is. Architecture is not only a visual thing, it is also the concept from the architect and also from the client [...] It is lots of information at the same time and when we are able to understand all together what we need, that is the best way to start doing architecture. (Heikkinen, 2016)

The importance of representations and tools is determinant to the concurrence between the intentions of the Architect and also the receptor's ones. The final result of the design should be a commitment between both of them: not just the demands of the client as also not only the proposals of the architect. As a qualified person with certified knowledge in this area, the Architect should be aware of the best possibilities for the good execution of the pretended request. Therefore, the communication between emitter and receptor should be as fair as possible, explaining these possibilities. Some technical representations that the architect often uses for the exposition of the project to the technicians, might not be understood by laypersons. The fact that the clients, users, stakeholders - receptors- may not clearly understand the design may affect its good execution and condition the answers to programmatic requirements.

Summarising, not only do the specific characteristics of each project require a possible array of tools, also the different purposes for representing the project demand an adequate choice of tools. Therefore, there is the need to understand them and their potentialities.



Considering the characteristics of representation, two groups are possible to identify: the analog and the digital. (Bermudez & King, 1998, p. 7) The analog handmade drawings and models have centuries of existence, even if in the beginning they were offerings or recreational artefacts. (Astbury, 2014, p.1) Therefore, all the current generations had been educated already with the wide ingrained use of analog representations- as physical drawings made in paper with pencils and models produced with a variety of materials, for example. Whereas digital representations have the constraint of being more recent, and some individuals had to adapt themselves to use them. For that reason, digital tools may not be so wide ingrained as analog ones. However in the next generations - from now on – digital will be as well ingrained. Besides this, they must be distinguished: “Analog systems have also been termed ‘handmade’, ‘manual’, ‘material’ or ‘physical’. [...] Digital systems have also been called ‘electronic’, ‘computer-aided’, ‘virtual’[...]” (Bermudez & King, 1998, p.7)

For the sake of clarity the use of the terms analog and digital is here clarified. Analog derives from the word analogy, “relating to a device or process in which data is represented by physical quantities that change continuously” (www.merriam-webster.com). Digital derives from the Latin word *digitus*, meaning fingers and in contrast with *analog*, digital refers to a process in which data is represented through discrete quantities, where the fundamental unit is one bit (www.merriam-webster.com).

In this discussion analog will refer to hand-made and digital will refer to computer assisted representations. By their characteristics they may have different applications:

Analog representations are far more fluid and appropriate than digital media for initial and fast development of ideas, the stimulation of the imagination, free inquiry, the intentional and random cross- reference of diverse sources. [...]

Digital media are stronger for design development as they demand higher levels of geometrical definition and abstraction, and the elaboration and coordination of complexity and details (and delivering in kind) [...], allow the easy articulation and generation of multiple viewpoints (visualization), as well as access and manipulation of information (specially imagery), the storing of models and images



[...], the generation of hyperrealistic rendering-simulations [...] (Bermudez & King, 1998)

In this case, the authors referred analog representation straight related to fluidity, not including rigorous hand-made drawings. Even if some characteristics are more suitable for the conception and others for the communication, all these moments constitute the actual resources of the design process. The discussion about which are the best methods for the design process, either analog or digital, does not integrate this dissertation. Since this various moments are faced into the design process, a hybrid procedure of combination between the two methods of representation could be considered. The attempt is to “negotiate between centuries-old analog design methods and the new digital systems of production.” (Bermudez; King, 1998, p.7). For that commitment it is needed to recognize all the potential tools and accept that some have similar functions, while others have singular potentialities, but essentially they work better if synchronised:

In other words, the likely outcome of the competitive interaction between the two media is not the extinction of the analog in the hands of the digital but rather a coordinated and collaborative coexistence of both representational systems, each one highly evolved to do what it does best. (Bermudez & King, 1998, p. 8)

Besides these two different methods - digital and analog - three groups of representations would be distinguished for the purpose of this discussion: drawings, models, and specifically 1:1 scaled models.

Drawings could be divided in *rigorous* or *fluid*. They can be either two dimensional (2D) or three dimensional (3D). In the scope of this dissertation, this type of representation named as drawings includes: plans, sections, façades and axonometries, sketches, images, graphics and diagrams, for instance.

*Rigorous drawings* are geometrically defined and so that they are mainly used in a phase where the intentions of the project are more set. They can be hand-made –by paper, tracing paper, pencils, pens, rulers or squares, for example - or digital – produced with a





software, using a computer, for example. They are scaled and have the aim of giving technical information. For that they are drawn in standard language so that the drawing by itself should be able to report the assigned data as a technical codification of reality.

*Fluid drawings* are a fast way to express an idea, or to represent some elements. They are often used by the architect for conception, as an approach to thinking about their own ideas and intentions. However, this type of drawings may fall into a disconnected expression - as the architects' monologue yet described- , too illegible for the receptor and only suitable for the own work of the architect. Captured images - as photographs or videos -, generated images - as renders - and manipulated images - as collages - are other ways to express ideas. These may have a less codifying expression and so they might be a good tool to communicate. However images may only reproduce parts of the project, giving isolated perspectives and not an integral expression of it. This group of elements has an important role for the architect in the conception of the project. However to receptors it mainly promotes a visualization approach, meaning that they can only interpret the represented data by seeing it. That is the only approach this type of representation can provide. These may limit the understanding of the project.

Some other elements are often used to promote other kinds of approaches, not only for the receptor but also for the architect. Physical and digital models are expressed in 3D, reflecting three real-world dimensions, receptors can recognise them as spatial reference. These representations are also scaled. Some aim at the integral expression of the project, while others aim to represent details that can provide a better understanding of the disposition of materials and elements. Scaled models are an efficient way to the architect reflect on the disposition of the volumes, proportions of spaces and their contact with the light. Since it might be possible to touch, handle and manage them, it is possible to establish a closer contact with the design in order to understand it better. So, besides visualization, these models can also promote manipulation –they can be modified by interacting-, enriching the contact with the project both for the architect and for the receptors. Even so, the receptors may feel difficulties in understanding the design just from drawings and models:



In fact, the majority of people does not have the capacity of visualise the designs that we are developing. Even if some times through models, which for us [architects] is something very real, for the common people is a great abstraction. (Paulino, 2016) <sup>6</sup>

1:1 scaled models have several particularities apart from the other type of models and for that reason they can be put apart from the previous ones. Either in their digital or physical expression, they can be a closer version of the final physical structure. In this way, before the appearance of digital resources only physical 1:1 scaled models were possible to be produced. Yet, as it revealed to be a very expensive method of representation, it is not often used. Digital 1:1 scaled models - especially representations of the whole building - revealed to reach lower costs of production, in a more ecological way, and be easily modifiable, as it will be exemplified. Since they depend on some special equipment to be displayed, this fact can also add cost implications. However, one of the benefits in acquiring these equipments is reutilization, since the same devices can display an amount of 1:1 scaled models. After a few displayed models, is possible that the costs of construction of the same amount of physical 1:1 scaled models surpasses the costs of the equipment for digital ones.

Along with visualization, spatial recognition and manipulation, they also promote action in the contact with the project. This action is assured by: immersion, interaction and navigation. *Immersion* is to be in an environment and see it in person, reaching a close contact with it, by immersing into the represented element. *Interaction* is mutual or reciprocal actions or influence between two or more elements. *Navigation* is the act of chose a route into a certain environment not requiring necessarily displacement. Virtual Reality can provide these three moments, however immersion is the necessary element to VR experience occur, while the others are complements to increase the reliability of the simulation. The appearance of computers promoted the creation of computer-aided design (CAD) software, which allowed the production of digital representations, such as 3D digital models, and consequently the possibility to reach VR representations:

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<sup>6</sup> Translated from portuguese: “De facto, a maior parte das pessoas não tem capacidade de visualizar os projetos que estamos a desenvolver. Até mesmo às vezes através de uma maquete, que para nós é algo muito real, é uma grande abstração para o comum das pessoas.” (Paulino, 2016)



In a certain way, Virtual Reality fills the great gap of 2D presentation, deepens the issue of 3D representations [...] and helps either the professionals of this area [Architecture] as the clients. Therefore it enriches this in four dimensions, with the dimension of time included. [...] Nowadays, the renders are used as tools for visualization, verification and communication. The next step would be introducing the dimension of time. (Briosa, 2016)<sup>7</sup>

All these approaches are important to bring the architect and receptor closer to the project, so, they have more possibilities to comprehend the project. Action - as a process that provides immersion, interaction and navigation in this case - is a slope missing in the other ways of representing - drawings and models - and it is important in conceiving and communicating. Therefore, even if the physical 1:1 scaled models are not often produced, the digital ones can be an option to consider:

The view that the digital will not displace the analog, but instead will help clarify its different strengths, force specialization and complementation is shared by other researchers. [...] This inclusive and symbiotic position is also the most reasonable to take when trying to prepare for an uncertain future. [...] The best resource against new challenges is diversity of resources, methodologies, skills, etc. (Bermudez & King, 1998, p.8)

A variety of tools and representations does not mean that ones can replace others. Each representation might have its potentialities. Therefore, VR is one more possible architectural representation along with the others that already exist and some that might be added in the future. Since representations have the potentiality to inform and anticipate they can give a main contribute in the design process. The work of the architect is inherent to the physical world and before any design, or any project, the architect needs to face the

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<sup>7</sup> Translated from portuguese: “De certa maneira a Realidade Virtual colmata a grande falha de apresentação em 2D, aprofunda a questão das representações tridimensionais [...] e auxilia tanto os profissionais da área como os clientes. Portanto colmata isso em 4 dimensões, com a dimensão temporal incluída. Isto para perceber de certa forma o enquadramento. [...] Hoje em dia, utilizam-se instrumentos de visualização, de verificação e de comunicação, as *renderizações*. O passo seguinte seria introduzir-lhe a dimensão de tempo.” (Briosa, 2016)



physical world – for instance, visiting the implantation area and being aware of the context:

Architecture lives a lot from the design process, it is not about arriving to the implantation area and starting to build something. The design process is what gives the opportunity to think, prevent and anticipate an amount of issues. That is one of the main aims of design process. (Martinucci, 2016)<sup>8</sup>

There is this need to think, design, plan, predict and manage what may become a physical structure before its execution. The design process is the stage where the architect has the opportunity to experiment his proposals in the most various approaches to assure its impacts, functionalities and viability. There is the need to represent reality in order to comprehend it and propose about it. The commitment between the “*voyeur*” and “*walker*”<sup>9</sup> position of the architect may be assured by representations and the living experience of the architect. The architect needs plans, sections, drawings and models, to control and assure the main issues of the design. These representations are suitable for a static and technical approach. But he also may need other component which may add some realistic points to this need to represent: action. Drawings and models are ways of representing and visualising a design, but beyond visualisation a first-person perspective – by experiencing an environment – adds other types of relevant information. VR provides this experience and so it might be useful for the architect and the general public to also contact with this type of architectural representation.

Concluding, every tool that contributes to inform and anticipate data assigned to the design adds potentialities to the representations. The various tools have different ways to inform and anticipate, as it was presented in this chapter.

Therefore an array of tools should be available to the architect in order to generate different types of representation- analog and digitals, 2D and 3D, fluid or rigorous.

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<sup>8</sup> Translated from portuguese: “A arquitetura vive muito do projeto, não é apenas chegar ao local e começar a construir qualquer coisa. A fase de projeto serve para pensar, prevenir e poder antever muitas questões. Esse é um dos principais objetivos do projeto.” (Martinucci, 2016)

<sup>9</sup> The words “*voyeur*” and “*walker*” are alluding to the definition of the terms by Michel De Certeau (1984, pp. 92-93).

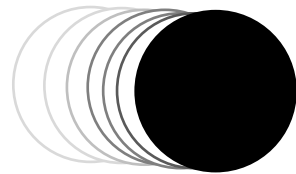




For the architect the architectural representations' application might depend on their characteristics, on the evaluation of the need to acquire the skills to produce them and also on the need to understand if they are adequate to develop his work.

VR has particular characteristics when compared with the other types of representation. The architect might have the opportunity to consider if VR could be an added value for his work. Therefore, the next chapter intends to inform about its characteristics, analysing practical cases of its usage – in architecture offices, for instance - and systematising its possible applications in the scope of Architecture.





## **2. An action point:**

Virtual Reality



Before adding any progress about this action point, a few notions must be clarified: Virtual Reality (VR) brings a few opportunities into the architectural scope by adding a type of action – by immersion, navigation and interaction <sup>10</sup>- to representations. There is a priority in defining what will be meant by VR in this discussion, since the word is relentlessly used to describe an amount of things as: dreams, thoughts, artificial environments, or anything that is very close to be something without actually being it. Decomposing the terms, *virtual* refers to what is near or close and *reality* to what human beings experience. (www.vrs.org.uk.) So, the meaning of the full expression would be: near to what human beings experience.

Over the aims of this discussion, VR must be detached from other definitions, in its technical terms. The definition considered for this is:

[...] a three-dimensional, computer generated environment which can be explored and interacted with by a person. That person becomes part of this virtual world or is immersed within this environment and whilst there, is able to manipulate objects or perform a series of actions. (www.vrs.org.uk.)

There is often a confusion between VR and digital 3D that this technical definition pretends to clarify. To create a VR environment a 3D model has to be generated. However not every 3D aims at immersion and to be interacted by a person. Therefore not every 3D is VR. For instance, a visualization of a 3D digital model animation is assigned as well to a three-dimensional computer generated object, however it does not aim at providing immersion to a person. In this case, it is a 3D element without being considered VR.

Everything that we know from the real world comes from our senses and not just by the five traditional ones: touch, taste, smell, sight and hearing (TTSSH). Also other senses enable the entire experience of reality along with brain combinations and procession of sensory information (www.vrs.org.uk.). The challenge for VR is to persuade the brain by stimulating the human senses - as TTSSH and the sense of balance. It is not easy to

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<sup>10</sup> See in the previous chapter.



Figure 11 - *The Siege of La Rochelle* (1631) from Jacques Callot  
Source: Vereycken, K. (1996)



Figure 12 - *Battle of Borodino* (1812) by Franz Roubaud  
Source: [www.vrs.org.uk](http://www.vrs.org.uk)

achieve that, since the brain is prepared to provide a reliable, finely, synchronized and mediated experience. Although, with a good combination of hardware, software and sensors, synchronicity can be achieved in what is called as “sense of presence” ([www.vrs.org.uk](http://www.vrs.org.uk)).

The invention and evolution of perspective, the development of stereoscopes and the creation of computers, especially the software of computer-aided design (CAD), were trigger phenomena to the evolvement of VR as a type of representation:

In 1400, period of the invention of the conic perspective, the philosophic question that was being set was the relation between reality and its representation. Suddenly, the Man become the center of the universe defining his point of view and architecture shift from being just construction, gaining the power of being designed as a project. It will not be the real and concrete world to influence representation, but the own representation transforming continuously the reality, through demands of the own project. (Martinucci, 2014, p. 68)

The debate about the invention and development of perspective is not established yet and stills way vast. Apart from that discussion, some examples may illustrate the relevance of the perspective in representations. Roughly five hundred years before Man was able to flight, some landscapes and sceneries were represented from above giving a depiction of scenes that could be observed while flying, as in *The Siege of La Rochelle* (1631) from Jacques Callot. Perspective was also explored by other authors in order to embed the viewer into the represented scene as *Battle of Borodino* (1812) from Franz Roubaud, a 360 degree painting. In this sense, perspective brought the opportunity to inform and anticipate events, and those aspects were absorbed by Architecture in the design process as representations.

Stereoscopes are devices that aim at the perception of depth in two dimensional (2D) images. Those devices allow the visualization of stereograms - two separate images that are combined in order to achieve a single three-dimensional (3D) image. Some stereoscopic images, namely anaglyphs, also promote the representation of a certain environment in 3D, yet in a single image. Glasses with lenses from different colours – as





Figure 13 - [left] Example of a two separate stereoscopic image  
Source: [www.snapily.com](http://www.snapily.com)

Figure 14 - [right] Example of an anaglyph image [which can be seen with the 3D glasses below by consulting the printed version]  
Source: <http://www.snapily.com>



red and cyan - allow the visualization of anaglyphs. The stereoscopes and 3D anaglyphs glasses were a contribution to some current VR devices that will be presented in this chapter. Even though perspective and stereoscopes evolved in an analogic stage, it is when they achieved the digital state that the conditions for the appearance of VR arose.

### **Beyond the keyboard and the mouse**

“Sense of presence” is about believing to be in an environment, having the impulse to interact with it, but not actually being in it. ([www.vrs.org.uk](http://www.vrs.org.uk).) This sensation could be provided currently by some special gear and devices as bodysuits, gloves, glasses and headphones or devices as head mounted display (HMD) and Cave Automatic Virtual Environment (CAVE). In the future, other devices may be created in order to achieve this simulated experience. These devices can be considered the available resources to reach that, however the main concerns should be associated to the action that VR is able to provide. This type of action, achieved by interaction, navigation and immersion, can bring the architect and the receptors closer to the design. Also, this helps to fill in the gaps between the emitters, the message and the receptors. As described in the introduction of this work, various interviews were made to architects, professors and technicians in order to inquire them about a few issues related with VR in Architecture - as it will be developed in chapter 3. One of the questions aimed at finding out their opinion about the role of VR in the communication and the conception of the design. This gap in the communication between architects and clients was a fact highlighted by various interviewees:

[...] many times they [clients] are actually very passive, even though, they should be very active. This is the consequence of an amount of things as: they don't have our [architects] education and they may not have the skills we have. Even though they are exciting, they are really insecure and unsure of their contribution. (Heikkinen, 2016)

For the architect, VR promotes an embedded experience, closer to the real expression of the design project as if it was constructed. While for the receptors it gives them the opportunity to comprehend the design, by promoting an approximate experience to their normal everyday practices. None of these approaches replaces others described already,

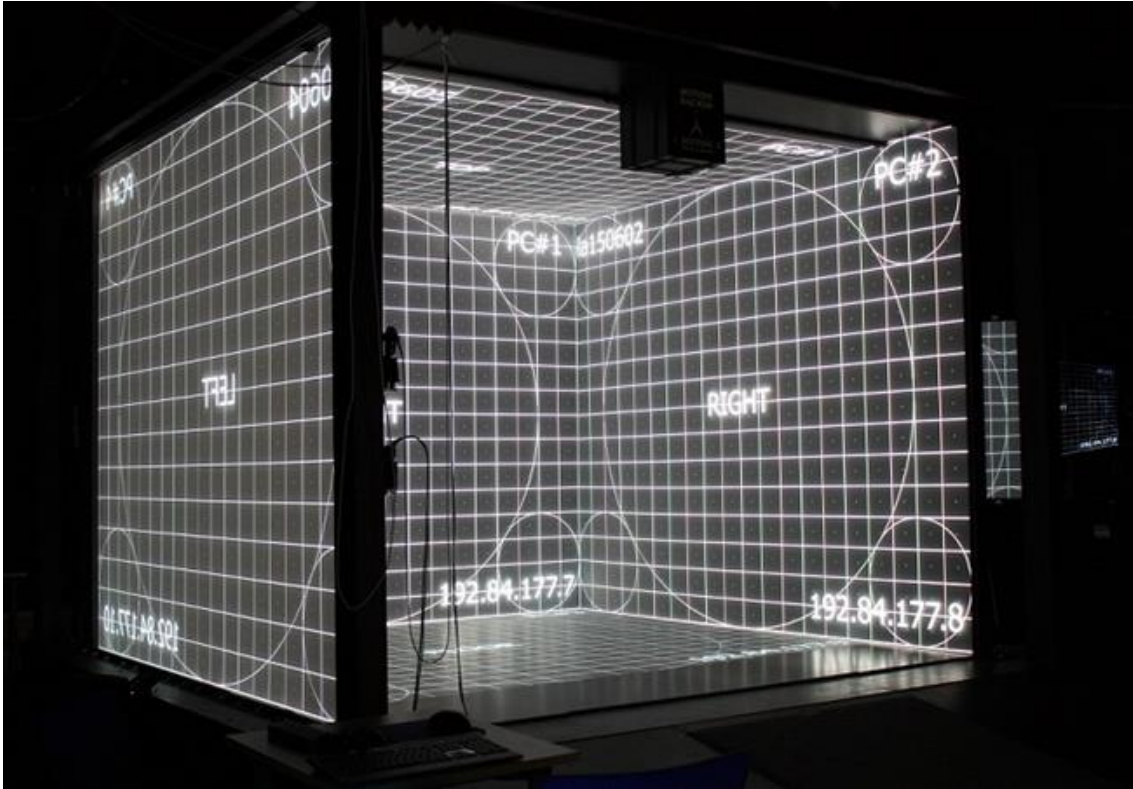


Figure 15 - VR laboratory SeAMK's CAVE  
Source: <http://www.seamk.fi/fi>



Figure 16 - Experiments with HDM in the VR laboratory of SeAMK (2016) by Ana Moreira Bento

but once combined, they enrich the experience of conception and communication of the design process:

Virtual reality is not a tool that replaces others. [...] This tool has highest potentialities and very particular characteristics that allow to reach what once was difficult or even impossible. [...] It is a tool that adds different possibilities. (Martinucci, 2016)<sup>11</sup>

Some architects described an inability on the part of the receptors to understand the design just by using traditional representations. Some architects referred that the relation with the clients reveals to be more efficient when other kind of tools as HMD and CAVE are used. This fact enriches the design process in various ways, by informing and anticipating the final product, providing the experience of it before its construction, during the design process. Inform and anticipate were characteristics already assigned to representations in the first chapter. This fact proves that VR pursues those characteristics immersing the viewer. As better are the ways to foresee the impact and fulfil the stakeholders' expectations, more are the possibilities of getting good results in the final physical product. The collaborative work between the architects, technicians and clients or final users is another very detached topic by some interviewed architects:

[...] we [architects] have to understand really what the need is. Architecture is not only a visual thing, it is also the concept from the architect and also from the client, more or less for me. It is lots of information at the same time and when we are able to understand all together what we need, that is the best way to start doing architecture. (Heikkinen, 2016)

In the 1990's digital architectural representations were already been used to stimulate the relation between all the stakeholders - as it was referred in the first chapter by presenting Cambridge Futures as an example of it.

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<sup>11</sup> Translated from portuguese: "A Realidade Virtual não é uma ferramenta que venha substituir as outras. [...] Este instrumento tem potencialidades altíssimas e características muito particulares que permitem alcançar o que antigamente seria difícil ou mesmo impossível. [...] Não é um substituto de nada. É um instrumento que acrescenta possibilidades diferentes."



Figure 17 – A collective visualization in CAVE about the design of the Hospital District of South Ostrobothnia , image released by Uki Arkkitehdit



Figure 18 - A visualization on HDM, shot from the video: River House by Tom walker  
Source : <https://www.youtube.com/watch?v=X4ALrFcmSkw>

As referred previously, the impacts of the use of VR tools, as HDM and CAVE, are considerable either for the concept, as for the communication of the design. However, it is important to clarify each strengths and failings, since these devices have different characteristics. In order to understand their potentialities the two must be distinguished.

Computers are nowadays a fulltime element of the architects' work environment. They are wide-use devices that allow many tasks for the architect like: running software – to modulation and representation-, archiving files, organising data, doing web searches and communicating, for example. Therefore, standard hardware are largely used such as the keyboard, the mouse and also the touch screen. These are inclusive and general hardware that have enough capacity to reach multiple tasks. Computers allow either the modulation, the visualization or the interaction of elements.

Various software promote the creation of 3D modulation as Building Information Modelling (BIM) – like ArchiCAD -, which allow a full immersive and interactive experience, but the common devices where they are displayed provide an inappropriate and unnatural kind of sensory interaction. Screens of computers do not allow the full experience for many reasons as: “The human visual field does not look like a video frame. [...] We have (more or less) 180 degrees of vision and although you are not always consciously aware of your peripheral vision, if it were gone you'd notice.” (<http://www.vrs.org.uk/>) On the other hand, specific VR tools allow a real immersive experience. Thereby, when it comes to interaction, navigation and immersion some appropriate gear must be considered.

### **Experiences with VR devices**

These two VR devices promote a 1:1 scale visit to a simulated environment with all the action assigned to interaction, navigation and immersion. The sharper difference between them is that HMD is a device to wear in the head in order to fulfil the viewer's vision field and CAVE is a unit to go inside, in order to display an artificial environment around the user. At the first sign, CAVE might appear to give a closer experience to what is visiting a real building, by entering into a space and walking on it. But, apart from that possibility, the two devices are suitable to promote a VR experience.



Figure 19 - *The Ultimated Display* (1965) by Ivan Sutherland  
Source: [www.roadtovr.com](http://www.roadtovr.com)

Head-mounted display (HMD) are devices assigned to head use, similar to helmets or glasses, having an optic display in front of one or each eye (monocular or binocular) where the 3D information is presented. The first proposal of this type of device was the *Ultimate Display*, proposed by Sutherland in 1965. In this device computer-generated images would be displayed and behave as if the observation was being made from the real-world (Chung *et al*, 1989, p.16). One curious aspects was its kinematic feedback that responded to the user's movements:

The senses of sight, sound, and feeling lend themselves most easily to this effect, as objects can be moved out of sight, apparent sound sources can shift their relative position when the user's head is turned, and force feedback mechanisms can respond to hand and arm movements. (Chung *et al*, 1989)

In 1989, an article written by a group of investigators of the Department of Computer Science of the University of North Carolina at Chapel Hill addressed the exploration of virtual worlds using HMD. The authors recognized that the most important issue about sensory simulated experience was the possibility of response promoted by computers display to the users' movement. (Chung *et al*, 1989, p. 16) They aimed to make the state of the art about the device by pointing out some advances in this field and aiming at practical and future applications of the device. One of those practical applications was into the Architecture scope:

In architecture, the head-mounted display enables clients to better appreciate three-dimensional designs, which may be misinterpreted in their conventional two-dimensional form by untrained eyes. [...] Whereas the architect has been trained to visualize unrealized designs, the client may often be unable to translate drawings and descriptions into a complete mental image. With this handicap the client may wind up accepting unsatisfactory designs because of some misunderstanding. (Chung *et al*, 1989, pp. 15,18)



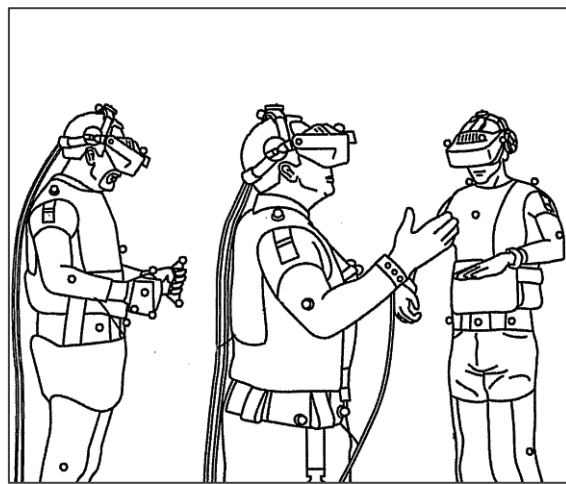
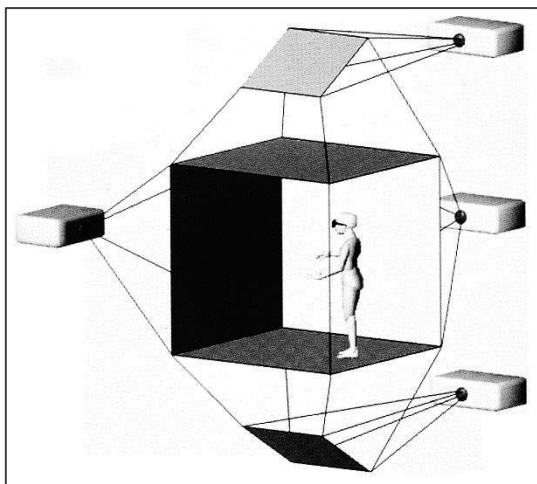
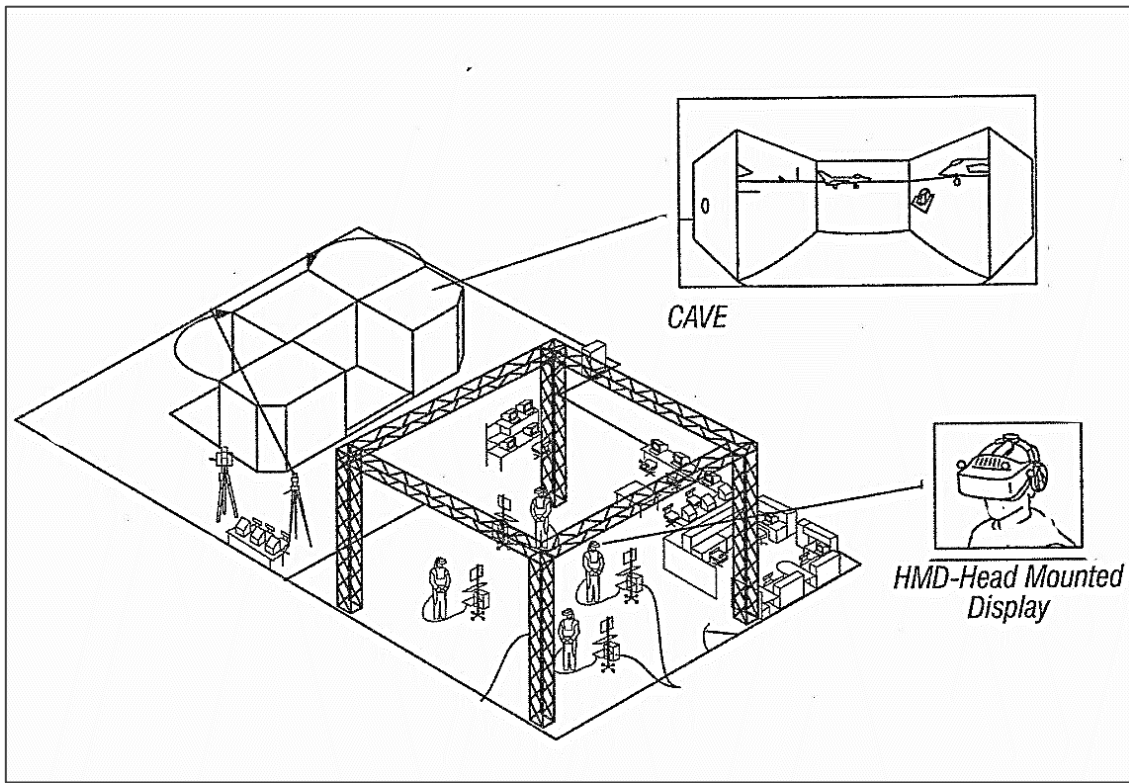


Figure 20 - [above] The differences between CAVE and HDM, image edited by Ana Moreira Bento from the original: Portable immersive environment using motion capture and head mounted display by Michael K. Dobbins *et al.*

Source: <http://www.google.tl/patents/US8624924>

Figure 21 - [below, left] CAVE Audio visual experience automatic virtual environment by Carolina Cruz-Neira *et al.*

Source: Cruz-Neira, C. *et al* (1992)

Figure 22 - [below, right] HDM, image edited by Ana Moreira Bento from the original: Portable immersive environment using motion capture and head mounted display by Michael K. Dobbins *et al.*

Source: <http://www.google.tl/patents/US8624924>



Stereoscopes aimed at visualization and perception of depth from 2D images: The Ultimate Display reached further, connected to computer, it aimed at the synchronisation between the movements of the viewer and the responses from the 3D display. The current HMD has similar characteristics to the Sutherland's device, however these days the display may not be process only by a computer, but also by a smartphone - as Samsung VR Gear.

Along with HMD, also CAVE is a dispositive that provides VR experiences. It is usually a five walls room, including the floor and the ceiling, where the virtual environment is projected. In 1992, a project named Cave Automatic Virtual Environment (CAVE), was developed into the Electronic Visualization Laboratory of the University of Illinois, Chicago (Cruz-Neira *et al*, 1992, p.65). There are also devices with two to six walls for the same purpose. The stereoscopic sensors disposed on the walls and in VR's gear give the possibility to track movements from the users. While the simulated environment is being displayed one or more users can interact in real-time with the simulation.

Luca Martinucci suggested that *Sala dei Giganti*, a room at the Pallazo del Te (1524-34) created by Giulio Romano is one of the first virtualised spaces, since the paintings on the walls pretend to communicate a different environment from the real one. (Martinucci, 2016) An illusionary perspective is achieved, pretending to dissolve the own spatiality of the room.

The term CAVE is an allusion to the allegory of the cavern by Plato. (Kenyon, 1995, p.1). The cavern represents a space that isolates Men, preventing them to see the real world. Some shadows, as projections of the outside world, are shown to them. Inside, the cave they get a filtrated perception of reality. Plato presents a derogative vision of a cave which will be subverted with the following exposition of CAVE:

The greatest advantages of the utilization of CAVE system are linked to the fact of promoting an easy communication of the design with the client, user, or even with the public in general. It is not always easy for laypersons to comprehend one project just through drawings (plans, facades and sections). The 3D models, perspectives

	Oculus Rift HMD	VisCube CAVE
Resolution	~1 Mpixel per eye	~2-8 Mpixels per screen
Image Quality	requires distortion and color correction	pixel perfect
Immersion	completely immersive	immersive
Field of View	100 degrees	170 degrees
Presence	disembodied, isolating	excellent, see your own body
User Volume	movement limited due to isolation, tether, and small tracked volume	completely wireless, precise tracking, move around freely in user volume
Users	single user	multiple viewers, one tracked user
Comfort	bulky, tethered, sweaty	lightweight glasses, wireless
Small Group Collaboration	not well suited	ideal for face-to-face meetings
Tracking Error/Latency	sensitive, simulator sickness more likely	much less sensitive, simulator sickness less likely
Accommodation	close screens cause eye discomfort over time	large, fixed screens comfortable with extended use
Cost	very low cost	high cost

Table 1- HMD displays vs CAVE

Source: [www.visbox.com/technology/cave-vs-hmd/](http://www.visbox.com/technology/cave-vs-hmd/)

and renderings are very useful, but they also present some limitations. When the project is displaying on the CAVE, the user has the opportunity of experiencing the building before the real experience of it: it is possible to better understand the project, the shapes of the building, the dimensions of the space, the light, the materials, the colours, etc. [...] We have observed a great interactivity and discussion of the project by people that watch the presentation of the project in a CAVE comparing with the ones that discuss the project in a “traditional” meeting room. (Antão, 2016)<sup>12</sup>

The possibility to represent the impacts of the design in a reliable version fortifies the dialectic system between all the stakeholders. Also it may provide a fair prevision of the impacts of the design project. It does not aim to distort the users’ vision, on the contrary, it may inform the user of real possible impacts. So, this description of CAVE differs from Plato’s description of the cave.

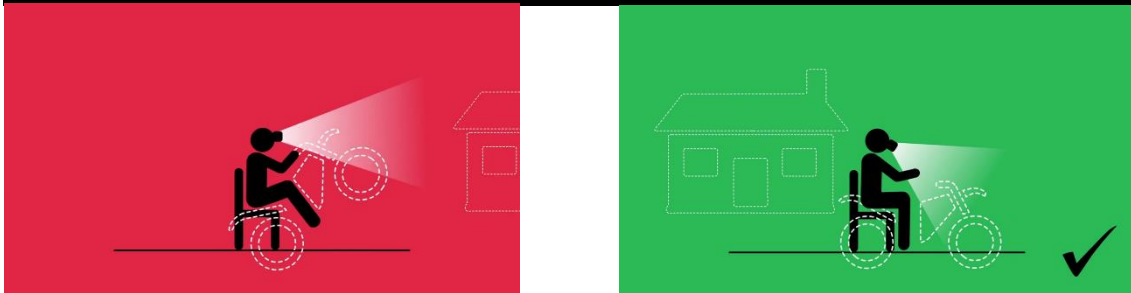
Having the table 1 as a reference to compare the two devices, some information can be understood about them. Note that since this table was retrieved from a website of a company that sells CAVEs, the following discussion will not be based on the information presented in this table, but rather on its comparison parameters.

Resolution and image quality are issues really dependent on the characteristics of the equipment. Thereby, it should not be assumed that CAVE can surpass HMD in this field. These devices are connected to computers or smartphones, therefore their performance may also depend on the quality of graphics card and central processing unit (CPU) of the computer. In the CAVE’s case, also the projectors’ quality influences the performance of the displaying set.

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<sup>12</sup> Translated from portuguese: “As maiores vantagens da utilização do sistema CAVE estão ligadas ao facto de facilitar a comunicação do projeto com o cliente, utilizador do edifício, ou mesmo público em geral. Nem sempre é fácil para uma pessoa não ligada à Arquitetura compreender um projeto apenas através de elementos desenhados (plantas, alçados e cortes). Os modelos 3D, desenhos em perspetiva/axonometria e visualizações/ renderings são bastante úteis mas ainda assim apresentam limitações. Quando o projeto é apresentado em CAVE o utilizador tem a oportunidade de experimentar o edifício antes de o experienciar: consegue perceber melhor o projeto, as formas do edifício, dimensões dos espaços, luz, materiais, cores, etc [...] Temos observado uma maior interatividade e discussão do projeto por parte das pessoas que assistem às apresentações no sistema CAVE em relação às que discutem um projeto numa sala de reuniões “tradicional”.” (Antão, 2016)

## VR RULES FOR ARCHITECTURE #1 Let the user control motion



## VR RULES FOR ARCHITECTURE #2 Beware Seated/Standing Mismatch



Figure 23 - Recommendations for a satisfying display with VR devices, set of shots from the video *MArch THESIS: VR AND ARCHITECTURE* by Daniel Voshart, edited by Ana Moreira Bento  
Source: <http://www.voshart.com>

The immersion sensation differs from one device to the other, since HMD promotes an individual visualization and the device is only assigned to the person who is seeing. Also, the glasses isolate the user from what is around him, plunging him into the displayed environment. In the CAVE the viewer is still aware of his context, while the displayed environment is being presented. This fact may not affect the CAVE performance, since it gives the user more awareness of what is around him. For instance, with HMD, when people try to interact with the displayed environment, usually they tend to make movements and sometimes they hit in objects around them, stumble or fall, since the person is “blind”. In the CAVE that it is not so frequent, since people are aware of their body’s position in relation to the context.

The field of view has impacts in the experience, as referred. As closer to 180 degrees field of vision, more approximately it will be from the current human being’s perception, and the CAVE ensures a more approximated experience on this topic.

The sense of presence differs between both devices. With HMD the users do not see their own body into the simulation and so they may feel isolated or disembodied. While in the CAVE the presence of the body enhances the sensation of making part of the simulated environment.

The comfort and accommodation topics may depend on the individual characteristics of the user. It is possible to feel sick with the two devices depending very much on the sensitivity of each person. Close screens may cause discomfort, however lenses may be aided by HMD in order to create the illusion of distance and disguise the real position of the screen. Sickness may also decrease with a fine synchronization between the movements of the user and by avoiding sudden movements or unnatural perspectives. These issues are not directly related to the type of devices, but with its specificities and the way the environment was pre-set.

Also the limitation of movements can be a considerable issue. HMD might need to be wired to computers. That could promote a tethered sensation and the inability to move with no restraints.



Figure 24 - A collective visualization in CAVE about the design of the Hospital District of South Ostrobothnia , image released by Uki Arkkitehdit

However, the CAVE does not allow full freedom of movements since the user is limited by the device's size. In both cases an omnidirectional treadmill synchronized with the devices could be added to help in this movement's limitation.

The number of users and the capacity of collective displays could be a differentiating aspect in what comes to architects and clients' needs for communicating. HMD is assigned to a single user, whereas the CAVE allows a multiple viewers presentation. In CAVE it is also possible to record the users' feedback about the simulated environment and watch it later in order to improve the design. Even though it is possible to display the simulation in HMD and see what the user is seeing in the computer, or display the same simulation in various HMD at the same time, the experience is always individual or assigned to each user's navigation. While the CAVE can host a group of people in one single display. However, navigation can only be determined by one person. There is one main user that is tracked and the others can also see the displayed environment by being inside the CAVE, but for an accurate perspective of the simulation they must stay as close as possible to the main user.

In terms of prices and logistical issues HMD have a lower price in relation to the CAVE. Also, HMD are portable while the CAVE requires installation and steady permanence.

Any of these devices could have a supportive role in the design process. However their acquisition might be a commitment between their characteristics, the function they are assigned to and the requirements of the design process. Even though the impact on communication is the most highlighted aspect in these sources, the impact on the conception of the designs is also relevant. The outburst of their impact reflects in the increase of a collaborative design process. This has a great impact in the Living Lab experiences, as it can be assessed by the following example.

In Finland, since 2006, the Hospital District of South Ostrobothnia is being designed with this kind of collective design spirit. A large team from different areas such as architects, doctors, nurses, VR engineers, and potential users are working together to design a *Hospital District*. Several experiences were made into a CAVE and the aim was to assess



Figure 25 – The assessment of the design project of the Hospital District of South Ostrobothnia  
Source: Wahlström, M. et al. (2009)



Figure 26 - The assessment of the design project of the Hospital District of South Ostrobothnia  
Source: Wahlström, M. et al. (2009)



the design process and the stakeholders' CAVE experiences at the same time. This project had three stages: the *Hospitool* (2006-2007) - to investigate different types of patient rooms-, *HospiCaseY* (2009-2010) – investigating the design of patient rooms, doctors'rooms and 1000m<sup>2</sup> on Emergency department - and *Evicures* (2014-2016) - investigating single patient rooms in the intensive care unit. The principal aim was to create a building totally assigned to the stakeholders' needs. With the participation of this large team it was possible to requalify the first proposals of the architects and to understand together the best options to that building. (Hellman & Jääskeläinen & Yli-Karhu, 2016)

This example shows how this type of tools help in the accuracy of the design before the construction stage, providing relevant economic, social and ecological impacts.

Two visits were made into architecture offices - which use these devices integrated in their design process- in order to understand the practical implications of their use. *Uki Arkkitehdit* and *18:25* were the architecture offices visited. The first is in Oulu (Finland) and was the first architectural office in Finland implementing the CAVE as a tool to support the design process. (Heikkinen, 2016) The second is in Lisbon (Portugal) and is one of the first offices integrating HMD in their work in Portugal. These are two pioneer cases that explored their own methodologies of work revealing the benefits of VR potentialities. Mikko Heikkinen is the director of *Uki Arkkitehdit* and described the attempt of implementation a CAVE into a living lab design experience- the Hospital District of South Ostrobothnia:

When the new hospital project started the promoters were thinking about 'how can we use the Virtual Reality, the CAVE, in the design of this new hospital?' And they ask us if we saw some opportunity to work with that, some kind of benefits about this approach. Nobody knew anything, of course. We only knew that it was totally new for us. But fortunately we reconsidered about it and we thought: 'yes, sure'. [...] we went into a room like this, and we were there for one day thinking: 'How can we implement the CAVE into the normal design process?'. We were thinking: 'why do we want to use it? What is the point of it? How we can gain some



Figure 27 - Photo from the Finnish architecture office Uki Arkkitehdit by Ana Moreira Bento

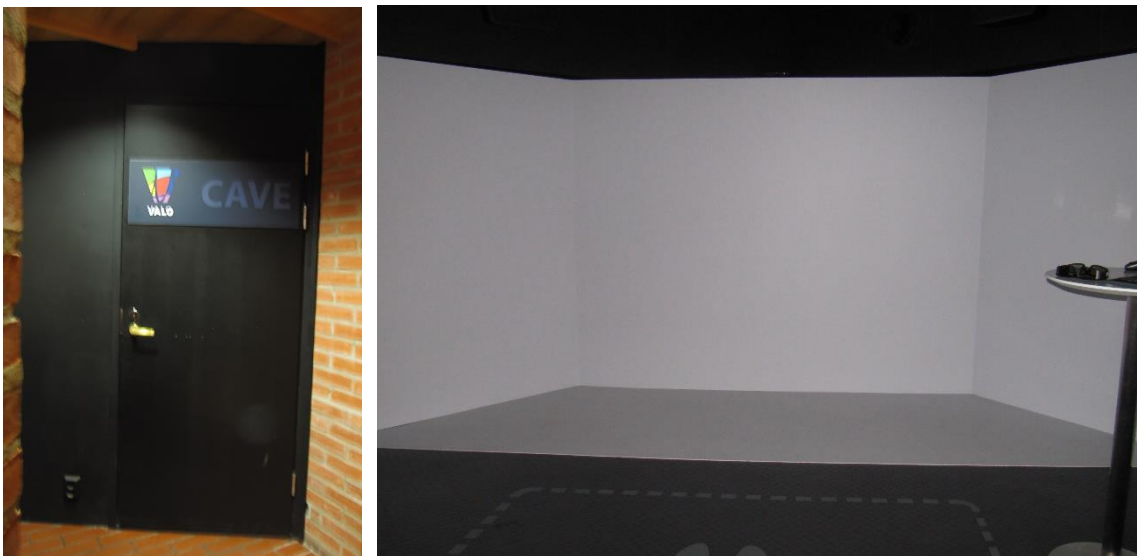


Figure 28 - Photos from the CAVE of the Finnish architecture office Uki Arkkitehdit by Ana Moreira Bento

information out of it? We were total zeros, but we started to think about it: ‘What can be the benefits?’ (Heikkinen, 2016)

This attitude reminds March’s temperance assigned to the exploration of suitable potentialities of a recent device. That behaviour can be detached in both cases. These explorations may reveal to be ground-breaking moments and become relevant for the introduction of new resources, methodologies and tools in the architectural practices. Heikkinen explains the benefits of the CAVE for the architect, in the contact with the clients and final users and also from the point of view of the office:

We have 45 people working here [at the office] and they are excited about the possibility to use CAVE, because we can visualize extremely fast the design. If we use it at the beginning of the design process - which we do now, because we have also developed our own software and the tools to do it - we can actually make some sketches there and make actually good comparisons with other designs. (Heikkinen, 2016)

Despite these benefits for the conception in the design process, the director also described the advantages for the communication process with the client. He claimed that the major benefits were outside the architect’s scope:

[...] we had this one project that the client came to us and presented their concept which included three buildings. Then we started to work on it and at the very beginning we reedited the concept, we modelled it and we went to the CAVE. Then the client and also the end users came to us and they were able to rethink their own thoughts about their own project in the CAVE. After all, the end users realised that one of the buildings, didn’t need to happen at all. They took 30% out of their budget, because everything worked in two buildings only. You can understand how this was extremely useful for our clients then. After that, they took this 1/3 of the initial budget and they did a much better building out of those two. And this happened already. It really can be a very benefiting tool. (Heikkinen, 2016)

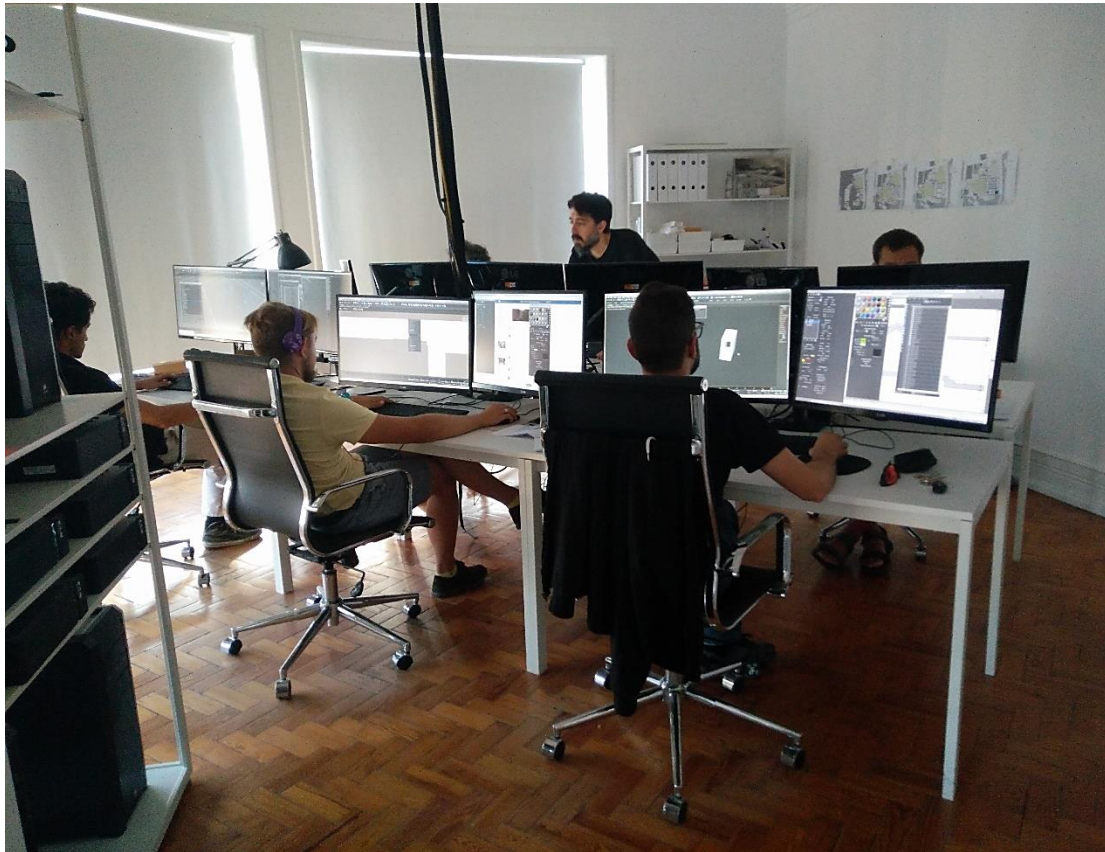


Figure 29 - Photo from the Portuguese architecture office 18:25 by Ana Moreira Bento



Figure 30 - An example of the 3D images, able to be seen with VR devices, generated by 18:25  
Source: <http://1825.in>

As it was already referred, VR devices can promote a suitable dialogue between all the stakeholders. A more active position in the evaluation of the design by the client, does not mean that the architect loses the control of the design. On the contrary, by knowing each other's intentions it becomes possibly easier to discuss the issues assigned to the design and to get to a reasonable commitment. The architect can use this tool to clarify his intentions and to justify possible changes.

Into the office perspective, Heikkinen explained that CAVE helped to expand the amount of work and consequently it was needed to increase the number of hired architects: “[...] we have more [clients]. It had benefits in that also: 8 years ago we were 25 people working here and now we are 45.” (Heikkinen, 2016). While *Uki Arkkitehdit* emphasized the use of the CAVE for the communication between the architect and the client, in 18:25 the impact into the conception of the design for the architect is the relevant point. Luca Martinucci, director of the office, said:

Besides this tool can be used to communicate [...], here in the office we use it into conception's perspective, to assure issues of the design. As you could see, we work often using Skype together with other architects. Through screen's sharing, we can interact with the 3D model and together solving the design. At the same time, we can generate *real-time renders* and assess the changes we are making. (Martinucci, 2016)<sup>13</sup>

There is an attempt of 18:25 office to produce 3D models of the designs, as they were actually constructing the buildings, by building it in a digital version. That could justify the fact that they call themselves *digital's builders* ([www.1825.in](http://www.1825.in)). They often help architects to understand the impacts of their architectural intentions by exploring them together into a VR representation. At the end of the process, a generated 3D environment of the building is created and reports the visual expression of the building.

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<sup>13</sup> Translated from portuguese: “Embora esta ferramenta possa ser utilizada a nível de comunicação [...] nós aqui no escritório usamo-la na perspectiva da concepção para aferir questões do projecto. Como pudeste observar, nós trabalhamos muitas vezes por Skype em conjunto com outros arquitectos. Através da partilha de ecrãs, vamos interagindo com o modelo 3D e em conjunto vamos resolvendo o Projecto. Ao mesmo tempo conseguimos gerar renders em tempo real e ir aferindo as modificações que vamos fazendo.” (Martinucci, 2016)



However these are not only promotional images of the design, but a visual consequence of the verifications made during the design process. These are not only generated images to communicate with the clients or the end-users, but also representations created and used during the architects' work process. As in *Uki Arkkitehdit*'s case, they have also developed a software aimed for the use of HMD devices:

The software that we developed to use the glasses [Samsung Gear VR], makes part of our own process, which the aim is the maximum control of architecture. We develop a simpler system of interaction. We have various pairs of glasses that we rent, sell or borrow. Often, we send them to architecture offices which we work with, in order to see the design in 3D, in 360 degrees and in real time, and make changes together. This allows an improved control of the design and also the scale issues. (Martinucci, 2016)<sup>14</sup>

The creation of an image to represent the design deserves a careful attention by the architect. This issue is not only assigned to VR, but to all the types of representation. The objectives of representing in Architecture are also assigned to functional aspects and so representations may not delude the viewer by subverting the qualities of the design:

The problem is the possibility to become addicted in constructing an image, once Architecture is not an image. It will be the same problem if we become addicted about a drawing. This [VR] is only a support or a tool so that we can construct. Good Architecture is not the drawing. It is what the drawing might provide to be generated in spatial terms, in physical terms. My concern is this one, it is that we became to be addicted in found a good image and we did not think that, in fact, Architecture is

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<sup>14</sup> Translated from portuguese: “O software que desenvolvemos para utilizar os óculos faz parte do nosso processo, em que o objectivo é o máximo controlo da Arquitectura. Nós desenvolvemos um sistema mais simples de interacção. Temos vários pares de óculos que alugamos, vendemos ou emprestamos. Muitas vezes enviamo-los para os escritórios de Arquitectura com quem trabalhamos para podermos, em tempo real, ver o projecto em 3D e em 360 graus, para fazermos alterações em conjunto. Isto permite um controlo mais aperfeiçoado, para além de podermos controlar melhor as questões de escala.” (Martinucci, 2016)



## Paralysed patients are able to walk again using virtual reality and brain training in 'suprising' breakthrough

- Scientists used a VR system which worked with patients' brain activity
- System simulated control of the patients' legs during the programme
- The technique could offer hope to people who suffer spinal cord injuries

By ABIGAIL BEALL FOR MAILONLINE and COLIN FERNANDEZ FOR THE DAILY MAIL  
PUBLISHED: 13:01 GMT, 11 August 2016 | UPDATED: 07:50 GMT, 12 August 2016

ASTRONOMÍA, TECNOLOGÍA

La alucinante realidad virtual que nos permite pasear por Marte

Por Zuberóa Marcos | 31-08-2016

MUSIC

## Virtual Reality Waits for the Music Industry to Catch Up

By GREGORY SCHMIDT | JULY 25, 2016



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## 2016: the year when VR goes from virtual to reality



Rory Cellan-Jones  
Technology correspondent

1 January 2016 | Technology

## O que é que a realidade virtual pode fazer pelo jornalismo?

R.B. Brenner, director da Escola de Jornalismo da Universidade do Texas, é o orador principal das "Conversas sobre o Futuro do Jornalismo"

Texto de Adriana F. Afonso • 31/05/2016 - 15:21

## Le cinéma s'immerge dans la réalité virtuelle

Tandis que MK2 ouvre une salle dédiée à la « VR », la frontière s'efface entre jeu vidéo interactif et récit cinématographique.

LE MONDE | 07.12.2016 à 06h44 • Mis à jour le 09.12.2016 à 10h57 |

Par Laurent Carpentier

The Telegraph

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Apple iPhone Technology News Technology Companies Technology Reviews Video

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## How virtual reality is going to change our lives

2016 will be the year of VR. Here's how it will change everything from medicine to the military.

Figure 31 - A few online international newspaper-clippings about VR and its impacts, collected and edited by Ana Moreira Bento

Sources [starting from above]: [www.dailymail.co.uk](http://www.dailymail.co.uk), [www.elpais.com/](http://www.elpais.com/), [www.nytimes.com/](http://www.nytimes.com/), [www.bbc.com/news](http://www.bbc.com/news), [www.publico.pt/](http://www.publico.pt/), [www.lemonde.fr/](http://www.lemonde.fr/) and [www.telegraph.co.uk/](http://www.telegraph.co.uk/)



way much than that. However the fault is not on the system, but on the way that it is used. (Mendes Ribeiro, 2016)<sup>15</sup>

This position reminds once more the need to use representations in a critical way aiming at the fair information about solutions and functionalities and also the anticipation of elements or events.

### **Spreading factors and evolution of VR**

Considering the potentialities and the particular characteristics of VR, as a tool that adds different possibilities into the architectural scope, some new approaches may be created. VR is increasing its application into the various areas as medicine (into psychiatry and surgery), mechanical engineering, education, journalism, music industry, cinema industry, military purposes and astronomy, for instance.

The entertainment business is one of most active fields of VR explorations. 2016 was considered the year of VR from some European media as *The Telegraph*, *Euronews* and *BBC News*, by the amount of VR devices launched. The main utilisation of VR has been made by Video Games Industries. According to the website Fortune.com, “consumers will spend \$5.1 billion on virtual reality gaming hardware, accessories and software in 2016”. Europe will be the highest consumer with a forecast of \$1.9 billion spent on VR and the forecast announces an exponential increase until 2020. (Fortune.com) The HMD was the VR device highlighted for 2016 with the launching of new devices: either for smartphones – as Google Cardboard and Samsung Gear VR -, for personal computers (PC) – as Facebook’s Oculus Rift and the HTC Vive -, or even for consoles - as Sony’s PlayStation VR.

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<sup>15</sup> Translated from Portuguese: “O problema é a possibilidade de nos viciarmos na construção de uma imagem, sendo que a Arquitectura não é imagem. Seria a mesma coisa que nos viciarmos num desenho. Isto é apenas um suporte ou um meio para podermos construir. A boa Arquitectura não é o desenho. É aquilo que o desenho pode possibilitar que se gere em termos de espaço, em termos físicos. O meu receio é esse, é ficarmos viciados em encontrar uma boa imagem e não pensarmos que, de facto, a Arquitectura é muito mais que isso. Mas a culpa não é do sistema, é a forma como se utiliza.” (Mendes Ribeiro, 2016)

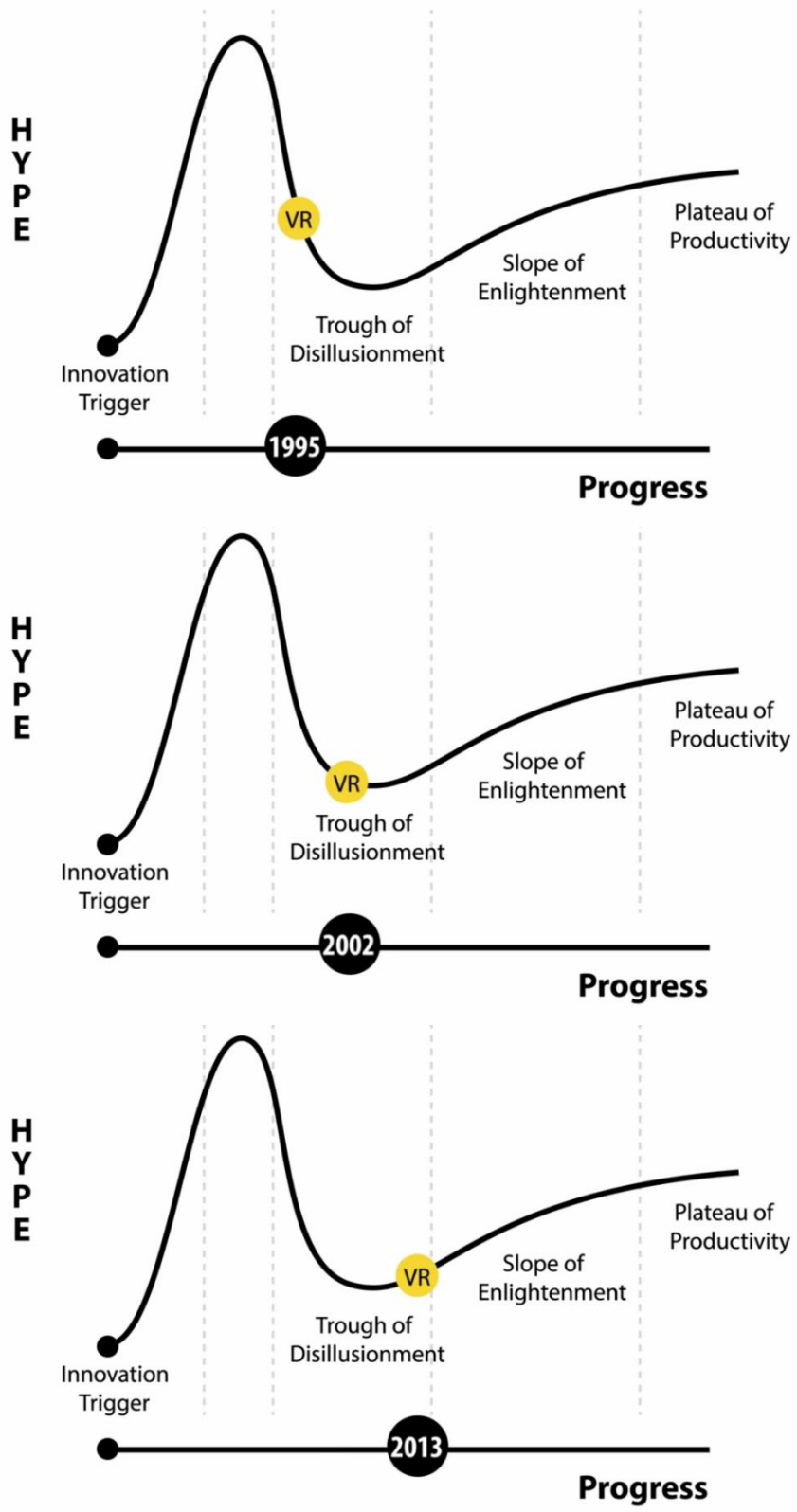


Figure 32 – “The hype cycle”, set of shots from the video *MARch thesis: vr and architecture* by Daniel Voshart, edited by Ana Moreira Bento  
 Source: <http://www.voshart.com>

Despite the gaming issues, this situation will contribute for the spreading and the development of this tool. This means that experiments are being made about this tool and the equipment assigned to this type of experience – as VR devices – are reaching lower prices. The contribution that the video gaming industry has been given is worthwhile in order to preserve and increase the valences of this tool so that the various areas previously enounced along with Architecture can start to use it as an operative tool.

Not just its spreading factor can be considered, but also its evolution. According with the graphic from Daniel Voshart the period of disillusionment about VR technology has already passed. 2016 is at the beginning of the “slope of enlightenment”. After this period Voshart predicts that VR tends to reach a “plateau of productivity” (Voshart, 2015). Considering Moore’s Law<sup>16</sup> it may be predicted that VR tends for the maximum sensation of reality with the minimum of hardware. The performance of a VR experience depends on how much the simulated environment can reach a closer approach to a real experience, by deluding the senses of the user. The fewer hardware used by the viewers and the higher quality of display can contribute to a more close version of a real-world experience.

Considering these factors of spreading and evolution of VR, Architecture may find some opportunities in using this tool as an approach to reality. In the scope of this dissertation and after some contact and reflection about this thematic, four fields of action were identified and pointed out, as situations that reveal the potential of VR in Architecture. The four fields identified are: Technical verification and validation of the design through VR; Preservation of the Architectural Patrimony through VR; Creation of virtual architectural environments through VR; Creation of architectural portfolios through VR.

Even though there are four fields, just the last one will be developed thoroughly in the next chapter. The presentation of the remaining fields ensures other possibilities of approach to VR in Architecture. They also help to clarify the pertinence in development

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<sup>16</sup>“Moore’s Law is a computing term which originated around 1970; the simplified version of this law states that processor speeds, or overall processing power for computers will double every two years. A quick check among technicians in different computer companies shows that the term is not very popular but the rule is still accepted.” ([www.moorelaw.org/](http://www.moorelaw.org/))

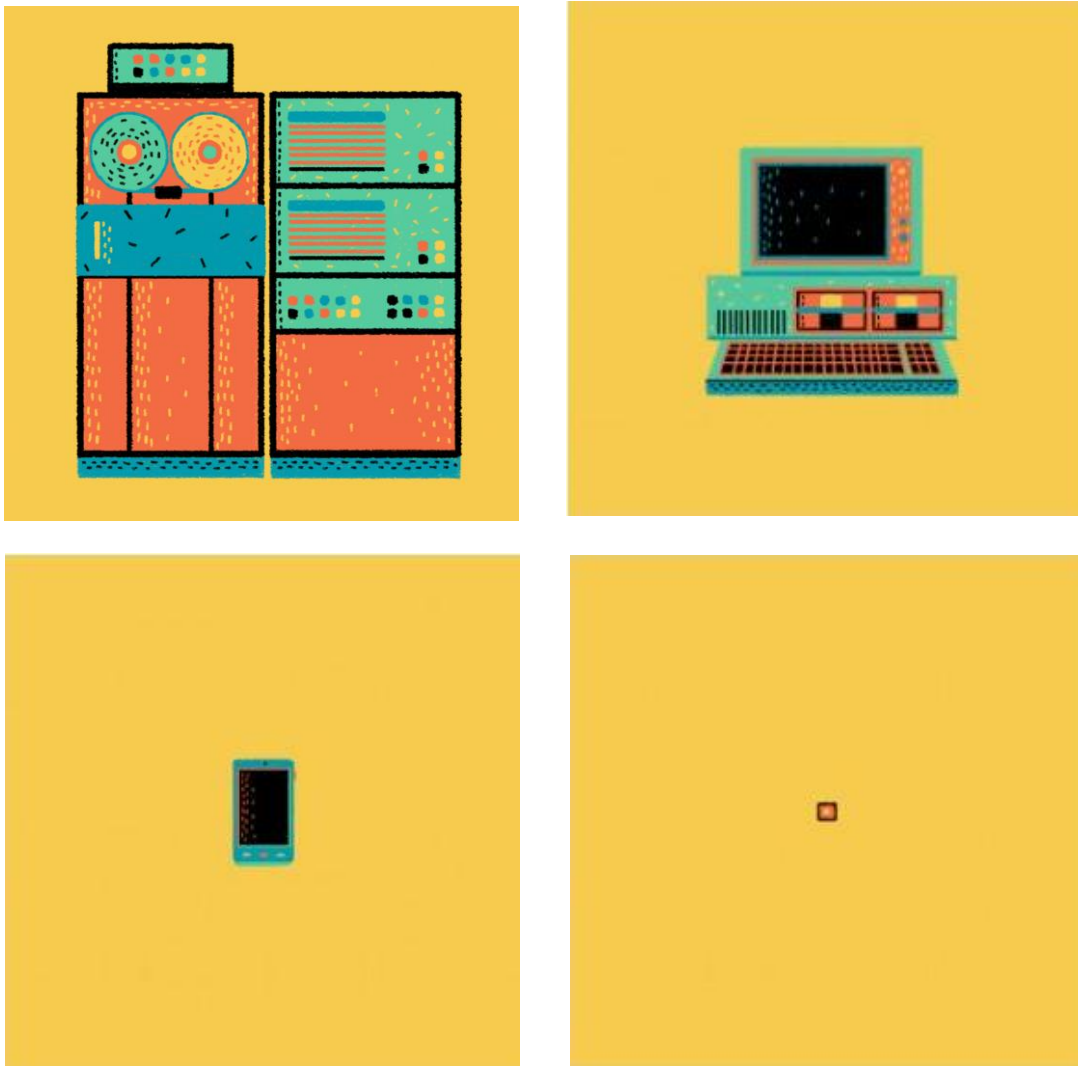


Figure 33 - Moore's Law applied to the size of hardware, set of shot from a Gif by Yukai Du Source: [www.technologyreview.com](http://www.technologyreview.com)

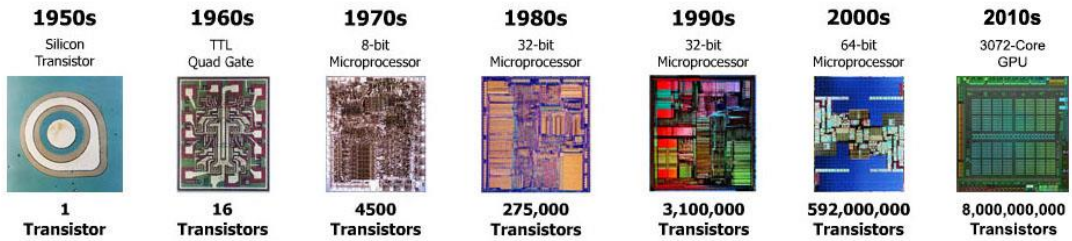


Figure 34 – Evolution of microprocessors Source: <http://www.computerhistory.org/>

just this detached field, since is the only that envisions the potentialities of VR into an experimental and learning environment as schools. Some of these fields are already being developed, while the last one may constitute a new opportunity for architects.

## **Four fields of approach**

### **Technical verification and validation of the design through VR**

This integration of VR as a tool to assess the design is already an established field, as it was previously demonstrated with *Uki Arkkitehdit and 18:25's* cases. The possibility to enter inside a building before its construction adds extra possibilities to the design process, providing two major advantages related to different stages: conception and communication.

One first main aspect is the possibility to develop a single virtual model that allows the verification of various aspects of the design. For instance, the capacity to alternate between closer perspectives and more distant ones, using one single model. Since there is the possibility – with just one model - to analyse the design in an immersive view, but it is also possible to see it in different perspectives - as its insertion into the urban scale or other scales that can reveal details of construction, for example. This ability to switch between perspectives gives the opportunity to assure various issues from the same building with just one model. In contrast, using analog representations this procedure would require the execution of several different models. Also, it is also possible to experience a space as a wheelchair person, allowing a closer anticipation of the building's accesses, for example. These are a few examples of the possibilities that VR provides to architects in their own process of work, as it was demonstrated by the two offices visited.

The second major aspect of VR potentialities in this field, is the possibility of having a collaborative work environment with various stakeholders. As VR simulates a modelled environment, it is possible to comprehend the technical aspects from various professionals and to have the feedback of laypersons, as it happened in the Finnish hospital referred. Since VR may promote a better understanding of the design as



compared with the traditional methods of representation, by the public in general, it constitutes a main resource for the design project. Buildings assigned to specific functions or to particular uses - as hospitals and schools - may suggest a living lab design project to assess its validation. Often the end-users have specific needs and profiting from a VR experience they can distinguish the operating aspects and the dysfunctional ones. They also can have particular requirements assigned to their profession that demand a close attention from the architect.

In order to understand these aspects and the importance of having all the stakeholders' collaboration, interviews were made to participants of the Finnish hospital district's design process. The Architects Jyrky Jääskeläinen and Pauli Koivisto, the designer coordinator Tiina Yli-Karhu and the VR laboratory engineer Tapio Hellman were interviewed in order to describe the impacts of a VR device, as CAVE, into a collaborative design process.<sup>17</sup>

Over 200 participants integrated this project and the conciliation of all of them ideas and indications was considered a challenge. (Jääskeläinen & Yli-Karhu & Hellman, 2016) As Jääskeläinen described, in this case was not necessary to model the entire building, just few parts from it. Those specific parts were considered the ones that required some special evaluation. For instance, the intensive care rooms were a daring case, because they aimed at a new disposition of the patients per room, which implied the nurses' concerns. In this collaborative design process, the testimony of the end-user was a relevant issue to assess the functions that the building would have to cover. In this particular case of the intensive care unit, a different approach in the contact between the nurses and the patients was reached. The nurses were used to look over various patients in the same room. However, in this new building patients were aimed to be disposed into single rooms. Since it was not profitable to have a nurse per room, all stakeholders had to work in order to find a suitable solution. Therefore, a corridor was designed to connect all the single rooms and the nurses' desks were set along the corridor in front of the patients' rooms. Through a glass wall, one single nurse was able to see inside the patients' room and watch over two or more patients.

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<sup>17</sup> The full interview is present in the appendix of this dissertation.





This type of solution was not familiar to the nurses and the designers were also not totally aware of all the requirements about this situation. Thereby, simulations were made in a CAVE in order to represent a real hospital situation. The nurses could experience to be sit in their desks and look after the patients. They also could test their dislocation from the desk to the patients' bed in order to assure their visibility, the disposition of the hospital furniture and the accesses to the room. After this a few modifications were suggested as patients' bathrooms disposition and a different position also for the nurses' desks.

These previous descriptions allow to support the potentialities of VR devices into the design process. VR aids to preview the design as it will be in the future and so it can help to accomplish its aims, providing and testing different scenarios in an immersive way:

I think it allows us to predict certain aspects of the design that avoid interventions into the construction stage. It is possible to have a major control and that can bring very beneficial consequences [...] The design process is a stage to think, prevent and predict. This is one of the main aims of design. If we have tools that allow us in that process, we should use them, then. (Martinucci, 2016)<sup>18</sup>

### **Preservation of the Architectural Patrimony through VR**

This second field of approach between VR and architecture has qualities beyond the archaeological aspect that might be associated to it. Using VR to model buildings can be a step into the preservation of architectural values, allowing a type of immortalization of some building's characteristics. By modulating buildings it is possible to have a VR experience and visit the building into a simulated environment. There are different types of buildings that may require this kind of backup modulation as: relevant buildings that no longer exist or that are in risk of disappearing – by wars, natural catastrophes, or deliberate demolitions made by humans -; designs of buildings that have never reached

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<sup>18</sup> Translated from portuguese: “Acho que nos permite prever certos aspetos do projeto, que evitam intervenções depois na fase de construção. Conseguir-se ter um maior controlo e isso pode ter consequências muito vantajosas [...] A fase de projeto serve para pensar, prevenir e poder antever muitas questões. Esse é um dos principais objetivos do projeto. Se tivermos ferramentas que nos ajudem nesse processo, então devemos usá-las.” (Martinucci, 2016)



construction; and also buildings that exist nowadays, but their modulation reveals to be worthwhile for the most diversified applications. This VR version of buildings does not compete with a real-physical one, it is a complement and a surplus value. The modulation of these designs and buildings can be assigned to different issues like: gathering a VR architectural legacy instigated by researches about Architecture; for academic purposes, in order to study or visit relevant buildings that have impossible or difficult access; or to promote the diffusion of architectural culture, aiming at the involvement of the public in general.

In order to record and compile an architectural heritage to posterity, along with other analog or digital elements, VR models could promote a virtual immortalization of buildings. Taking as example the Svalbard Global Seed Vault, the Norwegian seed bank created to preserve a large variety of plant seed to prevent their loss, also an architectural bank could be created. That could also add to prevent the loss of some architectural heritage which could be considered important to humanity. Even though buildings could disappear or be destroyed, a virtual backup could assure its virtual existence.

### **Creation of virtual architectural environments through VR**

Designing triggers critical points of view, cultural aspects, poetical stands, deeper scrutiny of social organization, utopic proposals of space or the prediction of future needs about edification and spatial relations:

But does that mean every idea has to be built to be validated? Not at all. The richness of ideas presented here, the value of describing radical visions for the future, of speculating about an architecture that may never exist, and of pursuing notions that may go nowhere at all: these are an essential part of architecture as a risk-taking discipline. It is these endeavours that keep the culture of architecture alive, and ultimately push built reality to greater heights. (Hunter, 2003, p. 3)

This possibility of designing without aiming at construction, yet aiming at achieving an answer to certain problems - into the scope of Architecture - , identified by the architect,



it is also a possibility for the architects with VR. This attitude of thinking and suggesting about a problem without any specific proposal from a client, yet with the intention of reaching a solution to an identified issue, also integrates the role of the architect.

Designs can have individual character just by giving or pointing out a direction found by the architect, as in the cases of the *Cénotaphe de Newton* (1784) of Louis Bouleé, the *Phalanstery* (1829) of Charles Fourier, the *Broadacre City* (1932) of Frank Lloyd Wright or the *Continuous Monument* (1969-70) of Super Studio, where is possible to realise the strength of designs as architectural proposals.

These are some samples of this powerful approach of Architecture. Design is a seminal moment where the delicate act of exploring ideas, intentions and conjecture about volumes occurs. In schools of architecture there are exercises that aim at the maximum exploration of students' creativity proposing spaces and answering to problems identified by themselves. Most of these exercises do not aim at a real execution. However VR can promote the immersion in these proposals, inviting architects and students to experience their own designs, facing a generated environment that does not exist in the real world.

By designing and displaying VR buildings, or VR cities, the architect would provide the opportunity to common citizens to know these proposals. VR in this case could be like a portal for a VR modelled dimension where 3D scenarios could be visited and explored as the real ones. In the interview with the Portuguese professor of phenomenology and theory of Architecture Amílcar Gil e Pires, he claimed:

The phenomenology has to do with this, with the memories, with the dreams, with the creation, with the part of inhabiting the spontaneous and original creation of ideas level. This inhabiting enabled of being demonstrated, in a virtual way, becomes incredible. (Gil e Pires, 2016)<sup>19</sup>

Daniel Voshart in his Master thesis *Architecture and VR* (2015) claims that places like the Louvre Museum, which has an average of 26.000 visitors per day, spending about four hours per visit, have a cumulative time spent of twelve years per day. Disney World

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<sup>19</sup> Translated from portuguese: “A fenomenologia tem a ver com isso, com as memórias, com os sonhos, com a criação, com a parte do habitar ao nível da criação espontânea e original das ideias. Esse habitar podendo ser demonstrado, de forma virtual, torna-se incrível.” (Gil e Pires, 2016)



has a cumulative time spent of forty three years per day. This data contrasts with the cumulative time spent with the most played video games like Halo or World of Warcraft, with an average of 80.5 and 3700 years per day, respectively. (Voshart, 2015) This not only proves that “unbuilt projects can be occupied and experienced”, as it also reveals that the time spent by users in virtual spaces can surpass some of the more visited places in the world. (Voshart, 2015) This must not be understood as if virtual spaces could compete with the physical ones, yet as an additional field into the Architecture scope for the architect to explore.

The architect can find an opportunity into this situation. The opportunity does not lead to the creation of video games scenarios, but rather to the possibility of taking advantage of people’s predisposition to face a VR scenario. This willingness of people to contact with VR is not strictly assigned to video games. This interested might be perceived in other situations as in the cinema or museums. VR environments can be seen as models or drawings could be also seen, but with the possibility to experience the space in person. About this issue of designs that could be experienced by people, Professor Gil e Pires referred:

This reminds me a fantastic movie, in which some of the characters were architects: *Inception*. It is precisely about this issue of Virtual Reality, where they enter in deep level of the subconscious, where Virtual Reality become the reality of the own person. However the instrument was the Architecture and its conceptual component. (Gil e Pires, 2016)<sup>20</sup>

What is nowadays seen as fiction, can be explored by VR to become part of reality. Architects could plan dreamt sceneries, or even video game environments, movie sets and those places could be explored and experimented. This adds a field in the job market that can be explored and developed by architects. They could promote their own VR models proposals and entertainment industry companies could buy them to present those models to the general public in various formats.

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<sup>20</sup> Translated from portuguese: “Faz-me até lembrar um filme fantástico, em que alguma das personagens são architectas: *Inception*. É mesmo sobre esta questão da Realidade Virtual, em que eles entram em níveis profundos do subconsciente, onde a Realidade Virtual se tornava a realidade da própria pessoa. Mas, o instrumento era a Arquitetura e era a componente conceptual da Arquitectura.” (Gil e Pires, 2016)





### **Creation of architectural portfolios through VR**

Even though this topic may seem too close to the previous one, some particularities define its autonomy as a specific field. Architects, mainly the ones that do not have yet an establish position in the job market, as young or recently graduate architects, may need some strategies to become recognized. Portfolios operate as identification documents that give awareness of the skills and competencies of the architect. In some cases, they are used to apply for jobs or to compile the designs of the architect. Recently graduate architects have often the constraint of not having yet built projects. However, their portfolios reflect their researches and developed work on Architecture, as a compilation of hypothetical proposals. Portfolios are also their opportunity to detach themselves beyond others.

Beyond plans, sections and all the data that already consists of digital portfolios, could also be possible to promote VR visits to the designed buildings. That would give a more real perspective of the design project and could reveal competitive benefits considering other traditional portfolios. This advantageous position could contribute to highlight the architects, particularly in a saturated job market.

Also by using VR into the design process - and not just in the end of the design, for communication - students could share ideas and access the qualities of the designs. Students and recently graduate architects could visit each other's modelled buildings, into a shared network centred on VR resources. VR's potentialities and applications may provide a contribution for students and architects. It can be an opportunity to extend the field of action of the architects as also a possibility to enlarge the profession. This field led to the development of a proposal that will be presented in the next chapter.





### **3. A new point:**

A proposal

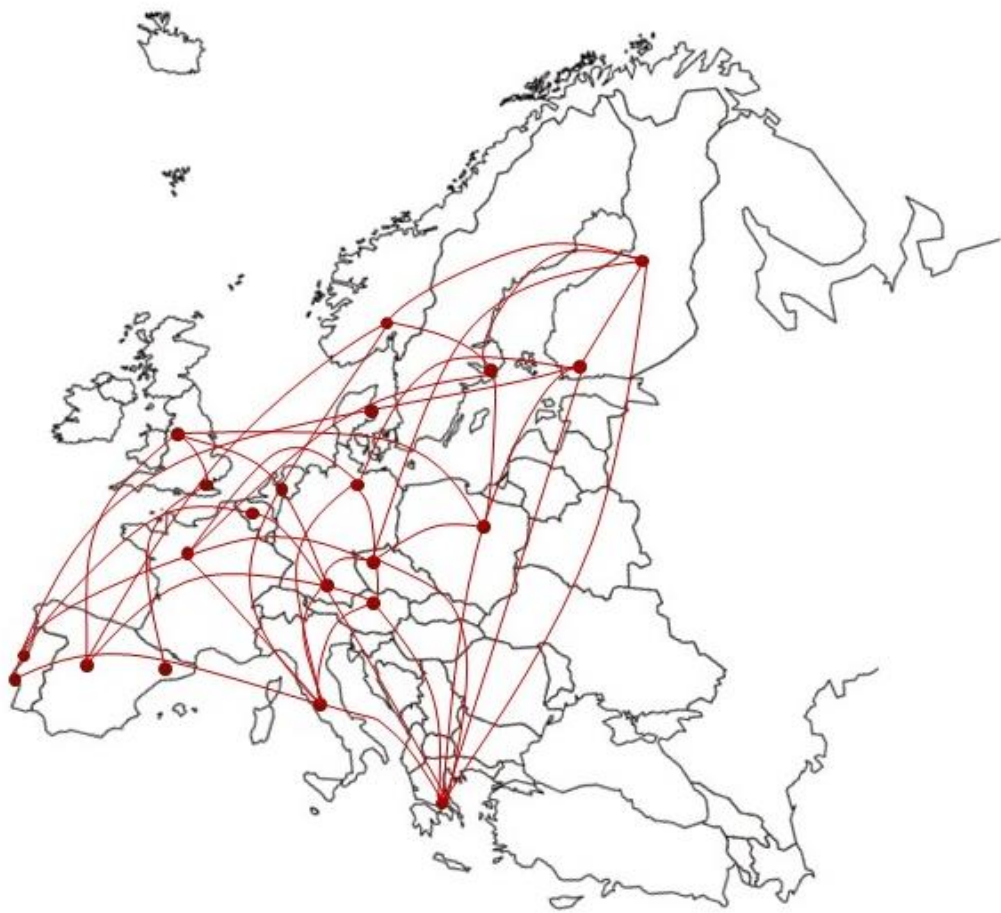


Figure 35 – A schematic representation of a possible European VR laboratories network, created by Ana Moreira Bento

After a technical analysis about the role of VR in Architecture and also after pointing some directions about its contribution at a conceptual level, one proposal will be developed, following on one of those directions pointed. The reason to follow this direction in particular is that, from the four cases presented, this one leads to a pioneer opportunity in Architecture.

### **From the idea to the field research**

All the discussion made, already in the previous chapters, about the contribution of VR for the architect was a starting point for this proposal. The possibility to establish a network between architects from different European countries, centred on the sharing of designs through VR architectural representations, was the core for proposing a project. VR, as a digital representation, has the possibility to be available in different places and to be seen from different people through proper devices in a type representation that is closer to reality. Considering this aspect, the possibility of having simultaneous exhibitions of designs developed by architects in different places around Europe in order to promote their work has been developed.

This project could be more appealing for architects, who do not have an established position in the job market, since they would be able to gain some visibility. Considering also that VR architectural representations could have costs and other constraints related to the required devices, space for equipment and acquisition of software, a VR lab was thought as a possibility to provide the necessary conditions to the interested architects. Following this intention, a submission of a project to Horizon 2020 (H2020) was considered as an opportunity to get the necessary budget to this kind of project. Also, the objectives and ambition of this project are coinciding with some of the objectives of the European Union - as it will be described in this chapter - and that justifies the relevance of the submission of this project to H2020.



Figure 36- Google cardboard  
Source: <https://vr.google.com/cardboard/>

The facilities assigned to those VR labs were thought to be integrated in schools of architecture. The necessity to acquire a critical capacity of management and skills about VR representations to designs was a topic considered. Therefore schools, as a place that might instigate creative experiments, that might reminds the aims and central problems to which Architecture intends to answer, that might promote a particular contact established between students, professors and architects, could be a relevant catalyst in the implementation of those labs.

Also, as said in the previous chapters students have a propensity to the new technologies: “The students are unequivocally much more apt and able to include that [digital resources] in their conception method.” (Campos, 2016).<sup>21</sup> This issue was related by Bermudez and King in 1998 about the computers’ usage from students:

[...] this design edge that academia has over practice is by and large not the result of faculty or administrators’ vision but rather a product of students’ proactivity. Having grown up surrounded by computers and pressed by the real need to develop marketable skills for jobs, architecture students slowly began bringing their own computers into the studio. As a result, schools find themselves today in the odd situation of having a hybrid productive environment with little or no elaborated pedagogy and theory to deal with it. (Bermudez & King, 1998, p. 9)

The fact that VR devices are being commercialised aiming a domestic acquisition makes it possible to purchase it from approximately five euros – in Google cardboard’s case. Considering, the recent release of these devices, their prices and the students interested in VR potentialities, it may exist the possibility of students to start to use them and bring them into schools as the 1990’s generation described before with computers.

The possibility of creating portfolios through VR might be an opportunity to students. Since VR is a tool that provides some opportunities to architects, which the “Digital Native” generation may have more appetite and sensitivity to explore and its exploration should be in integrated in experimental environments as schools.

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<sup>21</sup> Translated from portuguese: “Os alunos estão inequivocamente muito mais aptos e mais predispostos a incluir isso no seu meio de concepção.” (Campos, 2016)





Mark Prensky explains this situation by distinguish two kinds of generations in his article *Digital Natives, Digital Immigrants*. The author distinguishes the two terms: Digital Natives and Digital Immigrants. The first ones are described as the generation that: “grow up with this new technology. They have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age.” (Prensky, 2001, p.1). Digital Immigrants are described as those who: “were not born into the digital world but have, at some later point in our lives, become fascinated by and adopted many or most aspects of the new technology [...]” (Prensky, 2001, p.1). Prensky, alerts for the increasingly of a “new way of think and process information fundamentally differently” nowadays, by the younger generation (Prensky, 2001, p.1). For the Digital Natives the contact with digital world composes mainly their everyday practices, while Digital Immigrants may have the tendency to upgrade themselves to new technologies by comparing what they already knew from the analog ones. Thereby, the author completes: “Today’s students have not just changed *incrementally* from those of the past [...] A really big *discontinuity* has taken place” (Prensky, 2001, p.1)

Since those labs will be integrated in schools and students’ relation with technology is frequently detached, their relation and expectations about VR were assessed. The field research <sup>22</sup> allowed to question the students from six different schools. The surveys were distribute in three schools of Finland and Portugal, to students from the different years of the architectural courses. Five years integrate the Master degree in Architecture and the surveys aimed to enquire students from each year, however students from years over than the fifth were all integrated in the same group designated by 5 $\geq$ . Even though the surveys aimed to investigate the relation between students and VR, other questions were add about the other types of digital representations.

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<sup>22</sup> Described in the introduction of this dissertation.



## **From the field research to the project**

The main questions that instigated the surveys to students were:

- . *How is the relation between students and the digital resources – as 2D and 3D software;*
- . *How is the relation with VR resources?;*
- . *Can VR provide contributes to the architectural scope? Which ones?;*
- . *How are the expectations about the future of VR?;*
- . *What are the students' expectations in finding a job after graduation?;*
- . *Can VR contribute to finding a job in architecture?*

As expected results it was estimated that the relation of students with digital resources – 2D, 3D and VR- was closer in the Finnish schools than in the Portuguese ones. It was also expected that the prospects about the job market were better for the Finnish students than for Portuguese ones. It was also expected that the Portuguese students from the first and the second academic years were less aware about digital resources. It was estimated that the relation of students – from both countries - with digital resources were closer gradually from 2D, 3D to VR. It was not expected that students used VR devices, yet that they were aware of VR, its potentialities and also that they were interested about it. Some questions were more direct and short and others wider and open to achieve unpredictable answers. The surveys' script and the graphics of the results achieved are presented in the appendix of this dissertation. In order to make a critical analysis of the results obtained, some graphics will be presented forward.

*How is the relation between students and the digital resources – as 2D and 3D software? How is the relation with VR resources?*

This first question is not strictly related to VR, because it was also important to assess the relation with other types of digital resources. Since the relation between Portuguese schools and VR was already known before the research – by a previous contact established - the relation with the other digital representations was also assessed too. Also, since VR is a consequence of 3D software, the relation with the 3D was included in order to understand the students' propensity to use VR. For instance, students that only use 2D

**TOTAL [Finland & Portugal]**      **Total students inquired** [1st,2nd,3rd,4th,≥5th]: 305

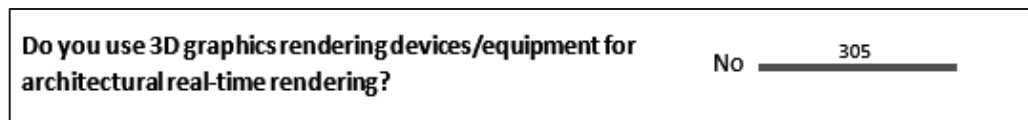
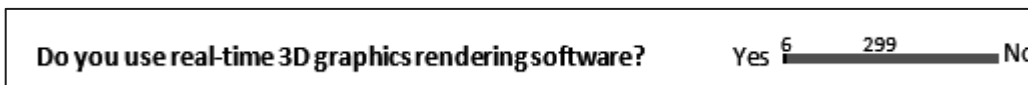
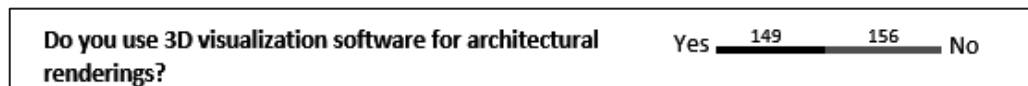
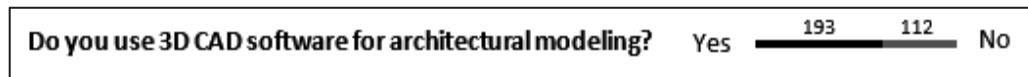
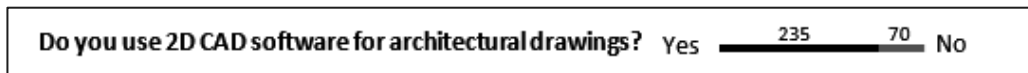


Figure 37 - The total results from the six schools (from all the students inquired, except ERASMUS students) about the questions that intended to assess the relation between students and digital resources. The full results are present in the Appendix of this dissertation.

CAD software in the design process are less able to use VR resources than students that, beyond 2D, use also other digital resources as 3D CAD software.

The scale provided in the survey that assessed the propensity to use VR into the design process starts from the use of 2D CAD software, followed by 3D CAD software, then 3D CAD rendering visualization software, then real-time 3D graphic rendering software and at last 3D real-time graphic rendering devices/ equipment – as HMD or CAVE.

The results show that, from the overall sample composed by the six schools, 2D CAD software are used by 235 students out of 305<sup>23</sup>; 3D CAD software are used by 193 students out of 305; 3D CAD rendering visualization software are used by 149 students out of 305; real-time 3D graphic rendering software 6 students out of 305; and 3D real-time graphic rendering devices/equipment is not used by any student out of 305 (Figure 37). The use of 2D CAD prevails over the other methods, while 3D real-time graphic rendering devices/equipment have a downgrade position into the design process.

In the Finnish schools the access to VR devices is less difficult than in the Portuguese schools. In Aalto's school there is a CAVE in the campus, placed at the research unit visited for the purpose of this dissertation. In Tampere's school there was a VR centre, with a CAVE, from 2000 until 2005, and some architecture students went there to have some courses. For some unsure reason, it was closed. (Lamppu, 2016) The Architecture department from Oulu, will move its facilities and Heikkinen suggested that in the new building they will have a CAVE. (Heikkinen, 2016) With the commercialization of HMD in 2016, an opportunity appears to the schools of both countries to be able to contact with VR devices.

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<sup>23</sup> A total of 316 students was inquired, however 11 of those students were under the ERASMUS program and for that reason they were analysed apart.

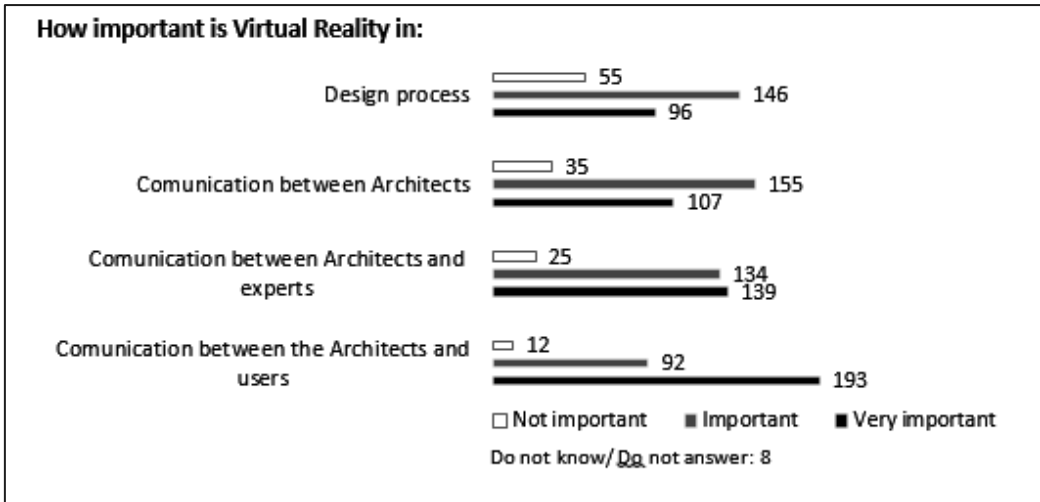


Figure 38 - The total results from the six schools (from all the students inquired, except ERASMUS students) about the typified question that intended to assess the importance of VR in student's opinions. The full results are present in the Appendix of this dissertation

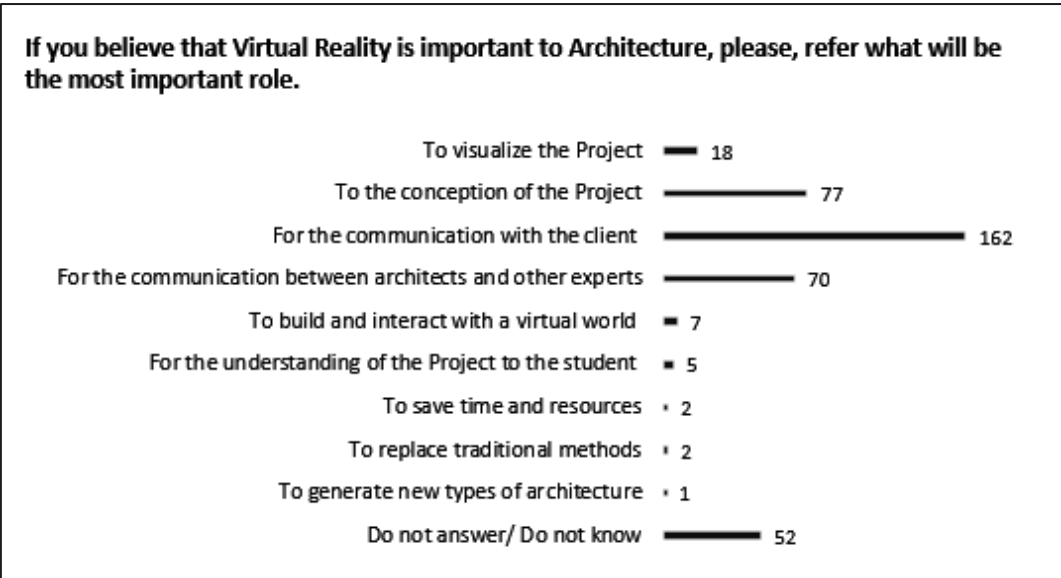


Figure 39 - The total results from the six schools (from all the students inquired, except ERASMUS students) about the open question that intended to assess the importance of VR in student's opinions.

*Can VR provide contributes to the architectural scope? Which ones?*

Besides VR being an unused resource for these students, the majority of them recognized that VR is important/very important for the architect in the design process. Enquired students also consider VR important to the communication between the architects. In the communication between architects and experts - as engineers and managers – students' opinions are divided between considering VR important and very important. While into the communication between architects and clients or end-users the majority of the students detached that it is very important. (Figure 38)

Also an open-ended question was made in order to understand other contributions that VR could provide in the architectural scope, apart from these previous ones. Students detached other contributions as: a contribution to save time and resources, to generate new types of architecture, to replace traditional methods and to build and interact with a virtual world. They also repeated the impacts into the highlighted aspects previously enounced like the contribution for communication and conception of designs. (Figure 39)

*How are the expectations about the future of VR?*

The majority of students said to believe that the future developments of VR will be increasing in both the schools of architecture and the job market. However, the majority of the students answered that into the job market the development of VR will take a greater increase. While in schools, the majority of students answer that VR will just increase. There is less positives expectations about VR future developments in schools than in the job markets. (Figure 41)

*What are the students' expectations in finding a job after graduation?*

The results about this question must be analysed separately per country, since the answers have different expressions to each country's context. In Finland, the future perspectives

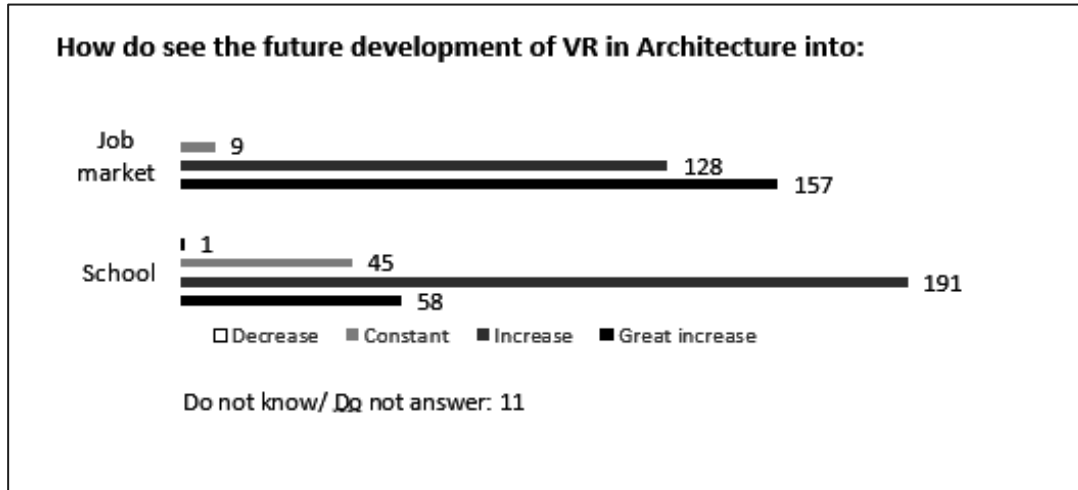


Figure 40 - The total results from the six schools (from all the students inquired, except ERASMUS students) about the typified question that intended to assess the expectations of the students about the Future of VR in Architecture.

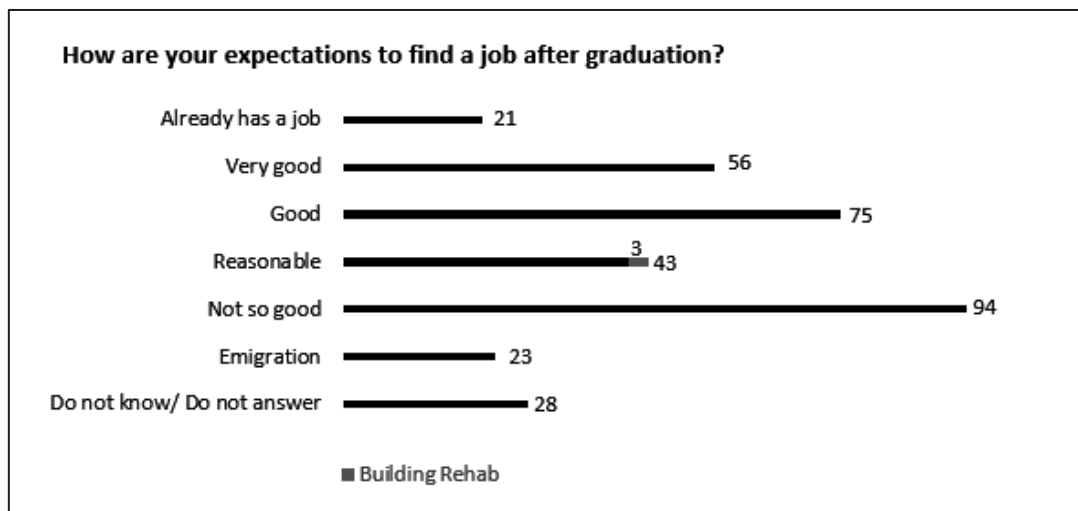


Figure 41 - The total results from the six schools (from all the students inquired, except ERASMUS students) about the open question that intended to assess the expectations of the students about finding a job in Architecture after graduation.



about finding a job after graduation are positive. The majority of students answered that their expectations are good, followed by the ones that said very good, and those are followed by the 21 students out of 137 that answered that they had a job already. A few Finnish students have less positive or negative perspectives in a total of 15 out of 137. (Figure 42)

In Portugal, the future perspectives about finding a job after graduation are more negative. The majority of students answered that their expectations are not so good, followed by the ones that said they were reasonable and those are followed by the 23 students out of 168 that answered that emigration were their expectations to find a job. A few Portuguese students have good or very good perspectives in a total of 15 out of 168. (Figure 43)

The differences between Finnish and Portuguese student's expectations are sharp. The number of Finnish students that answered to have a job already, are almost the same number of Portuguese students that said that emigration was their expectation. The values divert in a symmetric way between a positive and a negative scenario.

#### *Can VR contribute to finding a job in architecture?*

Even though the expectations about finding a job after graduating divert in each country's context, the majority of students settled about the contribution of VR in that situation. The most answered option was *yes* by 182 students out of 305, while 36 students said *maybe*, 47 students said *no* and 44 did not answer or did not know. (Figure 44)

The fact of students do not use VR as a tool, still recognised its potential and aimed at its integration in the architectural scope, is a relevant situation. A conclusion could be taken from it, as a possible desire and interest from the majority of the students, towards the already mentioned sensitivity and willingness to this kind of tool associated to a "Digital Native" generation. One the other hand, they may not explore the tool's potentialities, because it does not integrate the school's requirements. That may instigate them to explore this tool apart from the school plan of studies.

The autonomy to learn, as an autodidact component, is something that excels from students' learning process. Almost a third of the students who use 2D CAD software, 3D

**Country: Finland** **Total students inquired: 137**

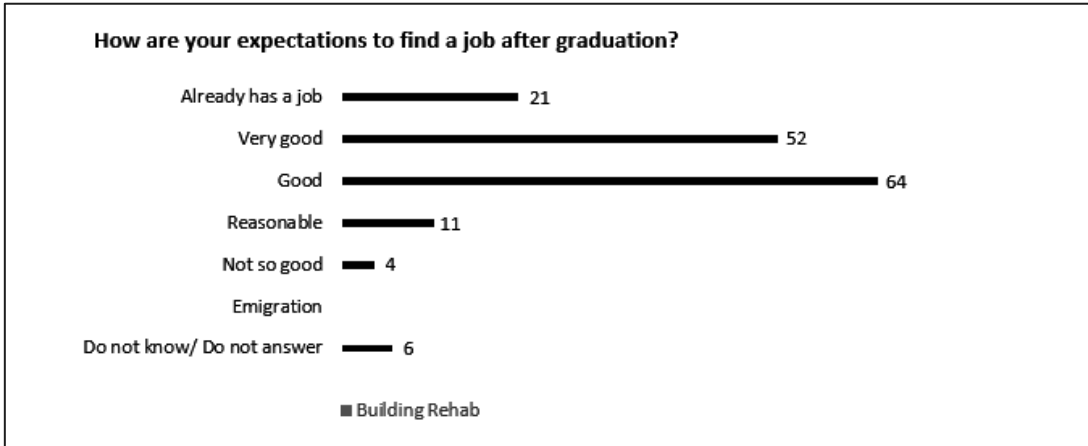


Figure 42 - The total results from the Finnish schools (from all the students inquired, except ERASMUS students) about the open question that intended to assess the expectations of the students about finding a job in Architecture after graduation.

**Country: Portugal** **Total students inquired: 168**

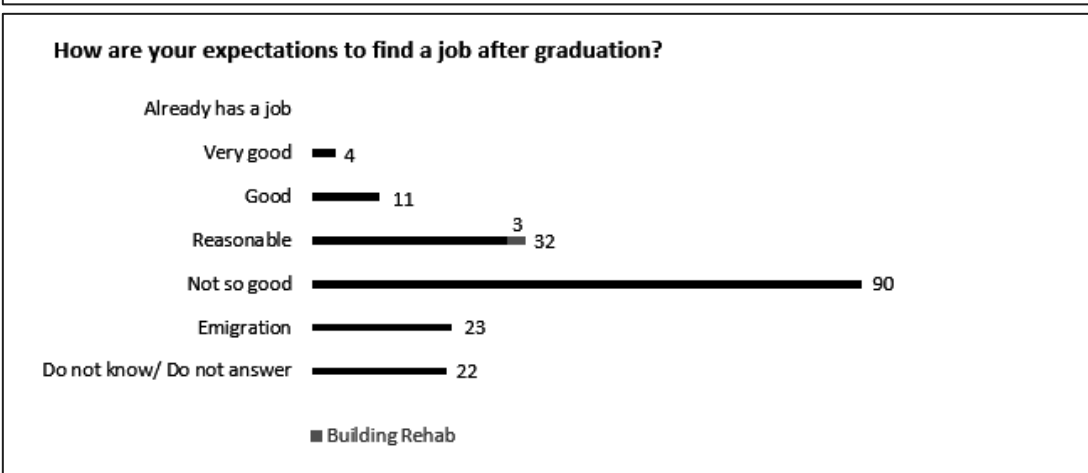


Figure 43 - The total results from the Portuguese schools (from all the students inquired, except ERASMUS students) about the open question that intended to assess the expectations of the students about finding a job in Architecture after graduation.

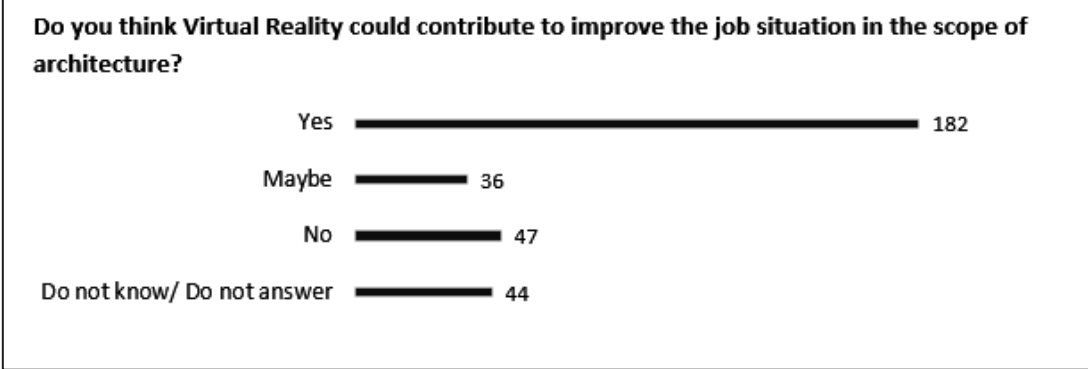


Figure 44 - The total results from the Portuguese schools (from all the students inquired, except ERASMUS students) about the typified question that intended to assess the contribution of VR at finding a job situation in Architecture after graduation, in students' opinions.

CAD software and 3D CAD rendering visualization software said to have learnt it by themselves. Oporto and Lisbon schools are the cases where this situation is wide expressive. While in real-time 3D graphic rendering software all the students that work with it, said to have learnt it on their own. In Oporto's school every type of software was mainly learnt in an autodidact way. Since students of Oporto's school only start to learn how to use digital tools in the third year beyond, the students may found the need to learn it before the lessons provided from the school. The autodidact approach may found more expression in the Portuguese schools since the software are taught through curricular units assigned to them.

In the Finnish schools the software are taught into lectures provided in the first curricular year and by some workshops provided by the school. Thereby, Finnish students do not have an expressive autodidact approach. Into this perspective Portuguese schools guide the use of digital tools by students, not providing lectures in the first year, separating the analog hand-made learning process from the digital one. While Finnish schools promote a media interaction environment between the analog and the digital since the first year.

In conclusion, more than a half of the students enquired have positive expectations and opinions about VR potentialities into the Architecture scope, even though the majority does not work with VR environments nor uses VR devices. Also, there is the willingness to learn in an autodidact mode that may mean the anticipation of the contents lectured in school - as 2D CAD software, 3D CAD software and 3D CAD rendering visualization software - or the interest in learning more contents and software apart from school- as real-time 3D graphic rendering software. The fact that students do not work with VR could be associated to the fact that schools do not have the software or the devices available. However, with the launching of VR devices in 2016 for commercial purposes, as already referred, the situation may change as students might acquire VR devices.

Professors from each school were also interviewed in order to assess their opinion about VR as a tool to integrate the architectural design and specifically for students' exploration. They also were inquired about the relevance of integrating VR into the school scope. Professors' considerations about the usage of those tools by students in the design process



diverge. Four of the twelve professor's enquired defend its usage from a wide array of tools and methodologies, with recognised potentialities, available to the students since the first year:

I would start with the first year students. They need to learn almost all the digital tools, software at the first year. They urge to get them in use. We have to remind them also that hand drawing is a very important thing and of course they know that. They will use them all. They will also make physical scale models. (Lamppu, 2016)

Once understood as a tool, an instrument, a set of codes that allow representation, conception and the communication of certain realities, I would say that it should be learnt as one learns how to draw or do models. The reasoning has to be predisposed to it. Thereby it might be learnt since the first year [...] (Campos, 2016)<sup>24</sup>

Six from the twelve professors defend a conditioned usage of the tools in the first years, which separates the analog from the digital ones – specially focusing in the VR ones -, by giving primacy to the analog resources. Professor Ahola, when asked about which year did she thought that VR resources should be learnt she answers: “Not in the first year. Only when you know what you are designing.” (Ahola, 2016). Also professor Manuel Graça Dias claimed:

I do not see a great need in that kind of thematic to be deepened into a school level. Because at the school level [...] it is instigated the experience of hand-drawing. Why are students not allowed to do the design process using computers before the second or third year? Because everyone knows that one thing is to know how to draw using computers and another is to know how to hand-draw. [...] Using AutoCAD it is possible to draw, but the intelligence spent in that kind of drawing is not the same as the one spent in hand-drawings [...] I also do not believe that schools of Architecture

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<sup>24</sup> Translated from portuguese: “Quando entendida como uma ferramenta, um instrumento, um conjunto de códigos que permitem representar, conceber, comunicar determinadas realidades, eu diria que se deveria aprender como se aprende a desenhar ou a fazer maquetes. O raciocínio tem de estar predisposto para isso, portanto pode ser aprendido desde o primeiro ano [...]”(Campos, 2016)



have to bend to every novelty that appears, under the risk of losing a certain kind of teaching in which we believe and that has given good results.

(Graça Dias, 2016)<sup>25</sup>

Two of the twelve professors enquired do not pronounce themselves about this, yet Professor Raquel Paulino, as member of the scientific board of Oporto's school, describes the intentions behind the pedagogical curriculum:

A certain agreement has been held over the years, [...] especially in the first and second years, but even more in the first, we should not introduce this kind of tool into the curriculum. [...] Before the third year students are not allowed to develop the design project using digital tools. It must be used the hand-drawing, with ink, and rulers [...] From the third year beyond, it is recognised that the student already dominates this initial stage and thereby every tool digital or virtual can and must be introduced to enrich the design process.<sup>26</sup> (Paulino, 2016)

The first perspective instigates an equal approach to tools, recognising each one's particular potentialities and Oulu's school is the exceeded example of it, having the higher positive answers on 2D CAD knowledge from the six schools – every student knows how to work in 2D CAD software. Also regarding the knowledge on the other types of software the answers are the highest from the other schools, except real-time 3D graphics rendering software, but the results are closer to the average results from the six schools.

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<sup>25</sup> Translated from portuguese: “Não vejo grande necessidade desse tipo de temas ser aprofundado a nível da Escola. Porque a nível da Escola [...] é incentivada a experiência do desenho à mão. Porque é que os alunos não estão autorizados a fazer projecto em computador antes do 2º ou do 3º ano? Porque todos nós sabemos que uma coisa é saber desenhar no computador e outra saber desenhar à mão. [...] No AutoCAD desenha-se, mas a inteligência posta ao serviço desse tipo de desenho não é a mesma do desenho à mão. [...] nem acredito que as escolas de Arquitectura tenham de ser vergar a todas as novidades, sob risco de se perder determinado tipo de ensino em que acreditamos e que tem dado bons resultados. (Graça Dias, 2016)

<sup>26</sup> Translated from portuguese: “Tem-se mantido um certo consenso ao longo dos tempos [...] sobretudo no 1º e 2º ano, mas até mais no 1º, que não deveríamos introduzir este tipo de ferramentas no Currículo. [...] Antes do 3º ano os alunos não estão autorizados a fazer entregas recorrendo às ferramentas digitais. É ainda o desenho à mão, passado a tinta, com paralelas [...] A partir do 3º ano, entende-se que o aluno já domina no fundo esta fase inicial e então tudo o que são estas ferramentas digitais e virtuais podem e devem ser introduzidas para enriquecer o processo. (Paulino, 2016)





The second perspective defines a hierarchy of tools, where some may have a detached role above others, considering the curricular aims. From all six schools, Oporto's school is the one with a closer profile to this perspective, since the students ought to use analog tools until the third grade and not use digital tools. In the schools of Lisbon and Coimbra is also a close situation, but students start to be introduced to digital representations one year before the school of Oporto.

Although the opinions from students and professors about the taught contents, could be considered relevant to establish a profile of possible usage of the VR tools into schools, the plan of studies is the determinant factor. It is not part of this dissertation to question the school's plan in order to integrate VR. Yet, it is recognized by Bermudez and King that "Schools are great experimental grounds" where explorations can occur (Bermudez and King, 1998, p.9). Schools can also instigate the formation of a critical intelligence as Gil suggested – already referred in the chapter 3 (Gil, 2005, p. 45). In that issue schools could assess the validation of the students' explorations about digital tool – including VR- and may prevent questionable usages of it without any alteration to the pedagogical curriculums.

Summarising and considering various factors, such as: the detached opportunities that VR might add to the architect, the contribution that VR architectural representations can provide in the visibility of designs, the expectations and sensitivity to the usage of this digital representations –including VR - from the Digital Native generations, the costs and constraints that this type of technology may imply and also considering the capacity that schools may have in present different methodologies and contents with a critical thought, a consolidative proposal was thought.



## **The European VR lab network project**

### **Introduction**

The integration of VR into architecture schools was thought considering that the character of schools may not just be seen from a plan of studies perspective, but also including the extra-curricular contents. This dissertation does not intend to reconfigure the contents taught by schools, yet to present a complementary approach envisioning other possibility assigned to an autonomous learning mode. Beyond the teaching activities, also investigation, transfer and valorization of knowledge are valued aspects, under the criteria of the University of Coimbra, for example ([www.uc.pt](http://www.uc.pt)). Also, after the accession to the Bologna Process - that covers Portuguese and Finnish schools - the time that each students spend in acquiring knowledge autonomously is contemplated in each curricular unit ([www.dre.pt](http://www.dre.pt)). There are components apart from lectures which can also assess students' acquisition of knowledge and skills that may assure the process of learning. Those components may also include the possibility of managing the exploration of a tool as VR into a critical and great experimental environment as laboratories.

Bruno Gil in his Master Thesis *School of Architecture, Today* (2005) suggests a laboratory for communication, as a “*space study*”, where information is obtained, shared and discussed also between other school's stakeholders. (Gil, 2005, p. 57) Gil describes the existence of networks that assure the communication inside each school and suggests the enlargement of those networks to other schools creating a global communication. That kind of laboratory is described “as a door to other schools”, in Gil's words (Gil, 2005, p. 87). The author also refers to physical spaces: design classrooms and electronic studios, the laboratories of real and virtual modelling, laboratories of critics and evaluation, library and analog-digital archive, electronic auditorium, laboratories of research and simulation, exhibition spaces, bar, cabinets and administration and residential spaces, as elements that could constitute schools of architecture. Laboratories have a strong presence in his descriptions and by thinking in the combination of a few of them, it is possible to think in another type of laboratory.



Through a cross thinking between those concepts and the intentions described about VR, is possible to conceive a VR laboratory as becoming a part of schools of architecture and work as a node for communication with other schools. These laboratories could be accessed by the community of architects such as: students, alumni or architects in general, as an enabler to the contact with the public at a large scale, and in this way opening new opportunities inside the field of Architecture. Pointing to the aims of the European Union regarding the approach between European citizens, professionals and a market for opportunities at an EU scale - pursued also by the ERASMUS' program, these labs could be an opportunity to schools and to architects.

### **Abstract**

A network of VR laboratories would be establish into schools of architecture, engaging a diversity of stakeholders, aiming at producing experiments of architectural work into a VR format. The laboratories would generate an opportunity to disclosure the work produced by the architects, students or alumni - not yet established into the job market – at an European scale. Simultaneous exhibitions around the VR labs of all Europe could be made in order to promote the designs of those architects. Also, through a digital platform assigned to those labs it will be possible to share designs produced in the VRlabs. The potential factors about this project are: the contact with VR resources to conceive and communicate architectural designs, the possibility to achieve visibility of the work produce at an European scale, the possibility to establish a close contact between European architects – namely students, Professor, employing entities and alumni -, the possibility of developing work that could integrate their portfolios. All of this, officially and actively, supported by the schools of architecture.

### **Objectives**

The current economic and financial crisis has triggered an extreme set of conditions demanding extraordinary and innovative possibilities. Spain, Greece and Portugal were indicated as the European countries with a major levels of unemployment in 2014 into Architecture's profession (Architect's Council of Europe, 2014). With 19 percent of unemployment, Portugal is a worrying case, since it is also detached as one of the



European countries with more architects per capita (Architect's Council of Europe, 2014). Portugal had 2 architects per 1000 population in 2014, only surpassed by Italy with 2.5 architects per 1000 population. The European average value is 1 architect per 1000 (Architect's Council of Europe, 2014). The ratio between the values of employment and the number of architects per capita, places Portugal as the most vulnerable case in Europe on the Architecture profession.

The recent graduate students and the architects that are not established into the job market are the ones who face more difficulties in this saturated market. Therefore there is the need to create conditions to capture ideas, knowledge and skills in order to achieve an enlargement and the equality of job opportunities. These intentions encounter some of the objectives of the European Union as a free internal market with loyal competition; a sustainable development that aim to the creation of jobs; the promotion of the technical and scientific progress; and the promotion of a cohesive environment between the member states. ([www.europa.eu](http://www.europa.eu))

The budget assigned for the project submitted to European Commission, would be channelled to the VR resources acquisition and maintenance and the hiring of experts to manage the labs. The budget could also cover the costs of the space assigned to this labs – in case of the school have not the possibility to allocate the required room for labs in their facilities. Therefore schools would be equipped with VR resources independently of their financial situation. By taking advantages of VR potentialities into the architectural scope, a laboratorial environment will be implemented to increase the number of students and alumni that become VR users. The creation of a network of laboratories starts as a pilot project just assigned to a few trial schools and can be replicated in other schools on countries in Europe.

The nodes of this network are Labs, combining the physical space, activities- as exhibitions and contests – and a web-platform. The physical spaces assesses the relation between the stakeholder and each school VR lab. The exhibitions and contents can be promoted and coordinated by professors, or companies, or municipal or independent





identities, for example. The web-platform assesses the connection and communication between all the stakeholders. Each lab will have enough autonomy to operate independently and simultaneously taking advantage of the successful designs by promoting their visibility into the market. Regional differences can be turned into strengths, via collaboration between municipal government, schools and regional architecture offices, creating synergies and environments of collaboration.

### **Ambition**

From the reactions achieved during the research phase, students, professors, architects and VR technicians reveal enthusiasm about the project proposed. As an ambition of this project, the positive acknowledgement by the possible partners was already accomplished. Therefore there is the aim of creating a large consortium that could maximise the number of students, young graduates and not established alumni of architecture engaged in the project. Students could learn and use VR resources to develop projects even though it does not integrate the schools' plan of studies. That would promote an opportunity to know and learn how to use the tool in a monitored way and reaching key objectives settled by the lab and the network partners.

The fields of action detached before about the potentialities of VR in the architectural scope as: technical verification and validation of the design through VR, preservation of the Architectural Patrimony through VR, creation of virtual architectural environments through VR<sup>27</sup>, among others, could be explored in the lab work. All the work that the architecture users would develop into the lab environment could integrate their portfolios. VR could play at least those two relevant roles on the stakeholders' position into the job market. On the one hand, the lab users would have the opportunity to deal with different perspectives and applications of VR into the architecture scope. It could contribute to the reflection about their job expectations, by realising which slope regards or pursues their architectural perspectives. On the other hand, VR promotes an advantageous point in the architects' portfolios, by promoting an immersive perspective of their architectural not constructed projects.

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<sup>27</sup> See in the second chapter.



**Relevance / Innovation**

The relevance of this project finds reason in the issues discussed along this dissertation as: the potentialities recognised to VR beyond the other tools that integrate the design process of the architect; the interaction that VR could have with the intentions of the architects and its articulation with other tools distinguishing each one's strengths; the importance of architects to know different tools and methodologies of work; the difficulties that non established architects may find facing the job market; the saturated market of architecture that some European countries are facing; the sensitivity and expectations that a younger generation, specially students, have about VR potentialities and the equilibrium between equal opportunities for the citizens of the European Union.

The innovation aspect is the possibility of connecting students and architects in a wide and large collaborative work environment, producing and being aware of each other's work. A web-platform could assure the connection between all the labs by including a profile from the different labs. Each profiles from the VR lab could include information about the work developed in that specific lab by its users. Those users could also have a profile to promote the work developed by them, as a portfolio of the designs produced on the lab. The profile of the users could be available on the VR lab profile where the user is integrated and be accessed by other architects. In this way employing identities could follow up the designs produced and make proposals. Those architectural proposals may aim at a VR format and can be disclosure for all the stakeholders, or be directly assigned to a specific lab – in the case of more regional proposals.

**Impact**

The laboratories will be open to any architect that would want to work in this environment, however as justified, it is expected that younger architects, students and not established architects could be the more interested in work in this type of technology. New initiatives with VR will be created, promoted and disseminated. Other opportunities that would not be recognized without this project are expected and would be identified. Teams of collaborators will be encouraged under the scope of this Project to develop ideas



and projects focusing on the transferring of the architectural VR work to the market. A gathering an amount of brains around Europe will be achieved to promote a new kind of thinking and experience Architecture.

Employment opportunities is one of the major prospects along with the ensuring that VR resources are easily understood by stakeholders. Architectural VR services could be provided to the various identities interested, guaranteeing the autonomy and credibility of the schools. Schools would also be highlighted into an European level, and the work produced by the lab could also be part of the learning contents of the pedagogical curriculum.

### **Partners**

Since this description of a possible pilot project to submit to the European Commission is just a draft, various aspects are not entrenched enough. The partners of the consortium, or the call where this project could be submitted in, along with other topics, are not deeply explored. For this reason, it is not possible to include in this draft the measuring of their impact or prediction of their responsibilities. The main regard in presenting and including this description of the project in this dissertation is to ensure the idea's exposition and to announce a possible direction for the opportunities discussed along this dissertation.

However it is possible to predict, by the reaction obtained while researching, that the schools, architectural offices and VR laboratories – as Seamk's VR lab – could be possible partners. More countries, schools and partners in general could be included, as for instance, the European Network of Living Labs (Enoll) and the Education and research in Computer Aided Architectural Design in Europe (ECAADE), among others.



**Call**

Also a Call was founded as a potential option to submit this project. Given its comprehensiveness, this project could be included in other Call. However this has been chosen as a commitment between the subject, the budget and validation of the date of submission.

**Call:** H2020 WIDESPREAD032017

**Subcall:** H2020 WIDESPREAD20162017

**Title:** ERA Chairs

**Budget:** 33,91 M€

**Dates of submit:** 12.04.2017 to 05.10.2017

**Important facts:** "ERA Chairs" is an important part of the EU's effort to unlock Europe's potential in research and innovation. ([ec.europa.eu/research/era/era-chairs\\_en.html](http://ec.europa.eu/research/era/era-chairs_en.html))





## **O u t l o o k**

In this dissertation there is an intention to introduce a discussion centred on the following question: what contribution may VR give to Architecture? At the first analysis it was possible to understand the role of VR as a type of representation in Architecture. Given the fact that there is not yet a well-established relation between VR and Architecture, the analysis proposed, in this dissertation, should be interpreted as an exercise that presents one of the possible viewpoints. Following this lines, an analysis was carried out, at conceptual level, based on the data that was possible to collect at present status. Using this information one approach was established, projecting how potentialities of VR in Architecture may evolve.

Seen from a technical point of view, VR is a possible type of representation in Architecture, already being used. The architecture types of representation in the scope of this dissertation are divided as: drawings, models and 1:1 scaled models. Two functions were identified, related to representations: one for the conception and the other for the communication of the designs.

The types of representation started to be only analog and hand-made, after the appearance of computer, it become possible to add also a digital version of those representations. Therefore, the drawings - such as plans, facades and sketches - gained a digital expression through the 2D CAD software. Besides, the models gain equally a digital expression through the 3D CAD software. Furthermore, with the introduction of VR it become possible to obtain a digital version of the 1:1 scaled models.

All these three types of representation, in their two versions – analog and digital – requiring their own tools in order to be executed, namely: paper, pencils, rulers, ink, wood, software or computers.

Along with the other digital representations, VR requires tools such as computers and software, being in this case used for visualization, devices such as HDM and CAVE.

This possibility of three types of representation, in two possible versions, does not mean that one version replaces the other. The digital version can contribute for the clarification and distinction of each of its potentialities adding more possibilities of representation beyond the analog ones. For instance, nowadays, in the architecture offices is not feasible



that plans, sections and facades, in their rigorous and technical version, are hand-made developed. The requirements of the market, the time of execution demanded by this type of representations and the pressure to answer in a useful time are factors that constrain this type of representation, in this case. However, in an initial phase of searching, thinking and planning, the hand-drawings – namely sketches, plans, facades and axonometries – are a fluid and fast possibility of work.

This approach intends to strengthen that the introduction of digital resources contributes not only to add other possibilities of representation, as also to evidence the facets of each system of representation.

It is nowadays up to each architect to understand and to choose, while facing different designs and different phases of each design, the types of representation more suitable to satisfy the requirements.

For each phase of the design, there are representations that can be more adequate and the architects should select according to their convenience. Giving up one of the versions, are they analog or digital, can be a limitation for the performance of architect:

There are things that may be gained, though others may not be lost. And we keep the others, because the new ones just *per se* are not capable enough, although they improve many other aspects. If we need an amount of windows, we will not draw one per one. We draw one very carefully, and then we copy it. (Graça Dias, 2016)<sup>28</sup>

Since the characteristics of each systems of representation are distinct and the potentialities are diverted, a method of work that could envision various types of representation could be a reasonable option. However, it is up to the architect to recognize the different types of representation, to identify the potentialities of each one, to evaluate the need to acquire new skills on each type of representation and finally to choose the one(s) that could be more adequate to develop his work.

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<sup>28</sup> Translated from portuguese: “Há coisas que se ganham, mas não se podem perder outras. E nós mantemos outras, porque as novas, só por si, não são suficientemente eficazes, embora melhorem muitos outros aspetos. Se precisamos de imensas janelas não vamos desenhar uma a uma. Desenhamos uma muito bem, e depois copiamos.” (Graça Dias, 2016)



In this sense, the architect may also consider if the characteristics and the potentialities of VR could be an added value for his work. Following this lines the question about the characteristics and the potentialities that could be of interest to the architect may arise.

VR as a system of representation, might contribute to gain awareness and anticipate aspects of the design and its future impacts, as other types of representation.

However, VR has specific characteristics, such as the capacity to immerse the viewer in the design. This characteristic along with others that are inherent to it – *e.g.* as navigation and interaction – allow that the viewer to perceive the design in a form closer to the reality.

This characteristic is also shared with its analog version: 1:1 scaled models. However, the analog version, because of some logistical issues, related with the cost, time of execution and difficulties in the upgrade, it is not often used. The architect can assure a visit to the whole building with lower costs of execution through VR. This type of representation allows the visit and experience, in person, for the viewers, through a 3D modulation of the design and its display in VR devices.

Like in other types of representation, the characteristics of VR contribute to the conception as well as to communication of the design.

Through the possibility of immersing in the design, allowed by VR, the architect can perceive, anticipate and comprehend the aspects of the design in its real scale, experiencing the space. This aspect allows the architect to have greater control of the design, being this one major objective of the design process.

At the level of the communication with the client, VR may also contribute by allowing the client to visit the design, so that he can have a better perception before its construction. Since VR provides an experience closer to reality and considering the difficulties that the client may feel in understanding other types of representation- because of its codification and technical language – the possibility of using VR also represents a considerable benefit.

Despite all these potentialities of VR does not have a presence comparable to the other types of representation- as drawings and models, particularly at the school level. Unlike what has happened with the emergence of other technological novelties - as Greenwald-Katz describes from the 1970s – schools are not taking the lead, in the case of VR.



It was the perception of this situation that led to the necessity of the field research that was developed in the scope of this dissertation. Within this research it was confirmed that VR is a type of representation that is not being used in the context of the analysed schools. No one of the 305 students inquired had already worked with VR devices. This aspect contrasts with the fact of about 87% of those inquired students considered that VR is important or very important for the conception or for the communication of the design.

There are various risks related with the usage of systems of representing that were identified, in this dissertation. One of them could be the absence of knowledge about the different types of representation available and the other is the distancing about the central issues of Architecture. The first can compromise the position of the architect in the job market. For instance, Greenwald-Katz described the panorama of 1976 when the architect felt the need of equip himself with other types of tools – like computers – for the elaboration of other types of representation, because of the demands of that period. At the present time, it would be difficult for an architecture office to resist towards the job market, just by conceiving hand-made representations. Even in architecture contests, currently, there is more and more the appeal to renders – which are images generated from digital drawing and models:

Having an image before the building is constructed is very interesting for its verification in fact, but since there is no experience on that type of work, often we request the production of this type of images out of the office. We request for a special presentation, for a contest, for an exposition, every time that is necessary to communicate in other way. For a contest, I recognise that this is absolutely essential, because the client needs to have an image. In other words, who does not deliver this type of image is practically excluded from winning the contest. (Mendes Ribeiro, 2016)<sup>29</sup>

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<sup>29</sup> Translated from portuguese: “Ter uma imagem antes do edifício construído é muito interessante para verificar de facto, mas como não há prática deste trabalho, normalmente encomendamos isso fora. Encomenda-se para uma apresentação especial, para um concurso, para uma exposição, sempre que é necessário comunicar de outra maneira. Num concurso, reconheço que é absolutamente central, porque o cliente precisa de ter uma imagem. Isto é, quem não entrega a imagem está praticamente excluído de ganhar o concurso.” (Mendes Ribeiro, 2016)





The other possible risk is the inebriation, caused by the work assigned to the image of the design in detriment of other characteristics and requirements of it. This does not mean that it should not exist a thought in the construction of an image, which can representing the design. The risk is to construct only an image that could become deceptive about the real qualities of the design. This risk is not only related with VR, since it can also occur with models and drawings digital or analog.

The utilization of representations might be, as relevant as or even more relevant, than its own potentialities. It should exist a knowledge and a critical intelligence, as Bruno Gil (2005) said, in the sense of make the representations operative in relation with the requirements of the design.

The schools could have a more relevant role about these risks by providing better information to the future architects about the different types of representation and at the same time stressing the adequacy of the requirements of the design.

In order to understand the opinion and position of professors towards VR, the field research carried out also included interviews with professors. The opinions about the integration of this type of representation in schools of architecture diverge in two main positions: there are professors that consider important to exist an array with the different types of representation and claim that it should be presented to the students from the first academic year – where VR is included - and those who defend a more conservative position by considering the importance of first establishing contact with the analog hand-made representations and then with the digital ones, in which VR should be included in the last years of the Master Degree or treated as a curiosity exterior to the school.

Given all the aspects in this dissertation it was carried out in this dissertation a systematic analysis of the potentialities of VR and their contribution to Architecture, in a conceptual way. Starting from this analysis and considering that the contents learnt in school does not depend directly on students and professors opinions but rather on a plan of study; since it does not integrate the objectives of this dissertation to question those plans of study, a specific proposal has been presented.

This proposal considers the exploitation of VR as a type of representation in Architecture at the school level, in a regime that does not compromises the curriculum of those schools.



This proposal consists on the creation of a network of VR laboratories, at a European scale, to be managed by schools. Thereby the students and architects interested could establish contact with this type of representation through VR laboratories that would be inserted in schools of architecture.

Those labs will be an opportunity to develop work and designs represented by VR, but also it could be an opportunity of sharing and get to know the works from other students or architects, from other schools and other countries. Through a network that could connect all the labs, it would be possible to have access to designs from other architects and contact with them, and at the same time to share the own designs developed. This network would be equipped with a digital platform that would allow simultaneous exhibitions for the general public with architecture designs in VR representations. One event such as this one could only be implemented based on a type of representation such as VR.

It will be also part of the project the possibility to allow the access to this platform to employing identities that could be interested in following the VR work developed or even in launching some VR work challenges. This would be other objective of this network: the possibility to develop designs in a VR format as an answer to launched challenges, contests or proposals, narrowing the relations between students, architects, professors and employing identities.

Thereby, this dissertation does not have the pretension to define the projection of VR in the future of Architecture. In first place, because VR is one type of representation, along with others that already exist and others that could be added in the future. Then, because Architecture does not depends on any specific type, method or tool of representation, since it could be created from drawings in tracing paper, clay models or digital representations.

However the architect might depend on the types of representation for the performance of its profession, may its position towards the market be conditioned by the use of certain type of representation.

Despite that issue, this dissertation does not have also the pretension to constraint or



condition the possibilities of representation to the architect. This dissertation intends to present VR as one more hypothesis of representation that could help the architect in its work.

Graça Dias reminded that the work of the architect should be placed on the central points of architecture. (Graça Dias, 2016) He added that those points are still the same since Vitruvius. In the first century b.C., Vitruvius suggested that the central aspects of Architecture were based on a triangle in which its vertexes were the dimensions of: *firmitas*, *venustas* and *utilitas*. That triangle was a reference to the building qualities. Representations are an attempt to report those qualities.

The building in its qualities is experienced by the people and is exposed to their ways of living, leading to the emergence of a spirit, the spirit of the place- *genius loci*.

On the other hand, the building is linked to a time, a period. In this way, another spirit emerge from Architecture, the spirit of time- *Zeitgeist*.

The perspective of Vitruvius about the three dimensions can be completed by a perspective of five dimensions including: *firmitas*, *venustas*, *utilitas*, time and action. At the representation level, VR brings the opportunity of adding those other two dimensions to Architecture, immersing the Man into the center of all the dimensions. The Man has the opportunity to immerse into Architecture, at the representation level, during the VR display – in certain time - and interacting with the simulated environment – with certain actions. In this way, VR brings to the Man the possibility to be immersed into Architecture before the Architecture itself.



## Bibliographical References

Abrahams, T. (2013). Computers in Theory and Practice. in *The Architectural Review*. 26 April 2013 . retrieved from [www.architectural-review.com](http://www.architectural-review.com)

Alesso, P. ; Smith, F. (2008). *Connections: Patterns of discovery*. New Jersey: John Willy & Sons

Allen, M. (2013) . *Archaeology of Digital*. retrieved from [www.domusweb.it](http://www.domusweb.it). consulted em Outubro de 2016

Architect's Council of Europe . (2014) . The Architectural Profession in Europe 2014 . retrieved from: <http://www.ace-cae.eu>

Astbury, J. (2014) . Architects do it with models: the history of architecture in 16 models. *The Architectural Review*. 25 February 2014 . pp 1-14

Bento, A. 2014 . Portugalilaisen arkkitehtiopiskelijan ajatuksia . in *ArchiMAD*. no.4 - 2014 . pp 22-25

Bermudez, J.; King, K (1998) . Media Interaction and Design Process: Establishing a Knowledge Base . in *Digital Design Studios: Do Computers make a Difference?* . ACADIA. pp 7-17

Chung, J. et al (1989) . Exploring Virtual Worlds with Head-Mounted Displays . in *Non-Holographic True 3-Dimensional Display Technologies* . Vol. 1083. Los Angeles . pp 15-20

Cruz-Neira C. ; Sandin D.; DeFanti T.; Kenyon R.; Hart J.; (1992) The CAVE: audio visual experience automatic virtual environment . pp. 64 -72

De Certeau, M. (1984) . Walking in the City . in *The Practice of Everyday Life* . Berkeley and Los Angeles: The University of California Press. pp 90-130

Durrant, J. (2005) . Cambridges Futures . in *Cidade-Sofia, Cidades Universitárias em Debate* . Coimbra: Edarq (Departamento de Arquitectura da FCTUC) . pp. 173-193

Eisenman, P. (2007) . A Matrix in the Jungle. in *The Charter of Zurich, Basel: Birkhäuser*, Ed. Furio Barzon *et al* . pp. 28-37





- Feijão, A. (2011) . *Anatomia Now! O corpo na Arquitectura da revolução digital* .  
Dissertação de Mestrado Integrado em Arquitectura. Universidade de Coimbra
- Gil, B. (2005) . *Escola de Arquitectura, Hoje*. Prova Final de Licenciatura. Universidade  
de Coimbra
- Greenwald-Katz, G. (1976) . Computers in architecture. in National Computer  
Conference. Max O. Urbahn Associates New York, New York . pp. 315-320
- Hunter, W. (2003) . Ideas and Tools: Architecture & Representation. in *The Architectural  
Review*. 26 Abril 2003 . retrieved from <http://www.architecturalreview.com> . pp. 1-3
- Kenyon, R. (1995) . The Cave Automatic Virtual Environment: Characteristics and  
Applications . in *Human-Computer Interaction and Virtual Environments* . NASA  
Conference Publication #3320 November . pp 149-168
- Krüger, M. (2005) . *Leslie Martin e a escola de Cambridge* . Departamento de  
Arquitectura da Faculdade de Ciências e Tecnologia da Universidade de Coimbra
- Malnar, J.; Vodvarka, F. (2004) . *Sensory Design*. Minnesota: University of Minnesota  
Press
- Martinucci, L . (2014) . A Máquina perspéctica 3.0 . in *Percursos FAA* . retrieved from  
<http://revistas.lis.ulsiada.pt/index.php/pfaa> . pp 67-79
- Piano, R. (1992) . Building Workshop: in *Search of a Balance* . Process Architecture . pp  
12-14
- Prensky, M. (2001) . Digital Natives, Digital Immigrants . in *On the Horizon* . retrieved  
from <http://www.marcprensky.com/writing/> pp 1-6
- Santiago, R . (2006) . *Ambientes de Imersão Virtual de Tecnologia Simplificada –  
AIVITS* . Relatório Final de Bolsa de Pesquisa . Escola de Arquitectura . Universidade  
Federal de Minas Gerais
- Siza, A. (n.d.) . in *L'école de Siza- un film de Richard Copans et Stan Neumann*. retrieved  
from [https://www.youtube.com/watch?v=6Tg\\_RiKIRPo&t=109s](https://www.youtube.com/watch?v=6Tg_RiKIRPo&t=109s) . dubbed in English



Vereycken, K. (1996) . *The Invention of Perspective* . in Fidelio vol. 5 no.4 Winter 1996 . Schiller Institute

Voshart, D. (2015) . *VR and Architecture*. retrieved from <http://www.voshart.com> . consulted in September 2016

Wahlström, M. et al. (2009) . *CAVE for collaborative patient room design: analysis with end-user opinion contrasting method* . retrieved from: <https://www.researchgate.net/>

Yares, E. (2013) . *50 Years of CAD*. retrieved from [www.designworldonline.com](http://www.designworldonline.com). consulted in October 2016

Zardini, M. (n.d.) . *Archaeologist of the Digital* . retrieved from [www.cca.qc.ca](http://www.cca.qc.ca) . Consulted in october 2016

### **Online Resources**

[www.vrs.org.uk](http://www.vrs.org.uk). Consulted in November 2015

[www.cambridgefutures.org/](http://www.cambridgefutures.org/). Consulted in November 2015

[www.martincentre.arct.cam.ac.uk](http://www.martincentre.arct.cam.ac.uk) . Consulted in January 2016

[www.openlivinglabs.eu](http://www.openlivinglabs.eu) . Consulted in June 2016

[www.pordata.pt](http://www.pordata.pt) . Consulted in August 2016

[www.euronews.com/2016/03/02/2016-will-be-virtual-reality-year](http://www.euronews.com/2016/03/02/2016-will-be-virtual-reality-year) . Consulted in August 2016

[www.fortune.com](http://www.fortune.com) . Consulted in September 2016

[www.merriam-webster.com](http://www.merriam-webster.com) . Consulted in September 2016

[www.europa.eu](http://www.europa.eu) . Consulted in November 2016

[www.dges.mctes.pt](http://www.dges.mctes.pt) . Consulted in November 2016

[www.1825.in](http://www.1825.in) . Consulted in November 2016

[www.moorelaw.org/](http://www.moorelaw.org/) . Consulted in November 2016

[www.uc.pt](http://www.uc.pt) . Consulted in November 2016

[www.dre.pt](http://www.dre.pt) . Consulted in December 2016

[www.europa.eu](http://www.europa.eu) . Consulted in December 2016



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Antão, C. (2016) interview in Uki Arkkitehdit on 14 March

Arenga, N. (2016) interview in Architecture Faculty of the University of Lisbon on 8 June

Briosa, J. (2016) interview in Department of Architecture of Sciences and Technology Faculty of the University of Coimbra on 9 June

Fortuna Campos, C. (2016) interview in Department of Architecture of Sciences and Technology Faculty of the University of Coimbra on 17 June

Gil e Pires, A. (2016) interview in Architecture Faculty of the University of Lisbon on 8 June

Graça Dias, M. (2016) interview in Architecture Faculty of the University of Oporto on 3 June

Heikkinen, M. (2016) interview in Uki Arkkitehdit on 14 March

Hellman, T.; Jääskeläinen, J. ; Yli-Karhu, T. (2016) interview in SeAMK VR Lab on 14 March

Huuhka, S. (2016) interview in School of Architecture - Tampere University of Technology on 15 March

Koivisto, P. (2016) interview in Uki Arkkitehdit on 14 March

Lamppu, M. (2016) interview in School of Architecture - Tampere University of Technology on 15 March

Mendes Ribeiro, J. (2016) interview in Department of Architecture of Sciences and Technology Faculty of the University of Coimbra on 16 June

Martinucci, L. (2016) interview in 18:25 on 13 September

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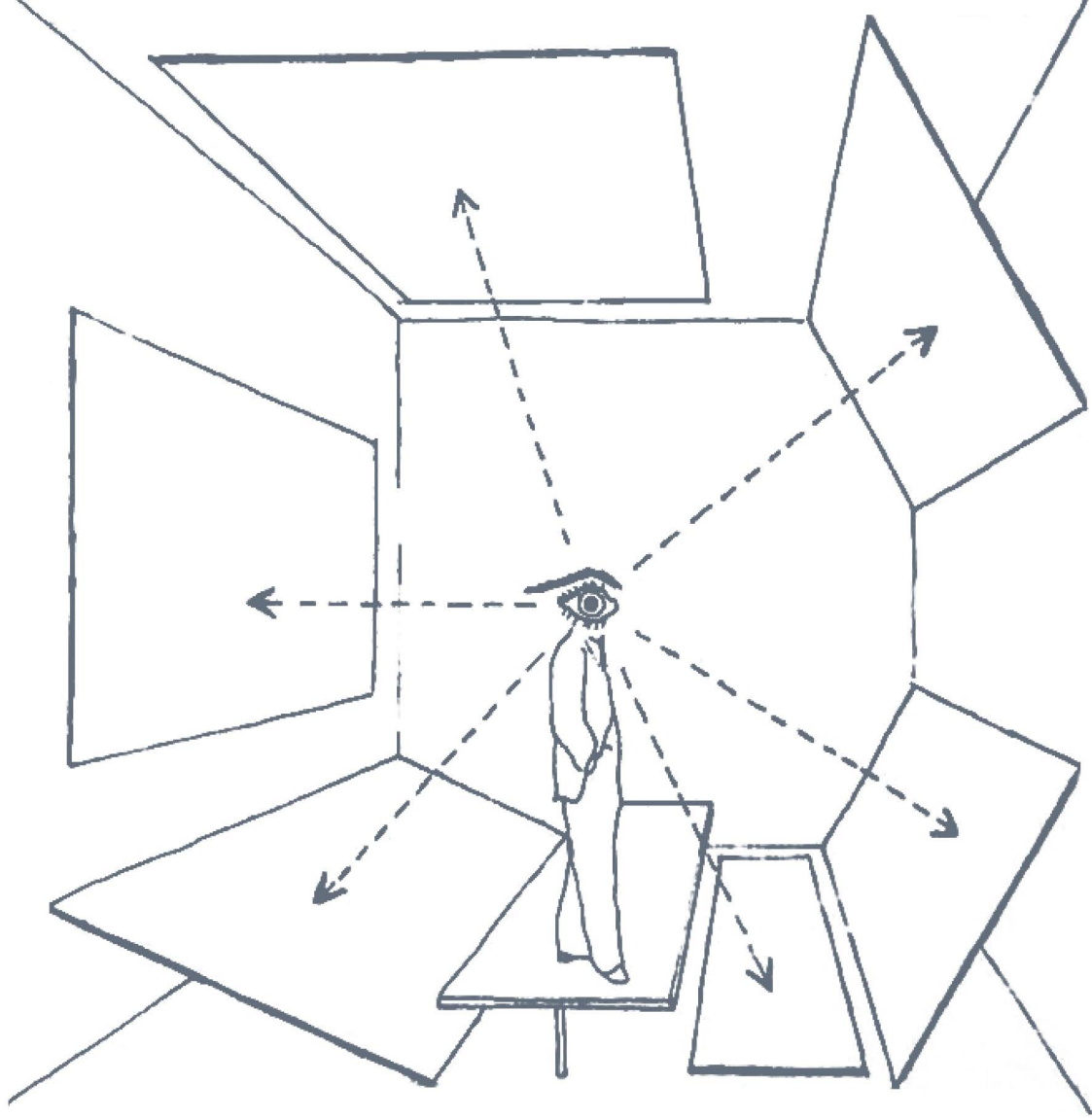
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## **Appendix of Immersing into Architecture before Architecture:**

The potentialities of Virtual Reality as an architectural representation

Ana Moreira São Miguel Bento

Supervisors: Professor José António Bandeirinha and Architect Carolina Coelho

Master Dissertation in Architecture submitted to the  
Department of Architecture of the University of Coimbra

December 2016







## **A c k n o w l e d g e m e n t s**

### **A g r a d e c i m e n t o s**

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Satu Huuhka, Hanna Vikberg, Mikko Heikkinen,  
Pauli Koivisto, Cláudia Antão, Tapio Hellman,  
Tiina Yli-Karhu, Jyrki Jääskeläinen, Juho-Pekka,  
Raquel Paulino, Manuel G. Dias, Nuno Arenga,  
Amílcar G. Pires, João Briosa, João M. Ribeiro,  
Catarina Campos, Luca Martinucci, Julio Bermudez



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## Introduction

This appendix is a complement to the main document *Immersing into Architecture before Architecture: the potentialities of Virtual Reality as an architectural representation*. This document gathers data related to events and contents presented in the dissertation. The purpose behind this gathering of reports, interviews, surveys' results and photographs is to provide awareness about the origin of intentions, curiosities, stimulations and interests about the thematic and the approach accomplished. The field research has an acuted presence in this document, once it gave an essential contribution for the acquisition of perspectives integrated in the discussion.

This document is divide in two moments. The first one is a report of the internship held in 2014, under the ERASMUS+ program, in a VR laboratory in Finland. The experience promoted a first contact with Virtual Reality where a project was carried out aiming the conciliation between the knowledge of third grade architecture student and the exploration of VR as a tool. The result was enriching, personaly and broadly, leading to an interview about the work pursued and other issues by ArchiMAD, a Finnish magazine<sup>1</sup>.

The second moment focus the field research realised within the scope of the dissertation. Interviews and surveys were the methodology used along with bibliographic research to achieve the informations needed. Therefore, this second moment is divided in four parts: *Interviewees*, where the professors, architects and technicians interviewed are presented; *Interviews*, that contains the contextualisation provided to the interviewees before the interview take place and also their feedback; *Surveys*, that contains the script of inquiries provided to the students and their feedback; and *Schools' photographic report*, that consists on a compilation of photographs taken during the visit to the architecture schools, in order to present their facilities.<sup>2</sup>

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<sup>1</sup> Explained in the Introduction of the main document

<sup>2</sup> Every photograph present in this document was taken by the author of this dissertation: Ana Moreira Bento



# Motivation

Internship in a Finnish VRlab





## Internship in a Finnish VRlab

In the summer of 2014 an internship was made under the ERASMUS+ program. The internship took place in the VR laboratory of SeAMK (Seinäjoki University of Applied Sciences) in Finland. During a period of 3 months, the work developed aimed to conciliate the architectural knowledge of a third year student and Virtual Reality as a tool to perform it. The work consist on a 3D model of *Lotta Svärd museum* (1924-26) designed by Alvar Aalto and to display it in a CAVE.

The first stage of the work aimed to collect the drawings –as plan, sections and façades– from the building. These drawings were requested during a visit to the town hall, also designed by Alvar Aalto.

The second stage consisted on the 3D modelling made from the drawings collected. The software chosen to this 3D modelling was ArchiCAD and this work required a previous learning that was taken autonomously in the scope of the internship.

The third stage was to present the work produced in a CAVE.



Figure 1 – Photograph from Lotta Svärd museum by Ana Moreira Bento



Figure 2 - Photograph from the modelled Lotta Svärd museum by Ana Moreira Bento



# Field Research

**Interviewees**

**Interviews**

Contextualisation

Guide of questions

Interviewees' feedback

**Surveys**

Script

Results

**Schools' photographic report**



**Interviewees**



## FINLAND

### Schools:

#### Oulu School of Architecture

Professor **Päivi Ahola**

Teaches interior design. Works as architect in Laatio Architecture's office, Oulu.

#### School of Architecture- Tampere University of Technology

Professor **Pekka Passinmäki**

Teaches Phenomenology and Theory of Architecture.

Professor **Martti Lampu**

Teaches computer aided design (CAD)

Professor **Satu Huuhka**

Teaches building's renovation

#### School of Arts, Design And Architecture – Aalto University

Professor **Hanna Vikberg**

Teaches day light's behave in architecture

### Architecture office:

#### Uki Arkkitehdit - Oulu

Architect **Mikko Heikkinen**

Managing Director – Main Partner

Architect **Pauli Koivisto**

Project Manager

Architect **Cláudia Antão**

Project Manager

### VR Laboratory:

#### SeAMK Virtual Reality Laboratory - Seinäjoki

Technical Engineer **Tapio Hellman**

Virtual Reality engineer

Architect **Tiina Yli-Karhu**

Designer for renovation and construction services

Architect **Jyrki Jääskeläinen**

Designer for renovation and construction services





**Research Centre:**

Centre of Excellence in Laser Scanning Research - Aalto University

PhD student **Juho-Pekka**

Researcher of methods that produce virtual models

**PORTUGAL****Schools:**

Architecture Faculty of the University of Oporto

Professor **Raquel Paulino**

Teaches design project

Professor **Manuel Graça Dias**

Teaches general organization of space

Architecture Faculty of the University of Lisbon

Professor **Nuno Arenga**

Teaches design project

Professor **Amílcar Gil e Pires**

Teaches design project and phenomenology and theory of Architecture

Department of Architecture of Sciences and Technology Faculty of the University of Coimbra

Teaching assistant **João Briosia**

Teaches design project

Professor **João Mendes Ribeiro**

Teaches design project

Professor **Catarina Fortuna Campos**

Teaches design project

**Architecture office:**

18:25 – Lisbon

Architect **Luca Martinucci**

Managing Director – Main Partner



## **Interviews**



## **Contextualisation**

This introduction was provided to the interviewees before the interview take place:

The provisional title of my dissertation is: "Unfolding CAVE: the potential of Virtual Reality in Schools of Architecture". I am studying and researching Virtual Reality as an immersive tool of representation – to conceive and communicate – in Architecture. I want to focus my work especially in students' perspective and in the moment of transition between schools and the job market. I am investigating if Virtual Reality can be useful to promote and help young architects to gain some visibility in the job market.

The premise for the approach of my dissertation was the idea of thinking about a hypothetical European network of architecture schools and VR Labs that could be integrated into a call to a Horizon 2020 program. That kind of network could promote and instigate schools to make a certain partnership, share work and promote exhibitions where young architects' work could be presented to the public in general, professors and other professional architects.

Since this project would be funded by H2020, the budget assigned to the project could be used to equip the schools, so that each one could invest in the technology required. Afterwards, that would mean having schools equipped with VR technology and labs exploring and transmitting that kind of knowledge to students and synchronizing that with their designs. This could also provide the chance to young architects to make their own virtual portfolio, which could include not only digital plans, sections and facades, but also 3D full immersive models.

As some of these issues were too wide to develop in a Master dissertation, I choose to start my research just with two countries: Portugal and Finland.



## Guide of questions

[1] How do you see, in particular, the connection that could be established between Finland and Portugal and then the possibility to be extended to all Europe?

[2] In your perspective, how difficult is to get a job here in Finland/Portugal after graduation?

[3] Do you think Virtual Reality could open the field of possibilities for young architects?

Now focus our attention in schools:

[4] How is the relationship with Virtual Reality in this department?

[5] Does the digital media have impacts in the design process? How?

[5.1] And Virtual Reality could have impacts in the design process? How?

[5.2] Which is the subject that you teach in the department closer to VR?

[6] What kind of influences would the introduction of Virtual Reality make in the school's plan of studies?

[6.2] In which year(s)?

[7] Do you think it could be an advantage to have a CAVE in the department?

[7.1] If so, for what kind of use: integration in the design process, communication of the Project to the academia in general or to communicate the Project to the public (like municipal issues)?

[8] Do you think this kind of subject should be taught in a cross-curricular/transversal way or would be better to have just one subject where VR is taught?





**Interviewees' feedback**



All the interviews were recorded with the permission of the interviewees. As it was already mentioned, the interviews were made under a casual atmosphere, where the interviewees had no kind of previous preparation. The guide of the interviews suited just to align the conversation and to ensure the achievement of information intended. Therefore, the discussion was wrote respecting the colloquial tone of the interview. Some subtractions that can be found, during the reading of the conversations, are due to some technical problems of the recording or some information not directly related with the discussed theme.



[2016.4.13]

## **Oulu School of Architecture**

Professor: **Päivi Ahola [PA]**

Teaches interior design. Works as architect in Laatio Architecture's office, Oulu.

**What do you think about the possibility to establish a VR architectural network between Finland and Portugal - and extend it to other countries around Europe - aiming the exploration of VR in Architecture?**

**PA|** First, I am interested in Virtual Reality. I think it would be able to be use, very efficiently, in the Future. I am familiar with this because my husband works in I.T (Information Technology) business, he is very interested in this things, but I am not sure if all people around here are so familiar with it. I think everyone knows CAVE, but I'm not sure about the glasses or software. Surely Finland and Portugal could co-operate. They are both small countries and could learn from each other. I think it could be very nice because of the differences between countries.

**So do you think CAVE is different from the glasses?**

**PA|** Yes.

**And which one of these devices would you choose to teach in schools of architecture?**

**PA|** It depends on the use. If you are just presenting to yourself or to someone aware of your work, maybe is enough if he/she watches your work on glasses. But if you are an architect in practice and you need to show to the client, they are people that have different needs to see, then maybe I think CAVE would be more efficiently.

**In your perspective, how difficult is to get a job here in Finland after graduation?**

**PA|** I graduated 17 years ago, so I am not the right person to answer to this question. I think it is not so easy at the moment, but that is because of the current situation in Finland.

**How was it 17 years ago?**

**PA|** Well, it was recession in Finland, again at that time, but I got a job and I am in the same company since that time.

**Can you realise why your students have said that they might easily find a job as architects after graduating?**

**PA|** They say it is easy? Well, it might be easy because they have new knowledge that companies need. So in that case I think I can understand why they said that.

**Do you think virtual reality could open the field of possibilities for young architects?**

**PA|** Yes, I do.

**Now focusing in this school, how is the relationship between VR and this school?**

**PA|** Unfortunately, I do not know. I am teaching interior design, so I am in a very limited field. Since I am a part-time teacher, I am not sure what they teach students on computing classes. The students have skills for 3D designing, but using these models in VR... I am not sure if they teach this.

**Does digital media have impacts in design process? How?**

**PA|** Yes, It makes it so much more efficient and faster and it gives the client a very good view of what he/she is ordering and what they are going to get.

**And what about VR, do you think it has impact in design process? How?**

**PA|** Maybe yes, but in the other hand the clients already like 3D, so they also may like 4D images as well. But you should know the basics like plans, sections, that old fashion procedures in order to bring credibility to the design.

**Which is the closer subject to VR that is taught in this school?**

**PA|** I don't know. They might be different programmes of 3D being taught, but I don't know if exists one just assign to VR.

**For the subject that you teach do they, the students, use this kind of tool?**

**PA|** Yes, they do. The students present their interior design projects in 3D. They have learnt to use the tools in other classes.

**Do you think VR should be taught by one single subject or in a cross-curricular way?**

**PA|** In a cross-curricular way, definitely. We already bind different subjects in teaching. The students design a building in Architectural Studies and continue working on the same 3D model for preparing the interior design. Also Architectural Detail design course is designed into the same building. VR could be integrated as a tool in the same way.

**In which year do you think that it should be introduced?**

**PA|** Not in the first year. Only when students know what they are designing. Then they should bring it into this tools.

**Do you think it could be useful to have a CAVE here in your school?**

**PA|** Yes, I think it could be good.

**Do you think you have physical space here in your school for that?**

**PA|** Do you know that the school is going to move? I think it should be in next year, so maybe then, you never know...

**And if you had it here in school, what would be the use assigned: to communicate between students and the professors, with the public in general or to the student themselves?**

**PA|** I would say it might be mostly used to the public in general. Of course the students themselves would get a better idea of the space they are designing. But, I think everyone who is working in architecture can realise spaces in a better way than a normal person or a client. •





[2016.4.15]

**School Of Architecture- Tampere University Of Technology**

Professor: **Pekka Passinmäki (PP)**

Teaches Phenomenology and Theory of Architecture.

**What do you think about the possibility to establish a VR architectural network between Finland and Portugal - and extend it to other countries around Europe - aiming the exploration of VR in Architecture?**

PP| What do I think about this system?

**About a network that could connect schools of Architecture from Finland, but also schools from Portugal using this kind of tool. So that we could share knowledge and designs based on this kind of system. What do you think about this possibility?**

PP| I think it is a good idea.

**Are you aware of the potentialities of VR and its devices?**

PP| Yes I know it, but I am not familiar with it.

**It is also important, in the scope of my work, to collect perspectives from Professors beyond the ones that teach CAD softwares. What subject do you teach?**

PP| My background is on Architecture and philosophy.

**As theory of Architecture?**

PP| Yes.

**What do you think about the job situation in Architecture after graduation here in Finland?**

PP| I think you should ask that to the students. Maybe is difficult, I do not know...

**And do you think VR could open the field of possibilities to young architects so that they can show themselves and what they were doing to the job market. Do you think that could help to get a job?**

PP| I am not an expert to answer to this kind of questions, but of course if you have a good portfolio it may impress the employers...

**Like a virtual curriculum, not just plans but also...**

PP| Yes, everything.

**How do you see the relationship with VR in this department?**

PP| I am mostly focus on the researching of reality, I am a bit critical about that system...

**Yes, but for the purpose of this research is also important to have contact with this kind of opinions. You were saying that you are a bit critical...**

**PP|** Yes, especially because VR is not the same as real reality. I know that here in school we have some departments more actives in this kind of research, about glasses and that kind of things.

**And CAVE, have you got one here in your school?**

**PP|** No. The only thing I know is that maybe there are, especially in this area, in our department, computers mostly for designing and planning buildings. You must ask that to other Professor not to me. [...] I know that there are researchers of VR in other departments, not in this one.

**So architecture department is not involved in VR?**

**PP|** No.

**Do you think that digital media has impacts in design process?**

**PP|** Yes, of course.

**How?**

**PP|** There are different kind of approaches. I am not a specialist.

**What do you think about VR in design process? Do you think it has more impact in the communication of the project to academy or to the public in general?**

**PP|** It has impacts more to the professionals. Not so much to the users. •

[2016.4.13]

**School of Architecture- Tampere University of Technology**

Professor: **Martti Lamppu [ML]**

Teaches computer aided design (CAD)

**What do you think about the possibility to establish a VR architectural network between Finland and Portugal - and extend it to other countries around Europe - aiming the exploration of VR in Architecture?**

**ML|** I think in both countries they are already researching that subject...

**Not so much in Portugal, I think...**

**ML|** But if you compare with other countries... I do not think Finland is so different from Portugal. Okay, geographically is east and Portugal is west, but it is not so different. For instance, if you choose Poland or Romania... that would be very different from Portugal. Finland is not so different. They have differences, different cultures and different points of view...okay. Anyway, I think it works.

**And what about reaching other countries in Europe, do you think is relevant to extend this connection to all Europe?**

**ML|** Yes, of course.

**In your perspective how difficult is to get a job here in Finland?**

**ML|** I think is quite easy. At the moment, because all the economy is a little bit low, it is a little bit harder. I have lived the very bad period in 1999, so compared to that period it is okay now. In a normal situation, in Finland, when the young students graduate, they quite easily get jobs.

**Do you think VR could open the field of possibilities to get a job?**

**ML|** Yes, I think so. And especially the job that they want. It gives to the employer a better view of what the student has done.

**It would be good to have a Virtual Curriculum?**

**ML|** Yes, maybe not just that, but yes.

**Do you think the architect that knows how to work with virtual environments is more independent? Because he/she knows already this kind of tool and doesn't need to achieve all that information after graduation?**

**ML|** Of course yes, yes. It gives them profit.

**Focus now in schools: how is the relation between this school and VR?**

**ML|** We are aware, but we don't actually teach that on regular courses. We have been organising some extra courses every now and then. I have been teaching some special

subjects maybe not exactly Virtual Reality, but things like that. For example real-time rendering, because we had VR centre here...

**And you do not have it anymore?**

**ML|** I don't know exactly why we do not have it anymore. For some reason it did not get air under its wings and it was closed. It was from 2000 to 2005 and it was some teacher here that triggered that, but not in our department. They had a course about VR and Tampere VR centre it was one of the best in our country.

**But do you know if architecture students were attending to that classes or if they had connections with that kind of classes?**

**ML|** In that time?

**Yes.**

**ML|** Yes, yes. Some of them. Of course not everybody, but some of them were very interested. So, they organised courses where they got students from our department and also engineering students.

**So you don't know why it stopped?**

**ML|** I think it could not get some profit from projects outside the University, not enough, so it have been said. It is a pity! And I think it was a consort with our University and the other University in Tampere's Centre. In Tampere we have the University of Tampere and Tampere University of Technology. Both were in that project and it was located here. I don't know... They invested lots of money and made some extends in this building. A whole wing in this building was constructed. Nowadays it works as an auditorium. It was converted when the project ended.

**So you had a CAVE that is now an auditorium?**

**ML|** Yes, there was a Cave in there. And the floor was flat in that time.

**Do you think the digital media has impact in design project?**

**ML|** Of course, yes. And I have noticed that, for example: I am teaching first year students and in the end of the course, in the exam, I ask them normally about what do they think about the Future, the near Future of Architecture and how I.T. works and how affects the work. It is a very interesting question and they give fine answers. I got fine essays from that. Many of them are very interested in what is coming up in the next years. They believe it will have an important role in both working and presenting of designs.

**In communication?**

**ML|** Yes, and working. They think that architecture could work with VR, with the glasses, overall...

**Well, that is interesting, because I was interviewing a first year girl today and she told me that she was not aware of digital media at all, so I guessed the first year did not have digital media subjects...**

**ML|** Yes, they have! The first course in the autumn, one of the first courses is Architecture media basics.

**But in 2D or 3D?**

**ML|** We start with SketchUp, so it is 3D modelling and of course Photoshop, picture processing and things like that. InDesign to make layouts and PowerPoint to present their work.

**What are exactly the subjects that you teach?**

**ML|** I teach ArchiCAD.

**Just in architecture department?**

**ML|** Just here. And nowadays, the second year students are integrating a course called Professional course of architecture teach by Ilmari Lahdelma, who has design the Jewish Museum in Warsaw.

**Is he here today?**

**ML|** No, he is on an excursion to Norway.

**And what about Virtual Reality, do you think it could have impacts in design process?**

**ML|** Yes, for sure.

**And how?**

**ML|** I see it as a tool for the designer. Not just a tool to presenting that is linked with, of course, CAD software. It gives the designer a much better view of what he/she is doing. In a way it is the next step from the 3D designing software.

**Which is the subject closer to VR that is taught here in your school?**

**ML|** I am not very aware, I must admit, but ArchiCAD is maybe that software. Do you know ArchiCAD?

**Yes.**

**ML|** Yes, ok it has that option that enable to look around things.

**Yes it is possible to do a BIM with it, for example...**

**ML|** Yes and save it as one.

**Yes and is also a good software to do a 2D and 3D and connect the two. Well, what kind of influences the introduction of Virtual Reality would make here in your department?**

**ML|** I would start with the first year students. They need to learn almost all the digital tools, software at the first year. They urge to get them in use. We have to remind them also that hand drawing is a very important thing and of course they know that. They will use them all. They will also make physical scale models.

**Do you think it could be an advantages to have CAVE in the department has you already had?**

ML| Like I said it was a big pity that we lost that.

**So it would be good if it come back?**

ML| Yes! In that time the technology was very expensive and nowadays you can do the same in a much cheaper way.

**And now the graphics are better, the projectors are better...**

ML| Yes, and cheaper. And smaller...

**Is it better and easier now?**

ML| Yes, and also I have some colleagues running a lab, where they have 3D printers. They are building it in the Faculty of Electricity's building and it will be open next fall. Maybe some kind of a CAVE system would be a logical next step, connecting to teaching...

**Yes, that is something that I was about to ask you: What kind of use do you think CAVE should have? To communicate, to teach?**

ML| All are good. Personally, nowadays, I am very interesting about the pedagogical aspects. I see a very big possibility to use that in a pedagogical way.

**For the communication between students and Professors, in this kind of communication?**

ML| Yes.

**Do you think this kind of subject should be taught in a cross-curricular way or as single subject?**

ML| It would be very nice if it could be integrated as a widely used subject, but it is easier to teach it in just one course. Nowadays, we are in a middle of integrating design courses like house designing, urban designing, we have been integrating all the architecture media basics in the first year and then ArchiCAD in the second year. It is working fine. They have been modelling in ArchiCAD one family house. They have their own work to model in ArchiCAD. Of course they first learn the basic tools and how to use them, otherwise it will be too difficult for them to start modelling their own house. Professor Ilmari Lahdelma is very satisfied and I think the students are more motivated to both courses when they get some profit about working in that symbiotic way.

**Do you think those subjects like this need not just a practical part but also a theoretical one?**

ML| Yes, yes. I mean, you can also make the same procedure with Virtual Reality tools. That would be the best way: first integrate it in one course, but then spread it wider. [...]

**If I had the possibility I would like to interview more Professors, but my schedule here in Finland is too tight, I just have one day per school.**

ML| I think Olli- Paavo is the only Professor here today. I have been talking with him and discussing about this. He thinks that he does not understand about VR enough, and also that it does not affect him, because he is a History teacher. I said to him: "you are wrong!". We had this little project in an Alvar Aalto museum. They were organizing an exhibition about

Alvar Aalto's projects which were never realised, unbuilt designs, and some students and teachers were doing that process, they were modelling some of those buildings, they were using VR. They created a small interface to the exhibition so that everyone could come from the street and interact with Alvar Aalto's buildings.

**When I was in Seinäjoki, two years ago, doing my summer internship, I was working at a VR Lab and my work was to model a museum designed by Alvar Aalto. I did the model and then it was displayed on a CAVE and we could walk into the museum even if we were not at the real museum. But this museum really exists, I mean it was constructed. It was quite a worthwhile work for me, really interesting. I had never had this contact with VR. I think in Portuguese schools, people think that Virtual Reality does not exist.**

ML| [laughs] They are right, it does not. It is virtual...

[laughs] **We had never talked about it in my school and when I came to Finland I was completely amazed with this kind of tool. When I came back to Portugal I wanted to explore this kind of tool. When I had to choose my Master dissertation's theme it became clear to me that VR in architecture was a good thematic to explore. And it was obvious for me that I would choose Portugal and Finland as cases studies, since Portugal is where I live and where I am studding and Finland it was where this interested appeared.**

ML| You were brave about choosing this subject, because here also some professors do not find themselves very familiar to that and that is why they do not see the benefits of it. And if somebody here had chosen that kind of subject, to a Master dissertation, then it would be a little bit hard to grade.

**And to argue...?**

ML| Yes.

[...]

**That is the problem. In the future we will use this and other things that will appear meanwhile, but maybe they don't see that. Hand-drawing still is the master tool.**

ML| It is always better to be on the front, than just take what the others have done.

**Actually, it is really more exciting to be on the front...**

ML| Yes, you can create with the others, of course, a special tool, appropriated for architects and not just get the tools that were created for video games' technology... •





[2016.4.15]

**School of Architecture - Tampere University of Technology**

Professor: **Satu Huuhka [SH]**

Teaches building's renovation

**What do you think about the possibility to establish a VR architectural network between Finland and Portugal - and extend it to other countries around Europe - aiming the exploration of VR in Architecture?**

**SH|** The first thing that comes to my mind is that they are from completely different sides of Europe: one is in the South, the other is in the North. And once you are Portuguese makes sense that you choose Portugal, but I don't know your intentions to choose Finland.

**I did a summer internship in Seinäjoki, two years ago. I must confess that I wanted to run away from architecture, in that summer, and so I was looking for some other area of knowledge and I chose Virtual Reality. At the end I realised that it was very connected to architecture. I was amazed with this kind of tool, the glasses, CAVE, and everything... and that is why I chose Finland. I also checked this geographic situation, I think these two countries frame Europe, because they are edges... But do you think it would be useful to spread the network project all over Europe?**

**SH|** Yes, it will be good. At least to research, it will be an opportunity to European countries to share knowledge.

**My main goal, behind this master thesis topic, is to submit a project to a European Commission call, like Horizon 2020.**

**SH|** Yes, yes. Quite ambitious.

**For that I would need a team and lots of work, but now I am just focused in my Master dissertation and I am using that expectations to develop this research. In your perspective how difficult is to get a job here in Finland after graduation?**

**SH|** The times are not so good to architecture offices, because of the recession, but I do not think it is difficult. Architecture and construction are very sensitive to economic stand so they stare at the recession immediately. Then there were no jobs, people were even fired in architecture offices, but when the economic situation will improve, things will change quickly. And now is of course not a very good situation, at the moment. I have not hear much about how it is for people that graduate and try to find jobs.

**Do you think VR could open the field of possibilities for young architects that leave schools, as with a sort of a virtual curriculum?**

**SH|** I think it would be a good way to show what is different in you, as student, from the others. Is something that will probably impress people who are hiring, because they are older and they do not have the knowledge. They tend to appreciate this CAD skills and

computer skills. And more often it will be an easy way to show your knowledge to a larger audience.

**Focus on school now, how do you see the relation between your department and VR, in this school?**

**SH|** I think is improving. We have a long tradition in CAD, but not so much in VR. Now we have a PhD researcher, I do not know if you heard about him, Jorge Garcia Fernandez. He is studying laser technology and how laser scanning can be used to produce information for innovation in technical construction.

**Do you think digital media has impacts in design process?**

**SH|** I am sure it does.

**How?**

**SH|** I think it guides the way we design.

**And what about VR, does it have impacts in process?**

**SH|** Well, we have these 3D perspectives views that I think that must be useful when we design. You can look around and you go like walking there, but of course the experience would be more real-like if it would be in a virtual environment, with virtual glasses...

**Or even in CAVE. I don't know if you are aware of what a CAVE is. I guess you had one before, here in the University, but now you do not have it anymore. At least that was what I have been told this morning. A CAVE is a sort of a room that has projectors displaying in 3/5 walls, where you can walk virtually inside your building - which you have modelled before. It is more or less the glasses' experience. Do you think that could be integrated in the design process too, or more to communicate?**

**SH|** Why not in design process? Of course not everyone has the access and probably if there was such a space like that it will be quite heavy so you could not just access it like quickly, when you were designing something, maybe at your home or wherever you were working. But it could be used for research and of course to communicate things to the client. Clients like all the 3D representations, because it is hard for them to read plans.

**Which is the subject that you teach here in your school closest to VR?**

**SH|** We have like CAD teaching and that would be the closest one.

**What kind of influence do you think that the introduction of VR would make in your academic curriculum? How do you think VR should be integrated in it? For instance in which years would you integrate it?**

**SH|** I am not so familiar with VR and how it would actually be, if it's hard to learn or easy, but I think people who are not architects they often enjoy this and understand better the 3D views. Therefore, I would think that if you could actually introduce that to the first year students, could help them to understand... but I don't know if it is so complicate to teach.

**Do you think it will be an advantage to have a CAVE here, in your department?**

**SH|** It is hard to say. If it was cost efficient...

**Disregarding the costs, since we should think that it would be included in the budget of the project...**

**SH|** It could be an advantage, but it's hard to say how it would be used, in which courses and what it would contribute to the teaching of those courses.

**Do you think it would be better: to the design process; for the communication of the design inside the academy - between students and professors; or to communicate the design to the public in general, like municipals...**

**SH|** I think it would help all.

**Do you think this kind of method, VR, should be taught in a cross-curricular way or just in one subject? Like physical models. We do models, but we do not have a specific subject to learn how models should be made. We just do models in every subject, even in History or Theory of Architecture. What do you think that should happen with VR?**

**SH|** Well, in practice, I think, it would be taught in one course, but the ideal would be that you could use it as a design tool and a communication tool in any course, but then we have like 50 students on a course and then we have only one CAVE, but it won't be possible to go through all the projects of all the students, so I don't know how that it would be organised. •



[2016.4.18]

**School of Arts, Design and Architecture- Aalto University**

Professor: **Hanna Vikberg [HV]**

Teaches day light's behave in architecture

**HV|** Can I ask you a question?

**Yes, please!**

**HV|** What do you mean with VR? Do you mean the planning process that you actually building the information modelling? Or do you mean like if you have modelled the building and you have like virtual building? Or do you mean like this kind of platform where people can share designs?

**I mean the 3D model of the building with the possibility to visit it virtually with some devices like glasses, and CAVE... I have to clarify that my work is settled on CAVE as a tool to representation.**

**[...] [Definition of CAVE]**

**HV|** But there is also, do you know, this big room concept? They use it quite a lot in the Finnish building market. I am not very familiar with it, but I know that my company uses it sometimes. You have like a room where all the planers of the project meet and then they can look at the model together in this room. It is a bit as this CAVE thing, but you don't use the glasses, it is called big room and is kind of a working method.

**And how can you see 3D things?**

**HV|** It is more like normal projections of the 3D model, but it still like a room where you collect everything and you meet, every week with the whole team.

**Like in a BIM?**

**HV|** Yes!

**Ok, that's a good approach, too. How do you see the connection that could be established between Finland and Portugal and then be extended to all Europe?**

**HV|** I have been working in different architecture offices, that have been working in different countries and they also have employees from different countries. I found it a broader perspective, because if we only work in Finland we always end up working in the same way we have done before. So, always when you go somewhere else, where they are kind of disconnected from us you see different ways of working and usually it brings something to your way of thinking and I also think it kind of opens up all the possibilities so that you can see that there are too possibilities, things you can do. For that, I think is important for us to get influences from different places.

**[...]**

**And what do you think about spreading the project all over Europe and not just Finland and Portugal?**

HV| Well, in my former work place, I have been working on this research project. There are some companies from Germany, Spain, all around Europe and it has its benefits, but it is also very difficult. The circumstances are so different that there may be difficulties in finding really synergies. You need to be pretty careful with what kind project you do, but then you could have architects working in different countries and it could be very enriching.

**In your perspective how difficult is to get a job here in Finland?**

HV| Right now I find it not very difficult, even though that we are on a recession. I think there are quite a lot of jobs.

**Do you think VR could open the field of possibilities to young architects to get a job?**

HV| I know that nowadays is becoming common to have digital CVs, which is a different think and is kind of one step in that direction. I think it is only a matter of time when we will start to forget more or less the 2D stuff and move on to 3D. I think it just going to be a natural part of the whole development process.

**Do you think the 2D and also 3D should be both used or instead do you believe that 3D can replace the 2D?**

HV| I think the 3D can replace the 2D, but not in the way it is working right now. In maybe 10 years, it will do it, but it will require quite a lot of people to get use to work with 3D and it is a very different way of working so you cannot even say that. You cannot just change the 2D to 3D. You need to think the whole project differently, when you are working in 3D. Back to the portfolio issue, it may also be a problem for young architects, because when you are only showing 2D pictures you can choose to show only the best parts of your project, but when you have the 3D and somebody can walk through all your project, they can also find all the difficulties and the problems and when you are a very young architect you maybe are not able to think about all the different angles of your projects. So there might be some problems especially if you compete with older people that maybe have more experience and even more time to develop.

**Now focus on schools. How is it the relation between this school and VR?**

HV| I must say I am really not an expert, I have no idea.

**Do you think the digital media has impacts in the design process?**

Yes.

**How?**

HV| It depends on what you want to say with design process, but at least with process it has a big, big impact. Maybe it should not really impact the result, because it is the tool that should design the building for us. The design should be made in our heads and the tools should only be resources to reach that goal. But the process is different and of course the fact that you can walk through it with the other designers and one very important thing is how it

makes it, how it shows the project to clients that are not professionals. I realised that many clients have a really hard time to read 2D pictures and they do not understand what it means. And for us is so clear that when we see a floor plan we know what it means, how it looks like, but for a general person they do not see from the floor plan that “the house is going to be like this”. In that kind of relationship I found it very important.

**And about VR, does it has impacts in the design process, too?**

HV| Yes, sure.

**How?**

HV| Well, more or less the same answer as the question before.

**Which is the subject that you teach here in school closer to VR?**

HV| I am here only to teach just this one course so I don't know anything about the other courses, except for when I was here as student, but that was some time ago. Already in my class I teach Day Lighting so we are using a 3D modelling tool to be able to research how the light is moving or how much light there is in one room and so on... And that's very, very helpful because I have a very short time. And otherwise, in the old fashion way, we would have to build models and that it would be very difficult to really make the lighting scene look as it actually is and not doing it wrong. So the digital tool is really, really helpful, or the 3D tool is very helpful, and it also has this kind of thing so you can calculate the light factor and stuff like that...

**What is the name of the software?**

HV| VELUX, daylight Visualizer.

**What kind of influence the VR would make in the plan of studies?**

HV| I do not see a big difference between the modelling and the VR, it is more a kind of a predicted step from the 3D modelling.

**In which year should the VR be taught?**

HV| Well, it depends on what the aim is. If the aim is that the student will use the VR in all her/his work that she/he presents it in the school I think it would be important to learn that in the beginning, because I found many students in trouble whenever they do not have the right tools to show their ideas. They were just taught in the 3rd or 4th grade, the digital tools, or the modelling tools, or the VR tools. But then again, now when VR is not the main tool for showing your ideas, then it could be just for the older students, who can understand already how a building is build up. But later, when VR becomes more common, then it can be taught at as a normal kind of drawing tool.

**How do you think that VR should be taught, in a cross-curricular way or in just one specific subject?**

**HV|** I think it might be used as any kind of tool that an architect needs, to show her/his ideas. Then maybe in the beginning it might be good to present the tool, the basic functions and so on...

**Theory of the tool?**

**HV|** Yes, kind of theory. So that students can get used to it and for them to learn that this tool exists. But after that, I think it should be just a normal part of the process. But it still is a tool so I find it very important for the students to understand that we should not only focus on the tool again, we should focus on the design. The tool is just a tool. To be able to show your design you need to know how to work with the tool. It is also very important that the students are active. As in old school days, when you learnt how to draw, you did it a lot by yourself, because that is how you learn your way of drawing. I think using modelling, or digital, or VR tools you need to find your own way of how to use it and how to work with them, because otherwise you will get the same kind of style as everybody.

**Which benefits do you see in having a CAVE here, in your school?**

**HV|** Well, I think it will be interesting and it could be used when students were showing their designs, but then again we need to remember that the student's designs are not complete. They are just kind of a sketch. Maybe the master thesis projects is a complete building, but the other projects that the students do are not. The aim is that they show the main idea and their main thoughts. So, the possibility with VR tool is again that you can see everything and all the faults too, so this might be a problem...

**But do you think that the introduction of a CAVE in school should have more advantages in the process of the student, in the communication with the rest of the academy or with the public in general?**

**HV|** For the public for sure. Again, with the public we have people who are not professionals. I think most professors and teachers are that far in their profession that they can see it from pictures already, how it is going to look like. But of course this might be a big bonus, to be able to walk in it, but maybe it does not give them so much more information. •



[2016.4.14]

## **Uki Arkkitehdit – Oulu**

Architect: **Mikko Heikkinen [MH]**

**I would like to hear what you have to say about Virtual Reality, from the architecture office's perspective, in terms of cost and everything that you can say about it.**

**MH|** We have a lot of experience, as you probably already know.

**Did this new method start at the same time as your office?**

**MH|** No. Our office is almost 60 years. My grandfather founded our office. I am the third generation working here. For us, this method started in 2005. We got one commission to do the new hospital in Seinäjoki and the school there - SeAMK- already had built a Virtual environment, like two years before this hospital project. It was quite new there, in Seinäjoki's school. When the new hospital project started the promoters were thinking about 'how can we use the Virtual Reality, the CAVE, in the design of this new hospital?' And they ask us if we saw some opportunity to work with that, some kind of benefits about this approach. Nobody knew anything, of course. We only knew that it was totally new for us. But fortunately we reconsidered about it and we thought: 'yes, sure'.

At first this seemed truly interesting and second we had a lot of experience in architecture, we have been doing architecture for tens of years and we knew the process completely. We knew normal or usual process, without Virtual Reality. So, me and my colleague Antti - who is now senior architect, half retired - we went into a room like this and we were there for one day, thinking: 'How can we implement the CAVE into the normal design process?'. We were also thinking: 'why do we want to use it? What is the point of it? How can we gain some information out of it?'. We were total zeros, but we started to think: 'What can be the benefits?'. Of course before that, we already had thought in the issues of a normal design process. In Finland at least, can be like that the end users of the building, they are often part of the process. However, many times they are actually very passive, even though, they should be very active. This is the consequence of an amount of things as: they don't have our education and they may not have the skills we have. Even though they are exciting, they are really insecure and unsure of their contribution. That was already recognised as problem many times. Thereby, we thought that we have to put our ideas more clearly and CAVE could actually be an almost perfect environment for that. We could put our designs there and go to the end-users or our clients. It is an efficient way to reach understanding. This was one of the starting points.

**Do you think CAVE has more impacts in the communication of the project with the public or to the own architect in order to understand his own project?**

**MH|** If you are asking me: "Do we gain something to our own work as architects?". Yes, of course there are some benefits! But the benefits are much bigger outside of our own scope.

### **But what kind of benefits can we gain, as architects, from it?**

**MH|** Well, actually it starts with a better understanding of the buildings. If we start to design and make architecture - this is my opinion, some architects may think differently- we have to understand really what the need is. Architecture is not only a visual thing, it is also the concept from the architect and also from the client, more or less for me. It is lots of information at the same time and when we are able to understand all together what we need, that is the best way to start doing architecture. But also what are the benefits for us? We have 45 people working here [at the office] and they are excited about the possibility to use CAVE, because we can visualize extremely fast the design. If we use it at the beginning of the design process- which we do now, because we have also developed our own software and the tools to do it- we can actually make some sketches there and make comparisons actually good with other designs.

### **What is the name of the software that you use?**

**MH|** It is based on a real extend open source code and we have built on top of that the software. We have made our own tool. So you can actually see what has been drawing in a few hours in our CAVE or in our clients' CAVE.

### **Your client's CAVE?**

**MH|** Yes, we have also clients that have their own CAVEs. For example, here in Oulu's Hospital area, it started a year ago, and the first thing they wanted was to have their own CAVE. I work there as well. So we are really integrated and we can connect our CAVE and their CAVE together to work.

### **So you are not the only office in Finland having a CAVE, are you?**

**MH|** No. We were the first ones. Actually the CAVE that they now sell - this Finnish company sales - in Finland, they actually made the concept with me. I told them what I needed and they like thought 'ok, we can do it together.'

**Yesterday, I was talking with Claudia and she talked with me about numbers and costs. She told me that we can save money with this kind of method, because in the end the building is more alike to the end users and we can skip some changes...**

**MH|** Yes, it is true. I can confirm that. It truly depends on the costs. For instances, we had this one project that the client came to us and presented their concept which included three buildings. Then we started to work on it and at the very beginning we reedit the concept, we modelled it and we went to CAVE. Then the client and also the end users came to us and they were able to rethink their own thoughts about they own project in CAVE. After all, the end users realized that one of the buildings, didn't need to happen at all. They took 30% out of their budget, because everything worked in two buildings only. You can understand how this is extremely useful for our clients then. After that, they took this 1/3 of the initial budget and they did a much better building out of those two. And this had been happen already. It really can be a very beneficial tool.

Also if you think about the cost, a hospital is a perfect example because is like a city in itself and the total cost of their labor work in a year is ten times the sum of the construct process. So, that is one of the key benefits for our customers of course.

**And looking at schools perspective, as an architect, what would you say to the approach that schools should have to use this kind of tool?**

**MH|** That is an interesting question. I'm not sure, at least in Oulu's school, I think they are thinking about it. I think there is going to be a Virtual Reality environment. I heard about that, because they are moving and I think in the new faculty they are going to have a CAVE, I heard something about it.

**But it will be linked with architecture's department or just to other courses?**

**MH|** I think it will make part of the architecture's department.

**That is interesting, because yesterday I went to Oulu's architecture school and I did not notice that people were aware of his kind of tool. I think it will provoke some changes in the plan of studies than, because they have not any subject teaching about VR.**

**MH|** I am a little bit surprised about that because I heard that two years ago. You have a point! I think it should be taught and studied there. In Finland we have now three technical schools and they are already teaching the Virtual environment. So, at least it has started at that level.

**But, that is taught to engineers or technical experts, right? Because to teach architecture students about this issue, other kind of teaching approach has to be found.**

**I would like to ask you if you think VR should be taught as a single subject or in a cross-curricular way - as in all the subjects, synchronizing everything. For instances, as models: we do models in almost every subject, even in History or Theory of Architecture, sometimes...**

**MH|** That's a very good question. In technical reality, things have to be little bit more developed yet, because for example the software that we use is new and we have started a company now so our plan is to develop and make it bigger and widespread. But my point is: it can be integrated easily in a technical aspect. But the point is: how can it be implemented in process of design? That is one of the things that needs to be thought very carefully. It has to start with someone that has already done it or someone who could see the benefits through experiences. Ok, maybe I am talking about myself now, but anyway, I cannot see any other point, because it has to start like that. Now I have done this for 8 years. To a new person, it takes a lot of time when he/she understands what this is about. Usually people start to think: "ok is just modelling and then we go to see it in the CAVE... oh it looks good!" But it requires lots of thinking and lots of work to make a person understand what is really necessary. Anyway, I am absolutely certain that it has benefits, because we have lots of evidences of that. And it also can make our design better that is my point of view, because we understand righter what this really is.

And on top of that we make our best, so actually, it makes our design better. We have to be in control of the process. If you give the control to the client or engineer or whatever other professional in this field, then we will be in a bad situation, because of course the lead of the process is what they want. In Europe, we start to really use it and implement it, so if in the field of architecture we lead this development, we will play like in a safe position. Because if we give that control to other persons...

**Claudia told me that you gain more clients, since you have the CAVE system...**

**MH|** Yes, we have, we have more. It had benefits in that also, 8 years ago we were 25 people working here and now we are 45.

[Introducing the question of the network and the European project]

**The first question about the connection between Portugal and Finland in this network project is: do you see advantages in this kind of connection?**

**MH|** Are you asking me if I see the benefits?

**Yes.**

**MH|** Of course!

**Because in Portugal all these questions about VR are not so clear yet.**

**MH|** I understand that. I can see that.

[...]

I think what you are doing now is really ground-breaking. Because, like I said, this could be really the main method to do in like 20 years or 10/20 years. The society and everything goes through that way. This kind of approach can be very beneficial if we now, here in Europe, really think about it. Please do the network project.

**Thank you, I need a team to do it...**

**MH|** I understand!

**I could talk with you again after finishing my master thesis...**

**MH|** Yes, I am interested about this, I am also interested about teaching.

**I cannot do it that now because I need a team, partners and to focus all my work on that for months, because that kind of submissions requires a lots of work. And now I am focused in my master thesis. But then I would like to go ahead with this idea and once that European Union has this kind of budget to invest in projects like this one, I would like to lead on this idea.**

**MH|** Please be in contact, because we want to develop also, of course. We had started of this technology in this company. Keep me informed about what is happening.

**Thank you so much, I will sent you an e-mail. It is worthwhile to see that people are interested in this kind of project, because I don't have always this kind of feedback about this subject. People sometimes are a bit afraid of talking about this...**

**MH**| Yes, because the tradition is hard for some people to go beyond. The point is: if you want to do this successfully, you really have to change the way that people work. And it is not easy, I can tell you! Because they have to go out of their comfort zone, they have to re-think their thoughts and we had succeeded in that, but it has taken lots of work. But also I have seen the importance of this and I had “infected” other people also with this...But they have also seen that this is very good for us and for the clients. I think you can use us as an exemple and we can help you in that as much as we can.

**Thank you very much. I was talking to Pauli and I said him that I will take your office as a case of study because it reflects in the practice some aspects that I am discussing in my thesis**

**MH**| I had heard all the counter-argument. If you went in some kind of point that you cannot go further, because you cannot argue about the potentialities of VR, please ask me, because I heard all those counter-arguments and I have answers to them. •



[2016.4.14]

## **Uki Arkkitehdit – Oulu**

Architect: **Pauli Koivisto [PK]**

### **What was your Diploma's work about exactly?**

**PK** It was about using Virtual environment in a hospital planning and we had this Seinäjoki central hospital project from 2006 to 2012. This time includes the planning and the construction. And I did this work in 2010. We had a group of work, Antti was the head leader. The 3D scene was made by Jako an architect student. I wrote about the project and I was involved on it since the beginning. We had many, many sessions to discuss the project.

### **Did you display your project in SeAMK's CAVE?**

**PK** Yes.

### **Where do you think that VR has more impacts: as tool of representation, of communication or as tool that could help the architect in his own design process?**

**PK** I think in all of them. I think maybe it has more impact for the end-users.

### **Do you think there are benefits in having a CAVE connected directly to an architecture Office?**

**PK** I think it had some results in Seinäjoki's CAVE, back in that time and I think nowadays we can do it faster. I believe that Virtual Reality systems are increasing and it will be used into the begging of planning.

### **What do you think about the interface between the display session and the drawing, in the upgrades of the project perspective?**

**PK** Yes, it is not automatic. It is not fast enough. And there is this problem that you can take lots of information from the users, but you cannot take everything.

### **What about the feedback of the users?**

**PK** It is mostly good, I think that they feel heard. I they can feel what we are planning.

### **That doesn't happen when you show them plans or sections, 2D material?**

**PK** Not really, because they do not understand.

### **When you were studying architecture, have you had any contact with Virtual Reality?**

**PK** No. I start studying in 1984 and I this work in 2010. I have been working in this with Mikko [the dean of the office]. I had contact with Virtual Reality in the office. In this Hospitool Y project, we worked with video games experts. The SeAMK's CAVE it was quite nice because it has this floor, selling and 3 walls projections.

**Is it better to have a fully virtual environment, I mean one with 5 walls, instead of the three walls that you have here?**

**PK|** Yes, I think, as you see in this pictures, you can even seat and evaluate the scenario, you think you are really in the room, it is better in that way.

**Do you know if schools have a close relationship with Virtual Reality?**

**PK|** Yes, I think more and more. It is increasing. There is a technical school here in Oulu, they have a full wall CAVE. But it is not the school of architecture.

**How much does it cost for the client a Virtual Reality experience?**

**PK|** I'm not so sure of it nowadays. Few years ago it was quite expensive. Nowadays is quicker and faster.

**Do you think students from architecture must have contact with this tool?**

**PK|** At least, some kind of. You have to know what it is about. It is quite a new think nowadays. I think that it is been hard times lately, but we still have a lot of work and I think virtual environment is the reason why. We have manage quite well. We have also new clients, because of CAVE.

**Are you the only office in Finland that has this system?**

**PK|** No, no we aren't. We are the only office that has this whole package, we have this CAVE and we have this feedback system.

**What is your feedback system?**

**PK|** We have got these surveys and we get the answers right away, not after a few months later. We have many options: for the clients we have a video that they can check two days after the experience in the YouTube channel. It is the most complete feedback system in Finland's offices.

**When I was searching for a more specific topic into Virtual Reality theme, I considered to choose either the CAVE or the VR glasses. Apparently the glasses were the most versatile, cheapest and especially most developed, while CAVE is getting behind...**

**PK|** Maybe so, but it allows the co-work as we do here in CAVE. I guess CAVE has the opportunity to develop even more in the future, when they get cheaper it will be easy to achieve one. •



[2016.4.14]

## **Uki Arkkitehdit – Oulu**

Arquitecta (alumni da FAUP): **Claúdia Antão [CA]**

### **Quais são, no seu ponto de vista, as principais diferenças entre os alunos portugueses e os finlandeses?**

CA| Concluir rapidamente o curso não é uma prioridade para a maioria dos estudantes finlandeses. A educação na Finlândia é gratuita e a maior parte dos estudantes universitários são economicamente independentes dos pais desde que entram na faculdade. Embora haja algum apoio financeiro do estado, muitos dos estudantes finlandeses trabalham durante as férias ou em determinadas alturas do curso não só para adquirirem experiência profissional, mas também como forma de sustento económico durante a formação. Assim sendo, grande parte dos estudantes de Arquitetura finlandeses tem experiência profissional, alguns deles estão até a trabalhar durante largos anos em escritórios de Arquitetura antes de terminarem o curso.

### **Que tipo de dificuldades sentiu face ao mercado de trabalho depois de terminar o curso?**

CA| Por motivos pessoais o meu objetivo foi sempre trabalhar na Finlândia. Ainda enquanto estudante de Arquitetura na FAUP, resolvi vir estudar durante um ano letivo para Faculdade de Arquitetura de Oulu, ao abrigo do programa ERASMUS. Depois disso, antes de concluir o curso, resolvi procurar estágio na Finlândia. Procurar estágio ou trabalho em Portugal sempre esteve fora de questão pelo mercado de trabalho estar saturado e não haver muitas oportunidades para jovens arquitetos. Na Finlândia, para um estudante ou arquiteto finlandês é relativamente fácil encontrar trabalho, havendo evidentemente variações de cidade para cidade e flutuações ligadas à situação económica do momento. Porém apercebi-me que para um arquiteto estrangeiro o cenário pode ser mais complexo: a falta de experiência profissional e o não domínio da língua finlandesa foram os elementos extra com que tive que lidar. Quanto à língua, o finlandês é um idioma particularmente difícil de aprender, poucas palavras são familiares para alguém cuja língua materna não pertence à mesma família linguística, as declinações possíveis para uma mesma palavra são imensas. Embora na Finlândia grande parte da população saiba falar e compreenda bem o inglês, muitos escritórios não estão dispostos a empregar estudantes ou arquitetos estrangeiros. Sendo a Arquitetura uma área em que tem que se lidar com clientes, engenheiros e técnicos de várias especialidades, participar em reuniões, produzir elementos escritos, fazer visitas à obra, *etc*, é compreensível a importância em saber dominar a língua local.

### **Como é que conseguiu então um lugar neste *atelier*?**

CA| Em escritórios de pequena dimensão é mais difícil e menos provável para um arquiteto estrangeiro conseguir arranjar trabalho. Os escritórios que ainda vão empregando arquitetos

estrangeiros são geralmente os de média ou grande dimensão e concentram-se nas cidades maiores do país. Acabei por encontrar estágio neste escritório onde trabalho atualmente e onde fui muito bem recebida. Quando acabei o estágio regresssei a Portugal para fazer o trabalho final e concluir o curso. Nessa altura (2008) a crise europeia refletiu-se também na economia finlandesa, o volume de construção diminuiu e havia menos trabalho. Consequentemente alguns escritórios de Arquitetura foram obrigados a despedir trabalhadores. Assim que concluí o curso em Portugal a situação económica na Finlândia ainda não tinha recuperado, mas ainda assim, consegui trabalho no mesmo escritório, por já me conhecerem e gostarem do meu trabalho.

**Que tipo de *upgrade* teve de fazer aos conhecimentos dos softwares e de outras ferramentas de representação quando começou a trabalhar no atelier?**

CA| Quando comecei a trabalhar no escritório não tive que imediatamente fazer nenhum tipo de *upgrade* aos conhecimentos dos softwares ou outras ferramentas de apresentação, uma vez que o programa que mais se usava na altura era o AutoCAD. À medida que foram surgindo novos programas nos projetos do escritório, fui participando nas formações que foram organizadas pelo escritório para grupos de trabalhadores, e também em formações que são organizadas esporadicamente pelos fornecedores dos próprios programas. Fui aprendendo aos poucos, com a dificuldade extra de a formação e alguns dos programas serem totalmente em finlandês (por exemplo ArchiCAD). Alguns programas mais simples tomei a iniciativa de ir aprendendo e aperfeiçoando o seu uso através de tutoriais que fui encontrando na internet. Atualmente a lista de programas que se usam nos projetos do escritório é bem mais alargada do que quando comecei. Neste momento eu e outros trabalhadores estamos numa formação de Revit.

**Que tipo de vantagens e desvantagens reconhece no sistema CAVE integrado num atelier?**

CA| O nosso escritório é pioneiro na utilização do sistema CAVE e tem-no utilizado enquanto ferramenta de comunicação do projeto com o utilizador e /ou cliente. Tem sido utilizado principalmente em projetos de grandes dimensões como por exemplo hospitais e centros de saúde. Em termos de comunicação e coordenação entre os diferentes especialistas que participam num projeto (arquitetos, engenheiros, técnicos) o sistema CAVE não é utilizado nem seria prático. Para isso são utilizados modelos 3d que possuem toda a informação do edifício em pormenor (estrutura, canalizações, eletricidade, ventilação, etc) e são usados programas como o Solibri ou Navisworks que permitem analisar e detetar possíveis problemas ou conflitos antes do edifício ser construído. Estes programas são bastante eficientes, permitem produzir relatórios dos problemas, e fazem um inventário dos diferentes elementos, permitindo também calcular o preço final da construção. Para o arquiteto, durante o processo criativo, o sistema CAVE também não é pertinente. O desenho à mão no papel continua a ser o ponto de partida mais rápido e imediato para se esclarecer, organizar e estruturar ideias, que depois irão ser testadas e desenvolvidas no computador através dos diferentes programas 2D e 3D. Também em termos de comunicação de projetos

ou ideias entre arquitetos, o sistema CAVE não é relevante e por isso não tem sido utilizado. As maiores vantagens da utilização do sistema CAVE estão ligadas ao facto de facilitar a comunicação do projeto com o cliente, utilizador do edifício, ou mesmo público em geral. Nem sempre é fácil para uma pessoa não ligada à Arquitetura compreender um projeto apenas através de elementos desenhados (plantas, alçados e cortes). Os modelos 3D, desenhos em perspetiva/axonometria e visualizações/ *renderings* são bastante úteis mas ainda assim apresentam limitações. Quando o projeto é apresentado em CAVE o utilizador tem a oportunidade de experimentar o edifício antes de o experienciar: consegue perceber melhor o projeto, as formas do edifício, dimensões dos espaços, luz, materiais, cores, etc. Ao compreender melhor o edifício, o utilizador é mais capaz de fazer comentários ao projeto, ou mesmo mencionar aspetos que tinham ficado esquecidos à partida ou que nunca tinham ocorrido. Temos observado uma maior interatividade e discussão do projeto por parte das pessoas que assistem às apresentações no sistema CAVE em relação às que discutem um projeto numa sala de reuniões “tradicional”. As sessões CAVE costumam ser em grupo, o que contribui também para uma maior discussão e interação entre todos os participantes. Temos notado também uma maior satisfação e motivação por parte dos utilizadores, no sentido em que se sentem mais envolvidos no projeto, e que as suas opiniões e necessidades são ouvidas e tidas em conta. Por sua vez, o arquiteto consegue também compreender melhor as expectativas dos utilizadores e pode melhor equacionar soluções alternativas às que foram apresentadas. O sistema CAVE tem-se revelado muito eficaz na adequação do projeto às verdadeiras necessidades do cliente e/ou do utilizador. Consequentemente há também uma redução dos custos do projeto, não havendo necessidade de fazer alterações ou redimensionar espaços quando a obra está concluída.

O sistema CAVE não é suficientemente flexível para rapidamente podermos fazer pequenas modificações em tempo real. Ou seja, sempre que é sugerido pelo utilizador e/ou cliente alguma modificação no projeto não é possível experimentar logo no momento, há que fazer essa alteração nalgum outro programa, e posteriormente organizar uma nova sessão CAVE, caso seja solicitada. Não se consegue imediatamente a partir do programa em que foi desenvolvido o projeto (geralmente ArchiCAD ou Revit), produzir um ficheiro pronto a ser utilizado diretamente no sistema CAVE. Há vários programas intermédios que são utilizados com a finalidade de melhorar as características ou aperfeiçoar/detalhar os ficheiros. Geralmente os projetos que são apresentados no sistema CAVE requerem grande pormenor e podem ser bastante detalhados, podendo incluir por exemplo acabamentos, mobiliário fixo e móvel, mobiliário à medida, aparelhos vários, iluminação, etc... Dependendo do tamanho do projeto, pode ser um processo moroso e caro por envolver muitas horas de trabalho e diferentes programas. Contudo estas limitações por mim apontadas, advêm possivelmente do facto de o sistema CAVE estar ainda numa fase inicial do seu desenvolvimento. Acredito que é um sistema promissor, com muito potencial e que irá desenvolver-se bastante nos próximos anos e que por isso irá aos poucos superar estas e outras lacunas. •



[2016.4.14]

## **Seamk Virtual Reality Laboratory – Seinäjoki**

VR Technical Engineer: **Tapio Hellman [TH]**

Design Coordinator: **Tiina Yli-Karhu [TYK]**

Architect: **Jyrki Jääskeläinen [JJ]**

### **How long have you been involved in Virtual Reality?**

**TYK** | I have been involved in this since 2007. We had the Hospitool project together with Finnish Technical Institute and Health Institute of Helsinki, where we analysed patients' rooms and after that the hospital like to continue and we had another case, a Hospicase 2 which was about patient rooms and doctors rooms and then we have a 1000 square meters of a new emergency unit to model.

### **So you had a hospital case and then you had to continue the construction?**

**TYK** | Yes, this building had been constructed after we had the first evaluation. We had over 200 nurses, doctors, cleaners, designers, constructors and people from administration to see the model. And now we have a new project together, a third project, we are developing the intensive care unit. We had modelled the intensive care room and intermediate care room, bathroom and nurses' office in Virtual Environment together with the staff.

### **The projects were all about the same hospital, I mean improving the same hospital?**

**TYK** | Yes, not the same place, but different units...

### **Do you design everything, plans, the models, the 3D models? Is it your office that does the modelling?**

**JJ** | Yes, we do the modelling. We had 3 months getting that room better and better and CAVE had 200 people giving ideas. After that we did the whole intensive care unit and it was model on Revit.

### **Did you use Revit as modelling software?**

**JJ** | Yes.

**TYK** | Who did the modelling in the CAVE environment?

**JJ** | There is a company who make it from our Revit model. They put the colours...

### **Do you have a CAVE in your Office?**

**JJ** | No, we don't have. We use this one [SeAMK's CAVE].

**I talked with Uki Architects Office and they shown me their Cave. Since they do not have this possibility in Oulu to use CAVEs from VR labs, they had to construct one for them.**

**TYK**| I found out that there are already 3 architecture offices who have their one CAVE. They might be more, but I found out 3.

**Once that you have one here, nearby your office you do not need to have one of your own. Can you recognize that CAVE has a lot of impacts in the project, in the evaluation of the project, in the communications to the public? And about the architect himself, VR has more impact in the process of the project or in the communication of it?**

**JJ**| It has, at least in one of those aspects. But thinking of this project, those persons that we have working with, they know the best how to do it. We had to hear what they are saying, how they are working, but we also try to teach them to work differently in this project, because is also a learning process to them.

**TYK**| Yes, because this patient room that we were designing will change their way of work. Now in the intensive care, the nurses work in one room where there is a lot of beds in the same space. However, in the new intensive care unit, which they will have in 2018, there will be a single patient room. So, they have to learn how to work in a different way. This design process can help them to understand the changes. Also they will have a workshop there to realize what will change, what things they should count on, whenever they will be working in the new unit.

**All these have impacts for the nurses and doctors - the users. But talking about the office scope: the architects that work in the project did not have the knowledge to work with VR, did they? Did they have to learn how to manage everything from the beginning? Or did they have learnt something from school already?**

**JJ**| You can't learn everything from school. You can learn a lot from the olders or from office work. The students that came from school to our office, they really do not know anything. We have to teach them...

**I am aware of that. Yesterday I made some questions to students, in the school of Oulu and I was surprised because students seemed to be apart from VR even though they could recognize some potentialities and expectations about it. When I was talking with Mikko from Uki Architects Office, he told me that soon the school of Architecture of Oulu might have a CAVE and that is strange because students and professors might not be aware of that.**

**JJ**| I do not. I think first students have to learn hand drawings and that kind of things. They cannot go straight to the CAVE. In the last year of school I think it is ok, but you cannot use it earlier, because you lose a lot of things. If you start to do the sketches on CAVE, after that you cannot read pictures/drawings. You can image in your head that something will look like this, but if you constructed into CAVE without know how to drawing, you always have to be in/out of CAVE.

**As an architecture student I know that in first year we have a lot of hand drawing. In the second year we start with AutoCAD or ArchiCAD or another CAD software. So we do not improve, is always the same: 2D, a bit of 3D, but we not often reach knowledge beyond basic 3D. Same students aim to go further and they learn by their-own. I think if we have 5 years of studies, I would said that the 3 last years could explore other things like VR. I would like to know your perspective about it. I think everything could be synchronized.**

**JJ**| I think the teachers are also part of the problem. Same times it depends on how old they are.

**TYK**| But it is quite funny because CAVE is not the newest invention.

[...]

**JJ**| Once again I think if you go straight to CAVE, you can loose 3D hand-modelling, you loose something...

**Yes, I agree. Somethings can be lost if only CAVE were used. But the same can happen with hand-drawings. If we only work with hand drawings, then some other skills would be missing. If we would be able to make hand drawings, sketches, digital planning and VR, then you are a complete person. I do not know why people see this learning process separately. I think every tool has its contribute. This is just one more tool and it does not have to replace the others.**

**JJ**| As Tiina told us there are 3 CAVEs in Finland, but the biggest on is here in Seinäjoki. In this way, students cannot use easily this kind of devices. Why learning how to use if then there is no CAVE to use?

**Yes, I understand what you are saying. But first: one of the purposes of my thesis is to think about an hypothetical project to apply to a call of Horizon 2020 in order to get a budget to invest in this kind of tool. That could mean to have a CAVE in schools that do not have one now. But also, establishing this VR network around Europe so that contacts between VR labs can be promoted. You have an Office and you have a CAVE really next to your office, thereby you can use it for your projects as you have been using. But for that happen I believe that VR has to be taught. But taught as everything else, as AutoCAD or another digitals software. Of course it cannot be taught in the same way as it is for Informatics Engineers or VR Technicians. We need their help, but we also need to somehow understand how it works.**

**JJ**| CAVE was the first step into VR. The glasses were the next one and I think somebody is waiting for next step after these.

**TYK**| It is strange because CAVE has appeared in 1992 and it had taken so long time to use, to explore that. It is not yet explored. There are just a few people in Finland that know how to use it and how to make the modelling. Only a few offices can do that and this is the only University that has a CAVE. I know that Tampere had one before, but they do not have it anymore.

**So there is this CAVE here in Seinäjoki and more 3 at Architecture Offices?**

**TYK** | Yes.

**Mikko was telling me today that architects work for the clients and this kind of tool is very appealing for the clients, because they can have an active role, they can tell what they like or not, they can say what they think. They do not have that kind of approach when they see plans, or sections, or those traditional representations. And also the clients can save a lot of money by understanding more precisely the whole project, because sometimes, in the end the construction, some changes have to be done and this system can avoid some of that changes in the end.**

**TYK** | If you can model in a Virtual Environment before the construction starts you can make the preview and the end-users can say what they like: “this is not good, you can have more space here, or put some windows over there”, it saves money because you do not have to make the changes during the construction process or after the building has been built. The end-users cannot understand the 2D drawings. They do not know where the windows are. That is the problem and I have been working with this almost 10 years, but before when we went to the buildings with clients they say: “oh there is a window here, I did not know!” So they got very surprised. But now, when they have seen it into a virtual environment they say: “Yes I know that. This was in the virtual environment displayed” It gets familiar to them.

**And that is almost everything for an architect, since we work for the public and we need their feedback.**

**JJ** | It is quite hard to evaluate the whole building in CAVE because the ideal is to have two persons there. I think it takes more profit in this small parts, as this intensive care room, because there is lot of people working there. We can get different ideas from different persons and also from people of other hospitals. They came and say how they work in their hospitals and which are the best options and what does not work at all.

**TYK** | I think that the design process which we used in our first models, they were very simple, black and white, and they did not have all the details, textures and so they said that those aspects were missing. We did the next one much more detailed and the third one had colours, pictures, windows, see-through the windows options and at the end they did not complained about it.

[...]

**TH** | In the first stage you had a common toilet, did not you?

**TYK** | No, the toilet was at the back, but they complained that they could not access to the toilet, because it was here in the back and it was too narrow. They also complained about the window’s blackout.

**Do you think that the clients can understand this kind of drawings? [Referring to an axonometric plan]**

**JJ** | They can understand this kind of drawings. But they do not have some much the perception of scale, of dimensions and the size of things... But in CAVE they can walk around and realize: “oh yes, there is a bathroom there...”



[...]

**So do you think that 1:1 physical models are better?**

**JJ**| No, I think they are better for little dimensions. Because for the larger ones CAVE is better. And the best things in CAVE is that you have lots of worries about the building and in this case the nurses could seat and see what they would be able to see and what could happen if the doors were closed or open. And that is the benefit of VR, you can walk around. But if you want to check measures, like just a few centimetres, VR is not a good option.

**This has a lot to deal with functionality of the space but what about aesthetics? Can people recognize if the place is nice or bad?**

**TYK**| Yes, they can recognize the colours.

**But the light depends on the quality of the projectors...**

**TYK**| I think the colour match with the real design. We assure them that they can work there, that is the main issue.

**JJ**| This was the first one in Finland. There was not other intensive care room VR modelled.

**This is kind of the concept of a living lab. Architects should be more linked to this kind of approach. We had this famous project in Portugal, but VR was not used, it was some decades ago, the name of the project was SAAL. Álvaro Siza, the Pritzker Prize winner, was involved in this project of social houses. The architects worked intensively with the end-users too as in your participated project. I can imagine if they had this kind of possibility...**

**TYK**| I think the whole design process is a learning process also for the end-users, because they will use the building from 30 years or something like that and they can participated in the design process just once in a life time. I think that these nurses and doctors are already experts in this kind of project. If they had to participate again in a new project of design they will knew better the things that they had to say and advice. Because it is very easy to want everything, but the challenge is to finger it out what is really important for their work. And that they do not really know.

[...]

**Do you think in the Future this CAVE system will be use to design private houses?**

**JJ**| Yes, but I think the private houses are too small, but for a block of apartments maybe...

**TH**| In this case I disagree. Because it is so easy to arrange. A few weeks ago, one of our ex-professors, who is already retired, call me and he wanted to visualize his building project. We arrange that in maybe two or three weeks and we were able to do it without any problems. He used Inventor, because that software was familiar to him, once he had taught that in his classes. He did project with that software and it was converted to 3DMax, because it was easier to show the model. It was not a problem at all. It can be used also with normal people's houses. I don't think there is any injures in using that.

[...]

**TH|** Actually in a while we can go and see both Evicures intensive care unit Project, the football stadium and that residential building.

[...]

**TH|** I think the situation that we are debating right now is similar to *Homo-sapiens* discovering some hunter rock tools. They could look at a sharp rock and wonder “what can I do with this?” They could either try to imagine what to do with it or just throw it away. That is what we are trying to do right now. We are trying to figure out what wonderful things can we do with that tool before we threw it away. •

[2016.4.18]

**Technopolis - Aalto University**

PhD student: **Juho-Pekka [JP]**

[Talking about the existence of a CAVE in Building 35 of the Aalto's University- Otaniemi Campus]

**What is the purpose of having a CAVE here in the campus? Is it for students to use?**

**JP** I think for a number of students and also to some research activities, but it is especially for interesting collaborations.

**It is not connected to Architecture department?**

**JP** Unfortunately I do not have that background from architecture.

**I think they do not use it, because when I interviewed the students I talked about the VR glasses and everything and they wrote that they do not use this kind of devices at all. I think they are not aware of how to use it. So, is this CAVE used by other students?**

**JP** I have been involving in this project a bit but not that much to give you more details. Most of the CAVEs in Finland are from the same company.

**Which is?**

**JP** Sata Vision. [...] in my opinion there is a strong analogy between CAVE and virtual glasses, because essentially the content production is similar.

**So, what are the differences between the glasses experience and CAVE?**

**JP** I think one of the big differences is that the CAVE is much more flexible to people so that you do not need to develop a system like you have to the VR glasses.

**Because with the glasses you just can have an individual perspective. Can you connect the glasses in order to see what other person is seeing?**

**JP** You could, in theory, but that systems are quite expensive.

**Are there any other devices besides the CAVE and the glasses in VR scope? [...] The problem now is the price and the behaviour of technology. It is difficult to change things in a project because if you are evaluating a building you ca not easily change something.**

**JP** Yes that is also true. I think for most of design applications you need to develop an easy interface.

**Yes, but the problem is that Architecture is not a sustainable area in this kind of issues. It is not as video games.**

**JP** Yes there is a very limited room for investments if you need to expand to this tools in the Architecture field.

**That is why I think that this kind of project [the Horizon 2020 project] would be very helpful. Also in CAVE, there is a difficult problem to solve, because one person can see right the environment but the others are just followers and they see it a little bit distorted.**

JP| That depends also on the CAVE configurations. The one in Seinäjoki is like a cube that is relatively sensitive to the “main- user” position. The ones that have a lower angle, that are not exactly a cube, they are a bit more flexible in terms of where you stand.

**Ok, I never though like this about the three wall CAVEs.**

JP| We have a dual wall CAVE downstairs also.

**Yes and there are no students from architecture or alumnis working with it, are they?**

JP| It doesn't surprise me that they are not even aware of that.

**This also mean another thing: in this University you have the architecture department and also engineering informatics and there is no connection between them.**

JP| Yes.

**And they are not working in a synergic way. Ones have an equipment that could be useful for the others and they do not collaborate.**

JP| Another problem is that in many cases if you have a CAD system you do not directly get the VR dimension model. If you are doing building a design, even BIM, you might need some additional steps to go from the CAD to CAVE. [...] There is also this company now which tries to commercialize BIM extension to VR applications. It is called Trinity. I do not fully know, they try to bring VR to some applications. [...] This is changing very fast. There are some VR companies coming. [...] You can see, that there is already this VR association, I think you can find here a lot of information. This is just an association that tries to promote the VR industry.

**And what about your work what is that really about?**

JP| My research is about laser scanning. And this is all about measuring the environment. So, we 3D scan the environment.

**This is another tool that could be used in architecture.**

JP| Yes, and we have researching in city modelling applications.

**Is it this software that Google uses to do the 3D maps?**

JP| That is part of their system, but we have our own systems. This is part of a big collaboration of 3 Universities and one research unit and we are trying to develop this system.

**And this is something that could be integrated in architecture designs, because at the beginning of each project often we have to recognize the urban context and that would be a helpful tool to do it. [...]But this kind of scanning can be edited?**

JP| It depends.

**And what about colours and textures?**

**JP|** It is just a matter of integrating that after scanning. [...] But it would be interesting to see architects also using this tool.

**I notice that in Tampere they use this 3D printers quite a lot. In Portugal is something new, but anyway we do not often use it.**

**JP|** For architecture I think is quite interesting. It makes it much easy to do a physical model.

**Yes, we need to recognize all the city around our project and then just the terrain of our building. Combine this laser scanning system with 3D printers would be wonderful to make this city models more precise because we cannot exactly know the high of the buildings... It would be easy and quick. I think when we are avoiding this kind of technology we are just losing time.**

**JP|** Yes, but when you want to use technology you always have to study it first. The first step is always a bit slower than the traditional process. But after a while it increases a lot. •



[2016.6.3]

## **Faculdade de Arquitetura da Universidade do Porto (FAUP)**

Professor: **Raquel Paulino** (RP)

### **Parece-lhe pertinente esta ligação que proponho, numa fase de estudo e análise, entre estes dois países, Finlândia e Portugal?**

RP| As relações com a Finlândia, sobretudo no contexto aqui da escola, tem mais a ver, essencialmente, com esta questão do Arquiteto Alvar Aalto. É uma referência incontornável na obra do Arquiteto Álvaro Siza, um dos grandes mestres desta escola. Não é o único. É, digamos o último da última geração. Tivemos várias, desde o Arquiteto Marques da Silva, Arquiteto Carlos Ramos, Arquiteto Fernando Távora, Arquiteto Álvaro Siza – sobretudo na prática profissional. Portanto as pontes que existem com a Finlândia tem a ver, de facto, com a obra do Arquiteto Alvar Aalto, que é de facto incontornável. As citações na obra do Arquiteto Siza à obra de Alvar Aalto são imensas.

Entre escolas, existem protocolos, mas não existe propriamente um laço muito estreito entre a nossa escola, a FAUP, e algumas escolas de Arquitetura da Finlândia. Sei que há protocolos. Há alunos que ao abrigo do programa ERASMUS se deslocam para desenvolver uma parte do percurso curricular. Há menos alunos de lá a estarem cá, pelo menos que eu tenha conhecimento.

Portanto neste âmbito específico, neste trabalho específico, a relação surge por essa experiência pessoal que teve. Do meu ponto de vista e enquanto docente desta escola, se calhar questionaria o porquê. O que é que se passa de tão significativo nesta área da Realidade Virtual, que possa justificar, de facto, uma seleção de determinadas escolas portuguesas e de determinadas escolas da Finlândia. Acho que qualquer arguente no início, na definição do tema e na definição dos casos de estudo, uma das questões que colocará com certeza é o porquê destes casos de estudo.

Eu penso que obviamente se deve rentabilizar o conhecimento que se tem, os contactos e as redes, que já se escortinaram, mas um trabalho desta natureza não pode ficar só a esse nível. Poderia haver razões mais fortes que justificassem, ou razões que tem a ver com a mesma prática pedagógica ou similaridades na prática pedagógica, em que fosse interessante ver como é que num lado - na Finlândia-, onde eventualmente esta experiência possa estar a ser mais desenvolvida, se relaciona com a prática pedagógica da Arquitetura. E por outro lado, como é que em Portugal, no ponto de vista da Escola, estas questões têm começado a entrar, mas ainda muito pontualmente, ainda não se relacionando tanto, talvez. Pode ser por aí, não sei, também sem algum tempo de reflexão, no imediato, não consigo identificar uma relação muito óbvia entre os dois países.

**Como a Professora referiu, a escolha destes dois países está absolutamente ligada à minha motivação inicial. Mas também ao facto de ser uma dissertação de Mestrado, e de não me ser permitido esse alargamento no estudo exato de uma rede Europeia.**

**Acabei por ter de me cingir a países de estudo e estes dois pareceram-me os casos mais prementes para começar por analisar.**

**RP|** Eu penso que eventualmente, não com o nível de aprofundamento e detalhe com que possa a vir a fazer o enfoque, tanto nas Universidades Portuguesas como nas Escolas da Finlândia, eu penso que era interessante, em termos de panorama geral, fazer essa leitura global, de facto de nível Europeu. Perceber onde é que essas questões estão na ordem do dia, para no fundo se demonstrar que se domina este tema, que se tem conhecimento do que se anda a passar e depois estes dois casos de estudo têm um determinado contexto e têm uma determinada justificação.

**Considera pertinente esta rede ser estabelecida não só entre a Finlândia e Portugal, mas também entre outros países da União Europeia.**

**RP|** Eu acho que sim. Cada vez mais não podemos trabalhar isoladamente, não devemos investigar encimados e dentro do nosso contexto específico. Cada vez mais se privilegia, se favorece, e bem, no meu ponto de vista, a construção de redes nas diferentes áreas de conhecimento. Portanto acho que sim, convocar várias pessoas, várias escolas com contextos muito diversos e organizar plataformas de discussão, de reflexão e de trabalho, parece-me obviamente uma mais-valia e um caminho de facto a seguir.

**Uma das ideias principais, dentro desta partilha de dados e de conhecimentos, seria por exemplo dar oportunidade aos alunos de construírem o seu próprio currículo virtual, deixar de ser só a questão das plantas, dos cortes e dos alçados e passar a ter também esta componente do edifício, que pode ser visitado de uma outra forma. Eu em particular estou a focar-me em dispositivos de imersão e de interação, por exemplo os óculos que possibilitam aquela visita imersa, mas sobretudo o dispositivo CAVE, um compartimento, em que cada parede é uma tela com projecções e quando entramos no compartimento entramos no edifício simulado, que foi modelado previamente e está a ser projetado.**

**O que pensa da situação atual, de encontrar emprego depois da formação académica, em Portugal? Considera que este tipo de ferramenta poderia ajudar nesta situação?**

**RP|** O emprego depois da formação está muito complicado, neste momento, é uma fase muito difícil. Não é só a Arquitetura, são várias as áreas que enfrentam esta dificuldade a nível de emprego. O pouco emprego que vai havendo tem mais a ver com a área da reabilitação do que propriamente com a construção. Porque um dos grandes promotores de construção nova, de equipamentos, de edifícios relevantes, era o próprio Estado, que neste momento não tem capacidade para o fazer. Portanto houve uma desaceleração fortíssima e o trabalho agora é muito pouco.

O que está a acontecer é que os alunos já concluem o curso preparando os seu portefólios para os submeterem a uma série de gabinetes em contexto internacional. Têm tido, de facto, um bom acolhimento em vários países de destino muito diversos. Em Portugal, as oportunidades são muito pontuais. Às vezes decorrem de um concurso que se ganhou, e então torna-se necessário montar uma equipa para trabalhar naquele projecto. Mas findo esse projeto voltam a uma situação precária e portanto é um bocadinho complicado. Vai-se



trabalhando, mas de uma forma muito precária e não prevejo que nos próximos tempos esta situação se vá inverter. Esta era uma parte da pergunta.

Sobre a outra, eu acho que a Arquitetura, neste momento, vive muito dessa necessidade, mesmo nos próprios concursos, [...] cada vez mais a imagem e a comunicação são importantes. É muito frequente, gabinetes de Arquitetura que se candidatam a concursos, encomendarem trabalhos de 3D, determinadas perspectivas, pontos de vista, porque cada vez mais essa simulação da realidade é fundamental. Muitas vezes nos concursos é decisiva, para determinar quem serão os vencedores dessa edição. Portanto eu acho que na Arquitetura no geral, esta questão da Realidade Virtual cada vez mais é fundamental.

Também porque, com clientes de menor escala, estou a falar de clientes privados, nós nos deparamos com esta dificuldade. De facto a maior parte das pessoas não tem capacidade de visualizar os projetos que estamos a desenvolver. Até mesmo às vezes através de uma maquete, que para nós é algo muito real, é uma grande abstração para o comum das pessoas. Os próprios clientes, eu tenho essa experiência pessoal, estão muito dependentes dessas imagens e dessas simulações virtuais para lhes dar um certo realismo e eles de facto conseguem perceber aquele projeto que se está a desenvolver. Do ponto de vista do arquiteto, eu acho que pode ser muito útil obviamente para desenvolver e ajudar a trabalhar a solução, embora tenha alguns perigos.

Essas imagens são profundamente manipuladas e eu acho que de forma alguma substituem o modelo tridimensional de uma maquete em várias escalas, onde podemos fazer o aprofundamento do projeto, mas acho que são muito úteis. Cada vez mais se espera desta nova geração de arquitetos, que domine e consiga manipular todo o *software* necessário para esta montagem. Esta geração, eu não digo a minha, porque a minha ainda se envolve neste tipo de trabalho, mas a que domina a encomenda já não domina este tipo de *software* e portanto a expectativa, quando procura uma nova colaboração para o escritório, é que de facto, esta nova geração já tenha algumas competências nesta área.

Não respondi diretamente à questão, respondi de uma forma mais vasta, porque eu acho que a Realidade Virtual é fundamental a todos os níveis: no exercício da Arquitetura, no quotidiano e para as novas gerações que vão agora começar a sua carreira profissional.

**Acabou por responder já a algumas questões à frente. Eu queria só fazer uma pequena nota sobre a minha visita à Finlândia, onde visitei um gabinete que foi dos primeiros a implementar este sistema CAVE. Eles diziam que teve impactos positivos a nível do aumento de clientes e colaboradores e diziam também que o *feedback* do cliente não tem nada a ver face aos métodos tradicionais de representação, é uma participação muito mais activa.**

**RP** | Há um certo acanhamento em expor que não se está a compreender e fica a dúvida se está a compreender ou não.

**Focando-me agora a nível de escola, como é que a Professora vê a relação desta escola com a RV?**

**RP** | Estamos a falar destes dispositivos mais complexos... Eu estou a falar se calhar de um nível mais básico desta simulação, que são os 3D. Estes outros dispositivos e equipamentos

não existem aqui. Por um lado o desenvolvimento do próprio projeto começa a utilizar este tipo de ferramentas para se enriquecer, o próprio processo. Passamos de um sistema analógico para um sistema digital, que não é só na representação do projeto, ou que no imediato é, mas que tem, de facto, outra dimensão. Tem a ver com trabalhar estas imagens no sentido de o desenvolver, aprofundá-lo e enriquece-lo.

Há algumas cadeiras ligadas ao desenho e à computação gráfica, onde estão introduzidos alguns *softwares*, para que os alunos possam tomar conhecimento, começar a operar nele, com bastante receptividade. Há algumas cadeiras que são opcionais, mas percebemos que de uma forma generalizada, os alunos têm procurado ganhar estas competências, na faculdade e fora da faculdade. Notamos nas próprias entregas da Unidade de Projeto e na própria Anuária- na exposição anual que fazemos sempre em Setembro, Outubro e Novembro - que os painéis refletem de facto esse investimento. Ainda não é uma área que eu diga que é forte e profundamente explorada, mas que realmente ela tem sido acarinhada mais ou menos por alguns docentes. No projeto começa a ser de facto mais uma ferramenta de trabalho. Não com esta escala que se estava a falar, mas percebemos que o futuro obviamente passa por aí. Eu dou aulas a Projeto IV e nas aulas costumo falar, quando se aproximam as datas de entrega e durante o tempo letivo da aula prática, sobre aspetos de comunicação e também falo destas questões da virtualidade e da importância, da pertinência de comunicar a função e na etapa anterior, de facto, como instrumento e ferramenta de trabalho.

#### **Acha que os suportes digitais têm impacto no processo de desenho? De que forma?**

**RP** | Sim, acho que sim. Sobretudo, e é esse aspeto que a mim me interessa mais, claro comunicar a solução é fundamental e eu digo sempre aos meus alunos que uma solução mal comunicada pode destruir um projeto. Pelo menos destrói uma imediata adesão que poderia ser tida a determinada solução. Mas o que me interessa sobretudo com estas novas hipóteses, é que elas sejam uma efetiva ferramenta de trabalho. A partir daquelas simulações, eu conseguir controlar a própria solução de projeto e a abordagem que estou a fazer e conseguir no fundo aprofundar e melhorar a solução. Não acho que ela venha substituir os métodos antigos, acho que o processo fica mais rico com tudo ao mesmo tempo. Com um esquisso livre, que nos dá um descomprometimento muito grande para uma fase mais exploratória em que não há uma convicção muito clara do caminho que se quer seguir, mas que depois também ajuda no fundo a aprofundar esse caminho. Há o modelo tridimensional, real, uma maquete, que apesar de tudo nos permite um controlo contínuo e global da solução, porque o que eu acho que com esta Realidade Virtual às vezes acontece é: há momentos em que podemos ter esse controlo mais global, mas ela é muitas vezes muito parcial. Portanto perdemos esse confronto, que a maquete convencional nos coloca sempre com o todo, que às vezes não queremos ver. A maquete faz esse confronto permanente. O modelo virtual permite encantarmo-nos com uma parte do desenvolvimento da solução e adiarmos as outras que não estão tão bem ainda. De qualquer forma, temos obrigação de ter consciência disso e de contrariar. Acho que esse aspeto de nos permitir enriquecer o processo de conceção é real, é inequívoco e é o Futuro. Acho que passa por aí.

#### **Qual será a Unidade Curricular lecionada aqui na escola mais próxima da Realidade Virtual?**

**RP** | As Unidades Curriculares ainda têm o nome de CAD I e CAD II, embora neste momento estejamos numa revisão de plano de estudos e equaciona-se inclusivamente uma redefinição das designações destas Unidades Curriculares, porque elas tem muito mais a ver, não com o CAD – de AutoCAD ou ArchiCAD- mas com esta questão da comunicação propriamente dita e da iniciação dos alunos a um conjunto de ferramentas que lhes permita, em diferentes plataformas, trabalhar e comunicar a solução de projeto. Portanto, diria que são essas duas Unidades Curriculares as mais próximas. Eu penso que isto deve ser introduzido nessas Unidades que estão mais vocacionadas para apresentar e desenvolver esta nova ferramenta, mas deve ser feita a sincronização com projeto, porque acho que é aí que se faz a ligação e a exploração. Às vezes há a ideia de simular um exercício pequeno de projeto, e que eu acho bem no imediato, para estudar de uma forma mais simplificada a ferramenta. Mas eu acho que a verdadeira essência é depois incorporar isto na própria prática de Projeto. E haver uma coordenação entre Projeto e estas Unidades no sentido que estas questões ganhem outro enquadramento.

**Se a Realidade Virtual fosse integrada no Plano de estudos, qual seria a forma de o fazer? Em que anos seriam inseridos os conteúdos?**

**RP** | Isto teria de ir a discussão, não seria eu a decidir com é óbvio. Embora eu também faça parte do Concelho Científico. Eu posso é dar nota do que tem sido o entendimento da escola sobre este tipo de ferramentas. Tem-se mantido um certo consenso ao longo dos tempos - eu já concluí a minha licenciatura já há uns anos e na altura já se começavam a introduzir estas Unidades Curriculares que tinham a ver com o desenho assistido por computador- já desde essa altura se entendia, sobretudo no 1º e 2º ano, mas até mais no 1º, que não deveríamos introduzir este tipo de ferramentas no currículo. Isto por que são no fundo dois anos propedêuticos em que se constrói, nesta escola um método da abordagem ao projeto arquitetónico e entendeu-se que esse processo passava numa fase inicial por trabalhar o plano normativo.

No primeiro e segundo anos do curso existe a cadeira de desenho, com diferentes orientações. No primeiro desenvolve-se a capacidade do desenho puro e duro desde estátuas, esqueletos, o esfumado, desenho de árvores, plantas... E no segundo um desenho de Arquitetura. Portanto entendia-se que a par com esta capacitação, a nível do desenho, o modelo tridimensional, não completaria esta etapa inicial. Antes do 3º ano os alunos não estão autorizados a fazer entregas recorrendo às ferramentas digitais. É ainda o desenho à mão, passado a tinta, com paralelas, sobretudo por isto, para consolidar este nível.

A partir do 3º ano, entende-se que o aluno já domina no fundo esta fase inicial e então tudo o que são estas ferramentas digitais e virtuais podem e devem ser introduzidas para enriquecer o processo. É a partir do 3º ano que efetivamente há este alargar e este entendimento consensual pela parte do corpo docente da Escola de que é útil e pertinente estes *software* poderem apoiar a prática e a comunicação do projeto. Portanto, eu acredito que uma aposta nesta área, iniciar-se-ia a partir do 3º ano.

**De que forma seria esta ferramenta integrada no Plano de estudos? De uma forma mais ampla e transversal, abrangendo todas as Unidades Curriculares ou de uma forma pontual, lecionada apenas numa Unidade Curricular específica?**

**RP** | Eu fui falando de Projeto, porque é a Unidade que estou mais próxima. Mas devo dizer que, no 3º em Construção, o colega docente, que tem a cargo a regência da cadeira, tem feito estas experiências na área de construção. Os alunos analisam uma determinada obra, escarpelizam o processo construtivo dessa obra e constroem o seu modelo tridimensional. Já existem outras cadeiras em que esta questão já está a entrar. Não de uma forma sistematizada em todos os anos, mas de facto está-se a fazer esta introdução. Aqui nas várias cadeiras de História e Teoria, de facto o desenho e processo de investigação e compreensão através de modelos tridimensionais também existe, portanto acredito que um aluno dominando estas ferramentas, muito rapidamente, incorpora esta capacidade e esta mais-valia também noutras Unidades Curriculares. Portanto, acho que isto de repente se começa a contaminar. Já se vê isto a acontecer. Se essa área ganhar mais força, acho que inevitavelmente, até por via do próprio estudante, acaba por entrar por contaminar todas as Unidades.

### **Como é que vê a introdução de uma CAVE aqui na Escola?**

**RP** | Ora bem, aí já não serei eu, a docente de Projeto. Porque lá está as Unidades Curriculares que leciono que são Projeto IV e Projeto Tese no curso de Doutoramento, se calhar não me põem em contacto direto com este tipo de ferramentas. Eu pelo menos não tenho essa proximidade. Portanto, não vejo no imediato, sem que eu própria tenha algum tipo de formação nessa área, a dominar este tipo de ferramenta. É algo que têm avançado em áreas não só relacionados com simulação na Realidade Virtual, mas relacionadas com geometrias complexas e com toda uma nova forma de pensar a Arquitetura. O grupo liderado pelo Professor José Pedro Sousa, no Laboratório de Fabricação Digital, tem inclusivamente um robot que lhes permite construir esse tipo de exemplares de geometrias e tem estado em nível internacional em várias plataformas nesta área.

Portanto imagino que até muito ligado até a este tipo de laboratório este tipo de ferramenta fosse muito útil. Sobretudo, para essas geometrias complexas que são muito difíceis de prever tridimensionalmente e que dá para fazer protótipos de coisas mais pequeninas, mas por exemplo não dá para simular ambientes. Imagino que uma CAVE fosse muito útil para, de repente, podermos estar dentro daqueles edifícios e daquelas geometrias. Portanto vejo esta ferramenta muito ligada a esse grupo e tal como eles estão neste momento a fazer uma ponte com o Mestrado Integrado em Arquitetura e o desenvolvimento de projetos de investigação que integram os estudantes na recta final de formação, eu acho que pode ser um bocadinho através da investigação que podemos vir contaminar mais áreas.

### **Pensa que a Realidade Virtual terá mais pertinência para o desenvolvimento do processo de projeto do próprio aluno, para a comunicação da sua solução entre pares, com os Professores e colegas, ou por outro lado na comunicação das suas propostas a um público em geral?**

**RP** | Eu acho que entre o aluno e o Professor, ou a academia, até é o nível onde esta ferramenta pode ser menos necessária, porque estamos entre pares. Qualquer docente ou profissional, na área da Arquitetura, lê um projeto a partir das plantas, cortes e alçados e consegue rapidamente perceber a qualidade do trabalho que está presente. Isto é importante na prática profissional, como falávamos há pouco, um arquiteto perceber que tem um recém-formado com esse potencial, acho que sim. O que eu quero crer é que esta

ferramenta é sobretudo útil para nós arquitetos trabalharmos melhor. Para servirmos de facto esse ato de criação e podermos recorrer a todos os meios que temos para melhorara e aprofundar o que estamos a fazer.

Depois é também muito bom nesta lógica de comunicação entre o arquiteto ou alguém da área da Arquitetura para fora da nossa área disciplinar, porque de facto há toda esta grande dificuldade - e quem passa pela prática profissional apercebe-se facilmente desta questão -, que as pessoas não têm o nosso conhecimento e a nossa capacidade. O que nos pode parecer muito óbvio muitas vezes não se torna óbvio para as pessoas e portanto é muito útil para nos fazermos entender, mostrarmos o que estamos a desenvolver. E para que quem nos encomende algum projeto, seja o sector público, ou privado, de maior ou menos escala, rapidamente possa perceber o trabalho que está a ser desenvolvido ou a resposta que está a ser dada.

Portanto, acho sobretudo que nestes dois âmbitos, para aprofundarmos e para darmos a conhecer a quem não é da nossa área, acho que é importante. Entre um estudante de Arquitetura e um Professor, ou um conjunto de Professores ou um conjunto de profissionais, aí acho que é uma mais-valia, acho que é interessante, dá uma nova perspetiva do projeto, mas não acho que seja absolutamente imprescindível ou que tenha a mesma importância das outras duas situações. •



[2016.6.3]

**Faculdade de Arquitetura da Universidade do Porto (FAUP)**

Professor: **Manuel Graça Dias [MGD]**

**Parece-lhe pertinente a ligação que proponho, numa fase de estudo e análise, entre estes dois países, Finlândia e Portugal?**

**MGD** Não faço ideia. Não estou nada a par dessa “ferramenta”, como lhe chama, da Realidade Virtual. O facto de ser um trabalho que possa ligar Portugal e a Finlândia, pode ser interessante se encontrar pessoas interessantes do outro lado, mas pode tornar-se desinteressante, se der com pessoas desinteressantes. Não me parece que seja específico da Finlândia uma investigação nessa área. Se me dissesse que iria fazer uma investigação sobre o trabalho em madeira e queria colaborar com a Finlândia, faria sentido, já que há uma grande tradição; agora, em relação à Realidade Virtual, há uma grande tradição na Finlândia? Não sei, provavelmente tanto como na Islândia, na Noruega ou na China. Não me pergunte se isto faz sentido, porque desconheço.

**Acha pertinente esta rede ser estendida a toda a Europa?**

**MGD** A existir, acho que esse tipo de redes não deve ficar confinado. O que caracteriza a época em que vivemos e as tecnologias que podemos utilizar é precisamente não haver fronteiras. Penso que as pessoas que estão interessadas nesses sistemas não estão todas acantonadas no mesmo sítio, no mesmo país. Deve ser mais interessante uma “rede” que não esteja reduzida a dois polos; ser uma rede, na verdade; uma rede não é uma linha.

**Como é que vê as perspetivas do mercado de trabalho português na área da Arquitetura?**

**MGD** Neste momento os tempos estão difíceis para toda a gente. Tal como estão difíceis para os arquitetos que estão mais ou menos estabelecidos, mais difícil estarão para os jovens arquitetos que, em princípio, ingressarão num *atelier* para iniciar a aprendizagem. Como há pouco trabalho e grandes dificuldades nos *ateliers*, ainda pior para quem está a montante.

**Acha que a RV poderia abrir o campo de possibilidades dos jovens que entram no mercado de trabalho?**

**MGD** Repare, não é uma questão de se saber mais ou menos “truques”: não há trabalho! Não é o facto de se dominar ou não coisas esquisitas em 3D ou em termos de “Realidade Virtual” que as encomendas aparecem... Poderá abrir algumas portas em locais em que esse trabalho seja especificamente requerido, mas não estou a ver que abra oportunidades de projeto para toda a gente. Poderá haver um arquiteto que tenha um trabalho qualquer nesse sistema e que ande à procura de uma pessoa que o conheça, porque os seus colaboradores ainda não perderam tempo a estudá-lo e não estarão dentro do assunto. Mas tirando casos assim, uma vez que não existe trabalho, a questão não se resolverá com o dominar uma tecnologia ou outra. Porém, creio que não se deva negar nenhum dispositivo que apareça;

devemos experimentar tudo; haverá, depois, uns com os quais nos identificamos mais e a que acabaremos por aderir.

Mas, terei que dizer que não sou totalmente fã de situações que não nos obriguem a “pensar”; ou que diminuam a nossa capacidade de *abstração*; isto é, não sou fã de coisas muito “realistas”. A maquete, por exemplo: nós, arquitetos (vocês, enquanto estudantes, talvez a princípio não percebam bem), sabemos que uma maquete joga com um grau de abstração grande. Porque é que são brancas? Não tem nada a ver com “Escolas do Porto”; são brancas (ou monocromáticas, de uma qualquer cor clara) porque queremos ver as relações que a luz irá estabelecer e uma cor clara torna-o mais evidente. E queremos *experimentar* os jogos de espaço que propomos, sem o “barulho” das cores ou das texturas, sem “barulho” que possa partir das diversas superfícies que *encaixam* o espaço. Precisamos desse grau de abstração. Se nos chegar um aluno com telhados em cartão canelado vermelho, o chão da rua pintado de preto, com os lugares de estacionamento a tracejado branco, estaremos perante uma maquete *kitsch*, uma *foleirada*. Nas imobiliárias são essas que vendem. Quanto mais realistas, melhor, porque o público reconhece-se nelas mais depressa. O público não percebe bem o que está representado, mas o facto de “aquilo” se *parecer* com uma certa realidade, provoca adesão. “Isto é muito giro!”. Mas o que ali está representado, provavelmente, é monstruoso e o modo de o representar é também monstruoso. O mesmo aconteceu quando apareceram os *renderings*. Os *renderings* estabeleceram um elo de ligação com o promotor ou com o cliente com facilidade, mas pelas piores razões. Olha-se e reconhece-se um caixilho, ou uma cama, ou que ao fundo existe uma janela com uma vista sobre o mar; mas, o mais provável é faltarem conhecimentos, capacidade crítica suficiente, para se perceber que aquilo é uma banalidade, que não tem interesse nenhum... Existe adesão pelo lado menos interessante, pelo lado da similitude, do “parecer verdade”; e como parece verdade, o arquiteto é maravilhoso, vai-lhe fazer um quarto com vista sobre o Douro!

O meu medo é que uma mediocridade qualquer, passada a Realidade Virtual, só porque entramos numa câmara e tudo parece *mesmo* lá estar, seja apenas mais um instrumento para “vender gato por lebre”... Não é que os *renderings* não possam ter interesse, mas de uma maneira geral distanciamos-nos deles, porque uniformizam muito as coisas. Um esquisso feito à mão pode ficar deformado, mas texturamos a parede, mostramos que ali é pedra. Há uns códigos, mais livres, que cada um depois vai adequando ao seu modo de desenhar. Não fica tudo igual. Nos *renderings* há uma certa *facilidade*: “Isto é pedra; ah *ok*, tenho aqui o carimbo da pedra”; e lá vem uma coisa qualquer com ar de pedra de jogo de computador. Eu tenho medo que essas “Realidades Virtuais” acabem por nos conduzir, também, a vícios desse tipo.

**O que eu dizia sobre abrir o campo de possibilidades era a hipótese de, uma vez dominando a Realidade Virtual, poderem ser abertos campos, como por exemplo no cinema, onde antigamente o arquiteto poderia ter a oportunidade de projetar um edifício que compusesse um cenário físico e hoje em dia, por exemplo, ter o mesmo tipo de investimento, mas no âmbito Virtual, de um cenário digital, que compõem um imaginário. Podem criar-se mais vertentes de trabalho em áreas que hoje ainda não**



**estão totalmente exploradas e isso poderá ampliar o campo de ação do arquiteto. Ou até criar outro tipo de áreas pela fusão de capacidades. E uma outra questão, no âmbito dos atelier, são os sistemas como a CAVE, poderem ser sinónimos de um aumento a nível de clientes e consequentemente de colaboradores, exatamente por acrescentarem a possibilidade de o cliente poder intervir *a priori* de uma forma mais ativa.**

**MGD|** Mas, lá está, provavelmente pelas piores razões. Há um grande risco de identificação por aquilo parecer *real*. Quando alguém nos expressa um determinado mal-estar, face a uma solução de projeto, não será, necessariamente, pelas razões que apresenta. Enquanto arquitetos temos de interpretar aquele mal-estar, temos de identificar, a partir dali, como introduzir alterações, sem perca da coerência geral e capazes de apaziguar a perceção que ocasionou o *mal-estar*. Mas não, necessariamente, para fazer aquilo que a pessoa nos sugeriu como solução. Tenho sempre muitas dúvidas; até que ponto se deve atender completamente ao que pessoas dizem querer e não querer. É um ponto de partida, mas é discutível. Eu percebo que haja dois lados, mas mesmo o suposto leigo que entre na CAVE para ter essa tal experiência espacial não deverá ser tão leigo quanto isso. Ou terão de lhe ser explicadas, *a posteriori*, determinadas questões para que volte a entrar na CAVE e, então, compreenda aquele “envolvimento”... Também não podemos achar que todas as pessoas conseguem ler desenhos e, como tal, temos de recorrer a outros meios para que possam aperceber-se das propostas. Às vezes, mesmo em obra também não percebem bem, porque ainda não viram tudo finalizado. Quando veem a totalidade da obra, as coisas a baterem certo, o todo coerente, as pessoas percebem. Se me garantir que pode oferecer essa experiência total dentro da CAVE, então, nesse caso, se as pessoas gostarem da experiência, provavelmente, depois, irão também gostar da obra construída.

**É uma antecipação.**

**MGD|** É uma antecipação? Então está bem. Será uma aproximação à experiência final.

**Agora focando-nos mais sobre a Escola. Como é que o Professor vê a relação desta Escola com a Realidade Virtual?**

**MGD|** Não vejo grande necessidade desse tipo de temas ser aprofundado a nível da Escola. Porque a nível da Escola – e acho que essa será uma vantagem portuguesa, não sei como é que é o ensino na Finlândia – é incentivada a experiência do desenho à mão. Porque é que os alunos não estão autorizados a fazer Projeto em computador antes do 2º ou do 3º ano? Porque todos nós sabemos que uma coisa é saber desenhar no computador e outra saber desenhar à mão. Eu acho que o desenho à mão devia continuar até ao 5º ano, porque essa experiência é muito mais intensa. Só saberemos desenhar com o computador depois de desenharmos à mão, depois de termos tido essa experiência. No AutoCAD desenha-se, mas a inteligência posta ao serviço desse tipo de desenho não é a mesma do desenho à mão. A inteligência gasta no “desenho à mão” contém um espaço de tempo para refletir sobre o que se está a fazer. É como o fazer maquetas - não as de exposição ou para mostrar aos clientes -, maquetas de trabalho, pôr paredes, tirar paredes, pôr um bocado de papel, toda essa manualidade é altamente importante e é isso que provavelmente ainda nos distancia de algumas arquiteturas que se fazem na Europa. É um grande lado artesanal, tanto ao nível dos projetos como, depois, também, em alguma construção. Não se anda a comprar componentes

numa fábrica qualquer na Alemanha que depois seja só aparafusar; também é importante, mas se há alguma coisa que possa caracterizar a Arquitetura feita em Portugal, digamos que ainda é o facto de se experimentar muito, de não nos ficarmos só pelos computadores. Nesse sentido, penso que numa Escola de Arquitetura também tem de ser assim. Depois as pessoas irão à sua vida e farão como quiserem.

Não acredito que nenhum de nós vá passar a desenhar diretamente com o Revit; continuaremos a passar, inicialmente, por processos que implicam a mão. Nós continuamos a ter de imprimir os desenhos para os ver no seu todo, não podemos ver o desenho no computador, porque o ecrã é muito pequeno e quando ampliamos um qualquer bocado perdemos a noção do todo. Continuamos a necessitar de ver o desenho cá fora, para continuarmos a ter a noção do todo como na prancheta. Há coisas que se ganham, mas não se podem perder outras. E nós mantemos outras, porque as novas, só por si, não são suficientemente eficazes, embora melhorem muitos outros aspetos. Se precisamos de imensas janelas não vamos desenhar uma a uma. Desenhamos uma, muito bem, e depois copiamos. O Arquiteto Manuel Vicente, com quem eu trabalhei, muito antes dos computadores fazia truques deste género: desenhava uma janela muito bem desenhada, na escala pretendida; depois, faziam-se na máquina heliográfica, em autocolante transparente, as cópias necessárias que, em seguida, eram cortadas, uma a uma e coladas sobre uma quadrícula; era um modo de ultrapassar o trabalho estupidificante. O que quero dizer? Esta nova técnica, ou tecnologia, o que lhe queiramos chamar, trouxe coisas muito interessantes, não duvido, de maneira nenhuma. Não acredito é que tenha vindo substituir *todas* as que já tínhamos, nem acredito que as escolas de Arquitetura tenham de ser vergar a todas as novidades, sob risco de se perder determinado tipo de ensino em que acreditamos e que tem dado bons resultados. Houve uma altura em que havia computadores na FAUP e aulas de desenho assistido por computador; mas os alunos aprendem sozinhos! Já toda a gente percebeu que isso se aprende autonomamente. Claro que se houver Unidade Curricular própria, anda-se mais depressa e aprende-se mais rápido; mas creio que ninguém concebe que se comecem a dar “aulas de Word”; claro que se pode ir fazer um *workshop* para se perceber que há ali uns botões que nunca utilizámos e que têm determinada utilidade, mas, de resto, aprende-se a mexer no Word com a prática.

**Mas não será mais perigoso não haver uma sistematização teórica e sobretudo um aconselhamento sobre a exploração dessa prática, que o Professor acha que pode ser autodidata?**

**MGD|** Claro, mas isto é uma Escola de Arquitetura, não é um Centro de Formação de técnicos de Auto CAD.

**E essa sistematização não deveria ser feita na escola, sob risco de depois fora dela, poder obter outros contornos?**

**MGD|** Poderá ser, mas sempre com o objetivo de não nos iludirmos quanto ao verdadeiro sentido da Arquitetura. A Arquitetura é uma disciplina humanista e generalista, não se deveria envolver com tecnicismos nem especializações... Admito que se possa colocar aqui um técnico, num gabinete, que saiba trabalhar com esses sistemas, e que ele fizesse, durante o ano, quatro ou cinco passagens de alguns trabalhos para que os alunos e professores se

apercebessem, para que ficassem com uma noção (poderia até haver um *workshop* ou uma optativa), mas, se para cada tecnologia nova que aparece tivermos de andar a fazer um novo currículo... Digamos, que perder tempo com essas questões muito específicas é tempo que se tira à reflexão disciplinar. A Arquitetura é a mesma desde Vitruvius. Portanto, temos é que pensar em Arquitetura. Não creio que se imaginem “aulas de maquetas”! Unidade Curricular Maquetas: “podem fazer maquetas com esferovite, com balsa, com cartão; cortem com o *x-acto* da esquerda para a direita...”. Os alunos também não sabem “fazer maquetas”, quando entram na Escola; quando veem exposições pensam: “Eh! Isto é muito difícil, não quero ir para Arquitetura, tem de se saber fazer maquetas!”. Depois mal ou bem lá vão todos fazendo, aldrabando um bocado, e, mais tarde, percebem que o que interessa é a investigação que se está a fazer não é se a maquete é difícil ou fácil de executar, que tudo o resto são *virtuosismos*.

Sem desprimor por quem se dedica a esses temas, não podemos querer que os alunos sejam virtuosos em variadíssimos *media* sem que nunca, verdadeiramente, disponham de tempo para pensar a Arquitetura. Haverá, certamente, quem possa vir a desenvolver especial gosto por essas tecnologias: fará uma pós-graduação, andará num curso noturno de Realidade Virtual, qualquer coisa desse género, e ficará com mais uma “ferramenta”. Não me parece é que seja útil tornar isso obrigatório.

**Pergunto-lhe, em que anos poderia vir a ser introduzida esta questão da RV? Acha que seria benéfico ter uma CAVE associada ou mesmo na própria escola...**

**MGD** | Pois, como curiosidade, mas tenho medo que isso nos desvie do objetivo da área. Eu acho que se a Ana Moreira está muito por dentro do tema, também percebe o que quero dizer. Penso que está na posição correta e pode usar a sua Tese para falar sobre isso, para reunir um pouco da sua experiência, denunciando o lado mais perverso de que se tenha apercebido. Não embarcar numa perspetiva de “isto é maravilhoso!”. Ser mais crítica, mas também sem ser reacionária. Não se deve negar nada, só por ser novo. É novo, gostei e aderi, mas atenção! Também o *rendering* era novo e também há más interpretações. Os Professores disseram-me que era um instrumento maravilhoso, porque conseguiram comunicar com as pessoas. Mas terão as pessoas percebido? Não terão apenas gostado porque “parecia verdade”? O que é que acontece quando olham para maquetes realistas? Há ou não há uma reação maior a uma maquete com um certo grau de abstração do que a uma maquete, digamos, mais “realista”?

Poderíamos fazer uma experiência: construíamos uma maquete mais abstrata e outra mais realista, relativas a um mesmo objeto arquitetónico; depois, fazia-se uma exposição e pedia-se ao público que colocasse uma cruzinha na maquete de que mais gostava. Palpita-me que a maior parte iria gostar da “realista”. Três ou quatro mais *chiques* é que iriam preferir a mais abstrata! •



[2016.6.8]

**Faculdade de Arquitectura da Universidade de Lisboa**

Professor: **Nuno Arenga [NA]**

**Como é que vê esta hipótese, numa fase de estudo e análise, de estabelecer uma ligação entre Portugal e a Finlândia?**

NA| Parece-me bem que se estabeleçam relações entre escolas de países diferentes a partir da partilha de interesses comuns e experiências diversas.

**Considera que seria pertinente, numa outra fase, estender esta rede de escolas de arquitectura e laboratórios de Realidade Virtual a toda a Europa?**

NA| Sim.

**Como é que vê a situação de encontrar emprego depois de terminar o curso, na nossa área e no contexto português?**

NA| A formação em arquitectura confere aos alunos competências muito diversas, cruzando humanidades, ciências sociais e ciências exactas, formação artística e formação técnica... Existem ex-alunos de arquitectura empregados em ramos profissionais muito diferentes. Os que procuram a profissão do projecto de arquitectura encontram naturalmente mais dificuldades, trata-se de um mercado de trabalho com um reflexo muito expressivo da actual crise. Muitos dos bons alunos, mais empenhados no projecto, emigram e dão provas de excelente competência nas equipas em que são integrados. Os escritórios de arquitectura com grande volume de trabalho, e maior capacidade de gerar emprego na área do projecto de arquitectura, estarão eventualmente mais sujeitos aos imperativos que o grande negócio impõe ao projecto de arquitectura. Goste-se ou não, esta é uma área de aprendizagem que não se explora na escola, e que terá também a sua importância. Por outro lado, os alunos que conseguem trabalho num pequeno escritório relatam por vezes experiências muito gratificantes, de trabalhos mais pequenos, maior participação e aprendizagem, eventualmente com maior precaridade de emprego...

**Acha que a Realidade Virtual pode alargar o campo de possibilidades de trabalho dos jovens arquitectos na entrada para o mercado de trabalho?**

NA| Trabalhando noutras áreas que não o projecto de Arquitectura. Aí talvez, de outra forma não creio. Em todo o caso, nós percebemos que a formação que damos no curso de Arquitectura habilita as pessoas a fazer coisas muito diferentes e isso parece-me bem. Mas não acredito que traga mais trabalho a nível de projecto de Arquitectura. Eu estou a responder na óptica de um professor de Projecto do 3º ano. Alguém que dirija para aí as suas competências, é capaz de se tornar mais especializado em Realidade Virtual e não propriamente em projecto de Arquitectura. É uma saída possível.

**Agora focando-nos mais na escola, pergunto-lhe: como é que vê a relação entre a própria escola e a Realidade Virtual?**

NA| Não sei se consigo responder. Percebo através do trabalho dos alunos e em conversa com os colegas que dão as cadeiras relacionadas com as tecnologias digitais, modelação 3D, CAD, percebo um bocadinho o que vão fazendo, mas não consigo antever bem qual é o desenvolvimento que o trabalho dentro da escola irá ter na aproximação a este tema.

**Acha que os suportes digitais têm impacto no processo de projecto? De que forma?**

NA| Acho que têm muito impacto. Nós aqui na escola tentamos que os alunos não utilizem excessivamente as ferramentas digitais. Ou pelo menos que não substituam as ferramentas analógicas pelas digitais, porque isso está acontecer, infelizmente. Então o que temos tentado fazer é inibir a utilização de ferramentas digitais, forçando os alunos a manter em cima da mesa ferramentas analógicas. Continuarem a desenhar em papel de grande formato, articularem plantas com cortes, trabalharem em maquete física, que são competências que estão um bocadinho descuradas.

**Que tipo de impactos é que Realidade Virtual poderia ter no processo de projecto?**

NA| Imagino que permitiria aferir o que estamos a desenhar. Nós conseguimos fazê-lo através de maquetes, modelos físicos, através de uma modelação tridimensional, mais ou menos cuidada na renderização, mas é possível gerar uma imagem e verificar se uma situação de espaço, forma, matéria, cor ou luz, correspondem aquilo que imaginávamos, no modo como definem e qualificam uma situação arquitectónica. Uma ferramenta mais interactiva, como imagino que esta CAVE seja. Imagino que nos permita visualizar e aferir se as coisas correspondem àquilo que imaginávamos. Pode ser mais uma ferramenta de verificação, como outras que já existem.

**Qual será aqui na escola a Unidade Curricular mais próxima da Realidade Virtual?**

NA| Talvez a Unidade de modelação 3D. Não sei precisamente se este é o nome, mas os alunos do 3º tiveram uma entrega há poucos dias e era assim que se referiam, mas eu confesso que não sei se é exactamente o nome da cadeira. É aquela em que os alunos constroem um modelo tridimensional que gera imagens, elas estão fechadas num ecrã plano de um computador. Não estão projectadas nas faces interiores de uma cápsula.

**De que forma é que prevê que a Realidade Virtual fosse integrada no plano de estudos da escola? Seria introduzida numa Unidade Curricular específica e isolada ou seria um pouco como as maquetes, que têm uma presença transversal depois em todas as outras Unidades?**

NA| Se for uma forma de simulação, envolve um conhecimento muito específico, que talvez se transforme um pouco numa espécie de dispositivo, numa cápsula dentro da qual nós podemos entrar e permanecer para visualizarmos o espaço assim simulado. Isto associado a

um *software*, que a partir de um modelo tridimensional gera a projecção do seu interior. Isto parece uma coisa muito específica que poderá ter a presença equivalente a uma *plotter*. Ou seja, nós imprimimos, em papel ou em 3D, para pormos cá fora qualquer coisa que concebemos e que temos passado a suporte digital. Nós utilizamos uns *devices* ou periféricos que põem cá fora estas coisas. Se calhar uma CAVE pode não ser muito diferente de uma *plotter*, no sentido que simula, representa qualquer coisa. A representação é a substituição da coisa representada. Na ausência da própria coisa, recorremos a representações. Se essa cápsula for um representador nesse sentido, não muito diferente de uma *plotter* e de um ecrã de computador, ela é um dispositivo como outro qualquer. Isto para dizer, a consequência no plano de estudos poderá ser os alunos terem acesso a mais uma ferramenta de simulação e verificação.

Pode haver outra coisa que é a formação que habilite os alunos a criar modelos susceptíveis de serem simulados. As coisas têm evoluído num sentido que os *softwares* de CAD geram modelos tridimensionais passíveis de serem percorridos por uma câmara. Já no tempo do 3Dstudio era possível definir um trajecto de uma câmara, com o direccionamento da câmara, condições de abertura de lente, de luz, se calhar entre a simulação disso num ecrã plano e a simulação disso numa cápsula esférica, imaginemos assim, eu acho que é um problema de programação. É um problema de desenho de dispositivo e não de pensamento arquitectónico. Portanto nesse sentido, não sei se isso tem valor relevante na formação de um arquitecto. É uma ferramenta disponível. Agora, de facto aqui na escola, como se calhar em muitas outras escolas de Arquitectura, há a vertente de formação nas ferramentas digitais orientadas para a criação de modelos 3D e há pessoas que por via dessa formação se especializam nisso e deixam de ser arquitectos e passam a ser mais modeladores 3D. Essas pessoas se calhar podem trabalhar para Arquitectura construindo modelos digitais, mas para animação digital. Portanto é uma vertente de formação que eu acho que não é nuclear, é periférica e é orientada a utilização de periféricos, num outro sentido como é uma *plotter*.

**Em que ano é que seria expectável, na opinião do Professor, o contacto por parte dos alunos com este tipo de dispositivo?**

NA| Como ferramenta de verificação em qualquer um deles. Eu preferia que não nos primeiros anos. Talvez no terceiro começassem. Ou seja, era desejável que os alunos tomassem contacto no curso de Arquitectura com as ferramentas de sempre, que é poder desenhar com a mão com um pedaço de giz, de tijolo, de carvão, com um lápis, desenhar numa superfície, seja um papel, uma parede, um pavimento. E também construir com poucas coisas um modelo físico, uma maquete. E eu acho que essa aproximação à representação da Arquitectura tem de estar primeiro. E nos primeiros anos isso é fundamental. Quando os alunos nos aparecem muito deslumbrados com as ferramentas digitais, eu acho que seria mais interessante elas serem abordadas nos últimos anos, em que os alunos já realizaram, consolidaram esta ideia de que temos de trabalhar com desenho, com maquete, com as ferramentas de sempre.

**Quais são as situações em que o Professor acha que seria mais pertinente esta aproximação à Realidade Virtual: no processo de projecto do próprio aluno, para que**

**ele possa aferir e compreender o seu próprio projecto; entre o aluno e os pares que compõem a academia, como professores e colegas, numa vertente de comunicação e análise da solução de projecto; ou para a comunicação da solução da parte do jovem arquitecto ao público em geral?**

NA| Eu vejo vantagens em qualquer uma das três vertentes. Depende um bocadinho da orientação que se pode dar à ferramenta. Nós temos maquetes mais conceptuais, temos outras que procuram representar a proposta arquitectónica um bocadinho mais arrumada, em condições de se apresentar em exame e depois temos umas maquetes que se assemelham mais a miniaturas, mesmo aqui na escola, que teriam lugar mais sensato numa montra de uma empresa imobiliária do que numa escola de Arquitectura. Por vezes, nos exames finais verificamos, quando os alunos trazem o processo de trabalho todo, e nós tentamos que o tragam, verificamos que há maquetes preliminares, de carácter mais conceptual, que são mais justas, representam melhor aspectos fundamentais do objecto proposto, do que outras que estão já mais arrumadas. Portanto, para dizer também que nós podemos pensar que a maquete serve tanto para a concepção, como para a explicação do objecto entre pares, como até a pessoas que tem uma relação mais difícil com as nossas ferramentas, a clientes. Eu penso que uma ferramenta de Realidade Virtual será um bocadinho no mesmo sentido. Quer dizer, se nós usarmos uma ferramenta de Realidade Virtual que nos permita percorrer o edifício e estivermos à procura de relações de luz-sombra, podemos até dramatizar um bocadinho a expressão disso, como fariamos numa maquete, pela maneira como a expomos à luz do sol ou de um candeeiro, porque estamos à procura de coisas, que também são aquelas que constituem no fim o objecto, quando é fruído pelo seu destinatário ou quando é avaliado pelo cliente, mas não é dessa forma que as expomos a terceiros. E a forma como o aluno expõe aos professores num exame, pode ficar um bocadinho entre isto, sendo que nalgumas situações nós vamos mais para o lado enfático da conceptualidade, imaginamos que não é exactamente assim, mas sabemos que se representarmos assim acabamos por explicar melhor e isso é tão verdade num desenho, feito com uma mina macia, ou como numa maquete, ou num modelo virtual.

[...]

**O Professor referia-se ao controlo das ferramentas e eu gostava de fazer só esta pequena nota de que esta nova geração, miúdos com 5/6 anos já dominam os novos interfaces de uma maneira muito espontânea. Por isso, talvez isto seja uma questão de domínio de ferramentas e acho que ainda é tudo tão novo, que talvez ainda faça sentido falarmos das antigas com essa certeza de que as dominamos.**

NA| Há um autor, de quem não me lembro o nome, que fala da diferença entre nativos e imigrantes relativamente às tecnologias digitais, dizendo que as gerações mais recentes já são nativas e as mais velhas são ainda imigrantes. Quando nasceram as gerações agora mais velhas, estas coisas não existiam e este autor estabelecia essa diferença justamente para se referir à facilidade com que uns manobram esse universo e à inapetência que outros têm. Agora eu como imigrante, olhando para uma espécie de *timeline*, o computador apareceu na pontinha desta linha, num instante muitíssimo recente. Durante o restante tempo, nós fizemos, e faz parte do nosso ser, as coisas interagindo fisicamente. •



[2016.6.8]

## **Faculdade de Arquitetura da Universidade de Lisboa**

Professor: **Amílcar Gil e Pires** [AGP]

### **Parece-lhe pertinente a ligação que proponho, numa fase de estudo e análise, entre estes dois países, Finlândia e Portugal?**

**AGP** Tirando o Arquiteto Alvar Aalto, que é uma referência para a cultura arquitetónica portuguesa, parecem-me polos opostos. Mas acho muito interessante a cultura deles. Estas novas tecnologias fazem pontes e tornam todos estes processos mais atuais, mais eficazes. Portanto, acho pertinente e acho muito bom. Ainda mais se tens essa referência, acho ótimo.

### **O que lhe parece depois esta rede ser estendida a toda a Europa?**

**AGP** Acho pertinente. Cada vez mais a parte da conceção de Arquitetura tira partido das tecnologias e acho que se nós conseguirmos tirar partido em tempo real e fazer essa comunicação não só de informação, mas também de ideias- quando digo ideias é a manipulação da imagem da produção desta ideia como nós fazemos em projeto-, acho fantástico. Faz-me até lembrar um filme fantástico, em que alguma das personagens são arquitetas: *Inception*. É mesmo sobre esta questão da Realidade Virtual, em que eles entravam em níveis profundos do subconsciente, onde a Realidade Virtual se tornava a realidade da própria pessoa. Mas, o instrumento era a Arquitetura e era a componente conceptual da Arquitetura.

### **Uma das oportunidades que esta rede poderia possibilitar aos jovens arquitetos seria a conceção do seu portefólio, numa perspetiva virtual, não só com os alçados e com as plantas e tudo mais, mas também com estes 3D que podem ser até visitados.**

**AGP** De demonstração dos espaços que criaram. Acho ótimo. Nós ainda estamos na fase do *rendering* e acaba por ser um bocado limitada, porque é sempre a mesma coisa. Mas depois o Virtual também vai ser um bocado assim...

### **De que forma é que vê o mercado de trabalho na área da Arquitetura, aqui em Portugal?**

**AGP** Não existe. Existe um mercado muito restrito e está muito condicionado por interesses políticos. Infelizmente há pouco trabalho e ainda existe a agravante de uma gestão de projetos duvidosa.

### **Acha que a Realidade Virtual poderia alargar o campo de possibilidades de trabalho dos jovens arquitetos?**

**AGP** Eu acho que sim. Esta coisa que nós falámos agora: nós estamos na era das redes sociais. Eu tenho a impressão que há aí uma procura nesse sentido, aliás tu usaste o conceito

de rede. De repente pensei: olha uma rede virtual só de jovens arquitetos, de comunicação de ideias. Já que os jovens não têm hipótese de começar a trabalhar, eles próprios com as suas ideias, acho estupendo que se desenvolva isso! A sério, nunca me tinha lembrado disto, foi um prazer conhecer-te só por isto. Eu que estou sempre a tentar dar asas à imaginação, isto foi uma lufada de ar fresco que chegou aqui hoje. Não sei se tinhas pensado nisto também desta forma, se é este o objetivo... Uma rede que dá hipótese de habitar virtualmente a ideia de um colega teu que está em Helsínquia, que está no Japão...

**Sim, seria essa a ideia. Mas mais do que isso. Não só poderia acontecer entre estudantes, mas abrir esta rede a toda a comunidade, sobretudo a entidades empregadoras. Existem arquitetos que já estão estabilizados no mercado, que não têm esta necessidade de mostrar obra virtual, porque têm a possibilidade de apresentar obra construída. Mas estes jovens podem construir virtualmente estes edifícios, as pessoas podem visitá-los e aperceberem-se das capacidades daquele edifício e dos próprios arquitetos.**

**AGP|** Claro. Estás a referir-te a uma coisa com a qual eu ando a sonhar desde que tinha a tua idade: uma reconstrução virtual de Roma antiga. A zona do capitólio... Ainda hoje dei uma aula sobre fenomenologia e Arquitetura. A fenomenologia tem a ver com isso, com as memórias, com os sonhos, com a criação, com a parte do habitar ao nível da criação espontânea e original das ideias. Esse habitar podendo ser demonstrado, de forma virtual, torna-se incrível.

**Agora focando-nos na Escola em particular, queria perguntar-lhe como é que vê a relação entre a esta escola e a Realidade Virtual?**

**AGP|** Eu do ponto de vista operativo sou muito cético, porque eu acho que a nível pedagógico deve haver uma didática que leve os estudantes a estruturarem a sua capacidade conceptual, o seu conhecimento e etc. O que vejo muitas vezes acontecer é que os jovens são levados de forma muito precoce a materializarem e a usarem instrumentos com que depois acabam por estar a trabalhar mais a imagem do que propriamente o espaço, a Arquitetura e todas as outras componentes. Daí eu ser fã da fenomenologia. Passado esse estágio de formação clara, ao nível do 5º ano, então aí o desenvolvimento de forma conceptual, usando a tecnologia, acho fantástico. Aí sou o primeiro a apoiar. Até lá chegar... Há tanta vontade, um esforço enorme e a ambição de chegar, que depois é um bocado a Arquitetura sem formação. Quer-se mostrar e então vai-se construir já! Não se olha ao terreno, não se vê se é areia e depois aquilo ao fim de 2/3 pisos começa tudo a cair. Fui claro, ou não?

**Sim, até acabou por responder a algumas perguntas que lhe iria fazer mais à frente. Pergunto-lhe agora: que impactos é que os dispositivos digitais têm sobre o processo de projeto?**

**AGP|** Têm muita.

**De que forma é que têm?**

**AGP|** Condicionam. Quando se vai utilizar determinado *software* ou determinada ferramenta, é totalmente condicionado. Eu tenho muito cuidado quando estou a fazer um projeto- e tenho já várias obras construídas- quando parto para o processo informático, tenho

muito cuidado em ter já de tal maneira estruturadas as coisas para não serem influenciadas. Agora, muitas vezes isso interessa. Interessa e são ferramentas potentíssimas. Hoje em dia nós temos instrumentos incríveis.

**Qual é a Unidade Curricular, aqui na escola, mais próxima da Realidade Virtual?**

**AGP**| Aqui é o Projeto. A cadeira de Projeto e nós temos umas disciplinas de computação também.

**Neste momento não têm a Realidade Virtual presente no vosso plano de estudos, mas se tivessem de que maneira é que seria integrada?**

**AGP**| Ia ser introduzida numa área de Projeto, numa área conceptual.

**Mas ao mesmo nível da integração de maquetes, que de certa forma se dissemina pelas outras disciplinas, ou associada apenas a Projeto?**

**AGP**| Também poderá ser. Eu acho que a tendência poderia ser encaminhar essa Realidade Virtual para uma área de representação, mais na área de desenho, geometria e computação. Portanto o mais natural é começasse por aí. Agora, a aplicação efetiva seria na prática, no Projeto.

**Acharia pertinente que fosse adquirida uma CAVE aqui para o departamento? Qual seria o impacto da sua presença?**

**AGP**| Sim. Eu estou curioso para conhecer. Em Coimbra existe?

**Não, não existe. Se fosse utilizada cá, qual é que acha que seria a situação a retirar mais benefícios desta utilização? Para o próprio aluno poder compreender melhor a solução projetual durante o seu processo de desenvolvimento; Para a comunicação dessa mesma solução dentro da escola e portanto entre pares; Para a comunicação da solução arquitetónica de um jovem arquiteto ao público em geral?**

**AGP**| Tal como vejo o campo da fenomenologia, porque ela é muito entendida como uma ferramenta de análise de entendimento das coisas. Felizmente há muitos arquitetos que são uns verdadeiros fenomenólogos, que estudam a fenomenologia como ato de perceber a Arquitetura, o espaço arquitetónico, mas usam-na também como ato conceptual. Portanto, eu acho que a visão é a mais abrangente possível. Não só em termos de comunicação, de exposição, demonstração das ideias, mas também conceptual. Agora a Realidade Virtual como eu a vejo, com as potencialidades que tem e se vires no filme que eu te disse entenderás, é um mistério. Não se sabe o que pode vir. Tal como nós nos embriagamos quando bebemos, há um transtorno da nossa consciência. A Realidade Virtual poderá ser tão forte, que pode deturpar e provocar, digamos, esse estado de embriaguez que pode ser prejudicial. Nós vemos no cinema, há imensas situações de Realidade Virtual, que envolvem muitas naturezas, dos mais variados níveis, mas é um mistério. Eu acharia que seria mais seguro explorar nessa tal rede de demonstração das ideias como produto final. Agora, como processo conceptual, acho possível. É o desconhecido. •



[2016.6.9]

## **Departamento de Arquitetura da Universidade de Coimbra**

Professor: **João Briosa [JB]**

### **Parece-lhe pertinente esta ligação entre Portugal e a Finlândia?**

**JB** | Terei talvez depois de voltar atrás na pergunta. A pertinência sobre esta ligação, prende-se com questões que acho que já respondeste em grande parte. Havendo tecnologia, laboratórios, sendo que esta tecnologia é registada ou trabalhada, ou imagino que provavelmente tem a sua raiz na própria Finlândia. Além de todas as questões a que os países nórdicos já nos habituaram, de um nível de ensino bastante alto, bastante empenhado na formação, um grande acolhimento de realidades novas, ou de novidades no campo tecnológico. Se calhar a própria cultura finlandesa estará mais propensa a trabalhar esse campo, do que outros países. Provavelmente, dois países europeus, dois países da Europa ocidental ou da Europa tecnológica, são países em que essa população e essas características da população já estão bastante maduras para receber esse género de tecnologias, para trabalhar essas tecnologias.

Agora voltando um bocadinho atrás, o que eu te pedia era a definição dessas Realidades Virtuais aplicadas ao campo da tua tese. Estamos a falar de um instrumento, que poderá ser de trabalho para arquitetos ou engenheiros; um instrumento para o cliente visualizar coisas que muitas vezes são abstratas e que são difíceis de explicar em 2 dimensões ou mesmo em 3 dimensões, mas de forma estática. De certa maneira a Realidade Virtual colmata a grande falha de apresentação em 2D, aprofunda a questão das representações tridimensionais que já são bastante comuns, através do Rhino e do Revit, ou *softwares* que já existem há 20/30 anos e auxilia tantos os profissionais da área como os clientes. Portanto colmata isso em 4 dimensões, com a dimensão temporal incluída. Isto para perceber de certa forma o enquadramento.

### **Acha importante esta rede abranger outros países da Europa e não se cingir apenas a estes dois?**

**JB** | Havendo uma rede de elementos visualizáveis através dessa tecnologia, não fará sentido cingir-se a nenhum país. Hoje em dia, tudo o que se tenta fazer a nível de tecnologia e que se tenta criar qualquer tipo de barreira, sejam limites à utilização de propriedade intelectual de determinados conteúdos, essas barreiras não existem na nossa civilização. Portanto qualquer tipo de barreira que se tente impingir, eu diria que seria inevitável que fosse transposta a determinado momento. Provavelmente até em termos de, pensando nisto como um campo potencial para se desenvolver algum tipo de economia, faria todo o sentido abranger o globo e não pensar em dois países ou apenas num mercado interno, mas pensar a uma escala global.

Pensando por exemplo na pertinência da tecnologia em si, estou a tentar perceber, mas estou a ver aqui 3 níveis de aplicação, como tu disseste e bem: o da produção, da pré-visualização

para auxiliar a promoção de elementos ou de espaços; a comunicação antes de ser feita a construção, antes de haver qualquer tipo de adjudicação, a comunicação é um ponto importante; mas depois a comunicação pós-execução também é um fator. Eu diria que fazer uma viagem e visitar um espaço é sempre mais importante, do que irmos para dentro de uma caixa com uns óculos especiais. Mas pode ser um momento ou que ajude a difundir determinados espaços, ou determinadas realidades, com as limitações sensoriais que provavelmente terá, ou que tente reproduzir algum ambiente e que auxilie a sua percepção. Estes 3 níveis podem funcionar como força que ajude a gerar, que aumente ou exponencie este género de tecnologias. Em termos de limitação no espaço, vejo isso com mais estranheza, porque é um tipo de tecnologia que chama muito mais a rede global e provavelmente acomoda muitas das tecnologias a que as gerações mais novas estão habituadas e gostam de explorar em rede. Agora, o teu projeto não sei se deveria expandir-se para todo o globo, não sei se era essa a questão.

**Não, a nível de tese é impossível eu fazer essa análise tão abrangente. Não tenho essa capacidade tendo em conta as exigências do documento da dissertação, uma vez que não é suposto uma tese de mestrado ser assim tão alargada. Foi essa uma das razões de me cingir apenas a estes dois países, os escolhidos para estudo. Para o projeto em si, seria obviamente pretendido que tivesse uma escala maior que pudesse ser considerado um projeto europeu ou até mais alargado. Mas esta ideia refletia obviamente a necessidade de haver um projeto piloto primeiro.**

**Perguntava-lhe agora a sua perspetiva sobre o mercado de trabalho na área da Arquitetura, no contexto português?**

**JB|** Vejo como a consequência de um mercado de trabalho, que nas últimas décadas apresentava algumas debilidades, que se acentuaram nitidamente nos últimos anos. As debilidades a nível de produção privada mantiveram-se ou houve uma retração e provavelmente terá sido até a retração da encomenda pública que provocou uma certa resvalia em grande parte do mercado interno português. Essas debilidades levaram à necessidade de gerar oportunidades fora de Portugal. Alguns *ateliers* já tinham essas experiências e tiveram de a acentuar. Outros profissionais desviaram ligeiramente o sentido de procura, ou acentuaram determinadas valências, como a fotografia, ou a *renderização* 3D para encomenda externa. Enfim, é um mercado que terá de continuar provavelmente nessa procura de diversificação e de expansão para o exterior.

Durante muitos anos nós tivemos a necessidade de criar um parque habitacional de raiz. Uma percentagem elevada da população até aos anos 70, vivia em condições de habitabilidade muito más. Houve também a necessidade de dotar as cidades de equipamentos importantes pelo menos até determinada altura, quer equipamentos desportivos, administrativos, tribunais, a Parque Escolar, tudo isso acaba por ter um limite durante pelo menos o tempo de vida deste tipo de equipamentos, são sempre longos ou médio-prazo. Até nós conseguirmos responder do ponto de vista da iniciativa privada e encontrar um equilíbrio também com a encomenda pública, vai ter continuar a ir-se pela diversificação e pela procura no exterior.

Se calhar entrando novamente no teu tema, esta questão da diversificação pode passar por aí. Não esquecendo porém que, por exemplo a questão da *renderização* a 3 dimensões tem custos elevadíssimos a nível de software, por se usarem múltiplos softwares. Da mesma maneira, imagino que a produção das experiências em Realidade Virtual tenha custos de aprendizagem, de aquisição de *software*, de aquisição de hardware, das tais CAVE, equipamentos, onde as pessoas podem ter acesso a esses ambientes. A aprendizagem da ferramenta também é um momento que demora o seu tempo, porque a nível de formação imagino que seja um tema com a sua complexidade. A própria aceitação tanto da parte do público como dos profissionais... Se o cliente se vir na necessidade de pagar mais 5 mil euros - um valor aleatório - porque pede a encomenda que promova aquele tipo de experiências ou aquele tipo de ambientes, ou porque o *atelier* utiliza esse software na conceção, a aceitação do público pode depender dessas questões.

**Eu posso dar o testemunho sobre a investigação que fiz à Finlândia, onde visitei um *atelier* que foi dos primeiros a implementar a CAVE nos seus projetos. Eu por acaso não sei quais são as implicações a nível de custo, nesse sentido de o cliente ter de pagar mais, mas sei que houve casos em que o cliente chegou a poupar um terço do orçamento, fazendo a simulação na CAVE, porque evitou custos *a posteriori* em obra. O que eles dizem que acontece muito é que existe outra componente que é o tipo de reação por parte do cliente. Há muito mais *feedback* num ambiente desses do que a ver o projeto em plantas, alçados e cortes, porque não está familiarizado com esse tipo de representação. Mas na CAVE sentem-se mais seguros daquilo que estão a ver e compreendem o que vai ser feito. Isso tem impactos grandes na obra em si. Pouparam nesse sentido recursos e dinheiro.**

**JB|** Portanto um investimento nessa experiência acaba por equilibrar as despesas. Isso que me estás a dizer faz-me encarar isto como uma faca de dois gumes. Isto que eu vou dizer pode ser um bocadinho polémico: é importante que o cliente esteja o mais informado possível, e nesse sentido pode ser uma experiência positiva, e como dizes retirar custos da fase de construção. Por outro lado, outras vezes o cliente, pode querer saber o que quer, mas aquilo que quer ter falhas, ou poder levar a compromissos em que as soluções encontradas não otimizam o desenho, não otimizam os recursos e nesse caso o excesso de informação sobre o cliente, pode ser um peso que o arquiteto está habituado a intermediar.

**Eu acho que pode continuar a fazê-lo. Eu penso que a formação da Realidade Virtual ao nível das escolas deve passar também por essa componente quase de gestão em relação ao cliente. Devemos contar que o cliente vá ter mais informação, mas o arquiteto deve saber gerir os conhecimentos que tem e gerir o contacto com o cliente também. Agora, não devemos é cegar o cliente de tal forma, que façamos aquilo tudo que achamos razoável iludindo-o. Parece-me que a situação mais razoável será uma comunicação justa para ambas as partes.**

**JB|** A primeira coisa que disse foi: o cliente deve estar o mais bem informado possível. Isso não é o mesmo que dizer que deve estar sobrecarregado de informação ou ter o poder total ou quase para decidir tudo o que quer a nível de desenho ou de ambientes. Normalmente, o cliente produz um programa ou uma lista de necessidades ou uma lista critérios que devem ser seguidos. Muitas vezes são questionados, outras contrapropostos, aceites ou não. Sempre

que possa haver uma sobrecarga de informação, pelo menos durante estas fases de ajustes a que os avanços tecnológicos obrigam, que torne a relação da cliente-equipa de projeção mais difícil. Temo que o instrumento de trabalho não seja um instrumento tão útil quanto poderia ser, mas que se torne uma sobrecarga para os dois lados. Mas isso passa sempre pela gestão cuidada dos recursos e há clientes e clientes.

**Acha então que a Realidade Virtual pode abrir o campo de possibilidades de trabalho dos jovens arquitetos? No fundo seria a Arquitetura noutros âmbitos e noutras perspetivas.**

**JB|** Eu compreendo a pergunta. Em certos aspetos há essa possibilidade, não sei se por maior apetência, se por maior facilidade, se por maior gosto, de jovens profissionais utilizarem este tipo de instrumento, mas acho que isso é como o *software* de 3 dimensões. E estou sempre a recorrer a esta comparação que é direta. Hoje em dia, utilizam-se instrumentos de visualização, de verificação e de comunicação, as *renderizações*. O passo seguinte seria introduzir-lhe a dimensão de tempo.

Dizia eu, há uma maior apetência, ou gosto, ou vontade, por parte das camadas mais jovens, para utilização dessas ferramentas digitais hoje em dia. Por isso, também imagino que sejam os primeiros a querer testar, aprender, utilizar instrumentos que se calhar têm uma complexidade maior. Ou que agora me parece muito complexos, mas que daqui a uns anos possam ter um uso de forma generalizada. Provavelmente poderá vir a ser um fator de distinção, na entrada do mercado, pelo facto de saber ou não saber dominar determinados *software* desta natureza. Dito isto, têm-se sentido uma pressão muito grande nas camadas mais jovens, e eu falo por experiência própria, no sentido de se saber dominar todo o tipo de *software*. Desde AutoCAD, Adobe, Rhino, tem havido essa pressão. Isso acaba por ser inconciliável com a vida profissional e pessoal saudável.

Há muita tendência também depois dentro do *atelier* de se proceder a uma especialização. Isto é, determinada pessoa desenha isto, a outra desenha aquilo e isso faz sentido em termos de tornar o processo de produção o mais oleado possível. Nesse sentido existem muitos casos de *ateliers* de alguma dimensão, em que certas pessoas fazem os projetos, outros que fazem os projetos de execução e outros que preparam a *renderização*, há essa especialização. E há *ateliers* que já só trabalham em grande medida com pré-visualização, com *renderização* para outros *ateliers*. Pode dar-se o caso de quem aprende, quem faz a formação nesse tipo de *software* da Realidade Virtual, nos *ateliers* que detém a possibilidade de utilizarem essa ferramenta, de se especializarem.

Novamente, voltando atrás, pode ser um fator de distinção para pessoas que estão à procura de trabalho num *atelier*, por se especializarem na oferta de determinado serviço. Pode ser um fator de distinção dentro do próprio, dentro do mercado de trabalho interno e externo, o facto de um *atelier* se especializar neste tipo de serviço. Acaba por ser uma aposta pessoal. Agora, não sei se o arquiteto deveria fazer essa reflexão: se estamos a trabalhar de repente para um campo, uma disciplina, que se especializa de tal maneira que deixa de haver arquiteto genérico e passa a haver o arquiteto de *renderização* e outros de outras especializações. A discussão deve ser feita em termos de formação na academia. Estamos a



formar especialistas em x, y e z? Estamos a formar profissionais capazes de dominar de tudo um pouco de uma forma menos aprofundada? Essa discussão pode ser feita ainda no espaço da academia ou nos primeiros 5/6 anos de formação, que possa levar a uma fase posterior onde se deve proceder a esse tipo de especialização. Tal como outras disciplinas têm, como é o caso da medicina que tem, além de 6 anos de academia, outros 6 anos de formação de especialidade. Não sei em que ponto é que devemos parar.

**As próximas questões estão mais ligadas a questões da própria escola em si, do Darq. Perguntava-lhe como é que vê a relação entre o departamento e a Realidade Virtual? Existe, não existe, é estreita?**

**JB|** Tirando as cadeiras que já procuram a *renderização*, o Cinema 4D, tirando estas unidades curriculares...

**Opcionais?**

**JB|** São opcionais? A.P.D [Arquitetura e Projeto Digital] ?

**A.P.D. é obrigatória. Aprende-se 2D e um bocadinho de 3D, mas não abordava o *rendering* interativo, pelo menos há 3 anos. Mas então a ligação deste departamento à Realidade Virtual é feita por estas Unidades Curriculares?**

**JB|** É feita como ferramenta de formação em determinados campos. Lá está neste caso, a academia, ou o departamento de Arquitetura, o que tenta fazer - e com isto que eu vou dizer não estou a dizer se está certo ou está errado, acho que essa discussão pode e deve ser feita - é dar uma formação o mais global possível.

**Global a nível de ferramentas? Ou seja, indo do analógico ao digital?**

**JB|** Sim, sim. Alguns instrumentos, algumas ferramentas não podem ser exploradas até ao limite.

**Em que ano é que considera que deve ser introduzida esta questão do digital e nomeadamente da Realidade Virtual?**

**JB|** Sendo ajudante de ensino em Projeto II, eu diria que é necessário uma formação inicial em que o desenho à mão levantada e o desenho rigoroso à mão são importantes para perceber o controlo do traço, ou o controlo da mancha, ou o controlo do desenho, que são informações que são transportadas posteriormente para o campo digital. É preciso um domínio da mão e do olho para mais tarde utilizar esses instrumentos em que deixa de ser a mão e olho e passa a ser a folha de papel intermediada por um ecrã e o olho que tem que conseguir dominar essa diferença entre a escala que está no ecrã e a escala da realidade; a mão que é substituída por instrumentos que lhe dão uma precisão tecnicamente superior. Portanto, temos evolução que creio que deve existir talvez no 2º ou 3º ano. Dito isto, falava em serem feitas experiências, em que algumas cadeiras do 1º e do 2º ano requerem o digital. Quer dizer os trabalhos hoje em dia são feitos de alguma maneira com recurso ao digital, portanto vai havendo sempre essa pressão de começar mais cedo ou utilizar já o digital como instrumento de trabalho que auxilia o desenho.

**Considera que a introdução da Realidade Virtual deveria ser feita pontualmente numa Unidade Curricular ou deveria ser feita de uma forma transversal?**

**JB|** Eu diria que já é feita de forma transversal, por pressão ou vontade dos alunos, já é feita de forma transversal. O acesso a um computador, é um instrumento que custa muito dinheiro, pode custar tanto como um ano de propinas e adquiri-lo para depois não utilizar é um desperdício de recursos. É um instrumento que se degrada, portanto deve ser utilizado com alguma frequência. Dito isto, não sei se até o próprio departamento de Arquitetura não deveria ter uma sala de computadores disponível para os alunos utilizarem durante o ano. Dito isso, a *praxis* é ditada pelos alunos e é transversal e vai continuar a sê-lo. Pode ser incorporada e é incorporada a partir do 3º ano não sei se pode ou deve ser incorporada antes. Há um momento de aprendizagem e de controlo que quando se inicia diretamente nas ferramentas digitais, pode haver uma perda de experiências. A mão e o olho só se controlam utilizando a mão e olho e essa experiência deve permanecer ao longo dos anos, desde o 1º ao último e não creio que vá desaparecer, mesmo com a existência de valências ou de instrumentos que permitam o acesso a Realidades Virtuais. •

[2016.6.16]

## **Departamento de Arquitetura da Universidade de Coimbra**

Professor: **João Mendes Ribeiro [JMR]**

### **A primeira pergunta que lhe faço é se considera pertinente esta ligação entre Portugal e a Finlândia?**

**JMR** | De facto, eu não conheço muito bem a realidade da Finlândia, porque nunca visitei o país e também não tive contactos com escolas de lá. A ideia que tenho, muito a partir de talvez de uma noção que tenho da Arquitetura nórdica - em particular da Finlândia, sobre as obras do Alvar Aalto-, é que tem uma Arquitetura com algumas pontes com o caso português. É um país periférico, tem uma cultura muito específica e também por ter uma relação muito forte com o *design* e com tecnologias artesanais, tradicionais. Eu diria que há, eventualmente, algumas formas de trabalho ainda marcadamente artesanais, mas de grande rigor construtivo, que se encontram na Finlândia, mas também em Portugal. Ainda em relação à pertinência da ligação estabelecida entre Portugal e a Finlândia, eu acho que haveria outro país, mas esse é fora da Europa, com o qual também seria interessante estabelecer essa conexão: o Chile. Eu acho que tem características muito parecidas com a Arquitetura portuguesa. Também é um país periférico, também não é um país rico, como são por exemplo a Argentina ou o Brasil. Tem uma Arquitetura, de pequena escala, doméstica, mas também de muita qualidade. Ainda também com processos artesanais, muito bem construído, muito atento ao sítio, as premissas são mesmo muito semelhantes ao caso português.

### **E sobre a questão da rede poder ser estendida a nível europeu e poder então incluir outros países no projeto, considera que seja pertinente?**

**JMR** | Isso parece-me muito interessante. Haver uma plataforma que seja comum e que permita exatamente ser um instrumento de comunicação entre jovens arquitetos parece-me uma coisa muitíssimo interessante. Eu diria que essa pode ser também uma forma de trabalho. Trabalhar a partir de outros instrumentos, para nós arquitetos que ainda trabalhamos muito com base no desenho, mesmo até quando passamos para o sistema digital, isto pode ser muito interessante. Explorar outras formas de comunicação, que não sejam os sistemas tradicionais. Se isso for operativo, se isso for de facto uma coisa relativamente fácil de operar, pode ser muito interessante.

### **O Professor está a referir-se mais à questão da comunicação, mas na parte da conceção do projeto vê alguns benefícios?**

**JMR** | Há aqui duas hipóteses de se tornar um instrumento importante que são: por um lado a possibilidade de experiência, experimentar um espaço que é uma tentativa de aproximação da Realidade. Por outro lado, a possibilidade também de manipular esse sistema e, por exemplo, termos eventualmente essa realidade aumentada. Portanto, a possibilidade de a partir de um sistema desse tipo ser, se quisermos, hiper-realistas e podermos fazer uma coisa que ultrapassa a própria realidade. Pode ser muito interessante isso que é de alguma

manipular para conseguir um efeito- isso por um lado. Por outro, nós já temos um pouco disso com as imagens 3D, a construção de imagens, que por vezes nos deixam na dúvida se é uma fotografia se é um *render*. Eu acho que pode ser muito importante como instrumento de comunicação. Sobretudo como instrumento de comunicação para profissionais que não são desta área, porque é uma forma deles entenderem. Não conseguem ler desenhos, a maquete eventualmente aproxima-se, mas não tem a relação com o contexto, não tem os materiais, não tem a cor, não tem a luz... Portanto, eu acho que desse ponto de vista, sobre a comunicação com outras pessoas que não as da área, pode ser um instrumento importante.

### **O que é que pensa sobre o panorama do mercado de trabalho na nossa área em Portugal?**

**JMR**| Eu acho que as coisas estão a mudar um pouco. Eu senti nos últimos meses que há bastante mais procura e sobretudo há muito - sobre uma área que até aqui não tinha tanta expressão - trabalho de reabilitação. Há um trabalho grande em reabilitação, sobretudo no Porto e em Lisboa. Depois também sobre equipamentos ligados ao turismo. Há muita procura de turismo em Portugal e com alguma frequência, aparecem pedidos de pequenos equipamentos relacionados com hotelaria. Há uma mudança. É uma mudança, que eu acho que eventualmente não absorve todos os arquitetos que existem em Portugal, que são claramente muitos. Acho que Portugal já ultrapassou mesmo a Itália no número de arquitetos por habitante, que era o país que estava mais à frente na Europa. Se conseguíssemos alterar a lei, isto é, se fosse obrigatório que os projetos fossem todos assinados por arquitetos, se calhar haveria trabalho suficiente para todos. Mas, como isso não é uma realidade, neste momento não há um mercado de trabalho que abranja todos os arquitetos.

Parece-me ainda assim que a formação dos jovens portugueses é muito boa, relativamente a outros países. Os jovens arquitetos português têm bastante prestígio fora de Portugal. Daquilo que eu conheço sobre ex-alunos é que todos arranjam trabalho. Agora na Suíça começa a ser mais difícil, mas no norte da Europa consegue-se arranjar trabalho e arranjam facilmente. Isso é uma característica importante. É por isso que os alunos têm uma boa formação e que as escolas de Arquitetura e os profissionais de Arquitetura, mesmo os jovens arquitetos têm prestígio lá fora. Portanto se vierem de Portugal, facilmente são aceites. Ainda há pouco tempo estive em Veneza, fui convidado por um grupo de arquitetos espanhóis, para estar na bienal de Veneza e eles diziam que quando têm pedidos de arquitetos portugueses que os introduzem logo à frente da lista para trabalhar nos *ateliers*. Acreditam que há uma boa escola de Arquitetura em Portugal e pela experiência que eles têm, e estamos a falar de professores de Barcelona e de Madrid, é que são dos melhores a trabalhar nos *ateliers*. Porque sabem desenhar, sabem pensar e também dominam os instrumentos, os sistemas digitais. Deste ponto de vista, eu acho que os alunos estão muito bem preparados. Eu tenho tido essa perspetiva de muitas partes da Europa, não é só de Espanha, embora estes últimos fossem de Espanha. Eles estão também com uma crise muito grande. Neste momento também estão a ir para outros mercados, porque também não têm trabalho. Mas não deixa de ser curioso que sempre que apareça um jovem arquiteto português, eles o prefiram em relação a um jovem arquiteto espanhol, porque acham que eles dominam melhor os instrumentos de trabalho.

**Na sequência da pergunta anterior, perguntava-lhe se acha que a Realidade Virtual pode ampliar o campo de possibilidades de trabalho dos jovens arquitetos?**

**JMR|** Sim. Eu acho que eventualmente é mais um domínio. E o domínio das novas tecnologias é sempre importante e portanto isto pode ser mais um instrumento fundamental. Eu diria que haver uma certa flexibilidade na forma como se manipula esses instrumentos, isto é, não aprender só um sistema, aprender vários sistemas e várias possibilidades, é muito bom, porque os gabinetes trabalham com sistemas muitíssimo distintos. Cada vez mais há uma relação entre profissionais, portanto há muitos trabalhos que são feitos em equipas multidisciplinares. Por exemplo, os engenheiros trabalham com um sistema que normalmente os arquitetos não trabalham, que tem a ver com o sistema de cálculo... Essa ideia de dominar os vários instrumentos digitais, é sempre uma vantagem para os *ateliers*, porque no contacto com múltiplas disciplinas, especialidades completamente distintas e sobretudo, agora mais neste cruzamento internacional, trabalhar com diferentes países é absolutamente necessária essa flexibilidade do ponto de vista instrumental. Por exemplo, imaginando, um trabalho exigente como trabalhar para o oriente, trabalhar para a China, onde a língua é claramente uma impossibilidade, se se dominarem sistemas que tenham a ver com a imagem, que é universal, isso pode ser uma vantagem enorme. De facto, isso é uma das vantagens dos arquitetos, é que os desenhos são universais e a Arquitetura é universal, entende-se em qualquer parte do mundo. Portanto esses sistemas de comunicação que sejam universais, como é a imagem, podem ser uma grande vantagem.

**Agora focando-nos sobre a nossa escola, o nosso departamento, como é que vê a relação entre a Realidade Virtual e a escola?**

**JMR|** Aí há ainda algum trabalho a fazer. A ideia que tenho é que eventualmente haverá outras escolas de Arquitetura que, do ponto de vista das novas tecnologias, e dos sistemas digitais, estão um pouco mais há frente. Por exemplo, aqui na escola, há poucos alunos a saber trabalhar em 3D. Noutras escolas, fabricar mais em 3D como resultado final de um edifício de projeto é fundamental. No departamento aqui em Coimbra isso não é assim. Existe uma ideia muito presa a duas dimensões, saber desenhar com as duas dimensões, ainda que o sistema digital e AutoCAD facilitem imenso as correções, mas é ainda um desenho bidimensional. Não tem muito a ver com a ideia da imagem. Ou quando se trabalha a imagem ainda é do aspeto de fotomontagem artesanal. Portanto, eu diria que, no departamento, comparando com outras escolas, por exemplo eu estive a dar aulas em Viseu, na Escola Católica de Viseu, e eles trabalhavam sempre imagens e as imagens era fundamentais como meio de comunicação. Os trabalhos eram todos feitos em 3D e eram depois passados para 2D. Isto para dizer que a forma como ainda se trabalha no departamento é ainda muito a partir do desenho. E depois o desenho 3D é ainda uma transposição desse desenho bidimensional e nós na disciplina de Projeto, não vamos muito mais longe. Quanto muito pedimos uma axonometria explodida, para se perceberem os materiais, ainda é um desenho bidimensional. Temos é outros instrumentos para o desenhar. Há ainda uma distância a percorrer no departamento.

**E qual será, no seu ponto de vista, a unidade curricular mais próxima da Realidade Virtual?**

**JMR** | Eu não sei se quando fazem os desenhos no 2º ano, se eventualmente isso seria o início dessas bases. Não sei que tipo de exercício é que vocês fazem, mas eventualmente seria aí a possibilidade de relação com essas matérias, mas depois disso eu acho que não tem continuidade. Perde-se. Há ali um momento em que há essa aproximação, mas o facto de não haver mais disciplinas nos anos seguintes, faz com que se perca essa possibilidade.

**Há depois opcionais no 4º e 5º anos...**

**JMR** | É uma coisa completamente secundária e perde-se essa possibilidade. Eu acho que os exercícios que o Professor Mauro dá são fundamentais e fazem essa abertura, mas depois era preciso dar-lhe continuidade nos anos seguintes.

**Na sua opinião qual é o impacto dos sistemas digitais no processo de projeto?**

**JMR** | Como eu faço, não tem impacto nenhum, porque eu não uso. Isto é, nós fazemos desenho no AutoCAD, como é evidente, mas só usamos desenho 3D, recorrendo à imagem, nesse aspeto de Realidade Virtual, quando fazemos concursos. Tem a ver muito com a comunicação, como eu estava a dizer, que é perceber se é um edifício feito no contexto, e isso tem muito impacto nos concursos. Depois acaba por ser um trabalho muito tradicional. Trabalhamos imenso em maquete, porque nos interessa muito o espaço e na maquete ele não é manipulável. Aquilo tem de ser controlado, pode ser iluminado, e se for preciso entrar, podemos ampliar e entrar lá dentro para olhar. O desenho em 2D também é um desenho que nos engana, mas a maquete não engana. O trabalho é muito verificado em maquete, em muitas escalas. Isso é aquilo que eu acho mais seguro, mais próximo daquilo que vai ser construído. E depois também no desenho rigoroso muito detalhado e aí eu acho que conseguimos algum controlo de trabalho. Ter uma imagem antes do edifício construído é muito interessante para verificar, de facto, mas como não há prática deste trabalho, normalmente encomendamos isso fora. Encomenda-se para uma apresentação especial, para um concurso, para uma exposição, sempre que é necessário comunicar de outra maneira. Num concurso, reconheço que é absolutamente central, porque o cliente precisa de ter uma imagem. Isto é, quem não entrega a imagem está praticamente excluído de ganhar o concurso. Como normalmente isso é feito fora e também tem custos grandes, não é tanto uma forma de trabalho é mais uma forma de comunicação. Isto é, aparece já *a posteriori* do edifício pensado e desenhado.

**A propósito disso que o Professor estava a referir, eu na minha fase de recolha de dados na Finlândia, tive oportunidade de visitar um dos *ateliers* que terá sido o primeiro a implementar este sistema de CAVE, a nível nacional, e os depoimentos que lá me deram foram sobre as consequências dessa introdução. Houve um aumento significativo a nível de clientes, que exigiu necessariamente que o aumento do número de colaboradores. Esta situação proporcionou-se devido ao facto de este sistema de apresentação 2D de plantas, cortes e alçados, não ser muito propositivo sobre o *feedback* do cliente. Eles não sabem avançar muito a sua opinião, sentem-se constrangidos por não dominarem este tipo de linguagem. No entanto, quando eram feitas apresentações dos projetos nessa tal CAVE, eles eram muito mais ativos, tinham segurança na opinião que davam. Isso depois também traz outras questões, que são por exemplo o facto de o arquiteto ter de ter uma gestão acrescida sobre aquilo que o cliente acha que sabe. Mas, em todo o caso, tinha isso de vantajoso.**

**JMR** | É verdade. De repente há uma experiência e é também uma experiência espacial, de sensações.

**Sim, embora dependa absolutamente dos equipamentos. Se houver mais qualidade, existe um tipo de experiência, com menor qualidade ter-se-á outro tipo.**

**JMR** | Mas há uma tentativa de remeter o cliente para a experiência e isso claramente é muito interessante. Melhor que isso só construindo uma maquete à escala real. O arquiteto Siza fez isso. Construiu o interior de casa, num pavilhão, para os clientes verificarem o tipo de espacialidade que queriam. Construíram, em paredes de gesso cartonado ou algo do género, o interior de cada casa para eles habitarem, para perceberem a relação com o espaço e depois fazerem opções. Mesmo nesta situação, não tens a relação de interior-exterior, nem luz natural, porque é dentro de um pavilhão, mas tens a noção do espaço. Não tens também os acabamentos que depois serão os reais, mas dá uma experiência espacial.

**Pergunto-lhe agora, em relação aos estudantes em si, portanto no âmbito da escola, quais serão os impactos dos suportes digitais no desenvolvimento do processo de projeto?**

**JMR** | Desse ponto de vista, tudo isso torna mais fácil a execução de desenhos. Quando era feito tudo à mão - imagina o que é fazer um desenho todo à mão. Colocar as espessuras todas... Ainda no outro dia estava a dizer aos meus alunos que a escala 1:50 era uma escala muito ingrata, porque nós ou colocávamos o reboco ou não colocávamos. Mas para colocar um reboco, à mão, na escala 1:50 era preciso um rigor brutal e era tudo feito com muito cuidado. Depois quando havia um engano era ter de ir com uma lâmina raspar e era uma loucura de trabalho. Portanto, nesse aspeto, o processo digital facilita imenso, mas também, esta facilidade permite não passar por todas as fases do processo e facilmente o projeto torna-se uma colagem de coisas. Tem esse problema, mas claro que isto é um instrumento fundamental.

Mesmo o 3D. Imaginar que se possam fazer imagens e que se possam aproximar da ideia de uma Arquitetura real, ao nível da manipulação de uma realidade, eu acho muitíssimo interessante essa possibilidade. No fundo isto é sempre um processo de comunicação de uma ideia. O problema é a possibilidade de nos viciarmos na construção de uma imagem, sendo que a Arquitetura não é imagem. Seria a mesma coisa que nos viciarmos num desenho. Isto é apenas um suporte ou um meio para podermos construir. A boa Arquitetura não é o desenho. É aquilo que o desenho pode possibilitar que se gere em termos de espaço, em termos físicos. O meu receio é esse, é ficarmos viciados em encontrar uma boa imagem e não pensarmos que, de facto, a Arquitetura é muito mais que isso. Mas a culpa não é do sistema, é a forma como se utiliza. O facto de existir essa possibilidade é fantástica. Acho sobretudo fantástica a forma de comunicação, porque acho que nós temos de ter o treino suficiente de perceber o que é que está por trás daquilo, qual é a qualidade espacial, a partir de um desenho, de uma maquete, de uma série de instrumentos mais convencionais. Nós conseguimos imaginar o espaço construído, conseguimos colocar-nos dentro do espaço, mas o cliente não consegue. Nós temos essa possibilidade de conseguir antecipar a realidade: ou a desenhar, ou a esquisar, mas quem está de fora não consegue. Nesse sentido é que esta

Arquitetura virtual pode ser muito interessante, como elemento de comunicação, porque no fundo antecipa a própria construção.

**Se a Realidade Virtual fosse integrada no plano de estudos da nossa escola, de que forma é que o Professor prevê que essa integração fosse feita?**

**JMR**| Eu acho bem não entrar logo no primeiro ano, por uma razão, porque acho que a questão do desenho manual é muito importante. Portanto, acho muito interessante no 1º e 2º anos fazer este trabalho de desenho manual, esquisar e depois até mesmo o desenho rigoroso é manual. Acho que a introdução, a apresentação no 2º ano está bem, portanto, eu diria, que no 3º ano é que devia ser concretizada essa matéria e podia ser um instrumento importante também de apoio ao Projeto. Eu acho que depois o 4º e 5º anos, o segundo ciclo, já são mais especializados, porque a ideia é de alguma forma escolher uma área que possa conduzir a uma investigação que começa na Prova Final, mas que possa depois ter um caminho qualquer de investigação. Eu não estou a dizer que aqui não possa existir também um processo de investigação própria, podia ser interessante. Mas uma coisa que fosse transversal a todos os alunos teria de ser no primeiro ciclo. Parecia-me mais interessante, que os alunos pudessem dominar mais um instrumento, que fosse uma base de conhecimento, e depois não quer dizer que não se pudesse avançar para um processo de investigação mais conduzida para uma área em específico, eventualmente.

**Qual destas situações lhe parece ser a que retiraria mais vantagens da utilização da Realidade Virtual enquanto ferramenta: uma situação de desenvolvimento de um projeto, para que o próprio aluno pudesse aferir a sua solução nas diferentes etapas de desenvolvimento; Para o aluno poder expor a sua proposta de projeto a professore e colegas, entre pares; Ou para uma situação em que o aluno ou jovem arquiteto tivesse de apresentar o seu projeto ao público em geral?**

**JMR**| Dentro da escola seria talvez mais interessante que se pudesse utilizar mais como instrumento de trabalho, mas que fosse também um processo de comunicação com os professores, com os pares. Obviamente que eu acho que ele é muito útil depois fora da escola, mas não faz muito sentido ter esse instrumento e não funcionar como instrumento de trabalho, integrando o processo, e ser uma coisa que se faça no fim. Porque aí vai-se verificar a solução, mas já não tem condições para fazer as alterações necessárias. O que é interessante na escola, não é tanto o resultado final, é muito mais o processo de trabalho e a grande questão é aprender. Embora eu reconheça que na vida profissional eu não faça uso disso, se for um sistema relativamente ágil, que é esse sempre o problema, se são fáceis de fazer ou não. Porque isso nunca substitui processos muito mais ágeis como o desenho, como o esquisso, ou como rapidamente fazer uma maquete com meia dúzia de peças de esferovite. A questão é a agilidade do sistema. Se for um sistema muito ágil, em que rapidamente se metem as coordenadas e facilmente se alteram, isso pode ser um instrumento de trabalho fantástico. Se for um sistema pouco ágil, vai naturalmente aparecer no fim do processo e então torna-se menos interessante, porque aí já passa a ser muito mais elemento só de comunicação do que de trabalho e de processo de trabalho. Embora eu também desconheça essas matérias para perceber, em rigor, se isso pode ser uma coisa mais ou menos operativa. •



[2016.6.17]

## **Departamento de Arquitetura da Universidade de Coimbra**

Professor: **Catarina Fortuna Campos [CFC]**

### **Como é que a Professora vê esta ligação possível estabelecida entre Portugal e a Finlândia?**

**CFC** | Quer dizer é uma pergunta que tu saberás seguramente responder melhor do que eu, no sentido em que eu não conheço a realidade finlandesa no que respeita ao estado e ao nível de investigação num laboratório de Realidade Virtual. Acho curioso a ligação de Portugal com a Finlândia, porque há inevitáveis comparações, quer em termos gerais, históricos e culturais de países na periferia da Europa. Mas também na Arquitetura, nos procedimentos e nas metodologias de trabalho. Fala-se muito do Arquiteto Alvar Aalto e do Arquiteto Siza e do modo de abordagens aos projetos muito sensorial, muito experimentais... Curiosamente, é uma experimentação muito física, muita da matéria, das mãos na massa, da oficina, onde se experimenta, com recurso a maquetes. Portanto, eu diria, que é pertinente e é curioso, porque podes partir de uma plataforma comum, que é imaginar este dois países na periferia da Europa e de alguma forma terem uma notabilidade na Arquitetura, com figuras internacionalmente reconhecidas e tendo por base este trabalho artesanal. E depois como é que estas duas realidades que têm este “corpo” comum, se enquadram agora na nova Realidade Virtual, de experimentação da Arquitetura, do espaço. Portanto, acho um bom ponto de partida.

### **E como é que vê a possível extensão da rede depois a toda a Europa, como está pensado para o projeto original?**

**CFC** | Vou colocar-me sob o ponto de vista da academia e da importância que tem atualmente a Arquitetura afirmar-se como área do conhecimento científico, com as especificidades próprias e com o reconhecimento que lhe é devido. Nessa medida, tudo o que tenha a ver com a integração de projetos multidisciplinares de investigação com instituições europeias ou outras e depois também com a possibilidade de concorrer a financiamentos nestes programas como o Horizonte 2020, parece-me importante. E que haja pessoas que se interessem por isso e que nas universidades haja um conjunto de pessoas vocacionadas para isso, também. Acho que a Arquitetura pode ter muitas frentes e muitos pontos de abordagem e esta é uma delas e é válida. Confesso que a mim, por questões geracionais, não excluo outras, naturalmente, mas reconheço-a como muito válida. E tenho curiosidade de perceber os resultados e de que maneira é que isso se pode integrar no nosso trabalho, torná-lo melhor e nas escolas criar um corpo presente interessado em apostar nisto e em explorar isto e que passe depois este conhecimento para o meio académico. Isso parece-me uma das coisas que podes aproveitar melhor nesse tipo de projeto. Haverá nos outros países gente como tu, com os mesmos interesses e portanto isto pode criar uma teia, uma rede, que é seguramente bom.

**Uma das possibilidades que esta rede acrescentava era a possibilidade de podermos partilhar conhecimento, sobretudo sobre a Arquitetura associada a esta ferramenta. Inclusive, uma das situações que eu tinha pensado para objetivar esta questão da rede,**

referia-se ao momento de transição entre academia e o mercado de trabalho, na perspectiva do jovem arquiteto, onde aparece a necessidade de apresentar portfólios. Seria uma forma de os construirmos não só com cortes, alçados, plantas e fotografias de maquetes, mas também com essa componente da Realidade Virtual. Assim, os seus edifícios projetados poderiam ser visitados, tanto por profissionais da área, arquitetos, que no fundo depois poderão ser também os empregadores, como por outros jovens arquitetos, que tenham interesse sobre o que os colegas andam a fazer em termos de Arquitetura, noutros países.

CFC| Ainda bem que me disseste isso, porque me esclareceu um bocadinho. Neste momento o que estás aqui destacar é a componente final, de apresentação, de comunicação dos projetos. Eu estava a pensar mais na conceção.

**Eu quando problematizar esta questão ao longo da minha tese, vou-me focar nessas duas perspectivas da comunicação da conceção. Para o aluno estar disponível para partilhar esse tipo de portefólio virtual, ele tem de ter também concebido os elementos apresentados dentro deste ambiente. Não se pressupõem que seja *a posteriori* que vai fazer uma modelação dos edifícios. O ideal seria integrar no processo de projeto. Mas depois há mais possibilidades. Podiam fazer-se exposições ao mesmo tempo em vários sítios sobre o mesmo tema, utilizando este tipo de dispositivos. O interessante deste tipo de candidaturas a projetos de financiamento, é poder dar hipótese, neste caso específico, às escolas de se apetrecharem com dispositivos que muitas delas economicamente não teriam possibilidade de adquirir. Isto implicaria obviamente um trabalho muito dirigido a esta questão de concretização da proposta e do projeto, que poderá vir mesmo a ser realizado mais tarde. Neste momento eu usei esta ideia enquanto mote, que me permite construir e desenvolver a minha dissertação de mestrado, gostaria depois até de dar continuidade a esta pesquisa e corporização desta ideia, mas isso também dependerá muito das oportunidades pós-formação.**

**Nesse sentido, perguntava-lhe como é que a Professora vê neste momento o panorama do mercado de trabalho na nossa área, em Portugal?**

CFC| É daquelas perguntas fáceis e difíceis ao mesmo tempo. O mercado de trabalho, em geral, seja para recém-licenciados, para arquitetos já estabelecidos, não está na sua melhor fase. É uma consequência dos problemas que se conhecem, da crise económica europeia, mundial e da escassez da encomenda. O trabalho em Arquitetura está muito dependente desta conjuntura e nós sentimos de forma indelével as oscilações e o impacto desta conjuntura económica. Percebe-se perfeitamente quando as pessoas têm mais à vontade para investir e estão mais entusiasmadas para fazer obras, alterações ou mesmo coisas de raiz. Noutros períodos, como agora, quando se retraem mais por receio, medo, insegurança, desconhecimento sobre o futuro, sentimos igualmente. Eu acho que nós somos um reflexo muito direto deste estado de sítio e como tal este momento não é uma época muito boa. Eu tenho esperança e temos alguns sinais de que as coisas estão a mudar.

Em todo o caso há umas assimetrias muito grandes, que me impressionam muito. Porque há referências muito parecidas, a formação é muito equivalente, as competências que se adquirem também, e no entanto num escritório em Londres ou em Berlim, o trabalho existe, decorre naturalmente e em Portugal não há trabalho. Os trabalhos são mal pagos, não se

podem dar as melhores condições de trabalho às pessoas que trabalham connosco, porque na verdade é difícil. E depois há outros sítios do mundo, em que isto decorre naturalmente, em que o mercado funciona. De facto, em Portugal, é uma luta dura. Portanto, não há muitas oportunidades neste momento em Portugal, mas há alguma ginástica de se reinventar aquilo que se pode fazer, para tentar ir ao encontro das encomendas.

**Nesse sentido a Professora pensa que esta ferramenta da Realidade Virtual poderia abrir o campo de possibilidades dos arquitetos sobre o mercado de trabalho?**

CFC| De uma maneira muito prosaica, por muito melhor que sejam as tuas competências, ou as ferramentas, se não houver ninguém interessado em encomendar-te um trabalho, por muito boa vontade que tenhas, podes fazer uma série de iniciativas paralelas, mas não acontece. Acho sempre que é seguramente uma mais-valia, porque aumentam as possibilidades, o campo de opções de trabalho. Ainda que não seja em Portugal, mais uma vez, pode abrir portas. Mas acho também, que há aqui uma questão cultural, de mentalidades, como deves ter percebido haverá algumas reservas a esse tipo de ferramentas mais elaboradas, ou desta tipologia que requerem um *know-how* mais específico. Portanto, acho que isso precisa de um caminho antes, e por isso é que acho que há uma grande importância da parte das escolas, em que isso seja uma coisa quase decorrente, em que todos os alunos tenham possibilidade de conhecer essa ferramenta. Tenho um sentido um bocado democrático e não elitista, em relação a isso. Acho que pode ser um meio de alargar as capacidades e as possibilidades de trabalho.

**A Professora referiu a questão de - em relação a este tipo de dispositivos - ter de haver um tipo de conhecimento acrescido, talvez mais específico. Eu não disse logo de início, mas este dispositivo, de que eu falava, a CAVE, não exige que se dominem *software* muito distantes do universo que nós conhecemos. A modelação que é exibida na CAVE pode ser feita através de *softwares* como o AutoCAD, o ArchiCAD ou o Revit. Há um passo depois entre a modelação e o ajuste de sincronização, propriamente dita, do dispositivo, que pode realmente exigir um outro tipo de conhecimentos. Pode até exigir a ajuda de alguém especializado, mas acontece tal como em muitas outras coisas na Arquitetura, em que nós colaboramos com outro tipo de profissionais. Ou mesmo as *plotters*, precisamos que alguém as calibre e as ligue ao computador, mas a partir daí conseguimos imprimir sem dificuldade. O que eu queria ressaltar são as exigências principais para a concretização de uma exibição na CAVE, que recaem sobretudo sob os aspetos básicos que um jovem arquiteto aprende a dominar. Não tem muitos acréscimos nesse nível, nem desvia o estudante de arquitetura da sua área de aprendizagem.**

**Agora, em relação à escola em si, falando particularmente sobre a nossa, como é que a Professora vê a relação entre o nosso departamento e a Realidade Virtual?**

CFC| A impressão que eu tenho, é que há esse interesse e há um conjunto, embora limitado, de pessoas que podem fomentar a investigação e o trabalho nessa área. No cerne, no seu âmago e na génese da própria escola, não penso que esteja esta vocação. Acho que vai ser uma coisa que vai suceder - a par de outras, porque acho que não substitui outras formas - um bocadinho à força. Quando digo isto não é de uma maneira negativa, é só para explicar

que não é uma coisa orgânica. E que é definitivamente mais impulsionada pelos alunos do que pelos professores, ou por docentes que entretanto foram alunos, ou que tiveram experiências como tu ou Professor Mauro Costa, ou outras pessoas que se interessaram mais por essas áreas. Acho que isso pode dar abordagens bastante interessantes, que não são só meramente técnicas, ou de processo, mesmo do ponto de vista da conceção, levanta questões humanistas, mais do que se pode imaginar numa primeira linha e que pode alterar a forma de projetar.

**Como é que a Professora vê o impacto dos suportes e ferramentas digitais no processo de projecto na perspetiva dos alunos?**

CFC| Da minha experiência pessoal, isso é claramente uma ferramenta e pouco mais do que isso. Nós não usamos processos de conceção digitais ou que derivem desse procedimento, basicamente somos *old school*, nesse aspecto. Os alunos estão inequivocamente muito mais aptos e mais predispostos a incluir isso no seu meio de conceção. Acho que também na escola, então no 3º ano, como sabes, é aquela fase de transição. As pessoas não dominam tão bem ferramentas, é naturalmente que apresentem muitas limitações. Desse ponto de vista, também é meramente uma ferramenta. Claro que acelera os procedimentos, poupa-se tempo, mas não é verdadeiramente aquilo que está na génese da conceção do projeto. Nem se tira muito partido, penso eu, das mais-valias, dos instrumentos digitais para se projetar. Admito que possa ser diferente noutras escolas, noutras anos, noutras fases ou como uma orientação diferente. Na prática profissional, a nossa aqui em particular, não é muito baseada nas ferramentas eletrónicas ou digitais.

**Qual será a unidade curricular que se aproximará mais da Realidade Virtual nesta escola?**

CFC| No sentido de tirar partido e promover o uso? Eu acho que Projeto tem todas as condições para isso acontecer. Projeto no sentido lato, de projeto de cidade, projeto de edifícios, projeto de objetos - desde a cidade à construção. Sim, a construção sem dúvida, inteiramente, poderia ser um pretexto e qualquer uma delas podia ser um bom veículo para se dar início a esse uso.

**Neste momento não consta ainda do nosso plano de estudo, mas se fosse integrada de que forma é que acha que seria encarada? De uma forma individual, numa unidade curricular ou de uma maneira mais transversal, que abranja mais unidades?**

CFC| Acho que sim, que deveria ser transversal.

**E em que ano é que acha que seria mais pertinente essa introdução?**

CFC| Quando entendido como uma ferramenta, um instrumento, um conjunto de códigos que permitem representar, conceber, comunicar determinadas realidades, eu diria que se deveria aprender como se aprende a desenhar ou a fazer maquetes. O raciocínio tem de estar predisposto para isso, portanto pode ser aprendido desde o primeiro ano, porque não?

**Curioso, é um ponto de vista singular no contexto português até agora, porque existe o culto do desenho...**

**CFC** | Mas eu não acho que uma coisa tire lugar à outra. Acho, que se assim entendermos, deve ter um valor equivalente e portanto tem de ser desenvolvido, acompanhado e estimulado, sobretudo.

### **Quais seriam os impactos da Realidade Virtual no processo de projeto?**

**CFC** | Eu antevio coisas muito boas, tão boas como com outros procedimentos. Uma parte da qualidade dos projetos do arquiteto Siza advêm do facto de ele ter esta especial atenção ao desenho e eu acho que isso depois se transpõe para o seu raciocínio, na sua forma de conceber. Da mesma forma que o Frank Ghery, ou alguns arquitetos do oriente, concebem tendo por base raciocínios fundados noutra tipo de meios e dão obras belíssimas, importantes e pertinentes. Portanto eu imagino que também nas escolas, a partir do momento que o raciocínio é treinado e se experimentam tipologias diferentes, os resultados serão igualmente bons ou maus, como acontece também com outros instrumentos.

**Qual destas situações lhe parece que retiraria mais vantagens da utilização da Realidade Virtual enquanto ferramenta: uma situação de desenvolvimento de um projeto, para que o próprio aluno pudesse aferir a sua solução nas diferentes etapas de desenvolvimento; Para o aluno poder expor a sua proposta de projeto a professores e colegas, entre pares?; Ou para uma situação em que o aluno ou jovem arquiteto tivesse de apresentar o seu projeto ao público em geral?**

**CFC** | Acho que seria em qualquer uma delas. Acho que nenhuma se exclui. Definitivamente que terá um grande impacto na situação de apresentação ao cliente ou a terceiros, porque como dizias, têm a possibilidade de antecipação da realidade que não conseguem ter com outros instrumentos. Enquanto se olhar para uma axonometria consigo mais ou menos perceber o que quer dizer, mas quando eu mostro aos meus clientes, eles têm uma dificuldade enorme em entender o desenho. Definitivamente em termos de impacto sensorial, eles seriam os primeiros a aderir a isso. Acho no entanto um bocadinho perigoso, esqueci-me de dizer isto, porque até agora tenho estado a fazer uma apologia e continuo a fazer, porque não tenho quaisquer reservas em relação a isso, mas como a Arquitetura tem muitas outras dimensões, por mais aperfeiçoada ou virtuosa que seja esta representação, depois há qualidades a nível da matéria, de reverberação de som, luz, cheiro, tácteis, que julgo ainda não ser possíveis simular. Nessa medida é sempre uma representação provisória. Ficará sempre muito aquém e espero eu que assim seja. Não é nunca a totalidade. A experiência completa e total.

De qualquer forma, acho que são instrumentos que podem ser acrescentados àqueles meios que nós já temos para comunicar e nesse sentido serem uma mais-valia. Tanto para a comunicação dos projetos, quer no âmbito da escola, quer no processo de trabalho para testar e verificar soluções. Também porque as pessoas têm estímulos muito diferentes e quando se tem alunos e se dá aulas isso torna-se muito claro. Tem a ver com experiência de vida, idade, maturidade, com o conhecimento, uns estão mais à vontade com determinada ferramenta e outros com outra. É certo, e não se pode escamotear isto, não com esta ferramenta ou estes recursos mais sofisticados, mas com a massificação das representações tridimensionais desenvolveu-se uma prática muito comum, que é as pessoas venderem um projeto quase como uma imagem e a Arquitetura é muito mais do que isso. É uma guerra difícil, porque os leigos simpatizam muito mais com este tipo de imagem do que com uma coisa abstrata

cheia de códigos, que eles nem sequer reconhecem porque nunca foram iniciados nisso. Então torna-se muito sedutor ver uma imagem da sua casa ou do seu hotel. Em termos espaciais aquilo pode ter uma qualidade duvidosa, mas a imagem é muito apelativa, sobretudo para quem não tiver outros recursos para discutir o assunto. •

[2016.9.13]

### **18:25 research studio for architectural visualization**

Arquiteto: **Luca Martinucci [LM]**

**Qual é a sua perspectiva sobre a Realidade Virtual, enquanto ferramenta de representação em Arquitetura?**

**LM|** A Realidade Virtual não é uma ferramenta que venha substituir as outras. Não é nada de novo. Começou com a invenção da perspectiva cônica. A representação em Arquitetura começou a desenvolver-se através da invenção dessa perspectiva e a RV é o último instrumento que permite, de uma maneira mais rápida, conseguir várias perspectivas. Mas, não é possível saber desenhar com a RV sem a compreender o desenho em perspectiva. Se é possível fazer Arquitetura sem este tipo de ferramentas? É! Foi até hoje. Mas devemos considerar que as novas ferramentas dão-nos uma nova maneira de representação e sobretudo de conceber novas arquiteturas. Dá uma oportunidade nova de pensar a Arquitetura.

**Existe ainda alguma resistência, no âmbito da Arquitetura, face ao uso deste tipo de ferramentas. Consegue interpretar este fenómeno?**

**LM|** Eu concordo que possa existir alguma resistência à RV que advém de um mau uso. Costumamos chamar a esse tipo de representações “imagens de agência imobiliária”. Esses são um tipo de representação que não acrescentam nada à Arquitetura, são apenas show-off. No entanto, a RV é uma ferramenta com potencialidades. Não é o mau uso que deve definir a sua utilização. Uma caneta também serve para escrever leis racistas, mas a utilização que Hitler lhe deu, não determina que não possamos encontrar outro tipo de utilização.

**São também vulgarmente apontadas várias críticas em relação ao aspeto de “jogo de computador” associado às imagens geradas em RV.**

**LM|** Concordo, porque isso diz respeito a um desenho muito técnico, mas como viste com alguns projetos que temos, é possível também um outro tipo de linguagem. Existe essa possibilidade de utilizar a RV numa linguagem mais mecânica, para se perceberem aspetos específicos relacionados com a escala e as proporções do espaço. Nesse caso existe uma abstração maior, menos pormenorização. Esse tipo de representação dá resposta a necessidades diferentes da fase de projeto.

**Muitas vezes existe uma mistura de níveis de representação que acentuam esse aspeto, por exemplo, quando no mesmo ambiente existem elementos com diferentes graus de representação.**

**LM|** Claro, ou escolhemos a linguagem mais mecânica ou uma linguagem mais completa. São dois tipos de linguagem que não devem ser misturados. Acho que não há problema nenhum em se usarem várias linguagens para diferentes fases de Projeto.

**Esse tipo de linguagem mais completo pode proporcionar uma leitura mais fiel do Projeto a pessoas que não estejam familiarizadas com a linguagem mais técnica da arquitetura. Isto é uma questão que já está a ser explorada nalguns projetos na Finlândia através da CAVE. Sentem também esta aproximação ao cliente com a RV através dos óculos?**

**LM|** Embora esta ferramenta possa ser utilizada a nível de comunicação, como referiste, nós aqui no escritório usamo-la na perspetiva da conceção para aferir questões do projeto. Como tu pudeste observar, nós trabalhamos muitas vezes por Skype em conjunto com outros arquitetos. Através da partilha de ecrãs, vamos interagindo com o modelo 3D e em conjunto vamos resolvendo o Projeto. Ao mesmo tempo conseguimos gerar *renders* em tempo real e ir aferindo as modificações que vamos fazendo. Também utilizamos os óculos VR para visualizar os projetos. O *software* que desenvolvemos para utilizar os óculos faz parte do nosso processo, em que o objetivo é o máximo controlo da Arquitetura. Nós desenvolvemos um sistema mais simples de interação. Temos vários pares de óculos que alugamos, vendemos ou emprestamos. Muitas vezes enviamo-los para os escritórios de Arquitetura com quem trabalhamos para podermos, em tempo real, ver o projeto em 3D e em 360 graus, para fazermos alterações em conjunto. Isto permite um controlo mais aperfeiçoado, para além de podermos controlar melhor as questões de escala.



Figure 3 - shot from the video Liberdade by 18:25 research studio for architectural visualization  
Source: [www.1825.in](http://www.1825.in)



### Como é que captam o ambiente envolvente e o integram nas vossas simulações?

**LM]** No caso destas imagens em que se vê a cidade através das janelas e das varandas, utilizamos o mesmo procedimento que muitas vezes se utiliza no cinema, por exemplo. Definimos as perspetivas que queremos desenvolver e definimos o sítio exato em que queremos inserir. Depois, agendamos um dia e hora que nos convenha para que fique coerente com a simulação criada e vamos ao local. Através de um *drone* recolhemos as imagens do sítio que definimos e depois inserimos na simulação.

[...]

No caso das reabilitações, como esta obra do Arquitecto Souto de Moura, fizemos um *scan* 3D à fachada, também através de *drones*, para conseguirmos representar com maior rigor elementos mais complexos, como as estátuas.

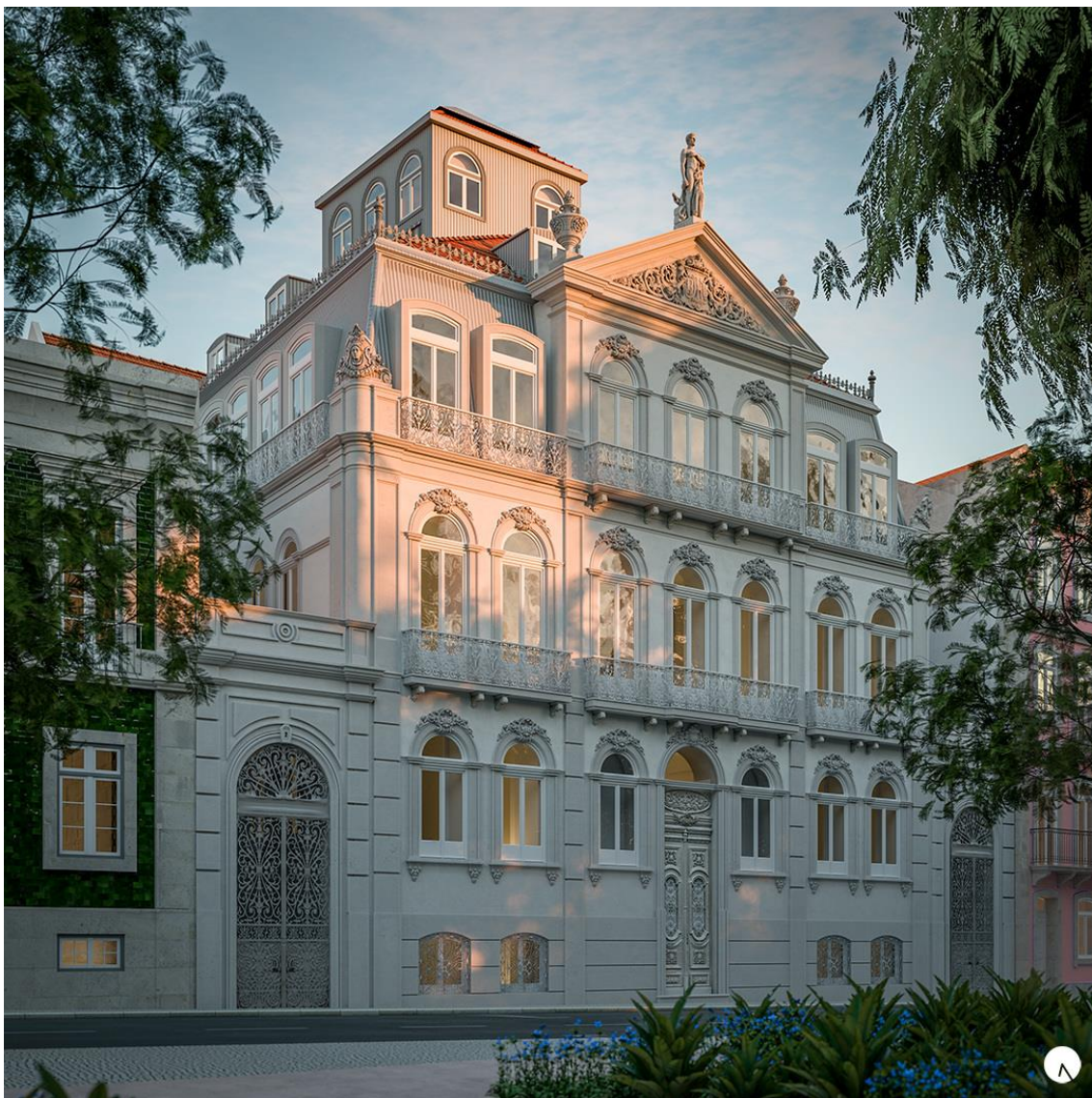


Figure 4 - photo from a design of Eduardo Souto de Moura by 18:25  
Source: [www.1825.in](http://www.1825.in)

Acho que esta ferramenta não é uma solução direta. Abre possibilidades para se fazerem pesquisas. É bom que se façam experiências, mas o que isso pode implicar depende diretamente do estudo que for feito com esta ferramenta. Acho que nos permite prever certos aspetos do projeto, que evitam intervenções depois na fase de construção. Conseguir-se ter um maior controlo e isso pode ter consequências muito vantajosas a nível económico, por exemplo. Um projeto é isso mesmo. A arquitetura vive muito do projeto, não é apenas chegar ao local e começar a construir qualquer coisa. A fase de projeto serve para pensar, prevenir e poder antever muitas questões. Esse é um dos principais objetivos do projeto. Se tivermos ferramentas que nos ajudem nesse processo, então devemos usá-las. No nosso caso achamos que a RV é muito vantajosa, quando integrada na fase de projeto.

**A única maneira de conseguirmos entrar numa obra antes da sua concretização é construir uma maquete à escala 1:1 e a RV dá-nos este tipo de oportunidade. Sobretudo em dispositivos como a CAVE que permitem a imersão total.**

LM| Conheces a Sala dos Gigantes de Giulio Romano, no Palácio Té em Mântua? É provavelmente a obra mais próxima da CAVE são vários espaços decorados pintados à escala real. Remetem-nos para outros espaços e é provavelmente um dos primeiros espaços virtualizados que pretendem comunicar um ambiente totalmente diferente do real. Neste caso, faz-se uma sala assim e fica para sempre, não é possível alterá-la. Não se consegue um processo de interação contínuo. A RV é uma exceção e é por isso que eu acho que pode ser um instrumento de Arquitetura, porque é possível experimentar, desenvolver, atualizar e controlar a Arquitetura. Hoje temos vários Projetos a decorrer sob esta forma de trabalho. É uma forma de pesquisa, mas ao mesmo tempo já está a ser utilizado e é um processo muito prático. Este instrumento tem potencialidades altíssimas e características muito particulares que permitem alcançar o que antigamente seria difícil ou mesmo impossível.

**O que pensa da introdução destes instrumentos na escola? É importante os alunos terem uma aproximação à RV?**

LM| É interessante que faças esta pergunta, porque nós recebemos um convite para dar um *workshop* aqui numa escola de Arquitetura de Lisboa. Esta oportunidade exige algum tempo de preparação e uma grande responsabilidade, por isso ainda não nos foi possível concretizar o convite. Mas eu acho que sim. Obviamente que a minha ambição é que na escola seja possível interagir com tudo o que são instrumentos: das canetas aos lasers ou outros instrumentos que possibilitem a pesquisa. Por isso é importante que haja contacto com tudo o que é inovação. Não existe porém a ferramenta certa. Na nossa opinião, esta ferramenta tem-se mostrado útil para nós. Ainda está em fase de exploração e isso é útil para descobrir coisas, para fazer pesquisas...

**Talvez isso seja um aspeto interessante para mostrar aos alunos, essa procura por uma ferramenta que possa gerar oportunidades no campo da Arquitetura e que seja usada segundo aquilo que interessa desenvolver ou pesquisar. Interessava, talvez, diminuir o**

**uso estereotipado e padronizado das ferramentas. Quais seriam as vantagens e desvantagens para os alunos no contacto com esta ferramenta?**

**LM|** Não sei se consigo dar uma resposta a isso. É como perguntar qual seria o interesse em se apresentar um *software* em vez de outro. Eu acho que a oportunidade está em conhecer uma metodologia nova e dar a oportunidade ao aluno de perceber se consegue ou não tirar vantagens sobre isso. Não é um substituto de nada. É um instrumento que acrescenta possibilidades diferentes. •



**Surveys**  
Script  
Results



Script





**These questions make part of a Master Dissertation methodology of research. Therefore, this is an anonymous inquiry for academic purposes.**

Please, answer the following questions and fill in the blank spaces below:

Attended University: \_\_\_\_\_

Attended Year: \_\_\_\_\_

**Do you use 2D CAD software for architectural drawings?** Yes  No

If you answered **Yes**,

**Which one(s)?** \_\_\_\_\_

**When have you started to use it?** 1<sup>st</sup> year  2<sup>nd</sup> year  3<sup>rd</sup> year  4<sup>th</sup> year  5<sup>th</sup> year

**Have you started to use it by yourself**  **or your university provided you lectures**  ?

If your university provided you lectures, **in which subject(s) was that?** \_\_\_\_\_

\_\_\_\_\_ **Do you use that knowledge in the design process?** Yes  No

**Do you use 3D CAD software for architectural modeling?** Yes  No

If you answered **Yes**,

**Which one(s)?** \_\_\_\_\_

**When have you started to use it?** 1<sup>st</sup> year  2<sup>nd</sup> year  3<sup>rd</sup> year  4<sup>th</sup> year  5<sup>th</sup> year

**Have you started to use it by yourself**  **or your university provided you lectures**  ?

If your university provided you lectures, **in which subject(s) was that?** \_\_\_\_\_

\_\_\_\_\_ **Do you use that knowledge in the design process?** Yes  No

**Do you use 3D visualization software for architectural renderings?** Yes  No

If you answered **Yes**,

**Which one(s)?** \_\_\_\_\_

**When have you started to use it?** 1<sup>st</sup> year  2<sup>nd</sup> year  3<sup>rd</sup> year  4<sup>th</sup> year  5<sup>th</sup> year

**Have you started to use it by yourself**  **or your university provided you lectures**  ?

If your university provided you lectures, **in which subject(s) was that?** \_\_\_\_\_

\_\_\_\_\_ **Do you use that knowledge in the design process?** Yes  No

**Do you use real-time 3D graphics rendering software?** Yes  No

If you answered **Yes**,

**Which one(s)?** \_\_\_\_\_

**When have you started to use it?** 1<sup>st</sup> year  2<sup>nd</sup> year  3<sup>rd</sup> year  4<sup>th</sup> year  5<sup>th</sup> year

**Have you started to use it by yourself**  **or your university provided you lectures**  ?

If your university provided you lectures, **in which subject(s) was that?** \_\_\_\_\_

\_\_\_\_\_ **Do you use that knowledge in the design process?** Yes  No

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?**

Yes  No

If you answered **Yes**,

**Which of them?** \_\_\_\_\_

**When have you started to use it?** 1<sup>st</sup> year  2<sup>nd</sup> year  3<sup>rd</sup> year  4<sup>th</sup> year  5<sup>th</sup> year

**Have you started to use it by yourself**  **or your university provided you lectures** ?

If your university provided you lectures, **in which subject(s) was that?** \_\_\_\_\_

\_\_\_\_\_ **Do you use that knowledge in the design process?** Yes  No

**Please quote from 1 to 3 the importance of the different fills.**

1- not important; 2- important; 3-very important

**How important is Virtual Reality in:**

the design process

the communication of the Project between the Architects themselves and the Architecture academy in general

the communication of the Project between the Architects and the experts (Engineers, Managers, etc)

the communication of the Project between the Architects and users or public in general

Other \_\_\_\_\_

**How do see the future development of the role of Virtual Reality in Architecture?**

	in the Academy	in Professional scope
great increase	✓	✓
Increase	✓	✓
stay constant	✓	✓
Decrease	✓	✓
Disappear	✓	✓

**If you believe that Virtual Reality is important to Architecture please refer what will be the most important role.** \_\_\_\_\_

\_\_\_\_\_

**How are your expectations to find a job after graduation?**

\_\_\_\_\_

**Do you think Virtual Reality could contribute to improve the job situation in architecture?**

\_\_\_\_\_

**Thank you!**

Results



**TOTAL [Finland & Portugal]**

**Total students inquired [1st,2nd,3rd,4th,≥5th]: 305**

**Do you use 2D CAD software for architectural drawings?** Yes **235** No **70**

**How did you start to use it?**

School **146** Autodidact **89**

**When did you start to use it?**

1st year **91**  
 2nd year **92**  
 3rd year **30**  
 4th year  
 ≥5th year

**Which one(s)?**

Autocad **223**  
 Archicad **28**  
 Rhino **11**  
 Revit **6**  
 Sketchup **3**  
 Microstation **2**  
 3Ds Max **1**  
 BricsCAD **1**  
 Draftsight **1**

**Do you use 3D CAD software for architectural modeling?** Yes **193** No **112**

**How did you start to use it?**

School **131** Autodidact **62**

**When did you start to use it?**

1st year **89**  
 2nd year **67**  
 3rd year **26**  
 4th year **10**  
 ≥5th year **2**

**Which one(s)?**

Autocad **32**  
 Archicad **91**  
 Rhino **64**  
 Revit **52**  
 Sketchup **76**  
 3Ds Max **13**  
 Blender **1**  
 Cinema 4D **3**  
 Solid works **1**  
 Grasshoper **1**

**Do you use 3D visualization software for architectural renderings?** Yes **149** No **156**

**How did you start to use it?**

School **93** Autodidact **56**

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year **33**  
 2nd year **56**  
 3rd year **47**  
 4th year **5**  
 ≥5th year **4**

**Which one(s)?**

Autocad **3**  
 Archicad **26**  
 Rhino **7**  
 Revit **13**  
 Sketchup **17**  
 3Ds Max **46**  
 Blender **1**  
 Cinema 4D **9**  
 Atlantis **32**  
 Podium **1**  
 V-ray **19**  
 Kerkythea **1**  
 Maxwell **20**  
 Brazil **7**  
 Keyshot **1**  
 Cinerender **2**

**Do you use real-time 3D graphics rendering software?** Yes 6 299 No

**How did you start to use it?**

Autodidact

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

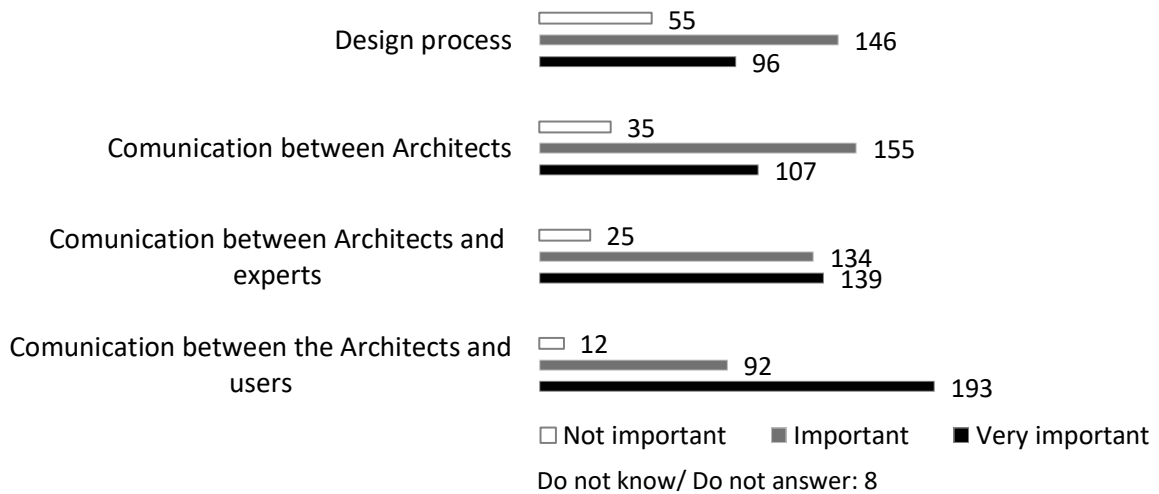
≥5th year

**Which one(s)?**

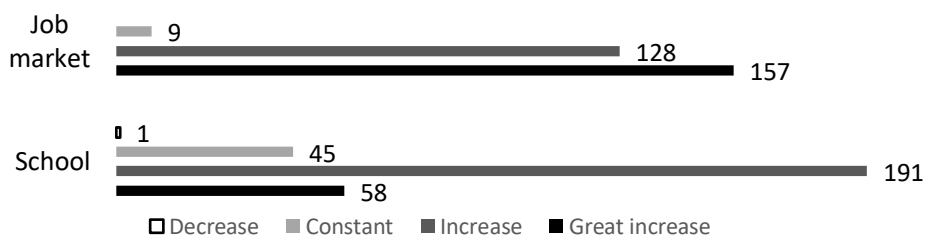
V-ray 1  
 Maxwell 2  
 Archicad 1  
 Podium 1  
 Lumen 1

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No 305

**How important is Virtual Reality in:**

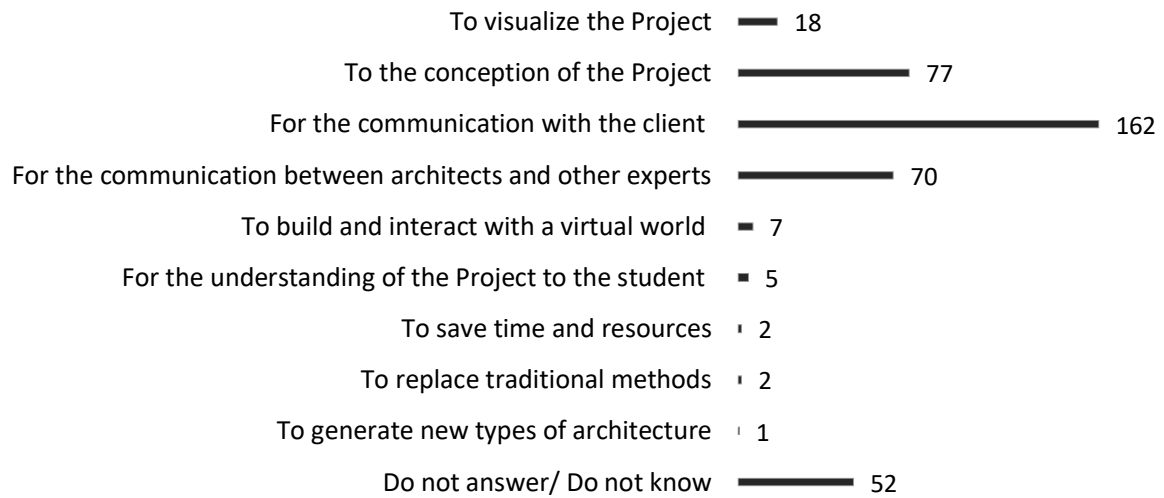


**How do see the future development of VR in Architecture into:**

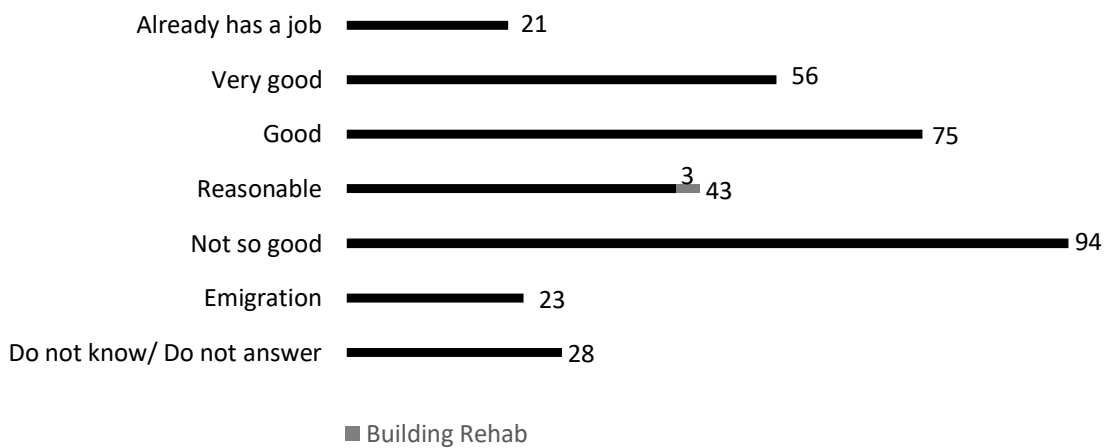


Do not know/ Do not answer: 11

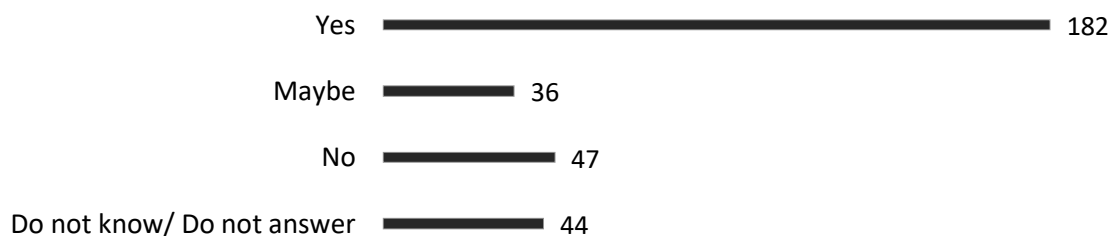
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



Country: Finland




Total students inquired: 137

Do you use 2D CAD software for architectural drawings? Yes  No







How did you start to use it?

School  Autodidact

When did you start to use it?

1st year  91  
2nd year  29  
3rd year  3  
4th year  
≥5th year

Which one(s)?





Autocad  120  
Archicad  18  
Rhino  3  
Revit  4  
Sketchup  3  
3Ds Max  
BricsCAD  
Draftsight  
Microstation  2

Do you use 3D CAD software for architectural modeling? Yes  No









How did you start to use it?

School  Autodidact

When did you start to use it?

1st year  74  
2nd year  41  
3rd year  5  
4th year  1  
≥5th year

Which one(s)?

Autocad  7  
Archicad  77  
Rhino  37  
Revit  47  
Sketchup  45  
3Ds Max  6  
Blender  1  
Cinema 4D  1  
Atlantis  
Solid works  
Grasshoper






Do you use 3D visualization software for architectural renderings? Yes  No

How did you start to use it?




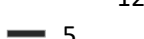










School  Autodidact

Do you use 3D visualization software for architectural renderings?

When did you start to use it?

1st year  26  
2nd year  41  
3rd year  23  
4th year  1  
≥5th year  1

Which one(s)?

Autocad  2  
Archicad  23  
Rhino  8  
Revit  12  
Sketchup  5  
3Ds Max  29  
Blender  1  
Cinema 4D  4  
Atlantis  28  
Podium  
V-ray  4  
Kerkythea  
Maxwell  18  
Brazil  7  
Keyshot  1  
Cinerender  2



**Do you use real-time 3D graphics rendering software?** Yes **5** 132 No

**How did you start to use it?**

Autodidact

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

≥5th year

**Which one(s)?**

V-ray

Maxwell **2**

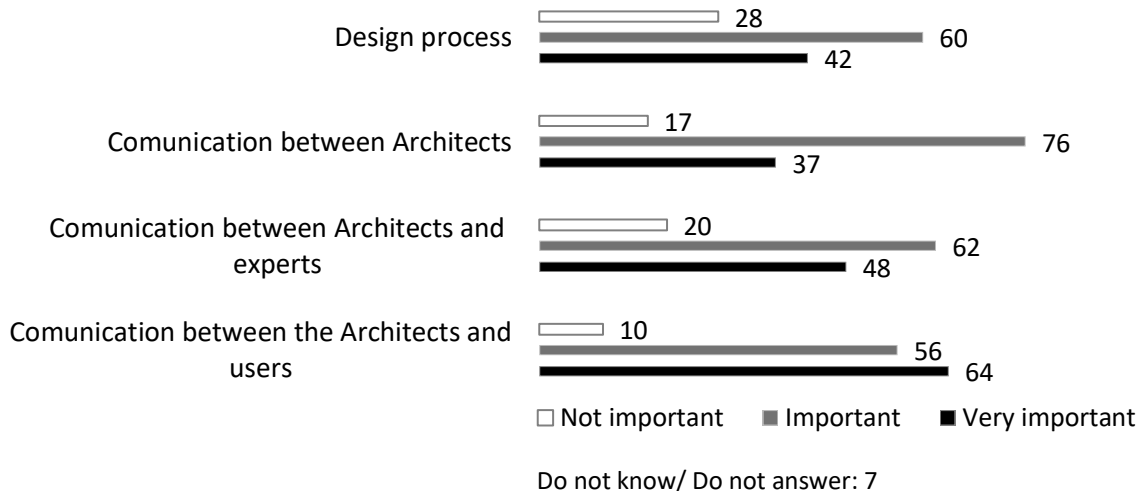
Archicad **1**

Podium **1**

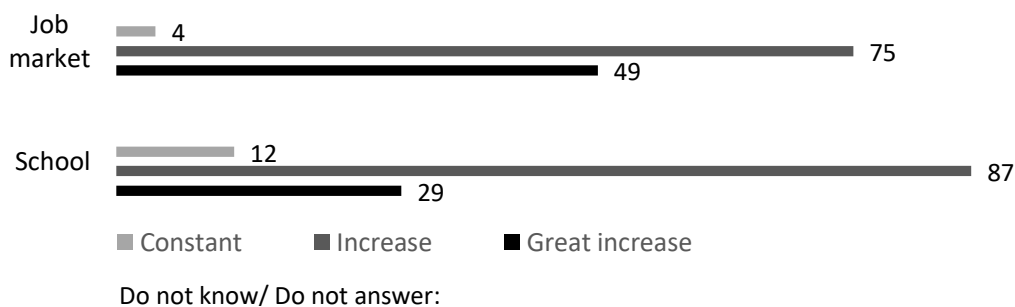
Lumen **1**

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **137**

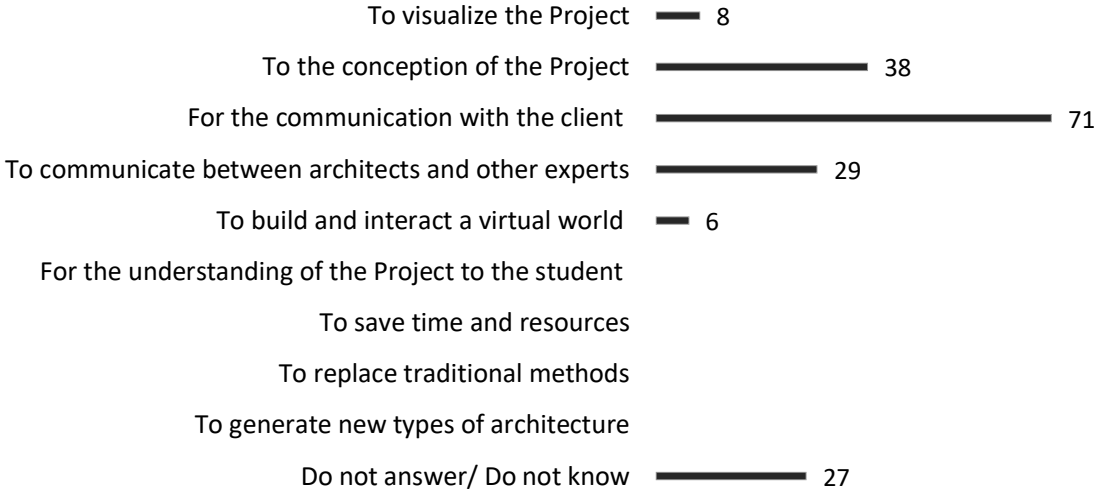
**How important is Virtual Reality in:**



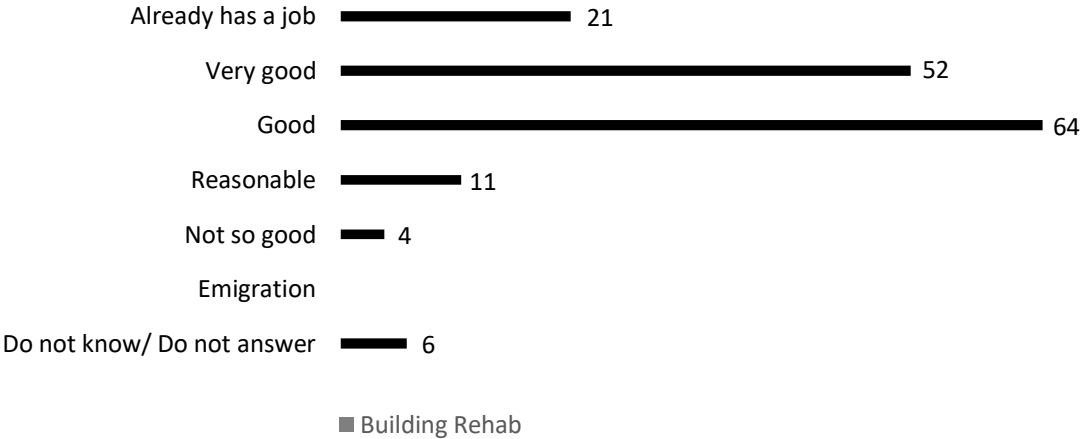
**How do see the future development of VR in Architecture into:**



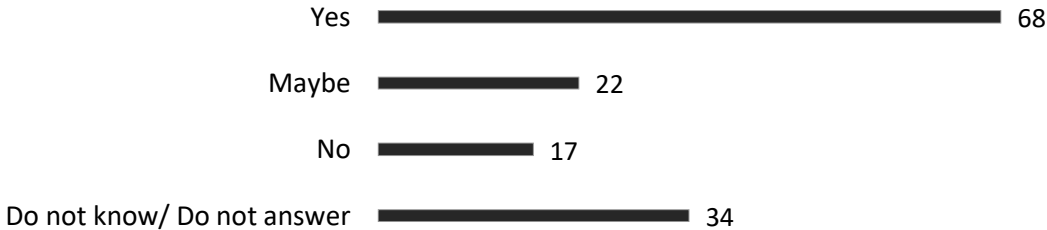
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



Country: Portugal

Total students inquired: 168

**Do you use 2D CAD software for architectural drawings?** Yes **111** 57 No

**How did you start to use it?**

School **57** 54 Autodidact

**When did you start to use it?**

1st year **20**  
 2nd year **63**  
 3rd year **27**  
 4th year  
 ≥5th year

**Which one(s)?**

Autocad **103**  
 Archicad **10**  
 Rhino **8**  
 Revit **2**  
 Sketchup  
 3Ds Max **1**  
 BricsCAD **1**  
 Draftsight **1**  
 Microstation

**Do you use 3D CAD software for architectural modeling?** Yes **76** 92 No

**How did you start to use it?**

School **35** 41 Autodidact

**When did you start to use it?**

1st year **15**  
 2nd year **26**  
 3rd year **21**  
 4th year **9**  
 ≥5th year **2**

**Which one(s)?**

Autocad **25**  
 Archicad **14**  
 Rhino **27**  
 Revit **5**  
 Sketchup **31**  
 3Ds Max **7**  
 Blender  
 Cinema 4D  
 Atlantis  
 Solid works **1**  
 Grasshoper **1**

**Do you use 3D visualization software for architectural renderings?** Yes **55** 113 No

**How did you start to use it?**

School **33** 25 Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year **7**  
 2nd year **15**  
 3rd year **24**  
 4th year **4**  
 ≥5th year **3**

**Which one(s)?**

Autocad **1**  
 Archicad **3**  
 Rhino **7**  
 Revit **1**  
 Sketchup **12**  
 3Ds Max **17**  
 Blender  
 Cinema 4D **5**  
 Atlantis **3**  
 Podium **1**  
 V-ray **15**  
 Kerkythea **1**  
 Maxwell **2**  
 Brazil  
 Keyshot  
 Cinerender

**Do you use real-time 3D graphics rendering software?** Yes **1** 167 No

**How did you start to use it?**

**Which one(s)?**

Autodidact

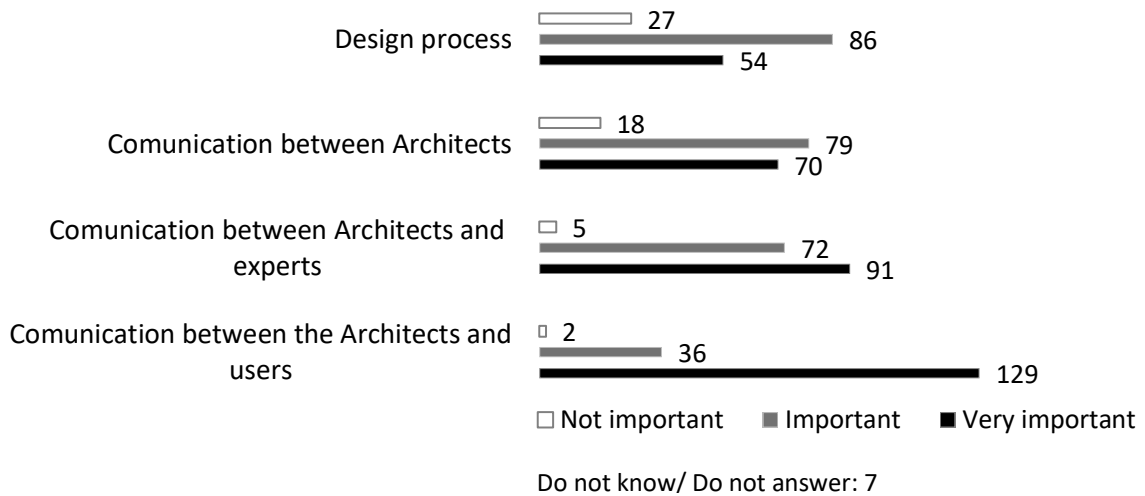
V-ray **1**  
 Maxwell  
 Archicad  
 Podium  
 Lumen

**When did you start to use it?**

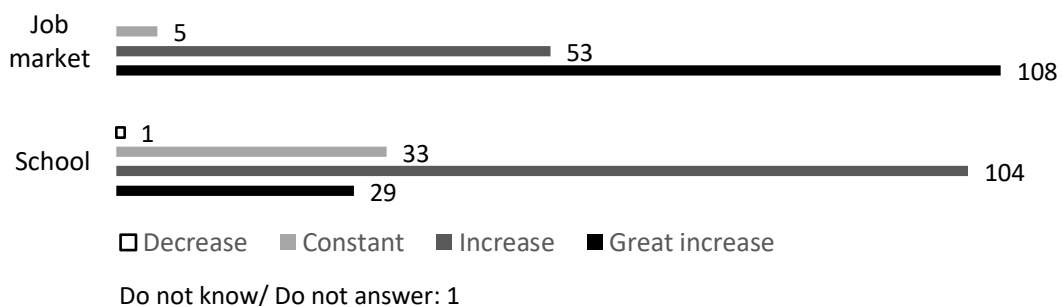
1st year  
 2nd year **1**  
 3rd year  
 4th year  
 ≥5th year

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **168**

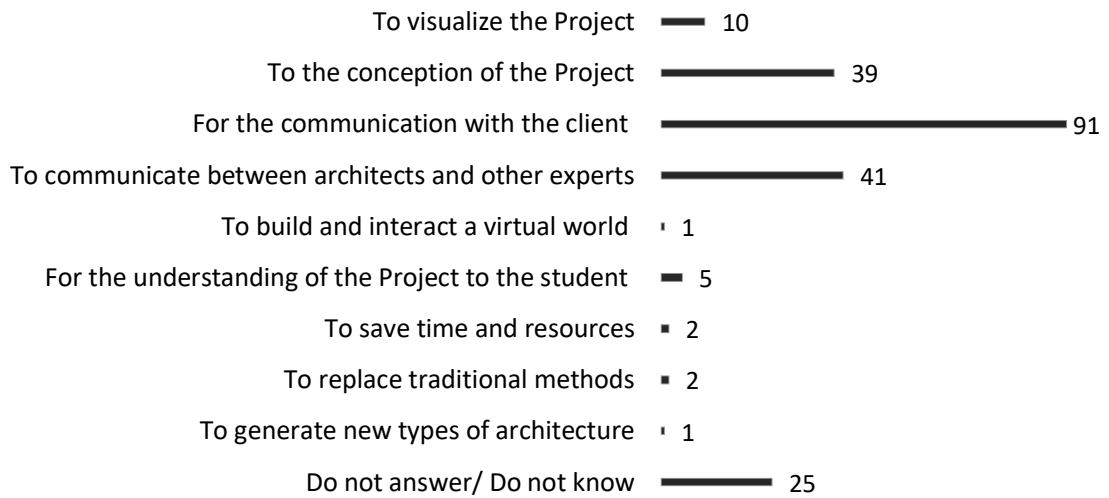
**How important is Virtual Reality in:**



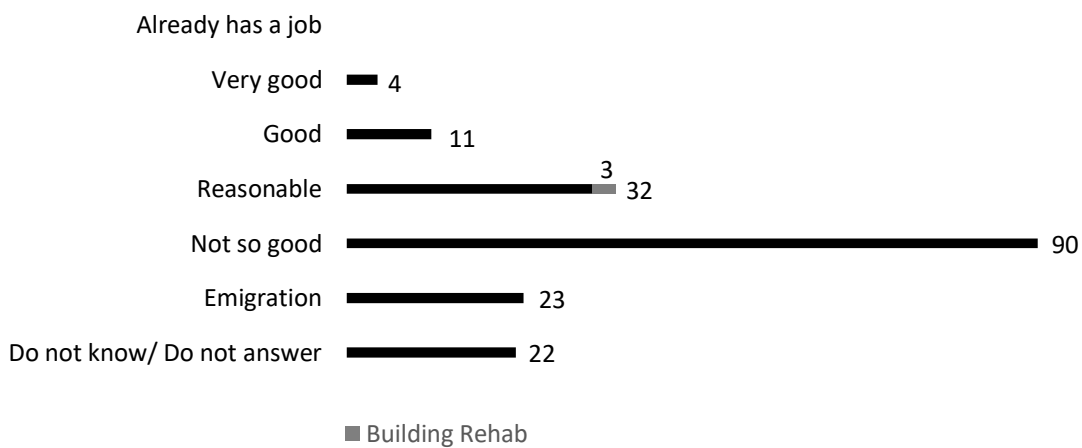
**How do see the future development of VR in Architecture into:**



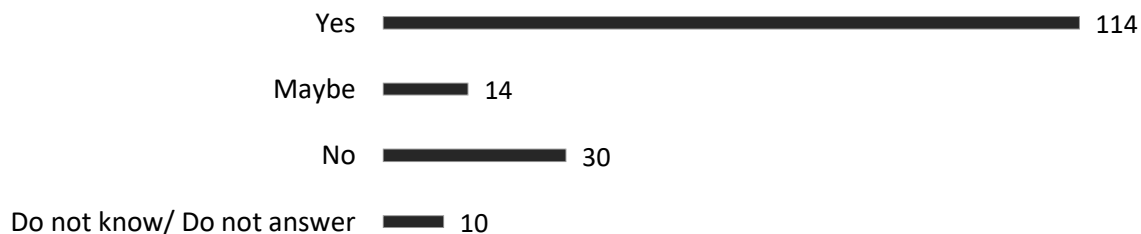
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**




**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**










**School:** Oulu School of Architecture

**Total students inquired:** 41


**Do you use 2D CAD software for architectural drawings?** Yes  41




**How did you start to use it?**  
School  40 1 Autodidact




**When did you start to use it?**  
1st year  19  
2nd year  14  
3rd year  1  
4th year  
≥5th year

**Which one(s)?**  
Autocad  41  
Archicad  4  
Rhino  
Revit  1  
Sketchup  2  
3Ds Max  
BricsCAD  
Draftsight  
Microstation


**Do you use 3D CAD software for architectural modeling?** Yes  33 8 No

**How did you start to use it?**  
School  32 1 Autodidact




**When did you start to use it?**  
1st year  17  
2nd year  19  
3rd year  1  
4th year  
≥5th year







**Which one(s)?**  
Autocad  
Archicad  27  
Rhino  
Revit  19  
Sketchup  14  
3Ds Max  
Blender  
Cinema 4D  
Atlantis  
Solid works  
Grasshoper

**Do you use 3D visualization software for architectural renderings?** Yes  27 14 No

**How did you start to use it?**  
School  25 2 Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**  
1st year  2  
2nd year  22  
3rd year  3  
4th year  
≥5th year

**Which one(s)?**  
Autocad  
Archicad  9  
Rhino  
Revit  4  
Sketchup  
3Ds Max  8  
Blender  1  
Cinema 4D  
Atlantis  20  
Podium  
V-ray  1  
Kerkythea  
Maxwell  
Brazil  
Keyshot  
Cinerender

**Do you use real-time 3D graphics rendering software?** No 41

**How did you start to use it?**

**Which one(s)?**

**When did you start to use it?**

1st year

2nd year

3rd year

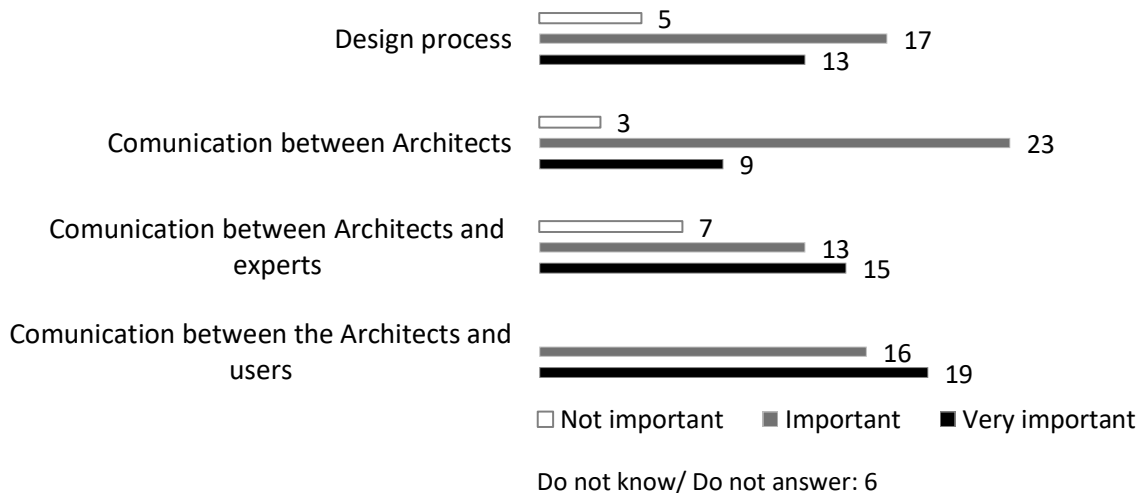
4th year

≥5th year

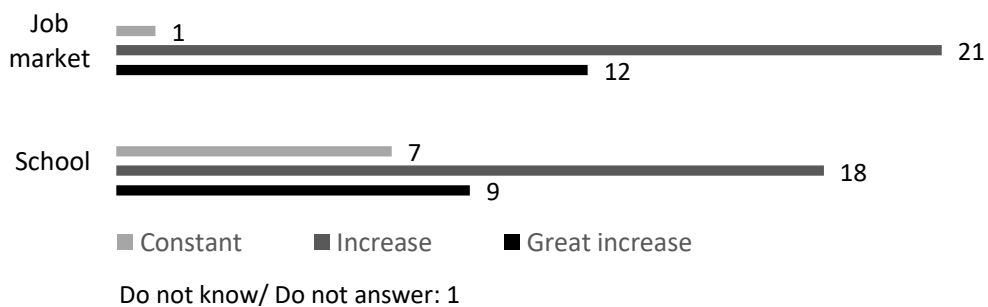
- V-ray
- Maxwell
- Archicad
- Podium
- Lumen

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No 41

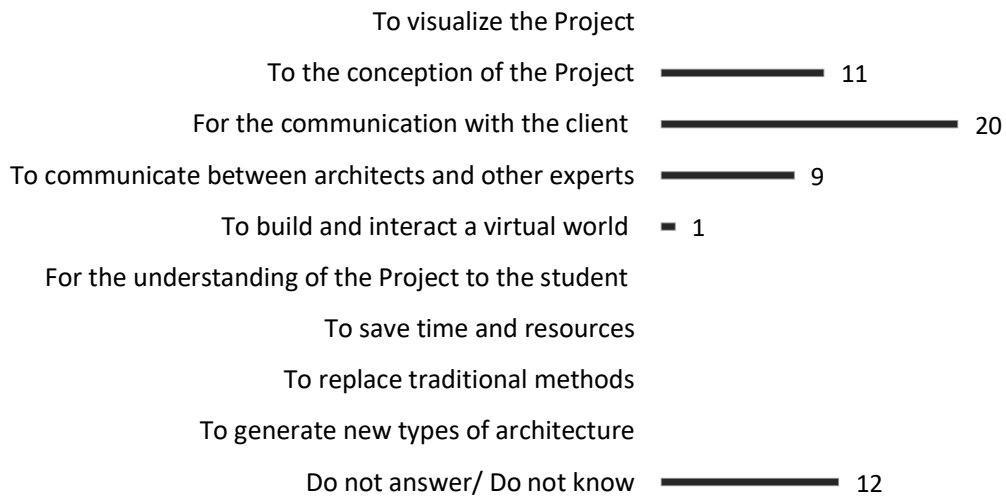
**How important is Virtual Reality in:**



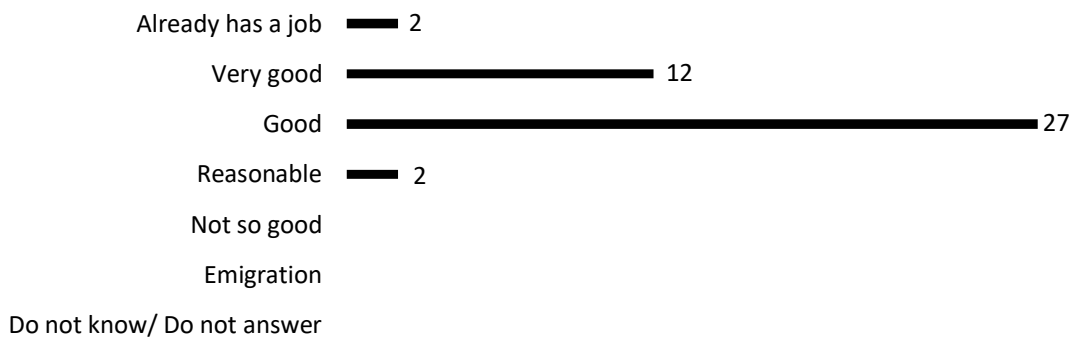
**How do see the future development of VR in Architecture into:**



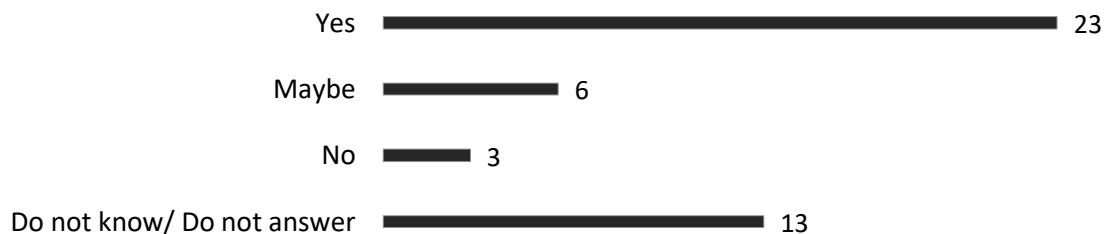
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**





**School:** School Of Architecture- Tampere University Of Technology

**Total students inquired:** 36

**Do you use 2D CAD software for architectural drawings?** Yes  No





**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  19  
 2nd year  5  
 3rd year  1  
 4th year  1  
 ≥5th year

**Which one(s)?**




Autocad  23  
 Archicad  9  
 Rhino  1  
 Revit  2  
 Sketchup  
 3Ds Max  
 BricsCAD  
 Draftsight  
 Microstation

**Do you use 3D CAD software for architectural modeling?** Yes  No







**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  14  
 2nd year  14  
 3rd year  2  
 4th year  
 ≥5th year

**Which one(s)?**

Autocad  4  
 Archicad  24  
 Rhino  6  
 Revit  17  
 Sketchup  12  
 3Ds Max  4  
 Blender  
 Cinema 4D  
 Atlantis  
 Solid works  
 Grasshoper




**Do you use 3D visualization software for architectural renderings?** Yes  No

**How did you start to use it?**









School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year  5  
 2nd year  9  
 3rd year  8  
 4th year  
 ≥5th year

**Which one(s)?**

Autocad  1  
 Archicad  4  
 Rhino  
 Revit  4  
 Sketchup  3  
 3Ds Max  14  
 Blender  
 Cinema 4D  4  
 Atlantis  6  
 Podium  
 V-ray  1  
 Kerkythea  
 Maxwell  
 Brazil  
 Keyshot  
 Cinerender

**Do you use real-time 3D graphics rendering software?** Yes **2** 34 No

**How did you start to use it?**

Autodidact

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

≥5th year

**Which one(s)?**

V-ray

Maxwell

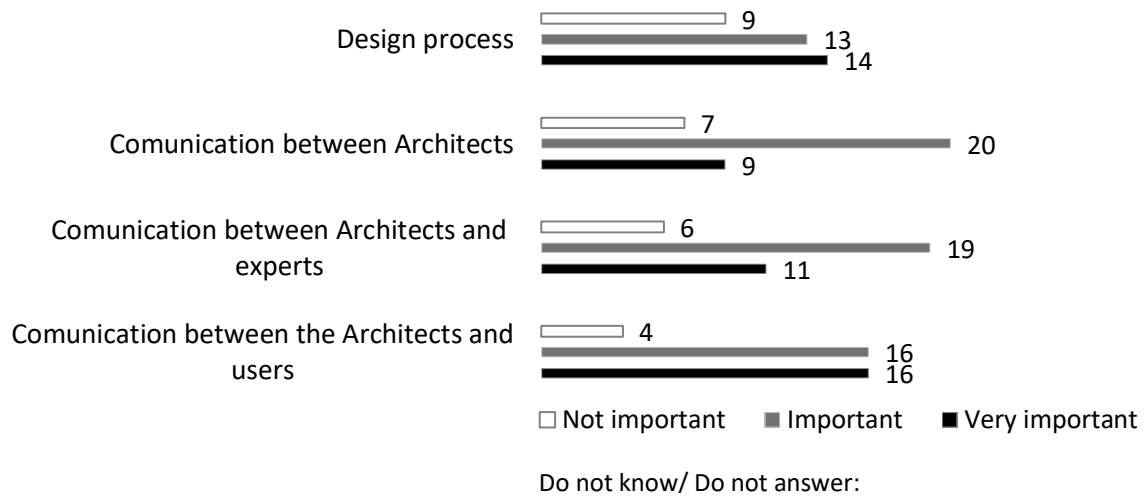
Archicad

Podium **1**

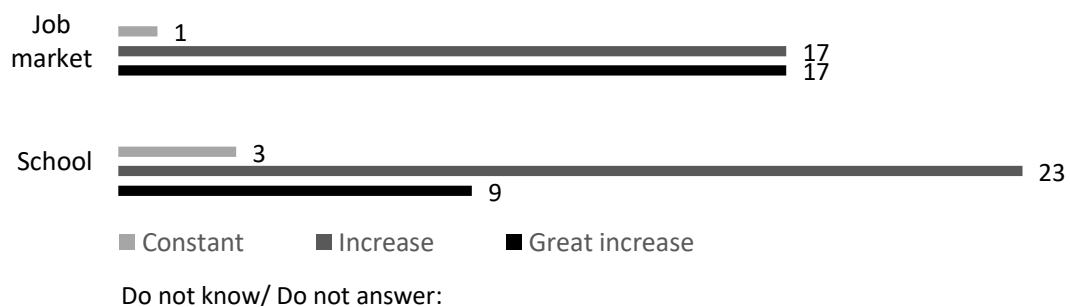
Lumen **1**

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **36**

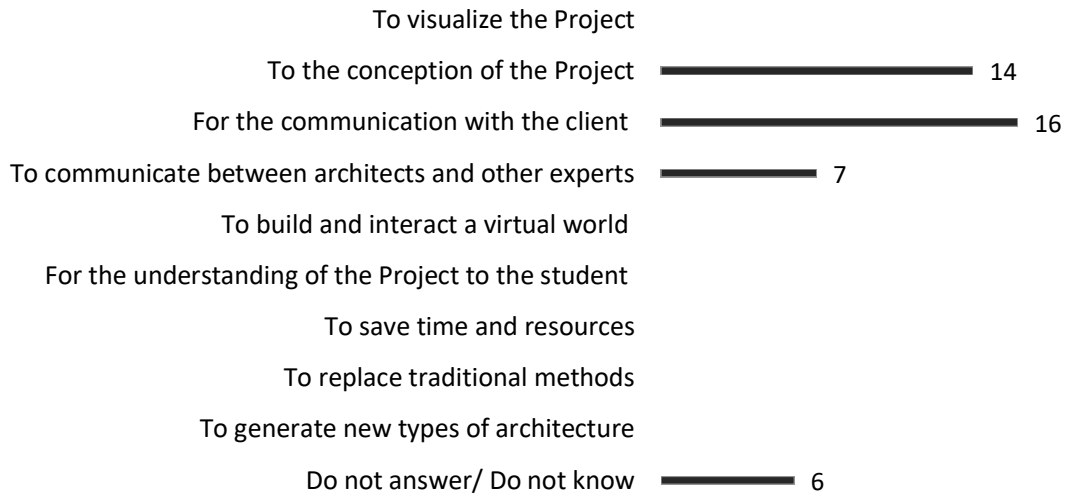
**How important is Virtual Reality in:**



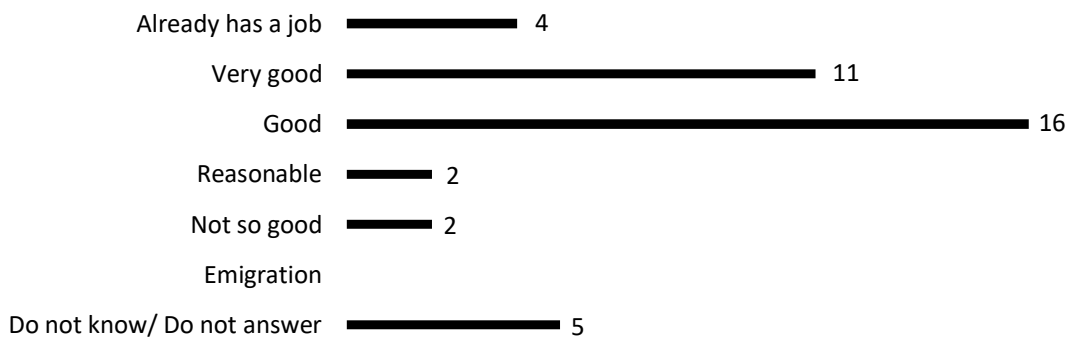
**How do see the future development of VR in Architecture into:**



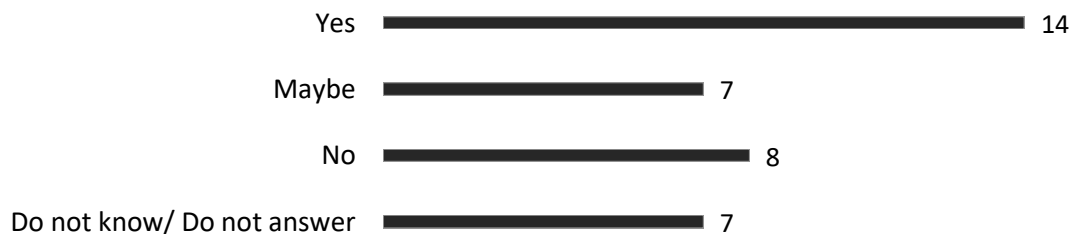
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



**School:** School of Arts, Design and Architecture- Aalto University

**Total students inquired:** 60

**Do you use 2D CAD software for architectural drawings?** Yes  No


**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  46

2nd year  10


3rd year  1


4th year

≥5th year

**Which one(s)?**

Autocad  56

Archicad  5

Rhino  2


Revit  1

Sketchup

3Ds Max

BricsCAD

Draftsight

Microstation  2


**Do you use 3D CAD software for architectural modeling?** Yes  No


**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  43


2nd year  8

3rd year  2

4th year  1

≥5th year

**Which one(s)?**

Autocad  3

Archicad  26

Rhino  31

Revit  11

Sketchup  19

3Ds Max  2

Blender

Cinema 4D

Atlantis

Solid works

Grasshoper

**Do you use 3D visualization software for architectural renderings?** Yes  No

**How did you start to use it?**

School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year  19


2nd year  10

3rd year  12

4th year  1

≥5th year  1


**Which one(s)?**

Autocad  1

Archicad  10

Rhino  8

Revit  4

Sketchup  2

3Ds Max  7

Blender

Cinema 4D

Atlantis  2

Podium

V-ray  2

Kerkythea

Maxwell  18

Brazil  7

Keyshot  1

Cinerender  2

**Do you use real-time 3D graphics rendering software?** Yes **3** No **57**

**How did you start to use it?**

Autodidact

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

≥5th year

**Which one(s)?**

V-ray

Maxwell **2**

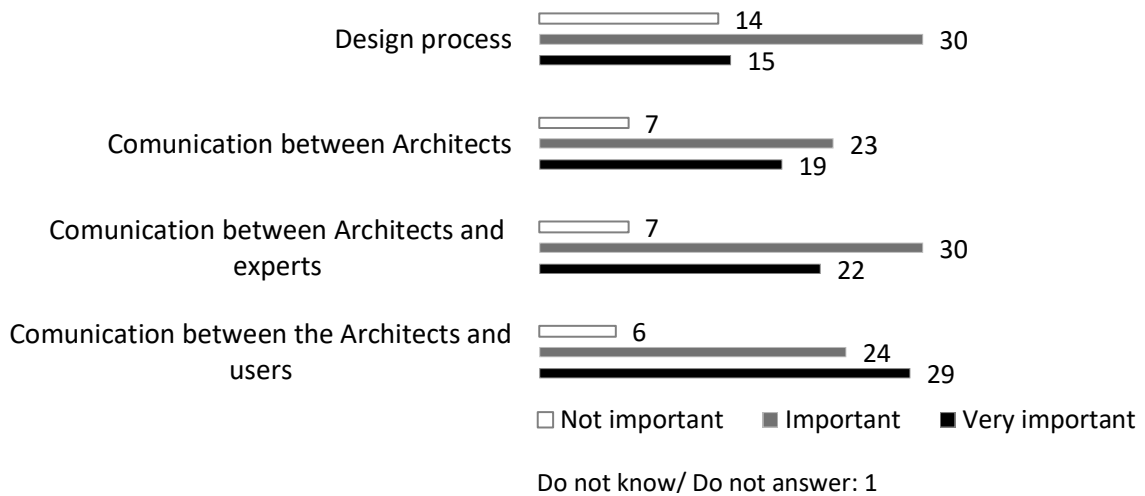
Archicad **1**

Podium

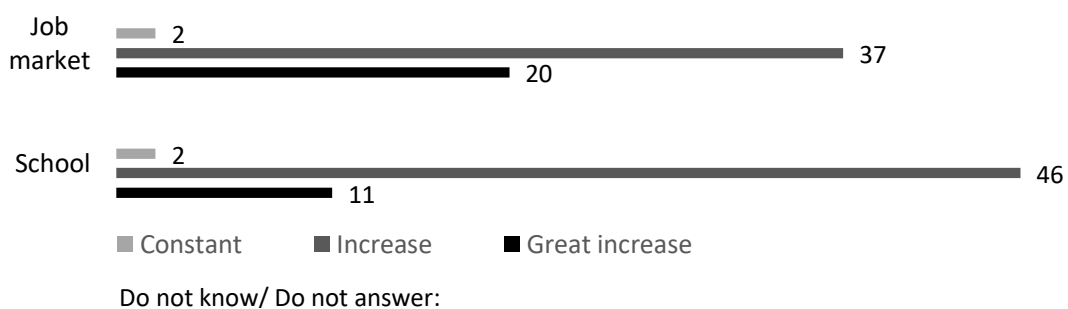
Lumen

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **60**

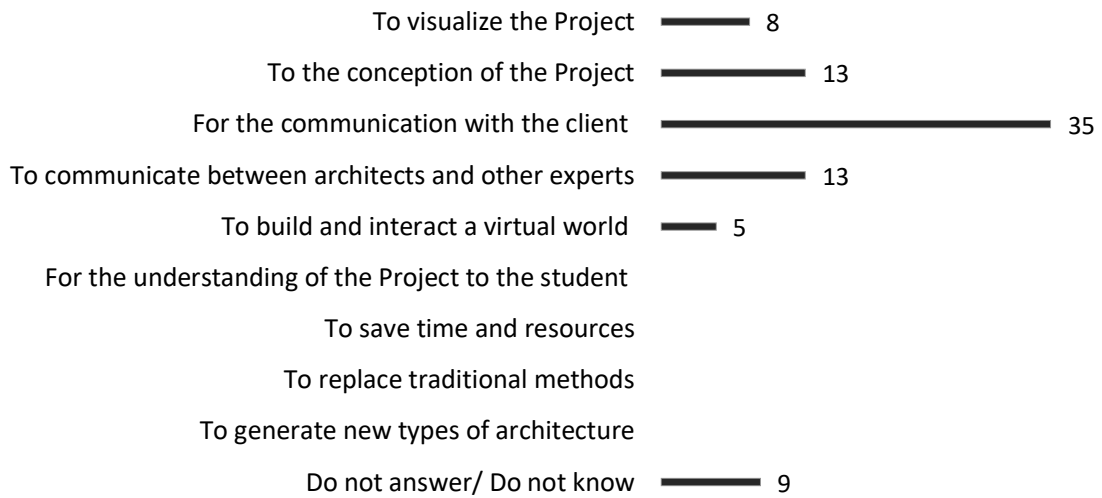
**How important is Virtual Reality in:**



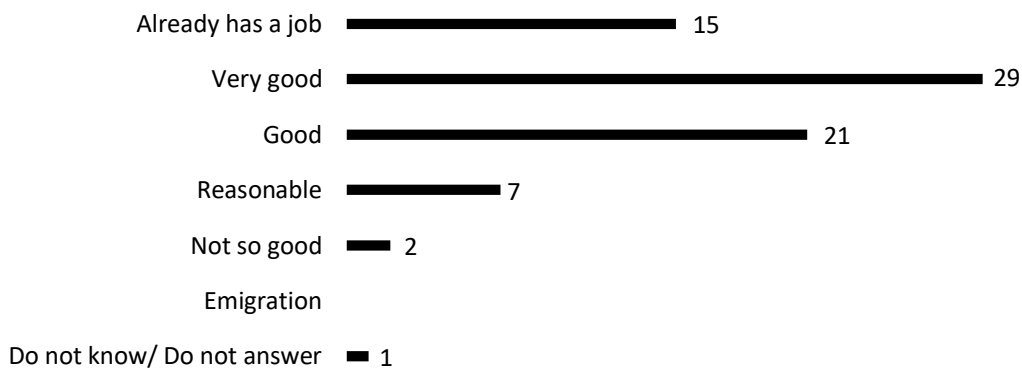
**How do see the future development of VR in Architecture into:**



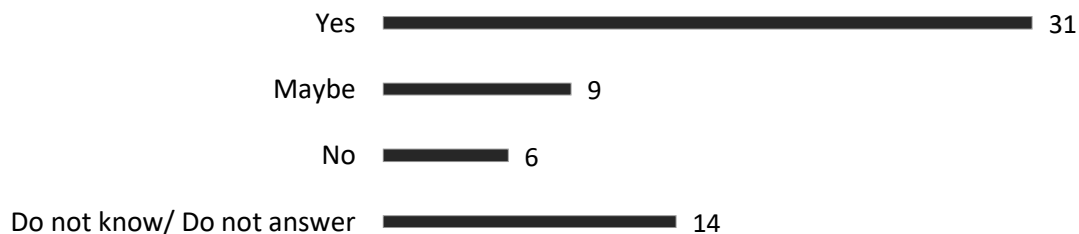
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**




**School:** Architecture Faculty of University of Oporto




**Total students inquired:**56

**Do you use 2D CAD software for architectural drawings?** Yes  No




**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

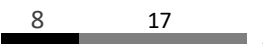
1st year  3  
 2nd year  5  
 3rd year  22  
 4th year  
 ≥5th year

**Which one(s)?**






Autocad  27  
 Archicad  9  
 Rhino  
 Revit  2  
 Sketchup  
 3Ds Max  
 BricsCAD  
 Draftsight  
 Microstation

**Do you use 3D CAD software for architectural modeling?** Yes  No







**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

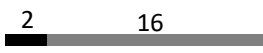
1st year  4  
 2nd year  1  
 3rd year  17  
 4th year  1  
 ≥5th year  1

**Which one(s)?**

Autocad  8  
 Archicad  8  
 Rhino  2  
 Revit  4  
 Sketchup  9  
 3Ds Max  
 BricsCAD  
 Draftsight  
 Blender  
 Cinema 4D  
 Atlantis  
 Solid works  1  
 Grasshoper




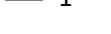
**Do you use 3D visualization software for architectural renderings?** Yes  No

**How did you start to use it?**







School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year  3  
 2nd year  2  
 3rd year  8  
 4th year  1  
 ≥5th year  2

**Which one(s)?**

Autocad  1  
 Archicad  
 Rhino  
 Revit  1  
 Sketchup  6  
 3Ds Max  4  
 BricsCAD  
 Draftsight  
 Blender  
 Cinema 4D  
 Atlantis  3  
 Solid works  
 Podium  
 V-ray  7  
 Kerkythea

**Do you use real-time 3D graphics rendering software?** No **56**

**How did you start to use it?** **Which one(s)?**

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

≥5th year

Autocad

Archicad

Rhino

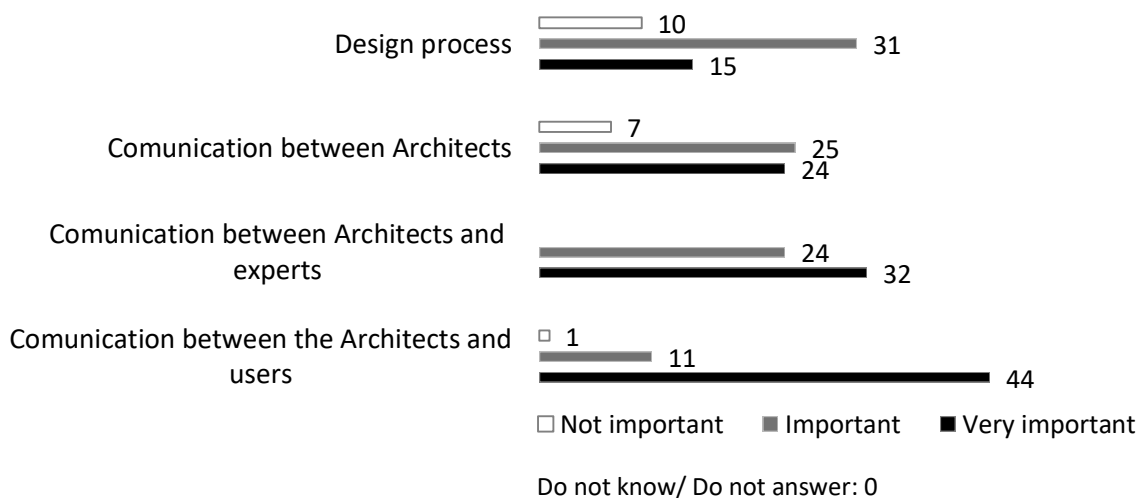
Revit

Sketchup

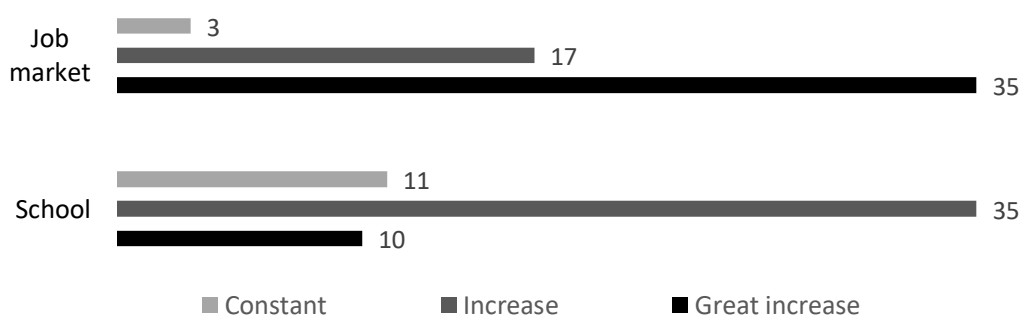
3Ds Max

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **56**

**How important is Virtual Reality in:**

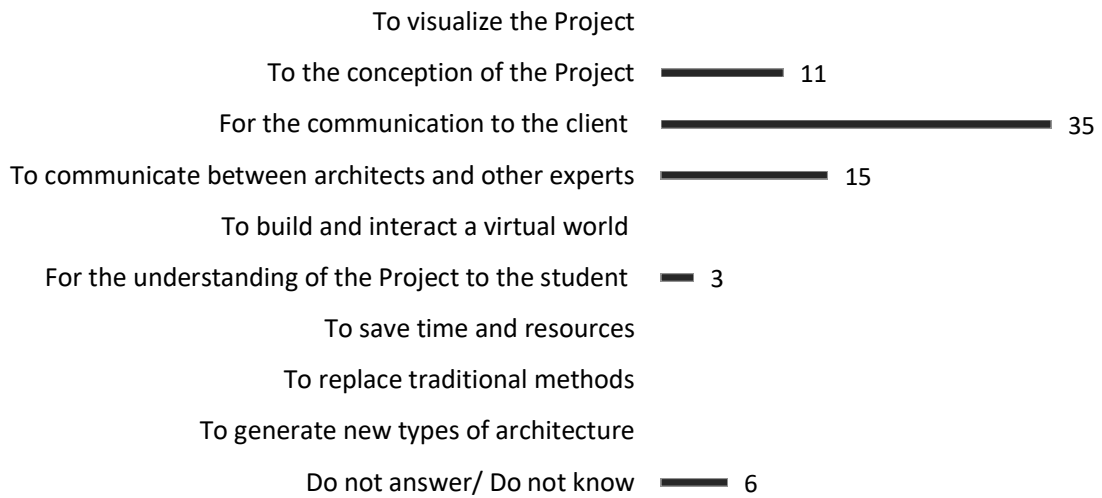


**How do you see the future development of VR in Architecture into:**

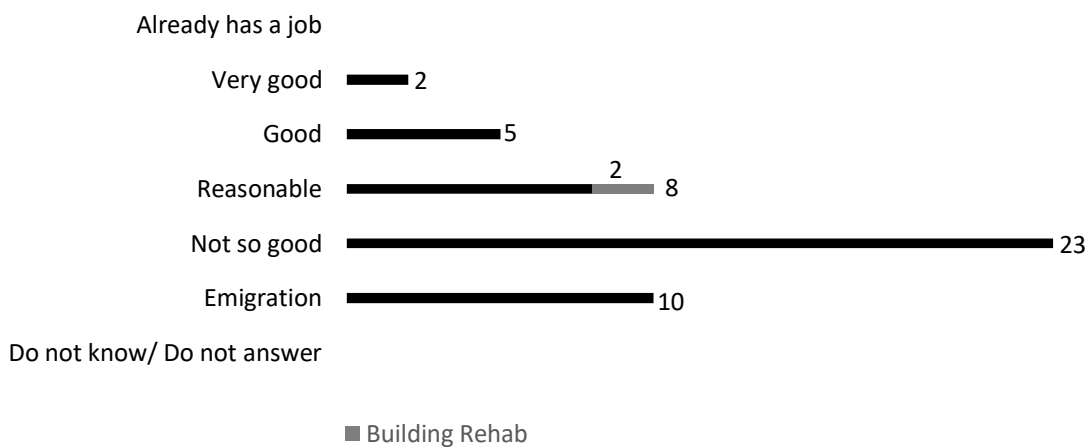




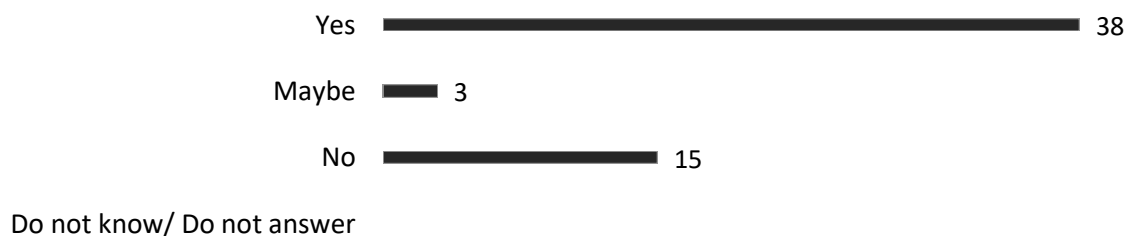
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



**School:** Architecture Faculty of University of Lisbon

**Total students inquired:** 61

**Do you use 2D CAD software for architectural drawings?** Yes  No


**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  14

2nd year  33


3rd year  1


4th year

≥5th year

**Which one(s)?**


Autocad  47

Archicad  1

Rhino  4

Revit

Sketchup  3

3Ds Max  1


BricsCAD

Draftsight

Microstation

**Do you use 3D CAD software for architectural modeling?** Yes  No

**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  11

2nd year  9


3rd year  2

4th year  4

≥5th year

**Which one(s)?**

Autocad  10

Archicad  3

Rhino  5

Revit  1

Sketchup  19


3Ds Max  4

Blender

Cinema 4D  2

Atlantis

Solid works

Grasshoper  1

**Do you use 3D visualization software for architectural renderings?** Yes  No

**How did you start to use it?**

School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year  4

2nd year  5


3rd year  10


4th year  1

≥5th year  1

**Which one(s)?**

Autocad

Archicad  2


Rhino  1

Revit


Sketchup  6

3Ds Max  7


Blender

Cinema 4D  2

Atlantis

Podium  1

V-ray  5

Kerkythea  1

Maxwell  2

Brazil

Keyshot

Cinerender

**Do you use real-time 3D graphics rendering software?** No **61**

**How did you start to use it?**

**Which one(s)?**

**When did you start to use it?**

1st year

2nd year

3rd year

4th year

≥5th year

V-ray

Maxwell

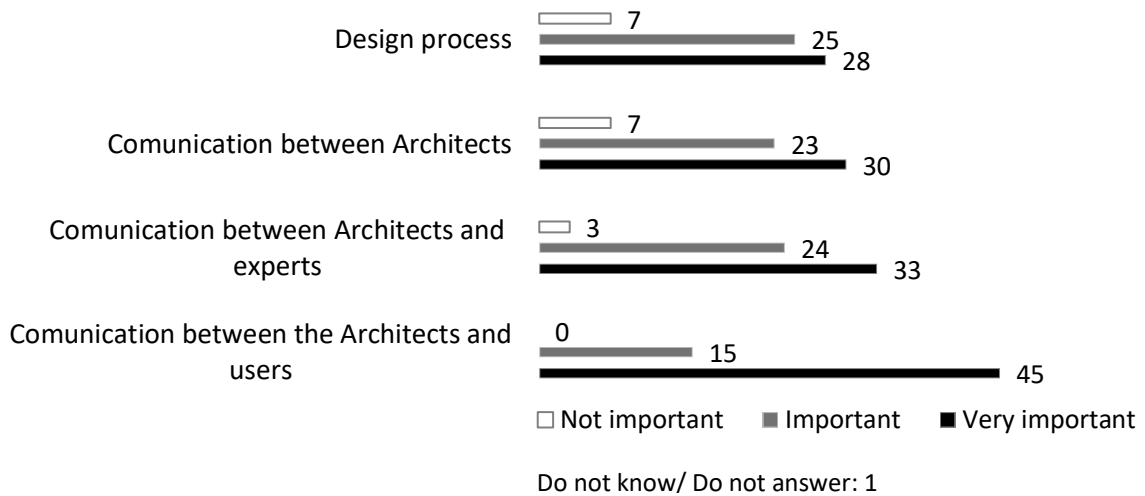
Archicad

Podium

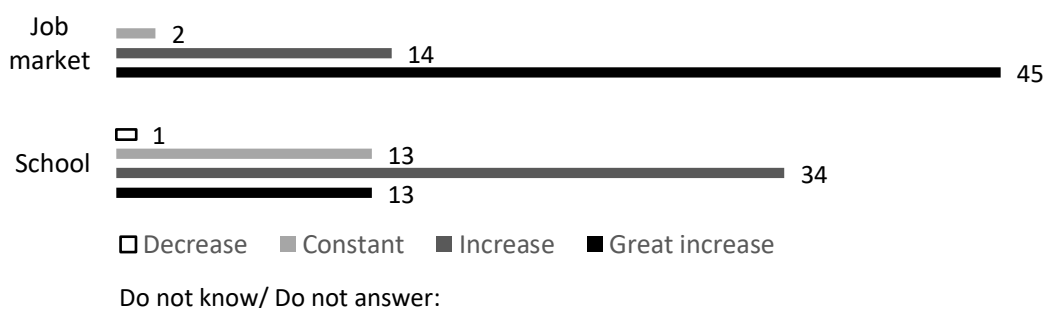
Lumen

**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?** No **61**

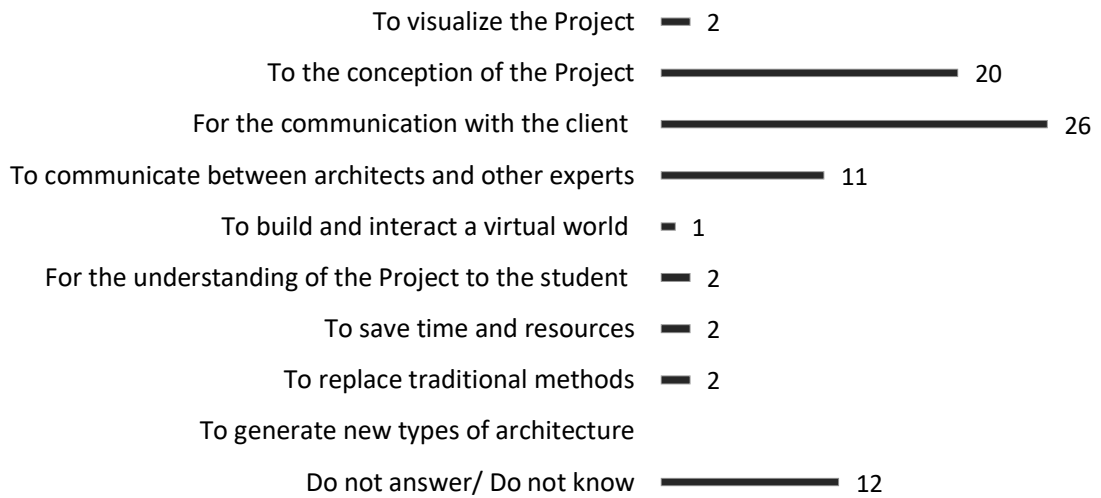
**How important is Virtual Reality in:**



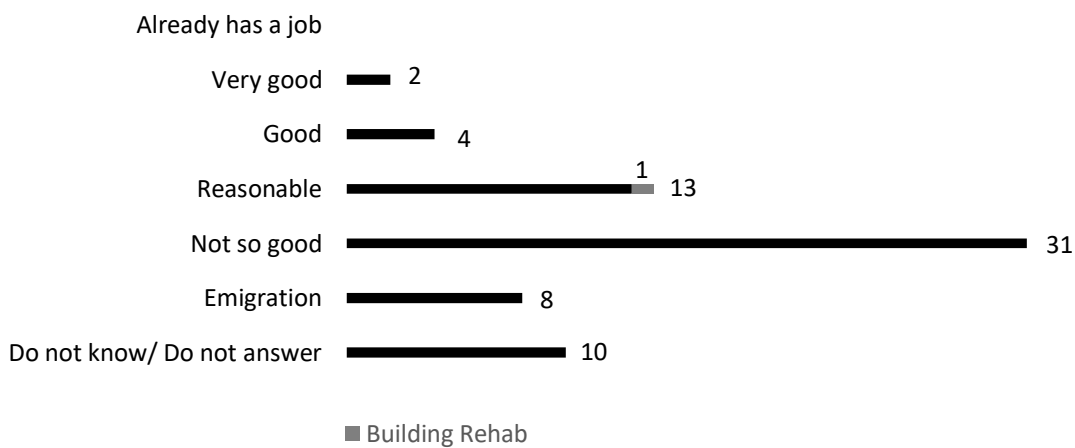
**How do see the future development of VR in Architecture into:**



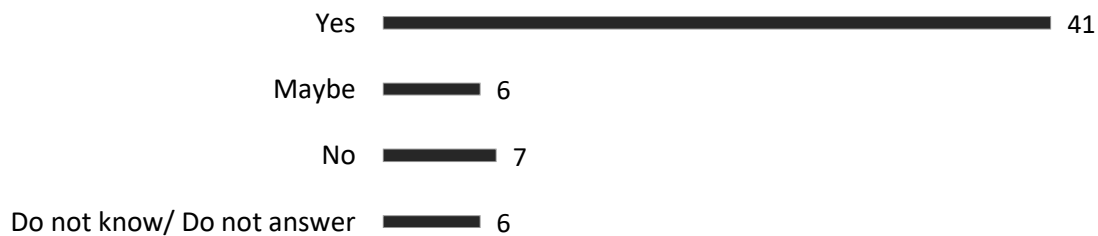
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



**School:** Architecture Department of University of Coimbra




**Total students inquired:** 51

**Do you use 2D CAD software for architectural drawings?** Yes  No





**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  3  
 2nd year  25  
 3rd year  4  
 4th year  
 ≥5th year

**Which one(s)?**





Autocad  29  
 Archicad  
 Rhino  4  
 Revit  
 Sketchup  
 3Ds Max  
 BricsCAD  1  
 Draftsight  1  
 Microstation

**Do you use 3D CAD software for architectural modeling?** Yes  No







**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year  
 2nd year  16  
 3rd year  2  
 4th year  4  
 ≥5th year  1

**Which one(s)?**

Autocad  7  
 Archicad  3  
 Rhino  20  
 Revit  
 Sketchup  3  
 3Ds Max  3  
 Blender  
 Cinema 4D  
 Atlantis  
 Solid works  
 Grasshoper  1




**Do you use 3D visualization software for architectural renderings?** Yes  No

**How did you start to use it?**







School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year  
 2nd year  8  
 3rd year  6  
 4th year  2  
 ≥5th year

**Which one(s)?**

Autocad  
 Archicad  1  
 Rhino  6  
 Revit  
 Sketchup  
 3Ds Max  6  
 Blender  
 Cinema 4D  3  
 Atlantis  1  
 Podium  
 V-ray  3  
 Kerkythea  
 Maxwell  
 Brazil  
 Keyshot  
 Cinerender

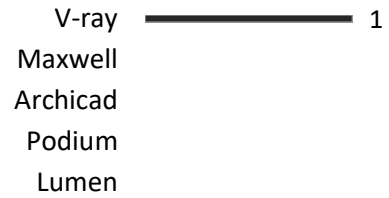
**Do you use real-time 3D graphics rendering software?**



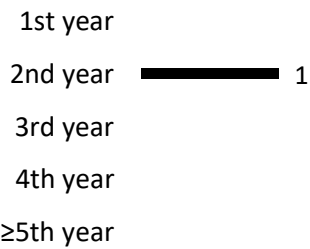
**How did you start to use it?**

Autodidact

**Which one(s)?**



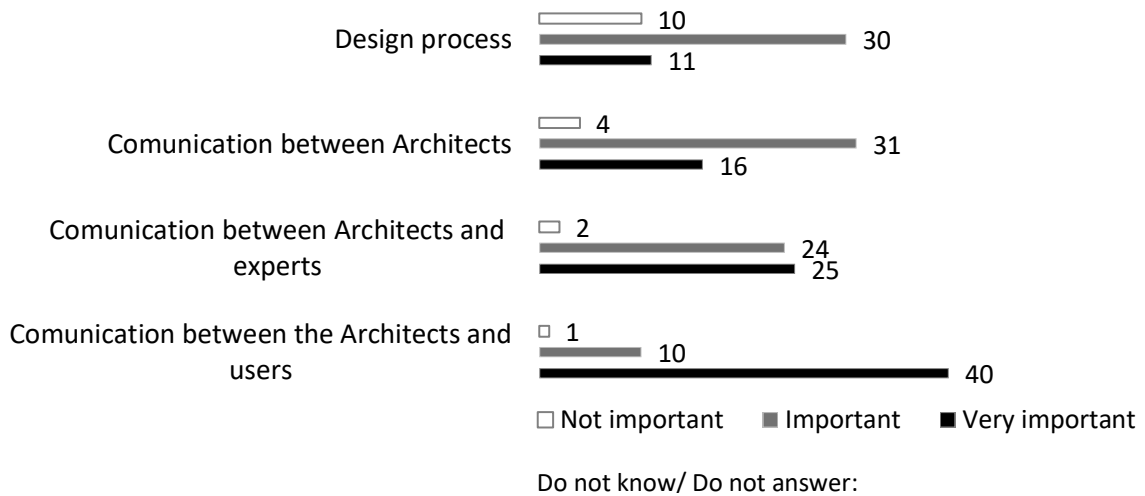
**When did you start to use it?**



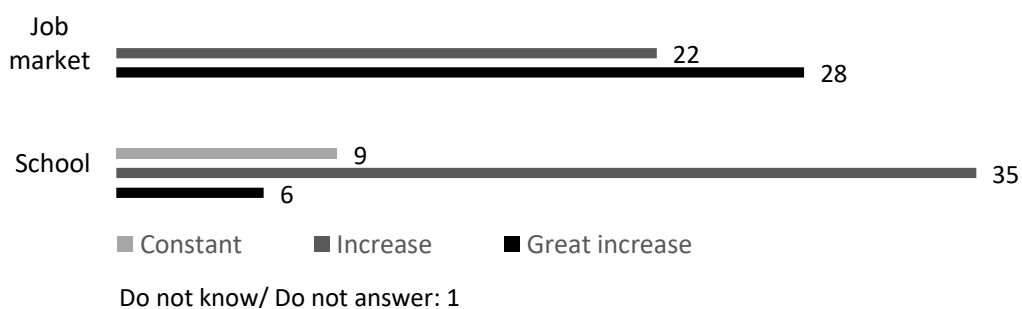
**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?**



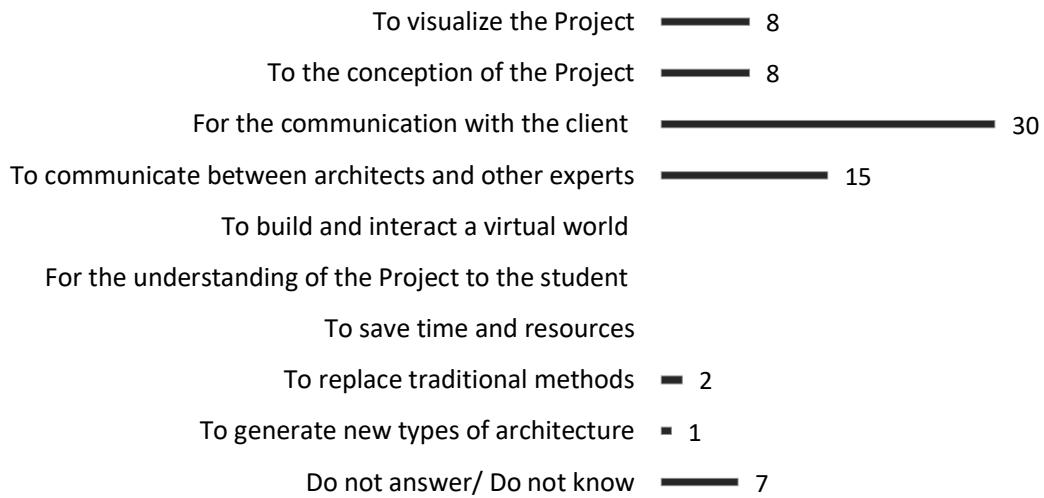
**How important is Virtual Reality in:**



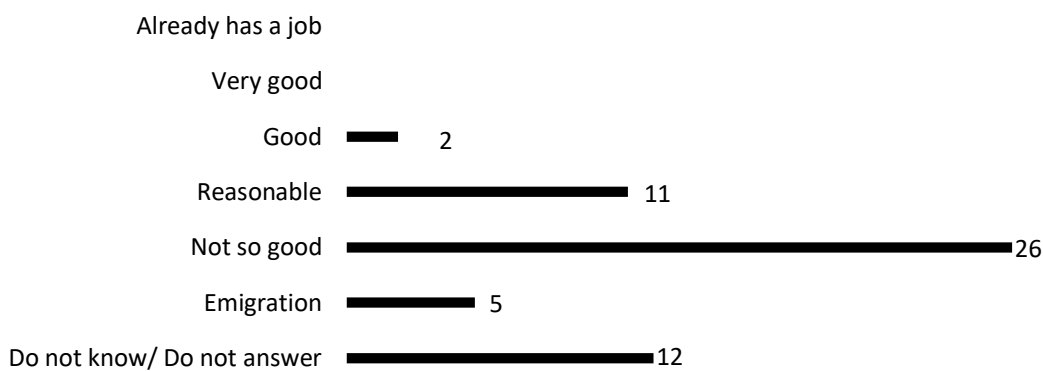
**How do see the future development of VR in Architecture into:**



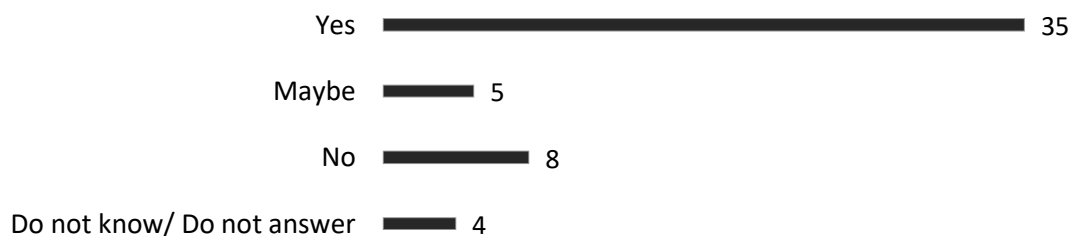
**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**






**Total Erasmus students inquired: 11**

**Do you use 2D CAD software for architectural drawings?** Yes  No



**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year   
 2nd year   
 3rd year   
 4th year  
 ≥5th year

**Which one(s)?**





Autocad   
 Archicad  
 Rhino   
 Revit  
 Sketchup  
 3Ds Max  
 BricsCAD  
 Draftsight  
 Microstation

**Do you use 3D CAD software for architectural modeling?** Yes 







**How did you start to use it?**

School  Autodidact

**When did you start to use it?**

1st year   
 2nd year   
 3rd year   
 4th year   
 ≥5th year

**Which one(s)?**

Autocad   
 Archicad   
 Rhino   
 Revit   
 Sketchup   
 3Ds Max   
 Blender  
 Cinema 4D  
 Atlantis  
 Solid works  
 Grasshoper






**Do you use 3D visualization software for architectural renderings?** Yes 

**How did you start to use it?**







School  Autodidact

**Do you use 3D visualization software for architectural renderings?**

**When did you start to use it?**

1st year   
 2nd year   
 3rd year   
 4th year   
 ≥5th year 

**Which one(s)?**

Autocad  
 Archicad  
 Rhino   
 Revit   
 Sketchup  
 3Ds Max   
 Blender  
 Cinema 4D  
 Atlantis  
 Podium   
 V-ray   
 Kerkythea  
 Maxwell  
 Brazil  
 Keyshot  
 Cinerender  
 Lumion 



**Do you use real-time 3D graphics rendering software?** Yes  No

**How did you start to use it?**

Autodidact

**When did you start to use it?**

1st year

2nd year

3rd year  1

4th year

≥5th year

**Which one(s)?**

V-ray

Maxwell


Archicad

Podium

Lumen

Atlantis  1


**Do you use 3D graphics rendering devices/equipment for architectural real-time rendering?**


No  11

**How important is Virtual Reality in:**

Design process 

Communication between Architects 

Communication between Architects and experts 

Communication between the Architects and users 

Not important  Important  Very important

Do not know/ Do not answer: 7

**How do see the future development of VR in Architecture into:**

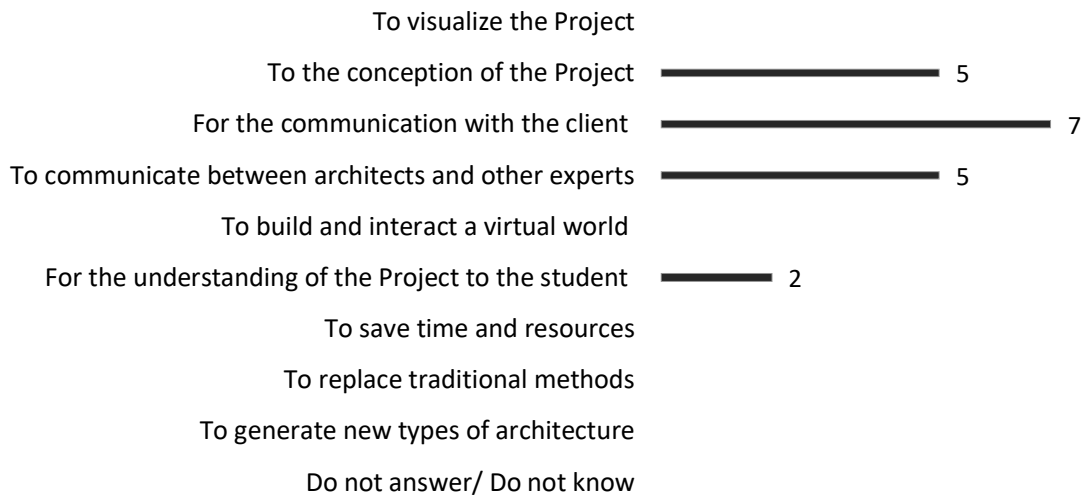
Job market 

School 

Constant  Increase  Great increase

Do not know/ Do not answer: 0

**If you believe that Virtual Reality is important to Architecture, please, refer what will be the most important role.**



**How are your expectations to find a job after graduation?**



**Do you think Virtual Reality could contribute to improve the job situation in the scope of architecture?**



**Schools' photographic report**





Figure 5 - Photo of the Oulu School of Architecture – University of Oulu by Ana Moreira Bento

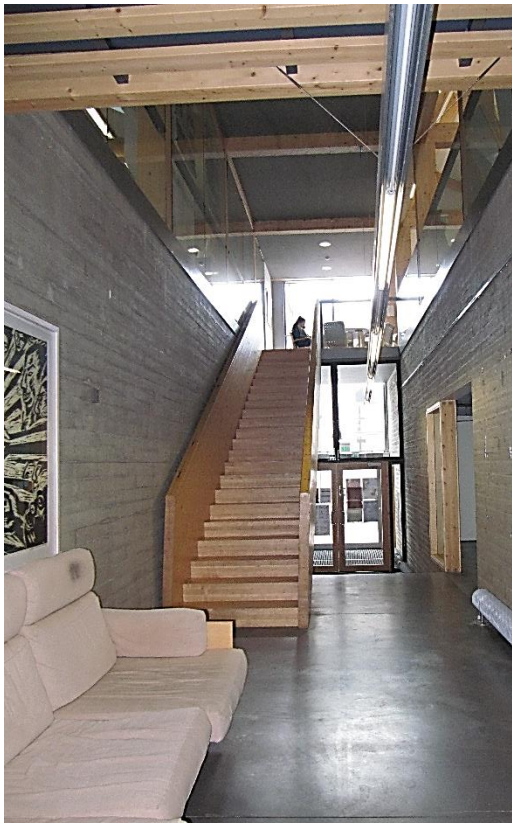


Figure 6



Figure 7



Figure 9

Figures 6 to 9 - Photos of the Oulu School of Architecture – University of Oulu by Ana Moreira Bento





Figure 10



Figure 11

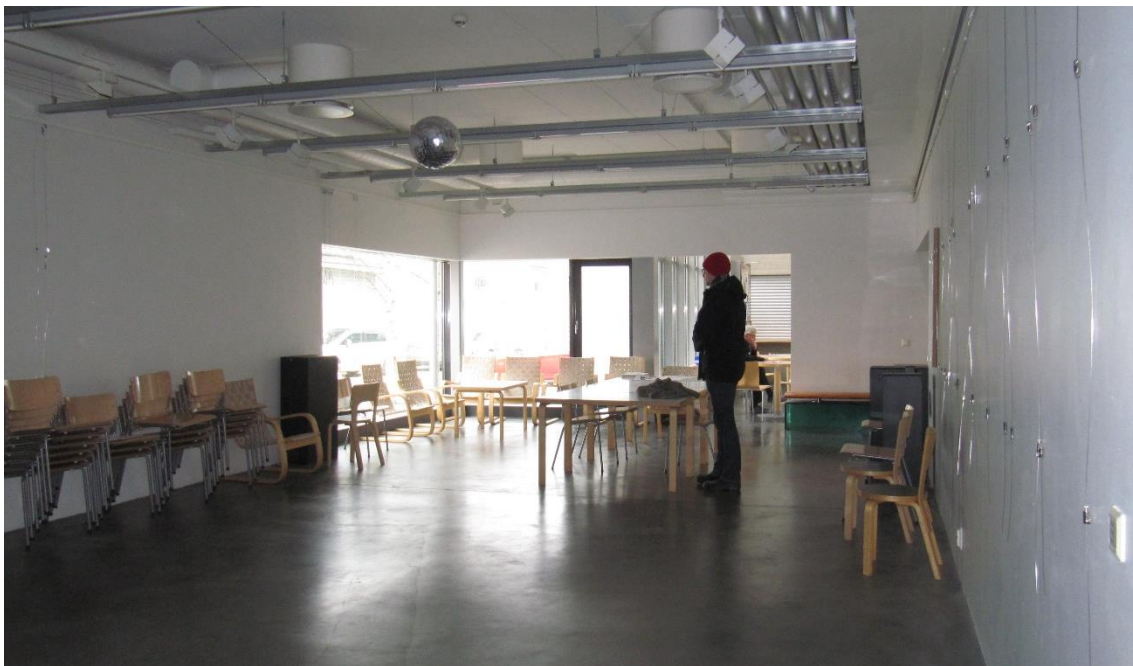


Figure 12

Figures 10 to 12 - Photos of the Oulu School of Architecture – University of Oulu by Ana Moreira Bento







Figure 13 - Photo of the School of Architecture – Tampere University of Technology by Ana Moreira Bento



Figure 14



Figure 15



Figure 16

Figures 14 to 16 - Photo of the School of Architecture – Tampere University of Technology  
by Ana Moreira Bento





Figure 17 - Photo of the School of Architecture – Tampere University of Technology by Ana Moreira Bento



Figure 18 - Photo of the School of Architecture – Tampere University of Technology by Ana Moreira Bento





Figure 19 - Photo of the School of Arts, Design and Architecture – Aalto University by Ana Moreira Bento





Figure 20 - Photo of the School of Arts, Design and Architecture – Aalto University by Ana Moreira Bento



Figure 21 - Photo of the School of Arts, Design and Architecture – Aalto University by Ana Moreira Bento



Figure 22 - Photo of the School of Arts, Design and Architecture – Aalto University by Ana Moreira Bento



Figure 23 - Photo of the School of Arts, Design and Architecture – Aalto University by Ana Moreira Bento







Figure 24 – Photo of the Architecture Faculty of the University of Oporto by Ana Moreira Bento



Figure 25 - Photo of the Architecture Faculty of the University of Oporto by Ana Moreira Bento



Figure 26 - Photo of the Architecture Faculty of the University of Oporto by Ana Moreira Bento





Figure 27



Figure 28



Figure 29







Figure 30 - Photo of the Architecture Faculty of the University of Lisbon by Ana Moreira Bento



Figure 32 - Photo of the Architecture Faculty of the University of Lisbon by Ana Moreira Bento



Figure 31 - Photo of the Architecture Faculty of the University of Lisbon by Ana Moreira Bento





Figure 33 - Photo of the Architecture Faculty of the University of Lisbon by Ana Moreira Bento



Figure 34 - Photo of the Architecture Faculty of the University of Lisbon by Ana Moreira Bento







Figure 35 - Photo of the Department of Architecture os Sciences and Technology Faculty of the University of Coimbra by Ana Moreira Bento



Figure 36



Figure 37



Figure 38



Figure 39





Figure 40



Figure 41

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