# Portugal: Network of Institutions Cooperate in Computer Graphics Education

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Portuguese researchers have been involved in computer graphics since the early '60s, and some of their contributions have become landmarks in computer graphics history. As pioneers, two individuals have had international careers. José Luis Encarnação developed his academic and professional life in Germany and has devoted special attention to computer graphics standards, applications and international cooperation. In the United States, Aristides Requicha developed the fundamentals of CSG (constructive solid modeling), one of the most popular solid modeling representation schemes. In Portugal, Madalena Quirino and João Cunha must be noted for their efforts in the '70s using the first computer graphics systems.

The current network of institutions which support the development and application of computer graphics in Portugal was established since the '80s. These institutions are of three types: universities and colleges, which undertake the basic and specialized teaching of computer graphics; R&D centers, which are involved in projects and take care of technology transfer; and private companies, which use computer graphics and its applications to support their economical activity.

The Portuguese universities of Coimbra, Lisbon (Lisbon University, Technical University of Lisbon and New University of Lisbon), Oporto and Aveiro teach regular courses in computer graphics. Nine professors and 10 assistants/Ph.D. students take care of about 500 undergraduate students per year for their regular courses on computer graphics fundamentals, graphical user interfaces and geometric modeling. These courses for computer science and engineering, mathematics, physics, geography, electronics and telecommunications students are increasing due to both the activity of new universities and the increasing interest of the students in this scientific and application area.

Besides the universities, there are also some engineering institutes (for example, Oporto and Coimbra) with regular courses in computer graphics. Regular postgraduate courses are held for about 80 master's students per year. Graphical interaction, virtual reality, scientific visualization and rendering are the most common options for these kinds of courses. To obtain the master's degree, a student should successfully attend three to six semester courses and work in a research project for at least six months. In Portugal there is

no regular Ph.D. program in computer graphics. Ph.D. students work in a long term research project under the supervision of a professor. The contacts are established directly with the supervisor.

Close to the universities, there are research institutes and centers for technology transfer. These institutions concentrate activities on national and international projects and professional teaching and training.
• INESC is an institute with locations close to the main Portuguese universities. Some of its R&D areas are:
— INESC/Oporto: rendering and parallel architectures for rendering, virtual reality, simulation, intuitive interaction for geometric modeling, CAD and GIS
— INESC/Aveiro: visualization, medical imaging and graphical user interfaces
— INESC/Lisbon: multimedia, graphical user interfaces, CAD and virtual reality
• IDITE-Minho is a technology transfer institution close to Minho University (Braga).
• CCG/ZGDV-Centro de Computação Gráfica (Coimbra) is a scientific, technological and training association of private and non-profit nature, taking part in the first International Network of Computer Graphics Centres. Its main R&D areas are:
— distributed multimedia information systems
— computer-supported medical diagnosis systems (teleconferencing, 3D imaging)
— virtual environments
— CSCW (computer supported cooperative work)
— multimedia training environments

The state laboratories are also places where computer graphics is used extensively. LNEC, a large (900 people) state owned research laboratory for civil engineering, deserves special mention. Its computer center is responsible for the information technologies infrastructures and part of the application development. Computer graphics has been used here since the '60s, and the main focus now is on scientific visualization.

A large number of small and medium sized companies are developing computer graphics applications, especially in the areas of multimedia information systems, CAD/CAE, visualization, graphical work environments and graphical simulation. WWW and virtual environments are two of the most important areas for computer service companies.

In Portugal, the participation of key persons in Portuguese and European projects has been one of the most important driving forces

behind computer graphics. Additionally, a close relationship between computer graphics and application areas like engineering, medicine and production companies provides the environment for a larger acceptance of computer graphics as a supporting technology for a broad range of applications. Among the projects running in the different institutions are:
• Application of virtual reality to environmental sciences.
• Virtual reality in architecture and natural environments simulation.
• Advanced visualization for medical imaging.
• Fluids dynamics visualization.
• Visualization techniques applied to the debugging of parallel programs.
• Automatic generation of multiple views of the same information.
• Driving simulators — computer-aided design for different production areas.
• Geographic information systems.
• Multimedia systems and WWW.
• Distributed multimedia teaching and training systems.

## Contacts

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