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The Organization of CAD Teaching in Design Schools

Robert S. Frew

Yale University School of Architecture

Introduction
This paper is the result of a survey of European CAD teaching that was conducted in 1987 and 1988. It makes comparisons with teaching at the Yale School of Architecture, and goes on to analyze the issues that should be addressed in a CAD program in a school of architecture.

Development of CAD Teaching
In the United States in 1965 CAD teaching options were very limited. If you had a Fortran compiler with graphic extensions, you were able to teach the introduction to CAD as an introductory graphics class. Often you had to introduce the student to programming in a separate class and then introduce graphics. Recently, this first class has become unnecessary because of the ease of using graphics with a high-level language. About five years ago the wave of CAD systems teaching hit the schools and in many cases programming was not offered. The exclusion of programming cuts out the important connection between language and product, which should be addressed in the future, when programming will be used as a general tool to introduce problem-solving skills into the curriculum.

Current CAD Teaching at Yale
At Yale we now have the following optional courses:

Introduction to CAD-word processing, spreadsheets, and CAD with a little programming in graphics
Advanced CAD-a continuation of CAD with graphics 3D wireframe and 3D surface modelling
Management and Computing-a new course that gives the student the basics of project management using spreadsheets and a project management system

Energy, Lighting, and Computing-a new course not yet offered that will give the student design-oriented lighting software and an introduction to energy systems and design
Outside Project-Students in the outside building project that is part of the first year studio should produce the documents, including the cost estimates, schedule, and drawings, using the computer. This is done as a group project, and the students who have taken the CAD course do most of the computer work.

During this past year a faculty task force on computing has recommended that the introductory computer class be required in the professional program.

The Relationship between CAD Teaching and Research

In all the schools I visited in Europe where there were people working on research, and there was a clear increase in the CAD activities and equipment within the professional program, even though research and teaching activities were separated both organizationally and physically. At Sheffield and Cambridge a system that was originally developed in the academic environment has been moved to an independent "for profit" company. Strathclyde intends in the next year to establish a company that is a part of the university but whose purpose is to do business in the professional community. At Edinburgh the graduate students are doing quite abstract work on data structures for geometric models, while the undergraduates have, as at most schools, a lab with low-level CAD systems. In all of the above cases the impact of the research activity on the professional program is quite positive.

In Britain, as in the United States, the individual researcher applies for funding from central agencies. In France, however, the central government has determined that there will be three CAD research centers-at Paris, Marseille, and Nantes-and researchers are naturally attracted to those schools. The work being done is quite interesting. It is executed primarily on the MAC platform and is the responsibility of one principal researcher at each location. In each institution there is a small group of graduate research students and staff. There is no need for this group to teach in the school of architecture and consequently the amount of research work done is substantial.

If one accepts that research and teaching are mutually beneficial, then one can focus on the way the relationship is organized. Some kind of research and development arm might, for example, be established. One of the first design schools to establish an outside practice within the school was the Ulm School of Design in Germany. Associated with the school was an Institute of Design that was responsible for many important design products, the Braun product line being one example. This model was later copied at the University of Waterloo in Canada in the 1960s, where a number of the more innovative

buildings for Expo '67 were designed. The important issue at Waterloo was shared facilities and personnel; that is, by putting all of the academic and professional personnel in one place, there could be a real interchange of ideas. In addition, the school could also justify more equipment, since much of it would come from the income of the institute. One issue that was very carefully dealt with was the position of the student. A student could be either a student or a professional in the institute, but not both at the same time. When the student was a professional, he or she was paid more than the normal professional scale, which further emphasized the difference.

It is important to consider the basic objectives of university-run practices. In the past they were merely a way for professors to extend their work into the community, and they reflected the university's inability to provide the opportunity. In return the staff were well paid and profits were typically distributed to the staff. In the Waterloo model the excess money was used for scholarships and equipment, and only those who worked in the institute had the right to determine the distribution. In general the objective should be to make the subject of CAD more accessible to students and to provide the students with the best equipment possible.

At Yale research is centered on the interest of the individual faculty member and student. Either one can develop a project and can arrange for assistance to complete the work. The role of the CAD faculty is to review and assist the assessment of time and technical knowledge needed to complete the work and to monitor progress. At present there is one major project and there are two smaller ones, which together do not present sufficient demands to justify a separate organizational structure.

Methods of CAD Teaching

Should computer-aided design be taught more as a design course than a computer course, or should it be formally taught at all? The primary objective of the student taking a course is to learn how to use CAD systems as design tools, which normally means that the theory behind the systems is taught after the student learns how to use them.

One of the best examples of teaching CAD that I found in Europe was at the Open University. In general the Open University is organized as a TV-Video University; in CAD that means that 200 students per term sign up for the course and in return they are given videos, a workbook, a tutor, and a computer with a CAD system that they rent for the term. It is then up to the students to fulfill the assignments, to meet with the advisor in their particular city, and to pace their way through the course. There is presently a waiting list of 400 for the course, which is some indication of the need for general CAD teaching. The method of teaching at the Open University is as follows. The student learns

how to use the system at his or her own speed through the videos and workbooks. Then the theoretical basis of the system can be taught in a traditional lecture format. I

Design faculties are divided about whether the CAD course should be required. At Aberdeen each student is required to take a computer course; that they have only one AutoCAD workstation and about twenty general workstations makes one concerned about the content of the course. At the Mackintosh School of Architecture in Glasgow there is no requirement for a computer course, but there is an active CAD group that serves as a resource center for students in general. The work began with the desktop publishing programs that the students use for various publications, and they have AutoCAD as their CAD system. Only the students who want to work on the machines are there, and the environment is very positive. The equipment can be more specialized in this school, as the objective is not to provide a large number of workstations for a class but to provide a quality graphic product that is then used in the design studio.

At Yale we use the analogy of the library to explain our activity in the computer lab. The staffing of the lab is a reflection of this. There is one overall coordinator, as is the case in all the curriculum sections, and there is a staff person in each of the subject areas, which are structures, energy, lighting, management, and design. The responsibility of the staff is to review the current software available and to encourage teachers to use the CAD software in their courses. One might think that this is easy; but the most obvious areas are often the most difficult. Although problems exist in the implementation of the library concept at this time, it appears to have the most merit.

CAD and the Theory of Design

Any theory or analysis of design can eventually lead to computer-aided design. In the same way, any development of the graphic capability of the computer can lead to an impact on computer-aided design. The gap between theory and practice is getting smaller, and student interest is increasing. The attitude to CAD that seems to be least threatening to the design faculty is that the computer is like a car that they should learn how to drive, and that the computer is here to stay and they should know how to use it. What the curriculum usually requires is that the student learn how to create a building database and how to draw a perspective. It is an unfortunately limited view of the role of CAD.

The analysis of form and problem-solving are basic subjects that should be incorporated into the architecture curriculum. Problem-solving can be taught in a CAD course, through the introduction to Pascal or C programming. The analysis of form has been introduced by a number of theorists, but it is not

generally taught as a separate course. Some of the information can be taught in a geometry course, but the real need is to offer a design course that deals with the analysis of the plan by abstracting and generalizing the plan types that can be used in buildings.

CAD and Architectural Technology

A computer is used in a design problem because it either gives greater accuracy, does it faster, or gives the designer greater analytical power to deal with the problem. Early programs for problem structuring and space allocation did not give the designer more but rather presented a number of alternate ways to think about design. The first major impact of the computer was at the time of the energy crisis, when it became necessary to use the computer to analyze the effect of passive solar strategies. The long-range outcome was the production of a number of books that gave the results of the computer analysis; it did not result in significant use of computer methods in design. The development of CAD systems has resulted instead from the need for drafting, and the systems are increasingly used for design and rendering.

One technique that may well change designers' attitudes toward the computer is lighting simulation. A system developed at Lawrence Berkeley Laboratories can produce a fully rendered view of a space with the simulated effect of the lighting design. The visual effect in combination with the extensive mathematical model that calculates the distribution of light gets at the qualitative aspects of the design. This system is important because designers do not have a good alternative. Existing methods of calculation by producing light contours and using physical models have major scale problems. The problems with the existing methods are significant enough that designers do not use them. In general, the computer models that will find success in *architecture are those that give the* designer the ability to design the 3D form with the technical calculations embedded in the program.

Note

[1] From this program, see: Joe Rooney and Philip Steadman, Principles of ComputerAdied Design. 1987. London: Pitman / The Open University.