INTEGRATION OF DESIGN METHODS, INDUSTRIAL ENGINEERING AND INFORMATICS

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With the composition of a new CAD education plan the opportunity presents itself to enter into new, valuable relationships with other faculties or faculty-units, at present already working in specific fields as computing or designing. Certain aspects, which are important for CAD-education, have already been taught for a longer period before CAD became a special, recognized part in the curriculum of the faculty. Because the University cannot afford duplication anymore, and because a unit concerned with CAD cannot have all the necessary knowledge of all specialties at its own disposal, it is an important task of that unit to integrate relevant parts or aspects of faculty or unit-curricula.

A few examples of aspects which in this case are considered are:
- Design Methodology, an aspect attended to by a special unit in our faculty.
- System Design, an aspect attended to by a unit of the faculty of Industrial Engineering.
- Informatics, for which aspect the University has a special subfaculty.

Besides attending to a consistent integration, the remaining tasks of a CAD-unit are:
- Introduction of new computer technologies.
- Making new computer technologies applicable.
The main aim of this conference, as described in the invitation letter, is "Exchange of Experiences on the field of Education in CAAD". Despite the fact that this paper cannot go into this subject, because of the very simple reason that we hardly have any experience at all, I think it is easy to justify why space has been reserved for this paper about recent developments and future plans for our curriculum on CAD. Reason is the fact that new and experienced teachers have met in a rather new and very sound environment.

THE SITUATION

In our country we have three Universities of Technology - Delft University of Technology - Eindhoven University of Technology - Twente University of Technology

The Eindhoven University of Technology consists of eight faculties:
- Faculty of Architecture, Building and Planning
- Faculty of Industrial Engineering
- Faculty of Electrical Engineering
- Faculty of Physics
- Faculty of Chemical Engineering
- Faculty of Mechanical Engineering
- Sub-Faculty of Mathematics and Informatics
- Sub-Faculty of Philosophy and Social Sciences

All faculties have the Central Computer Centre at their disposal. As the name already indicates, our faculty draws a distinction between three main streams, namely
- Architecture
- Building Technology
- Urban Planning

Each stream has several Teaching and Research Units of its own. Only our unit, the CAD Group, is expected to attend to teaching and research concerning the three streams without preference.

The programme of study consists of two phases
- Propaedeutics-phase, one year
- Doctoral-phase, three years of which one year for Thesis Work
lectures and exercises concerning CAD are compulsory in the first and second year. Thesis work has to fit into the research work of the unit the student prefers.

THE CAD GROUP

It is very important for our teaching and research that we do not have to be engaged in basic CAD aspects, such as computer graphics, computer interaction or system design, which are important topics for all faculties of our University. These topics are attended to by specialized (sub-)faculties. The same applies to Design Methodology, which is attended to by another specialized unit of our faculty.

However, we do have to attend to a consistent integration, the introduction of new computer technologies or the specification of new demands and make new computer technologies applicable or teachable, at first in CAD lectures and exercises, but later on also in lectures and exercises of other more or less specialized units.

In our programme of education we draw a distinction between the use of CAD systems and the development of new or improved parts of a system. Our first and second year lectures and exercises, which are compulsory, are devoted to the use of CAD systems. Our third year lectures and projects (20 hrs a week) are devoted to the development of a system.

CAD EDUCATION MODULES

During the eCAADe-conference in 1982 you could take notice of suggested standard CAAD course modules, namely

- Exposition of the concept underlying the subject, history, state of the art and introduction of design methodology, information analysis and appraisal techniques.
- Investigation, by controlled use of computer programs, of mathematics behind the programs.
- Application of computer programs to an actual design problem.
I would like to emphasize some new or more explicit items, such as:

- **Design Methodology**, including separate parts to compose a suitable design method.
- **System Development**, including information- and system analysis, system design and data base organisation.
- **System Documentation**, including data base management.

Reason for emphasizing these items is that I want to give them some extra weight in order to prevent that talking about CAD remains confined to a discussion about computer software- and hardware components.

The, in the same conference, suggested CAAD-course-notebook deals with all kind of subjects, such as:

- **History**
- **Hardware and Software**
- **Applications and Practice**
- **Adverse effects and Future**.

However, this notebook also passes over some subjects, such as those I have emphasized in relation with the CAD course modules.

Furthermore I think it is important to add a hardware independent way of dealing with software, applications, data base organisation etc. As far as practice and applications is concerned, I think that, beside Architecture, the notebook should also pay attention to Urban Planning and Building Technology, because of the primarily intermediary function of an architect.

The importance of most of the above mentioned, more or less, new aspects, is only recently distinguished in the engineering environment. Because of the fact that we, the CAD group, do not have any tradition to build on, it is easy for us to take them into account when composing a new programme of education and research.

Ultimately we will have to provide answers to the following questions, concerning user-aspects:

- What is information and what are special characteristics of building engineering information?
What is a computer system and what is the role of the building engineer in it?
What is a method and what is the influence of computers on e.g. design methods?

Questions concerning developer-aspects:
- How do you analyse information and design a computer system taking into account the building engineering information-flow?
- How do you realize a computer system taking into account the future users?
- How do you make a new application really workable taking into account the working-method in practice.

Besides the distinction between user- and developer-aspects, it is also possible to draw a distinction between Industrial Engineering-, Informatics- and Design Methodology-aspects.

Co-operation between other faculties and units of our own faculty concerning these aspects is possible and necessary.

Concrete this means co-operation with:
- Design Methodology Unit (Faculty of Architecture, Building and Planning)
- Faculty of Industrial Engineering (Management Information Systems and Automation Unit)
- Sub-faculty of Mathematics and Informatics.

Of course we also aim at close co-operation with other units in our faculty concerning certain specialities, however, despite of the importance, I do not wish to go into this matter in this paper.

DESIGN METHODOLOGY

It will be obvious for most readers that a methodological approach of e.g. design activities is indispensable for an appropriate application of any tool at all. The Design Methodology Unit is not primarily concerned with methods themselves, but more with distinguishable parts with which, dependent of its purpose, a special methodological approach can be chosen. For this purpose the unit divides the process, from problem to plan, into several basic operations, taking into account the special way of working in Building Engineering e.g. working from a rough to a specific plan and from complex to simple information.
These basic operations are:
- Analysis of existing performance and means.
- Formulation of desired performance.
- Choice and analysis of situation.
- Choice and analysis of elements.
- Development of models and formulation of (positioning) rules.
- Generation of variants.
- Evaluation of variants.

For "Choice and analysis of situation" various situations are being distinguished, with their own measures for a zoning or a grid, namely:
- Direct Environment (e.g. 6.000 mm)
- Building (e.g. 1.200 mm)
- Dwelling (e.g. 300 mm)
- Room (e.g. 100 mm)
- Detail (e.g. 25 mm)

For "Choice and analysis of elements" various functional aspects are being distinguished for describing, recognizing and cataloging elements (such as windows, walls and installations), namely:
- Use (usability)
- Construction (durability)
- Technique (manufacturability)

After variants have been generated, each element can be described in terms of
- Place of the element.
- Measures of the element.
- Function of the element.

The Design Methodology Unit gives lectures and exercises. From students who attend our lectures and exercises we expect that they are acquainted with the content of these above mentioned lectures and exercises, because knowledge of Design Methodology aspects is indispensable for users and developers of computer systems.

INFORMATICS

The Sub-faculty of Mathematics and Informatics gives all Mathematic lectures and exercises and also an Introduction of Informatics.
This introduction is compulsory in the second year and precedes our lectures. At first the contribution was restricted to teaching a programming language (Pascal). This year the contribution will be extended as far as the Introduction of Informatics is concerned, and they will participate in our third year lectures about developing a computer system. In order to discuss the relevant subjects we made use of the description of the M.Sc. course in Building Science (Computer Aided Building Design) of the University of Strathclyde (UK) (the part concerning Computing Methods). The result is that in the Introduction of Informatics the Sub-faculty deals with the following subjects:

- General concepts: history and digital computing
- Computer hardware: computers and peripherals
- Software: operating systems, software libraries and tools.

The exercise they give includes other subjects, namely:

- Using computers: terminal connection and running a program
- Programming languages: review and writing Pascal programs
- Advanced Pascal: file handling and data structures.

Their contribution to our third year lectures consists of the following subjects:

- Software engineering: concepts, modularisation and portability of software
- Graph theory
- Advanced consideration of computer graphics devices and techniques
- Data bases concepts design and management.

During the following project for third year students they pay attention to:

- Advanced Pascal: interactive and graphical computing
- Software tools: graphics and utility libraries and I/O conventions.

Industrial Engineering

In this faculty the Management Information Systems and Automation Unit has a central place. They attend to teaching for all other units of that faculty and to research. Furthermore the co-operation with the Sub-faculty of Mathematics and Informatics means that they have to attend to lectures concerning their own speciality, for that sub-faculty.
To them, the co-operation with our faculty means a comprehensive repetition of their lectures, which deal with the following, very important, subjects:
- Information systems: analysis and design
- Software engineering: concept and software design methodologies
- Data bases: use and management

These subjects will be covered in our third year lectures, but because of their importance we are going to try to arrange a special lecture course about them.

COMPUTER AIDED DESIGN

As you may notice, a large part of the necessary education in CAD can be covered by the expert contribution of the before mentioned parties. In the paragraph THE CAD GROUP, I have already mentioned the most important aspects we want to attend to, being:
- Consistent integration of Design Methodology, System Design and Informatics.
- Introduction of new computer technologies or the specification of new demands.
- Making new computer technologies applicable or teachable.

Of the items mentioned in the M.Sc.-course description we attend to the following items:
In second year lectures:
- Software: applications software
- Consideration of computer graphics devices and techniques
In second year exercises:
- Using computers: terminal connection, running a program
In third year lectures:
- Programming languages: standards
- Software tools, graphics and utility libraries
- Advanced consideration of computer graphics, devices and techniques.

In the following project for third year students we are primary concerned with formulating the project-problem in a right and realistic way and we look after an adequate application of techniques.
CONCLUSION

We try to apply methods and techniques, such as Design Methodology, System Development Methodology and Informatics, making use of the fact that the relevant faculty, sub-faculty and other units have special know how and experience and are performing much broader research as we could ever do in a short period. In this case we have to pass over the fact that in these methods and techniques the recent possibilities of CAD are not yet considered.

Our working-method also clarifies that CAD really is an aid concerning the differed methods and techniques, and not a pile to build those methods and techniques on.

Therefore the introduction of new computer technologies is a very important part in our work and therefore we attend to some special activities, such as:

- Symposium about CAD for students, staff members of our University and others who are interested in the subject.
- Summercourse about the application of CAD for staff members of our faculty only.

For making new computer technologies applicable or teachable we have to attend to some other items, such as:

- Proposals for obtaining new facilities.
- Research e.g. concerning a Building Engineering Data Base System.
- Development e.g. extension or improvement of already used computer systems.

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