A new framework for teaching computer-aided design at the Faculty of Architecture, Delft University of Technology

Alexander Koutamanis, Alan H. Bridges, Peter Paul van Loon

Faculty of Architecure, Delft University of Technology
NL-2628 CR Delft, The Netherlands

tel. +3 1-15-784957 • fax +31-15-784727 • e-mail KOUTAMANIS@BK.TUDELFT.NL

Abstract

The paper describes the new organization of computer-aided design courses at the Faculty of Architecture, Delft University of Technology. The main characteristics of the new organization are emphasis on both technical skills and methodical knowledge, and a wide spectrum of subjects and applications distributed in the thematic structure of the first and second years. As a representative of the new courses the paper outlines Schematic Design, the first computer course in the second year.

Introduction

Since the beginning of the 1990's the Faculty of Architecture, Delft University of Technology, is undergoing a radical revision focused mainly on the teaching curriculum. Based on the concept of *problem-based. learning* the new curriculum consists of blocks with a duration of six weeks (six blocks per year). [1] The twelve blocks of the first two years aim at delivering the basics of architectural education in a thematic series. These blocks are taught by a multidisciplinary group of staff members who cater for the full spectrum of knowledge and skills required by the block theme.

Computer-aided design forms a major subject ill the second year, with courses in five of the six blocks. The courses follow the thematic subdivision of the year, beginning with schematic design and ending with visualization and presentation. Starting with the academic year 1993-94 these courses are subdivided into (i) specialized applications such as Cost and structural analysis and (ii) a core of more general design courses given by the Sector Computer-aided Design (Bouwinformatica) under the title "Design representations, design processes". The purpose of this core is to provide not only computer literacy and practical skills but also the methodology of computer-aided design. The core courses are meant as a general introduction that is essential for the indepth understanding of specialized applications and courses and for the relevant and meaningful use of the computer in architectural design. The courses comprising "Design representations, design processes" are:

[1] For a comprehensive overview of the teaching curriculum and of its pertinence to the teaching of computer-aided design see A.H. Bridges, "Computing and problem based learning at Delft University of Technology, Faculty of Architecture". *Proceedings ECAADE´92.*

0 Schematic design
1 Analysis and evaluation
2 Two-dimensional design representations
3 Three-dimensional design representations
4 Visualization and presentation

The courses form an obvious series that starts with the development of a basic design, proceeds with its evaluation, improvement and evaluation, and concludes with the presentation of the results (on-line and hard copy). Designs and analyses produced by the students in one course form the basis for the following course.

The main departure of the 1993-94 curriculum is that tile computer is much more than a new technology for visualization and calculation. "Design representations, design processes" concentrates on the methodological aspects of computer-aided architectural design. Practical skills, i.e., the ability to use computer programs efficiently and effectively, constitute a basic form of computer literacy that is in itself insufficient for a designer who is expected to take decisions on the built environment using computer tools. What is moreover needed is a deeper understanding of the computer and of the way it can complement human perception and human reasoning. The new courses. aim at acquainting students with currently available computer tools and, through these tools and their capabilities, link the potential of the computer with the requirements and necessities of architectural design, thus making the use of' computer-aided design meaningful and relevant to the architectural student. (For a more detailed presentation of the relationships between the computer and architectural design methodology see A. Koutamanis, "On the correlation of design and computational techniques", elsewhere ill this volume.)

The changes in the curriculum are accompanied by changes in the organization and infrastructure of the Faculty. These focus on the function of the *CAD-Atelier,* the central computing facility for teaching purposes. The CAD-Atelier was originally envisaged as a central general-purpose facility that provided the necessary infrastructure for computer courses given by any staff member It soon became clear, however, that tile support the CAD-Atelier should provide was substantially bigger than a smoothly running network, a number of properly functioning computers and correctly installed software. The development and teaching of computer courses required specialist computer knowledge that is generally unavailable in areas other that computer-aided design. Moreover, as courses were given from a perspective other than computer-aided design using the computer as a mere tool, students obtained a fragmented picture of the possibilities and limitations of the computer that missed several important Pieces and in particular a strong cohesive backbone.

"Design representations, design processes", the main series of courses taught in the CAD-Atelier, is conceived as the main ingredient of this backbone. This, together with practical considerations concerning the development of computer- related courses in general, have led to the decision to transform the CAD-Atelier into the teaching laboratory of the Sector Computer-aided Design. The transition of the CAD-Atelier from general to specific also serves as a framework for the re-organization and improved coordination of all computer courses. For this purpose during it transition period the CAD-Atelier is governed by three committees whose. task is to establish a coherent and comprehensive framework for the near future oil the basis of existing courses and resources. The, committee structure aims at ensuring pluriformity in the decision-making around computer-aided design and promotes interaction between the general methodological and technical aspects of design computing and needs or requirements for specific applications.

The first committee is responsible for the current operations of the CAD-Atelier and comprises staff members of the Sector Computer-aided Design technical and managerial staff of the Faculty The activities of this committee concentrate on the organization of teaching in the current academic year and on the improvement of the infrastructure available in the CAD-Atelier. The second committee consists of representatives from all related and attempts to structure a policy concerning computer-aided design in the Faculty. The purpose of this committee is to develop a long-term plan for the future development of computing facilities and computer courses. The third committee is formed out of teaching staff who are currently giving computer courses. The main task of this committee is to improve these courses by integrating the computer tools used in the courses on both conceptual and technical levels.

Schematic design

Schematic design, the first Course of "Design representations, design processes", marks the true beginning of Computer-aided design for the students who, after a general familiarization with the computer and architectural design in the first year, are expected in the second year to design using the computer as their main vehicle. *Schematic design* concentrates on the following themes:

- Familiarization with computer-aided drafting (programs used: AutoCAD 12 and MiniCAD+ 4.0v3).
- Literature research in the early stages of the design process, with particular emphasis on the role of design precedents.
- Correlation of programmatic requirements and schematic designs through the comparison of geometric and topologic representations.
- The structure and meaning of design representations in general and of computer aided design representations in particular.

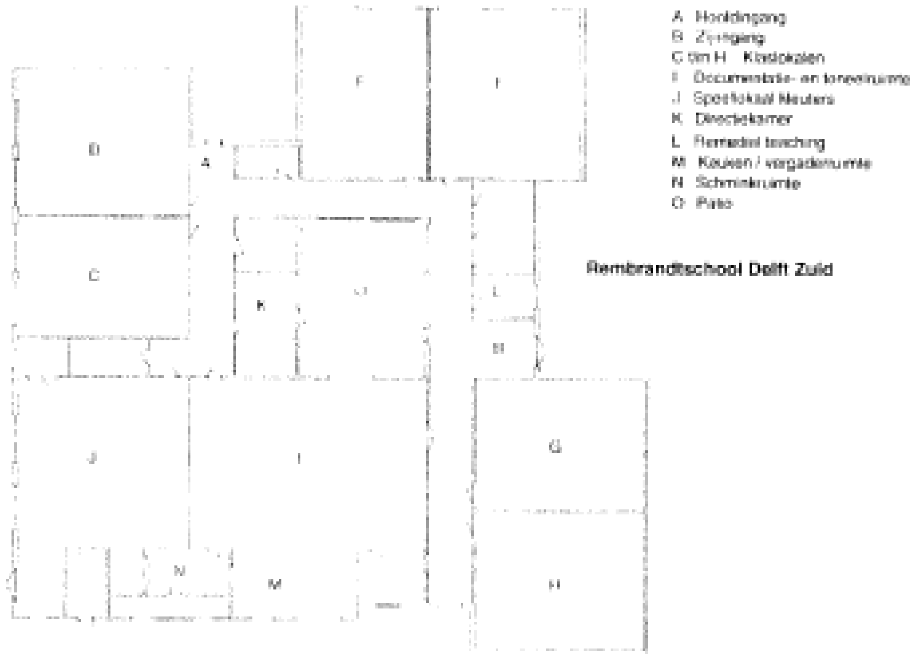
Students are asked to design a new building for an existing elementary school in Delft on the basis of a simplified building programme and a number of precedents. The precedents are:

0 The Open Air School, Amsterdam, by J. Duiker.
1 The Montessori School, Delft, by H. Hertzberger
2 The Agios Dimitrios High School, Athens by T.Ch. Zenetos

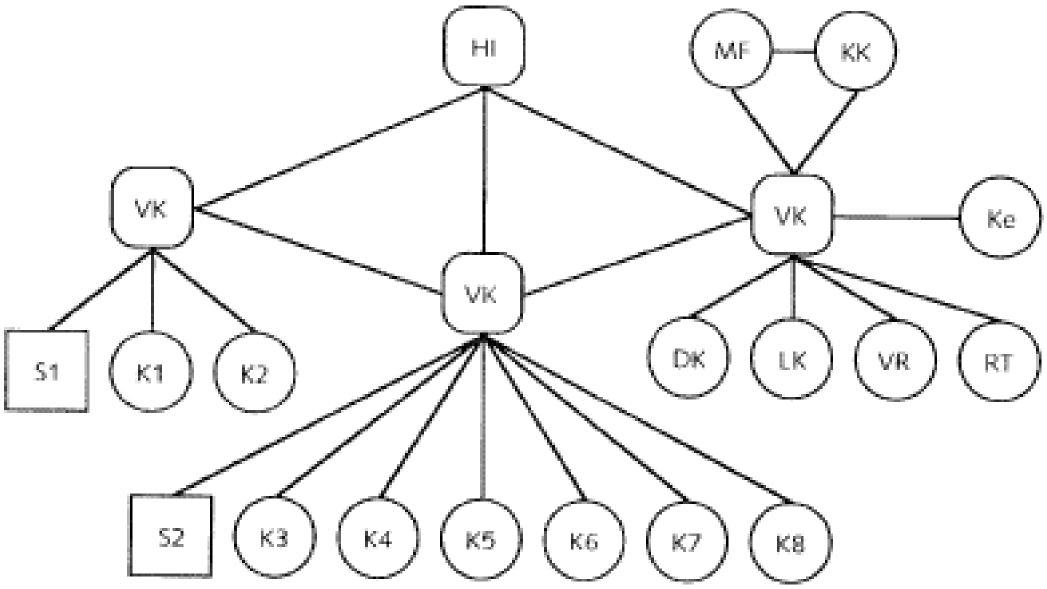
These school buildings represent different approaches to the resolution of similar problems- All three were derived from traditional precedents and attempted, through a transformation of these precedents, a renewal and improvement of the traditional school building type. As the existing building is a rather typical representative of elementary school buildings in The Netherlands, students may also use the existing building as a precedent.

The use of precedents in the course is motivated by the attention paid to precedents in recent research [Gero, 1990; Schmitt, 1993], as well as in traditional architectural theory [Collins, 1971]. In addition as these precedents are supplied to the students as AutoCAD and MiniCAD files, the first contact make with computer-aided drafting is one of meaningful manipulation of design representations rather than the more usual mechanical drawing of geometric shapes.

The building programme is derived from the existing school building with a couple of additions the school actually requires, such as two additional classrooms and a multifunctional space. The following illustrations are of the existing building, the list of spaces ill the flew programme and the required topological relationships between the spaces in the programme file.



Hl	Hoofdingang	
K1	Klaslokaal groep 1	40 M2
K2	Klaslokaal groep 2	40 M2
K3	Klaslokaal groep 3	40 m2
K4	Klaslokaal groep 4	40 M2
K5	Klaslokaal groep 5	40 M2
K6	Klaslokaal groep 6	40 M2
K7	Klaslokaal groep 7	40 m2
K8	Klaslokaal groep 8	40 M2
SL	Speellokaal kleuters (groepen 1 & 2)	50 M2
MF	Multifunctionele zaal / gymzaal	180 m2
KK	Kleedkamers en andere hulpruimten voor MF	50 M2
DK	Directickamer	1O M2
LK	Leerkrachten	20 M2
VR	Vergaderruimte	20 M2
RT	Remedial teaching	10 m2
Ke	Keuken	6 m2
S1	Speelplaats kleuters (groepen 1 & 2 -buiten)	
S2	Grote speelplaats (buiten)	
WC	Wc's: 2 per klaslokaal + 2 voor leerkrachten	
VK	Verkeersruimten	



For the design of the new building students, may choose between the following options:

0 Make a totally new design, using the supplied precedents as general knowledge on school buildings.
1 Adapt one of the precedents to the new programmatic requirements.
2 Create a new design out of elements from more than one precedents.

Superficially seen the first option is the easiest of the three. Nevertheless, after studying the supplied precedents students generally realize that starting without a clear central idea of their design is in fact time-consuming and rather dangerous for the quality of the design. Most students therefore choose for either an adaptation of one of the precedents or for a fusion of two precedents. Adaptations remain generally faithful to the spatial organization of the precedents, while fusions are often daring and amusing combinations of, for example, the curvilinear overall organization of the Agios Dimitrios School and the L-shaped classrooms of the Montessori School.

Analysis and evaluation of a design are the subject of subsequent courses in the same year. In *Schematic design* student designs are evaluated merely with respect to the space sizes and space connectivity as indicated in the building programme. Space connectivity is evaluated by means of the superimposition of the above topological representation of the new building on the floor plans produced by the students, in the manner of the dual graph representation [Steadman, 1976, Steadman, 1983].

Future development

Future development of the computer curriculum of the Faculty of Architecture, Delft University of Technology, evolves around the integration of the core courses given in the framework of "Design representations, design processes" with specialized courses that analyse and evaluate a design with respect to e.g. cost, structural stability, climatic performance or circulation. This integration is both technical and conceptual. Technical integration means that representations used in one course should be usable in other courses too. Importing and exporting data currently poses few problems which can nevertheless be irritating and time consuming. More intricate is the active linking of different applications so that the results of an evaluation can automatically modify a design, especially with respect to the structure of a design representation in drafting and modelling programs. The significance of this structure indicates that the conceptual integration of the courses should be the focus of attention: by developing a comprehensive and consistent framework for all aspects of computer-aided design we can expect improvement in the technical integration and, more significantly, improvement in the students' understanding of computer-aided design in general.

Future development of *Schematic design* concentrates on the issues of literature research and programmatic analysis. The four precedents that are currently supplied are a mere substitute of a proper literature research through which the designer identifies not only a larger and more varied number of precedents but also technical and legal documentation. We are currently working on the development of on-line precedent databases that offer extensive retrieval support [Koutamanis and Mitossi, 1992], through which attributes of the precedents (and hence programmatic requirements) can be related to technical and legal specifications. At a later stage we also intend to use automated recognition for inputting and indexing precedents in the database [Koutamanis and Mitossi, 1993; Koutamanis and Mitossi, 1993]. The immediate plans concerning programmatic analysis involve improvement and adaptation of an internally developed cluster analysis programme, through which spaces in a programme can be organized in a topological representation and then automatically matched to precedents in the database.

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