Teaching Design with CAD?

Claus Diessenbacher, Ernst Rank
Numerische Methoden und Informationsverarbeitung, Fakultät Bauwesen,
Universität Dortmund, D-44-921 Dortmund

1 Introduction

Abstract as well as functionally dependant design exercises are essential components of an architectural education at nearly every university. Their goal is to provide architect students with a feeling for proportions, colours, materials etc., and to teach and train them in three-dimensional thinking. Pictures and concepts, developed by the designer are materialized by various technologies such as with pencil and paper in the traditional two-dimensional techniques or with clay, wood, paper etc. in three-dimensional modeling.
Now the computer and the CAD-system join the palette of the designers available resources in presentation as both a two-dimensional and a three- dimension al medium. Although CAD is often considered and taught to be only a better drafting tool, the educational goal of our group at the University of Dortmund is to employ CAD as a design support medium.
The prerequisites for work with the computer and the CAD system are provided in a compulsory two semester undergraduate subject. Basic programming, work with spreadsheets etc. are some exemplary themes provided in the form of lectures and practical exercises. A main emphasis of this instruction is the mastery of three-dimensional working technology with a comprehensive CAD-System. In cooperation of our computer science group and architecture chairs, seminars involving the use of CAD as a three-dimensional design tool, are offered as graduate courses. The seminars consist of loops of modeling and evaluating objects in a three-dimensional space. With this, the most possible realistic studies in colour, light and proportion take place exclusively on the computer.

2 Architectural Design

There are numerous publications on the essence of architectural design (see, for example [1],[2]) which will not be discussed here. In the context of this paper it will be sufficient to consider architectural design as a process schematically outlined in figure 1.
There is always an interaction between an abstract, conceptual and a concrete, functionally oriented part, each being a loop of generating and evaluating three-dimensional objects in different representations.
Teaching design at universities has to discuss equally the abstract and the concrete parts. At the University of Dortmund there are essentially three groups of design exercises (see figure 2). In the first group the main emphasis is on abstract design, the second group (also in the undergraduate level) focusses on the concrete design and at the graduate level a synthesis of both aspects should be found. Prerequisite for all these traditional exercises is a handcraft skill to use classical modeling media like clay, pasteboard, wood, paper and pencil.

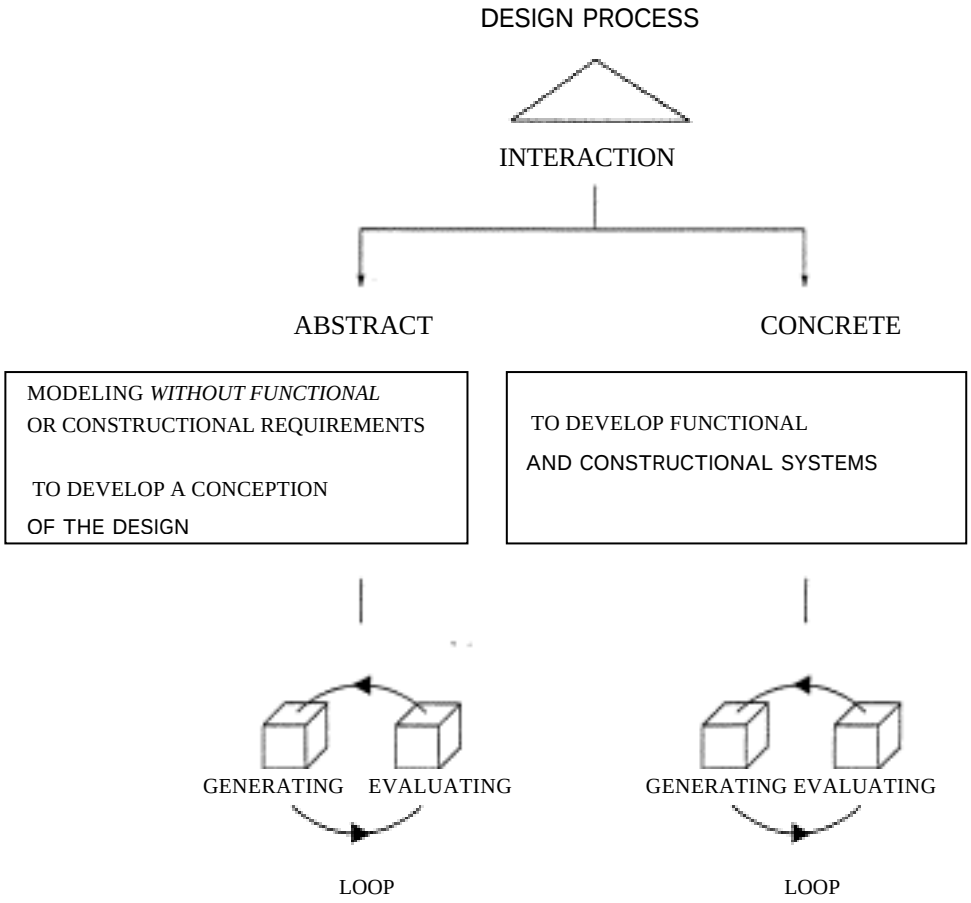


Figure 1 : Principles of design processes

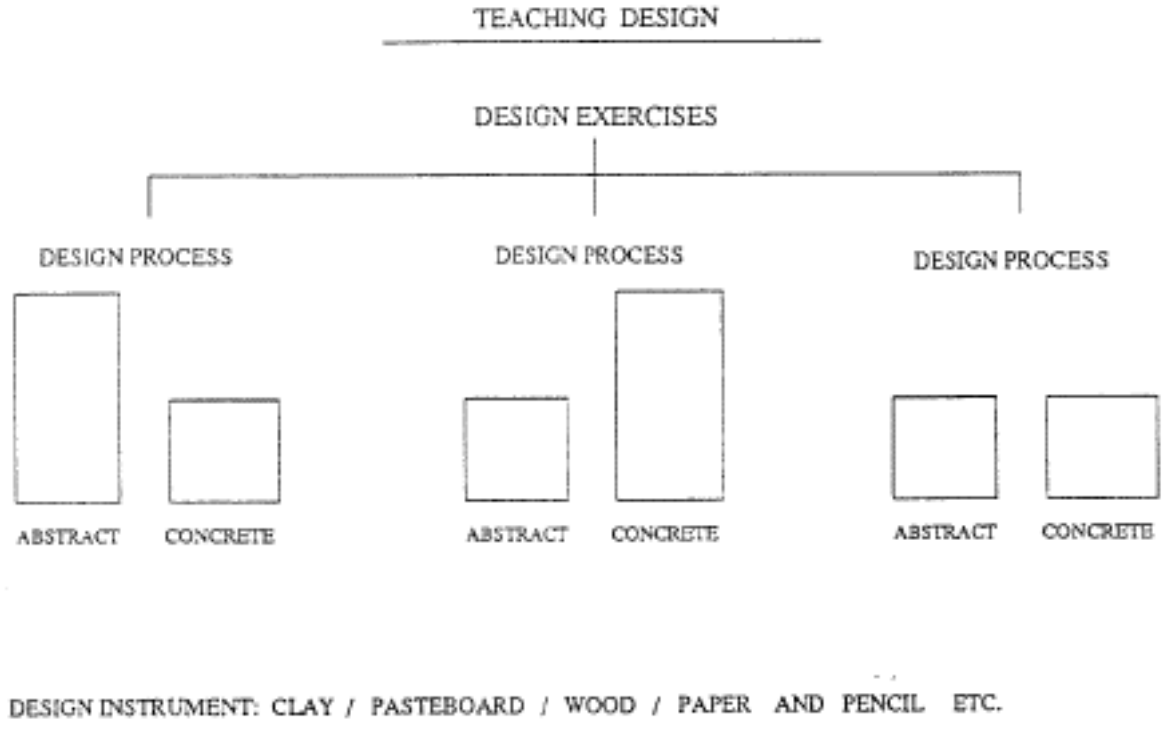


Figure 2 : Three phases of design exercises

3 Undergraduate Courses in Computer Science for Architects

It is exactly the handcraft skill as a prerequisite for working with CAAD, which is taught in two undergraduate courses at the University of Dortmund. (We recommend for example [3]). In two compulsory subjects in the third and fourth semester students are introduced to techniques and methods of computer science. During the third semester basic concepts are taught, (see figure 3) always with the goal not only to be able to operate the available software and hardware tools but more than that to understand *the principles behind* . *Lectures* and exercises in the fourth semester are brought into line with the special prerequisites for CAAD (e.g. [4]) where we consider it very important to introduce CAD to architects as a three-dimensional modeling medium and not as a two-dimensional drafting tool.

Third semester's content:

Lectures:	Exercises:
· Introduction to working with workstations	
	· work with interactive programs
· Fundamentals of Computer science: Hardware and software	
· Software in building science	
	· Work with a spreadsheet
· Components of CAD–hardware	
· CAD–models	

Figure 3 : Curriculum for third semester

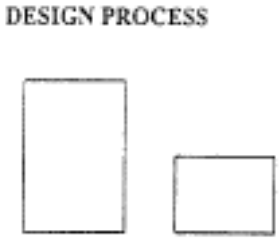
Fourth semester's content:

Lectures:	Exercises:
· Working techniques of CAD	
· CAD practice in architecture	
· CAAD - latest technology	
· Scientific visualisation in CAAD	
	· Work with a 3-D CAD–system

Figure 4 : Curriculum for fourth semester

4 Exercises for abstract design with CAD

Graduate courses in CAD at our University are taught in cooperation of our computer science group and of architecture chairs. Results of two seminars will be presented, the first emphasizing the abstract, formal aspect of design, the second one the concrete, functional part as outlined in section 2. The assignment of the first seminar [note 1] is given in figure 5. One major task was to make the *dynamics* of the design process visible, using the specific advantages of the electronic medium over classical modeling media, where often only the (static) final result of the design process is visualized. An exemplary result is shown in the sequence of pictures in figure 6. A fictitious interior 'power' decomposes and resculptures a cube, material is created and finally an abstract exhibition hall is placed in a fictitious landscape.



Assignment

1. With the help of a three dimensional grid, partition a 10mx10m cube
2. Create a composition with these new building stones
3. Put this sculpture in a fictitious landscape
4. Based on the sculpture, design an exhibition pavilion
5. Documentation of the design- / modeling-process

figure 5 : Assignment for an abstract design seminar

[1] Cooperation with : Lehrstuhl Entwerfen, Raumgestaltung und Darstellungsgrundlagen, Prof. Nalbach

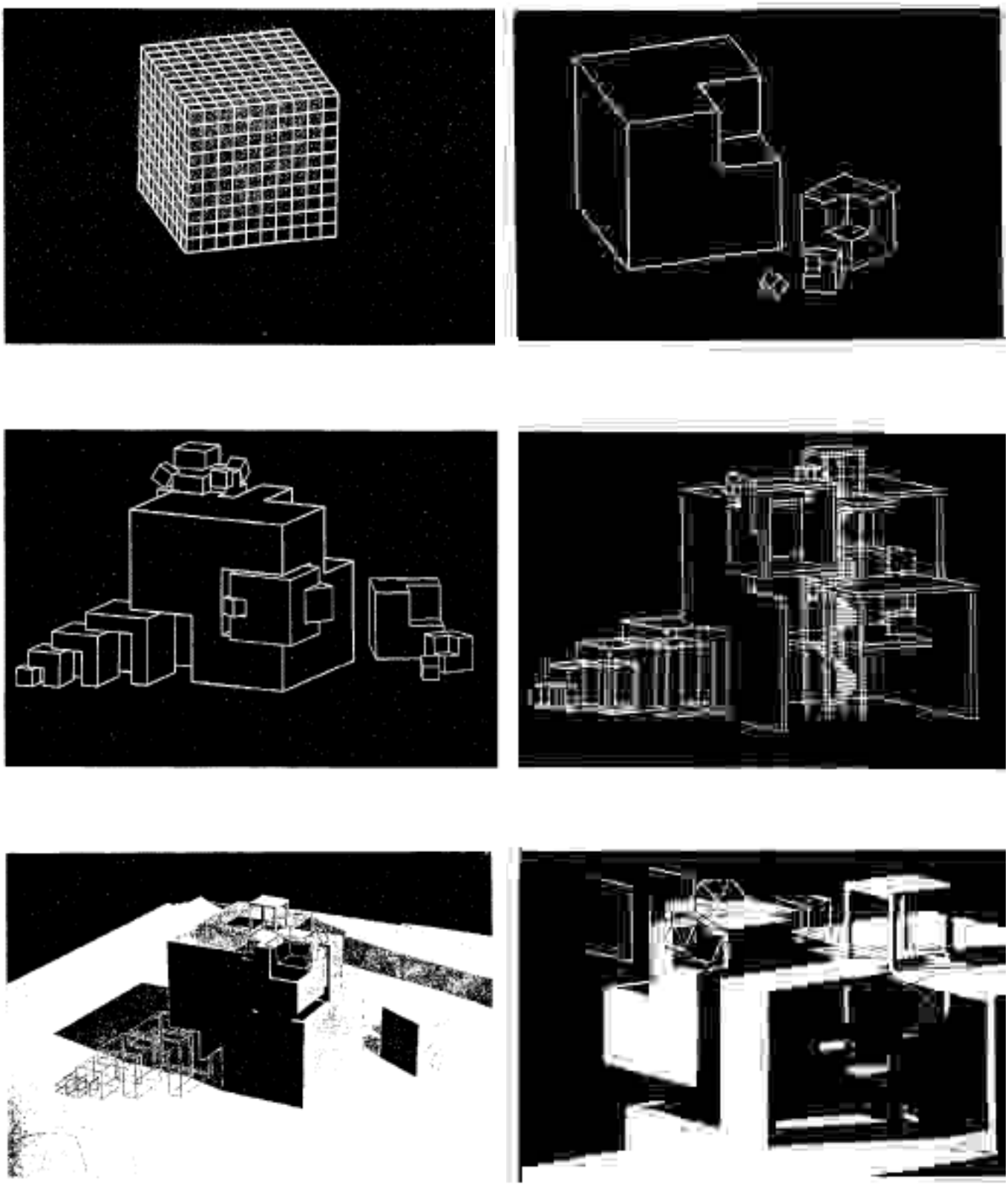
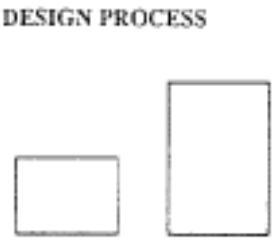


Figure 6 : One result of the abstract design Seminar

5 Exercises for a functionally oriented design with CAD

For the second seminar [note 2] (which is still in progress) another exhibition pavilion was chosen as subject, now emphasizing the concrete, functional design (figure 7: assignment). In this course architecture and civil engineering students work together. The chosen wood-construction for the building makes it possible to light upon another advantage of CAD over classical media: The interaction of parts and the whole, of local wood connections and the global building structure can be much better visualized. CAD can thus help to teach principles of good design. (For an example, see figure 8)



Assignment

- Design on an single-room exhibition building in light frame constructions

- Exhibition-room 300 m 2
  Store-rooms 80 m 2

- Presentation of the design in:
  - Floor plan - Elevation - Constructional details
  - Section - Perspective

- Documentation of studies in proportion, light, color and construction in 3-D

Figure 7 : Assignment for a functionally oriented design seminar

[2] Cooperation with : Lehrstuhl Entwerfen und Baukonstruktion, Prof. von Busse and Lehrstuhl Tragkonstruktionen, Dipl. Ing. Kleinschmidt

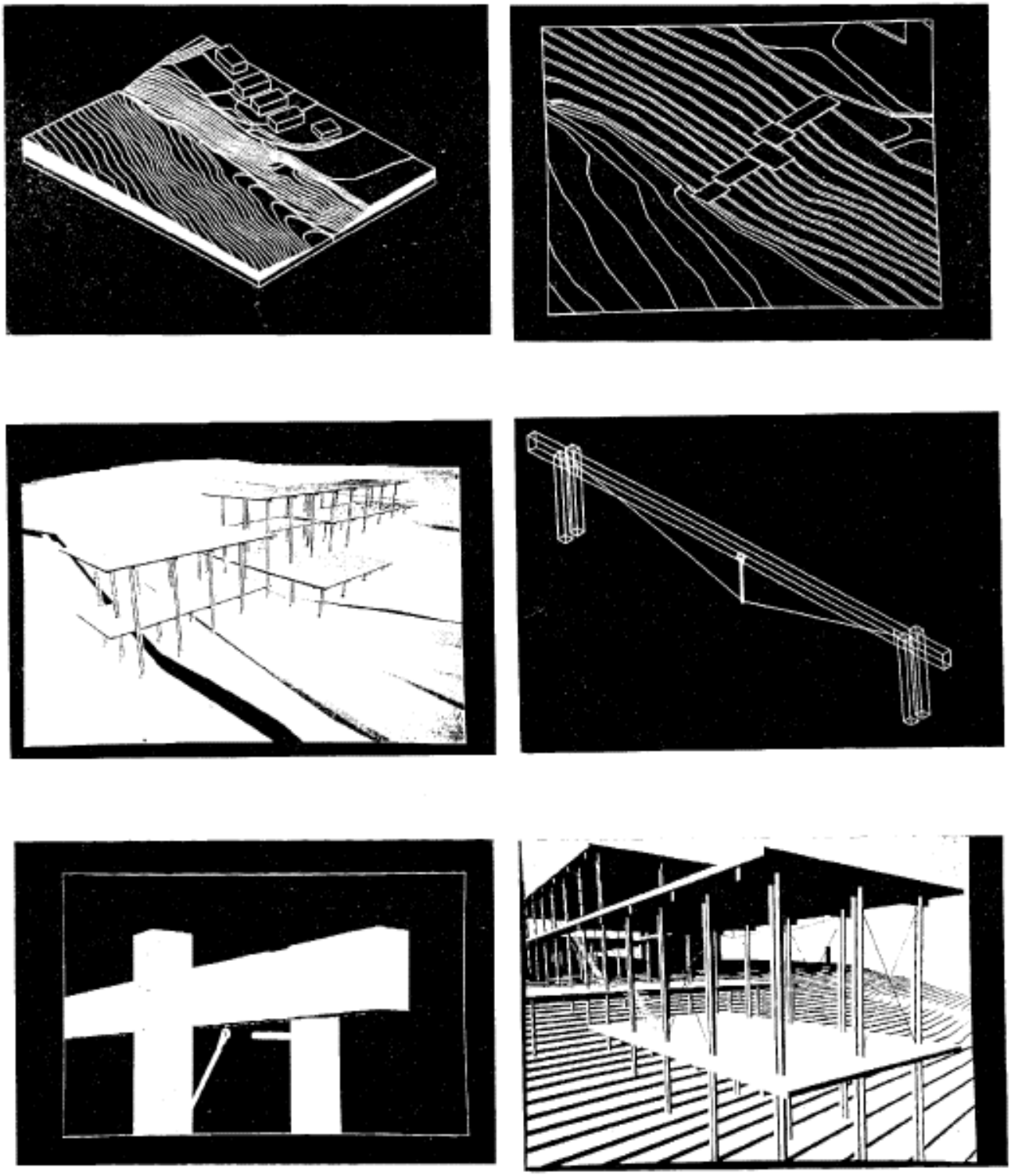


Figure 8 : Example

6 Conclusions

We consider the following points to be very important in education of architectural students in CAD:

- Elementary computer science should be taught as compulsory subject in undergraduate courses, emphasizing not superficial operation of given programs but the ability to understand the principles behind.

- CAD should be taught from the beginning in a three-dimensional framework, thus not being considered as a drafting but as a design tool.

- In graduate CAD-courses computer scientists and practicing architecture chairs should work together, making it possible to use advanced techniques *and* to teach design of professional quality.

- Architectural design courses using CAD should focus on the specific advantages of this new medium which are, among other

  - the possibility to make the design history visible
  - the ability to study designs in their interaction of local and global features.

References

[1] Busse, Hans Busso von ; W*ahrnehmungen , Karl* Kramer Verlag, Stuttgart/Zürich, 1990

[2]Laseau, Paul; *Graphic Thinking for Architects and Designers,* van Nostrand Reinhold Company, New York, 1980

[3]Gehri, Markus; Wiederkehr, Urs; *Computerwissen für Bauingenieure,* vfd Verlag der Fachvereine, Zürich, 1993

[41 Ferrante, A.J. et.al. ; Computer *Graphics for Engineers and Architects,* Elsevier Computational Mechanics Publication, Amsterdam, 1991