3.1 C-ad hoc education

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In the framework of an evolving curriculum we have been developing a series of CAAD exercises aimed at providing the basic knowledge and skills a student needs. The series formed initially a conventional sequence that mapped design stages and corresponded with the gradual development of knowledge and skills. Due to originally practical reasons we are currently relaxing the sequential structure of the CAAD curriculum. This gives us the opportunity to experiment with the integration of the CAAD exercises in the wider design activities of the students, as well as with the structure of the exercises themselves as fully self-contained units.

Introduction

As in the past few years the curriculum of the Faculty of Architecture, Delft University of Technology, has been undergoing a drastic and extensive reorganization, our main task and challenge has been the development of a series of CAAD exercises in a new, still evolving framework. Based on the concept of problem-based learning the new curriculum consists of blocks with a duration of six weeks (six blocks per year). The twelve blocks of the first two years aim at delivering the basics of architectural education in a thematic series. 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. This framework imposes strict and sometimes stringent constraints on the content and form of the CAAD exercises but its evolving character also offers the freedom to experiment with alternative approaches and exercise structures. Some of the experiments are originally due to practical consequences of the overall curricular structure and the multidisciplinary character of each block. Nevertheless, every experiment forms an opportunity to actively explore new themes and approaches that can be instrumental for testing our assumptions concerning CAAD and its teaching.

Experimentation and redevelopment of a exercise or of the overall structure of the CAAD curriculum focuses on a number of sometimes conflicting constraints. The first constraint is integration of the CAAD exercises into the wider design activities of a block. This allows us to build on the knowledge and skills students acquire in a block. It also facilitates the use of specific computer methods and tools for the resolution of specific design problems. In short, integration improves the homogeneity of a block and supports thus a close linking of computers and designing. A second constraint is the internal structure and order of the CAAD exercises. These aim at supporting the students’ gradual progress from basic to advanced skills and at a paced widening their understanding of and experiences with computer-aided design. Both constraints relate to a third one, correspondence with stages of the design process. The block structure aims at a thematic subdivision of the design process into parts that generally correspond to stages of analysis and synthesis, even though the relationships between different block themes is more intricate than what the block sequence might suggest. The gradual development of design knowledge and skills also corresponds with the development of a design, especially with respect to the abstraction and specificity of its representation.
The sequential approach

The overall structure of the CAAD curriculum had initially followed established conventional patterns. In five second year exercises spread across five blocks we have attempted to present the basic methodology and technology of CAAD so that the students acquire the essential knowledge and develop the necessary skills for the effective and efficient use of CAAD. The exercises formed a sequence that mapped a schematic model of the design process, starting with the development of a basic design, proceeding with its evaluation, improvement and detailed specification, and concluding with the presentation of the results. Designs and analyses produced by the students in one exercise formed the basis for the following exercise. The five exercises were:

- Preliminary design
- Analysis and evaluation
- Two-dimensional design representations
- Three-dimensional design representations
- Visualization and presentation

The principles of this schematization of the design process and its mapping appear to underlie a fair share of theoretical treatises and the majority of CAAD textbooks, as one can see from the logical organization of their content [Broadbent, 1988; Lawson, 1990; Mitchell, 1990; Mitchell and McCullough, 1991; Schmitt, 1993]. The methodological considerations are complemented by the practical benefits of the exercise sequence that also corresponds with the gradual development of the students’ CAAD skills, from the basic ones required for manipulating a simple computer document to the more advanced development of complex representations implemented in more than one applications.

However, the methodological and practical advantages of the strict sequential order of CAAD exercises were drastically reduced by the overall structure of the block curriculum. While blocks in each year form a clear thematic succession, students are not obliged to follow blocks in their thematic order. Not following this order generally reduces the student’s performance, as what one learns in a block partially builds on knowledge and skills acquired in the thematically preceding blocks. For the CAAD exercises it was more problematic because each exercise relied heavily on both the skills and the products of the previous CAAD exercise. What made things even worse was that because of capacity limitations the blocks of each year were offered in two different sequences (i.e., in each six week period not one but two blocks were given). The first of the sequences (which corresponded to the original thematic block succession) befit the order of CAAD exercises but the other one presented few opportunities for correlating block and CAAD themes. As a result, it was decided that the CAAD exercises would form an independent third sequence with little if any integration in the two block sequences. This was clearly confusing to the students who tended to lose motivation when the CAAD exercise was unrelated to the rest of the block. It also led to a number of administrative problems, as a student could skip blocks or follow blocks of both sequences.

The distributed approach

Integration of the five exercises in the corresponding blocks of the second year became a priority because of the inability (or unwillingness) of the students to follow the prescribed succession and their resulting poor performance in exercises such as ”Analysis and evaluation” or ”Visualization and presentation” that relied heavily on the products of the previous exercises. Integration was seen as an answer to motivation and comprehension problems and a definite solution to administrative problems—at least as far as the CAAD exercises are concerned.

The new exercises became more thematic in character and clearly independent of each other. Exercises with a clearly defined content, remained essentially unchanged, except for that they did not rely on results from other exercises. The content of other exercises that related more to different levels of abstraction / specificity in the representation of a design was analysed into a number of basic components that were subsequently reorganized into exercises that covered all relevant abstraction levels together with analysis and synthesis. The five new exercises are:

- Preliminary design: The design of a new building for an elementary school on the basis of a number of precedents that are supplied as computer documents. For the implementation of the design students use a drafting and a spreadsheet program (the latter for a comparison with programmatic requirements).
• **Parametric design:** The design of a staircase using initially a spreadsheet program to numerically represent the basic sizes of the stairs. The numerical representation is exported to a drafting program where it is automatically transformed into a geometric representation of the basic form of the stair. The student subsequently designs the remaining elements of the staircase in the drafting program.

• **Optimization:** The analysis, evaluation and optimization of a preliminary design with respect to a variety of aspects. The design is represented using a drafting program. The numerical analyses are performed using a spreadsheet program. Connections between the two programs permit direct exploration of different scenarios.

• **Daylighting analysis:** Representation and analysis of the built environment with respect to daylighting using a drafting program and photorealistic presentation. Students are asked to consider various levels of abstraction that correspond to different levels of spatial organization and use the results of the analysis to generate variations and alternative solutions. The design of sundials plays a central role in this exercise.

• **Visualization and presentation:** Representation of part of the envelope of an existing building, followed by photorealistic and dynamic presentation and finally generation of variations and alternative solutions.

As each of these exercises tackles a specific problem that forms part of the wider design problem of the corresponding block, the resulting overall picture of the new CAAD curriculum is one of a number of coordinated but independent exercises with a clearly defined knowledge component that might require skills also encountered in exercises. The thematic character of the exercises and the consequent distribution of CAAD knowledge and skills is not entirely due to practical reasons. To an extent it stems from more theoretically and methodologically oriented computer studies of architectural design where each approach or method is considered in isolation before a concluding comparative evaluation [Koutamanis and Tzonis, 1990; Bridges, 1992].

The practical problem that arises is that, while in the previous structure of the CAAD curriculum students could progressively develop their knowledge and skills, each of the new exercises presupposes a higher level of acquaintance with CAAD. The problem is resolved by including this acquaintance in each exercise. If, for example, an exercise requires the use of a drafting and a spreadsheet program, provision is made that students can learn these programs in the framework of the exercise. This permits in effect a student to follow the CAAD exercises in any order he or she wishes. Overlapping between exercises presents the students with an opportunity to improve their understanding of the programs and the corresponding skills or spend more time on the design they are asked to produce.

The inclusion of program learning in every exercise also relates to our expectations of the level students should reach with respect to CAAD —what we call a ‘variable achievement scheme’. Even though all CAAD exercises are compulsory and students are generally interested in computer technology, it is unreasonable to expect that every student should become proficient in CAAD, especially since the number of students that follow the exercises each year is quite large (over five hundred). Many students consider the computer as a mere tool that can improve efficiency in certain design tasks, while others (thankfully a small minority) are unable to comprehend or accept the possibilities offered by CAAD. For such students a basic computer and CAAD literacy is considered to be sufficient. Learning how to use the required programs in the framework of design exercises is therefore all they have to do. Students who are interested in both the technological and methodological aspects of CAAD can go further than mere CAAD literacy and actively explore more possibilities and capabilities. For these students the variable achievement scheme has additional benefits, as it allows closer and more intensive supervision by the teaching staff, use of more advanced computer facilities and the setting up of individual projects that prepare the students for a possible specialization in CAAD.

**Future development**

The transition of our CAAD curriculum from a conventional sequence of exercises to a coordinated distributed system has obvious practical benefits in the framework of the curricular structure of the Faculty of Architecture, Delft University of Technology. We trust that the ad hoc structure of CAAD exercises is sufficiently coherent and comprehensive for demonstrating the potential of computer-aided design and for learning its methods and techniques. What is further required is an extension of the CAAD curriculum so as to cover more design problems and aspects than the ones covered by the existing exercises. In addition, we should augment the CAAD instrumentation with more computer technologies, from information systems to virtual reality, that offer supplementary possibilities for the
automation of design tasks. From a methodological point of view the distribution of CAAD exercises may prove more beneficial for the involvement of other architectural and building specializations than the development of holistic CAAD projects where such specializations are only accidentally involved. In other words, it may be preferable to integrate CAAD in architectural and building science courses, even on an ad hoc basis, than include elements of the corresponding knowledge areas in CAAD courses.

References
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