Computing and Problem Based Learning at Delft University of Technology Faculty of Architecture

Prof. Dr. Alan H. Bridges

1 - Architectural Education at Delft University of Technology

Delft University of Technology, founded in 1842, is the oldest and largest technical university in the Netherlands. It provides education for more than 13,000 students in fifteen main subject areas. The Faculty of Architecture, Housing, Urban Design and Planning is one of the largest faculties of the DUT with some 2000 students and over 500 staff members. The course of study takes four academic years: a first year (Propaedeuse) and a further three years (Doctoraal) leading to the "Ingenieur" qualification. The basic course material is delivered in the first two years and is taken by all students. The third and fourth years consist of a smaller number of compulsory subjects in each of the department's specialist areas together with a wide range of option choices. The five main subject areas the students may choose from for their specialisation are Architecture, Building and Project Management, Building Technology, Urban Design and Planning, and Housing.

The curriculum of the Faculty has been radically revised over the last two years and is now based on the concept of "Problem-Based Learning". The subject matter taught is divided thematically into specific issues that are taught in six week blocks. The vehicles for these blocks are specially selected and adapted case studies prepared by teams of staff members. These provide a focus for integrating specialist subjects around a studio based design theme. In the case of second year this studio is largely computer-based: many drawings are produced by computer and several specially written computer applications are used in association with the specialist inputs.

This paper describes the "block structure" used in second year, giving examples of the special computer programs used, but also raises a number of broader educational issues. Introduction of the block system arose as a method of curriculum integration in response to difficulties emerging from the independent functioning of strong discipline areas in the traditional work groups. The need for a greater level of self-directed learning was recognised as opposed to the "passive information model" of student learning in which the students are seen as empty vessels to be filled with knowledge - which they are then usually unable to apply in design related contexts in the studio. Furthermore, the value of electives had been questioned: whilst enabling some diversity of choice, they may also be seen as diverting attention and resources from the real problems of teaching architecture.

2 - The Delivery of Educational Material

The role of the design studio is unique to architectural education. There is no counter-part in other university based courses and so the tendency has been to downgrade the importance of studio tuition in university schools of architecture to allow more time and resources to be allocated to those other parts of the curriculum which are able to be taught and examined in a more traditionally "academic" way. At the same time such academic theories of architecture as are developed in schools of architecture are seen as being irrelevant to practice and consequently the universities, which should be the centres for the promotion, development and transferral of professional competence, are perceived as being out of touch with the realities of architectural practice. This malaise has been attributed by Schön (1983) to a misguided epistemology. He describes the practice of architecture as "reflection in action" and argues that the educational methods of architecture should be modelled on that process and not imitate the methods used by other disciplines. The concern with theory and practice should be replaced by experience and reflection on that practice. The complexity of architectural practice with its convoluted relationships between client, user, statutory authorities, consultants and architects provides the background against which experience of architecture is gained. There is a serious mismatch between this practical experience and academic theories of what architecture is supposed to be - the grand, abstract theories of design. Whilst 't has often been said that theory should be divorced from practice an alternative approach is to re-evaluate that experience and rethink the rôle of architecture in the light of that experience. This approach has been given new intellectual impetus by Dreyfus (1991), building on the theories of Heidegger (1962), in arguing that scholarship does not require the development of theories against which experience is measured. The primacy of theory and carefully articulated explanation is replaced by common experience, desires and dialogue. Habermas (1973) argues that the defects of imperfect knowledge (this is simply another term for irrationality) originate in the "cognitive attitude" of positivist science. By adopting the logic of science architectural theorists have become unable to perceive themselves as the subject of reflection. By their scientific orientation its members are obliged to objectivate themselves. Unable to meet the demand for self-reflection without simultaneous abandonment of their theory, they reject that demand by conceiving a programme of theory that would make all demands of self-reflection immaterial. In other words, the terms that we bring from within ourselves (from experience) to the process of enquiry are amenable to a reflection that is rational for the very reason that it carries the potential for a more inclusive conceptualisation that is better attuned to the common interests of the profession.

Thus the primary objective in schools of architecture should be to provide the opportunity to gain experience and to debate the various ways in which designs may be developed. The teaching of design is carried out in the process of designing. Whilst most schools would share this objective they are also conscious of the difficulties of achieving it and of the very small amount of active design tuition that takes place. The problem based learning approach tackles this difficulty directly by integrating the curriculum around a series of "real" problems requiring niultidisciplinary co-operation for their solution. The resulting course structure may be seen as a matrix in which the various disciplines (or "areas of knowledge") are developed through a succession of problems (figure 1).

The adoption of such an approach forces a radical reappraisal of the whole curriculum. Basic questions that have to be answered include:

- problem setting as well as problem solving; that is, deciding what the problem really is and what its scope should include;

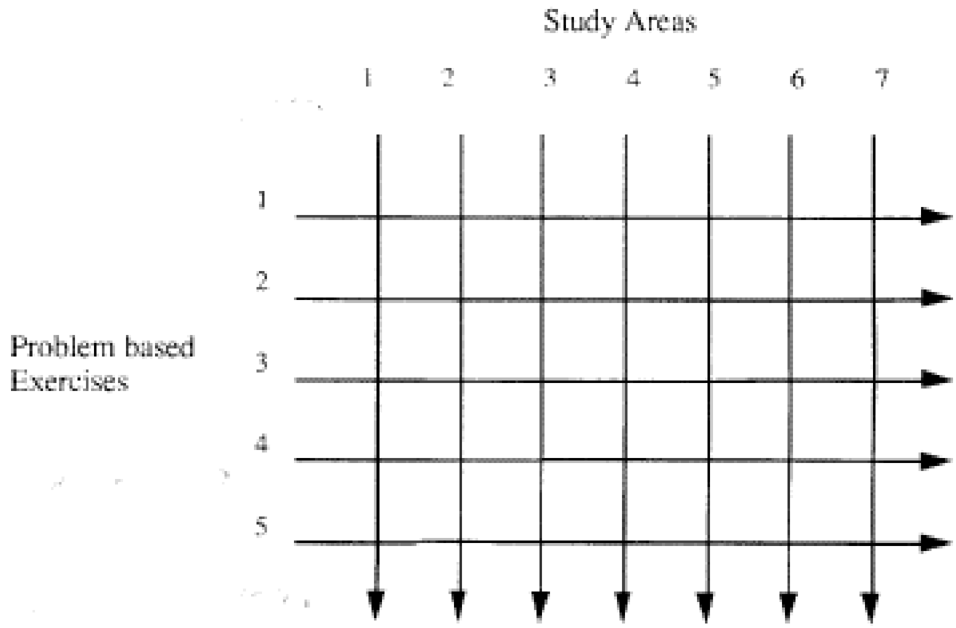

Figure 1 The Matrix Structure of Problem Based Learning

- identifying areas of skill and knowledge which have to be acquired in order to solve the problem;
- understanding the relationship between individual tasks within the whole cycle of a project so that the relatedness of decisions can be appreciated and a hierarchy of decision-making established.

3 - Principle Features of the Course

Since the problems offered to students are the generators of their learning process and the vehicle through which areas of specialist knowledge are to be introduced, the selection and definition of the problems are extremely important. They must be carefully designed to ensure that the knowledge required is of an appropriate level and that all aspects of the curriculum are covered. The range of problems developed should also relate to one another in an integrated way to enable students to build on earlier learning experiences.

The way in which this is done is to select a problem-theme for each year of study, so that the overall programme amounts to a reasonably comprehensive range of relevant problems. Various aspects of the theme are then explored through a succession of phases. Each phase is based upon a specific problem, which, inevitably, contain a number of sub problems. The duration of the phase will depend upon the range of sub problems and the depth to which the problem is to be explored. For example, the problem theme of second year is Social Housing. The students follow a complete design cycle from site investigation and briefing through to detailed construction drawings. The project thus contains many sub problems, such as defining the brief, spatial layout, environmental calculations, building construction, and so on. Each of these sub problems is addressed independently vet within the overall context of the main design problem.

4 - Study Areas

To structure the educational material the six blocks delivered in second year (numbered 7 to 12 to follow on from the six first year blocks) focus on particular study areas. These study areas roughly correspond to the stages of an idealised design cycle, and hence to the development of a solution to a typical architectural design problem.

Block 7 Order and Programming

This block defines the legal, financial and statutory background to the project. Students are required to undertake market analysis surveys, site investigations and cost and building quality studies. Population data arid other social statistics are analysed using standard statistical packages such as SPSS. The various building planning options are investigated using an in-house cluster analysis program, KLUS, running on MS-DOS machines.

Block 8 Form and Function

This block studies the typology of social housing and construction techniques. Students are introduced to a customised version of AutoCAD which enables outline plans to be drawn making use of predefined building construction elements. A specially written program for simple structural analysis (DRAKO, running on MSDOS machines) is used, together with an outline costing program (BOUKO) written as a MS-Excel template (running on MS-DOS and Apple Macintosh machines).

Block 9 Technical Installations

This block concentrates on the mechanical installations - water, electricity, lighting, heating, sanitation, lifts, etc. Some of the technical issues involved are taught using a simulation model written in Authorware Professional (Macintosh). Detailed analyses of internal temperatures are made using an in-house package WARMB (Macintosh) and heating installations and operational regimes designed using another specially developed package, KLIMA (MS-DOS). Further elements of the customised AutoCAD are revealed to enable the addition of services installation details.

Block 10 Environmental Issues
This block makes extensive use of a range of Macintosh based simulations to study the "environmental friendliness" of the proposed design. Issues discussed include the environmental implications associated with various building materials, the overall energy balance of the proposed design, alternative energy sources and so on. The background material is contained in two Hypercard stacks and the technical calculations performed using four specially developed MS-Excel templates.

Block 11 Obsolescence and Reuse
This block not only looks at the development over time of the proposed design, but also the alternatives to "new build" such as the renovation and reuse of existing buildings. More use is made of AutoCAD and a specially written costing program (INKOS) for costing change in use and renovation projects is linked to it.

Block 12 Building Technology
This block examines the details of the construction process and various building products and construction technologies. The customised AutoCAD is used to produce detailed construction drawings.

5 - Teaching Method

In the matrix like pattern in which problems and study areas are developed, members of staff play a variety of facilitating roles. One full-time member of staff is appointed as the Year Manager and is responsible for the overall management and time tabling of that year. Teaching and planning of the study areas is provided by full and part-time staff acting as "consultants". A full-time member of staff acts as Block Coordinator and is responsible for the course documentation and the supervision of the delivery of the course material. The full and part-time staff also act in a generalist role as tutors to smaller groups of students. Although some assignments are carried out individually, much of the work is done in groups. The purpose of this group working is partly pragmatic but also has benefits to the students in terms of tutorial assistance, gaining experience of group dynamics in design teams, providing social support and enabling the division of tasks.

The delivery of the teaching material is varied. It may take the form of traditional lectures, but concentrated workshops, field study trips, videotape programmes, computer exercises and practical work is also included. The basis of the approach is that new areas of skill and knowledge should be developed in the context of problems in which they can be applied and related to other such areas, so that a student is entitled to ask what the relevance of a particular presentation may be. The Second year course uses a large number of computer exercises and this poses some special problems in so far as new skills have to be developed in respect of computing before the need to use those skills in the design context. Thus special exercises are planned as preparation for a task that can be seen to lie ahead, just as a practitioner may need to develop some new skill or area of knowledge in anticipation of a new job.

Along with the consultant and group teaching sessions, a number of facilities have been developed to assist self-directed learning. The basic resource is the Block Handbook (TU Delft, 1991) which contains the key reference texts to support and supplement class sessions. A number of specially written computer programs have also been developed for computer-assisted individual learning.

6 - Conclusion

This paper has described in outline of the second year architecture course taught at TU Delft. It has described some of the background theories associated with problem-based learning. It has not discussed the considerable problems involved in the development of course material or the associated problems involved in staff training with respect to the computing elements of the course. The in-house course material has (in the main) been written by M. Mellis and S. Inanç of the Faculteit der Bouwkunde CAD Atelier. Staff training has been carried out in two stages. Firstly a series of introductory seminars explaining the use of computers in design was arranged for all staff involved. These seminars presented a broad overview of the subject and included presentations from TU Delft staff and invited contributions from TU Eindhoven and architectural practitioners. A second level of tutorials was arranged just before each module to enable the tutors involved to familiarise themselves with the CAD exercises. The supervision of the AutoCAD elements is provided by members of the CAD Atelier staff.

7 - References

Dreyfus, Hubert (1991); Being-in-the-World: a Commentary on Heidegger's Being and Time, Division 1; MIT Press, Cambridge, 1991.

Habermas, Jürgen (1973); A Postscript to Knowledge and Human Interests in Philosophy of the Social Sciences, 3, 1973. pp 157-189.

Heidegger, Martin (1962); Being and Time; Blackwell, 1962.

Schön, Donald A, (1983); The Reflective Practitioner: How Professionals Think in Action; Basic Books, N.Y., 1983.

TU Delft (1991)
- Blokboek 7 - Opdracht en Programma
- Blokboek 8 - Vorm en Functie
- Blokboek 9 - Technische Voorzieningen
- Blokboek 10 - Integratie van Milieuaspekten in de Gebouwde Omgeving
- Blokboek 11 - Veroudering en Hergebruik
- Blokboek 12 - Beeldvorming en Materialisatie