INTERNATIONAL IMPLEMENTATION OF A CAAD PROJECT

IN

SCHOOLS OF ARCHITECTURE

Prof T W Maver, BSc, PhD, ABACUS, University of Strathclyde, Glasgow UK
R Schijf IRArch, DocTHD, Dept. of Architecture, Technical University of
Delft, Netherlands

With funding from the European Cultural Committee, work is in hand
to develop a modular course structure which will promote CAAD
education in Schools of Architecture throughout Europe. The
paper identifies the need for the course structure and describes
the pilot work jointly carried out by the University of Strathclyde
and the Technical University of Delft. The course structure proposed
in the paper will be the focus of discussion and elaboration at a
meeting of European Schools of Architecture scheduled for October
1982, in Delft.
1. **INTRODUCTION**

Young people currently studying in Schools of Architecture will be at the height of their professional career around the year 2000. The Schools of Architecture have a responsibility to introduce students to the concepts underlying the new generation of computer-based design aids and to their application in design project work, for, quite clearly, this new generation of modelling aids will have as dramatic an impact on the process and product of architectural design and on the relationship between architect and client, as did the introduction of the drawn plan and elevation, 5000 years ago.

The aspects of architectural practice on which computers are already making an impact are:

- **management**: office organisation and project control
- **drafting**: the production of working drawings
- **design**: analysis, synthesis, appraisal and decision

Each aspect is as important as the other two and ultimately the full potential of the computer will only be realised when all three are brought into systematic conjunction. In the limited time available in undergraduate courses, however, and given the difficulty of simulating office conditions, including relationships with the contractor, the starting point in Schools of Architecture should be with computer aided design, or, more specifically, with computer aided architectural design (CAAD).

Consideration of how best to introduce CAAD into the undergraduate curriculum brings one immediately to the differentiation between using and developing CAAD techniques. Primarily, in Schools of Architecture, we are concerned with fostering in the student an understanding of the causal relationships between design decisions and performance consequences: the **use** of CAAD programs, as we shall see in a later section of this paper, simply as 'black boxes' which predict the cost and performance characteristics of alternative design hypotheses, affords the student a special insight into the nature of the design activity and the complex interactions between economic, environmental, structural and aesthetic criteria. All students, then, should have the opportunity to **use** typical CAAD programs and, through their use, to develop a broad understanding of their ultimate potential and of their technical, economic, social and professional implications.

It would be a mistake, however, to limit our commitment to **use** only. As the technical complexity of building has grown, responsibility for significant sub-systems within the building have been passed by the architect to a range of specialist consultants - the structural engineer, the environmental engineer, the quantity surveyor, the perspective artist, etc.; comprehensive CAAD models offer the opportunity to regain the integrative responsibility for the design in its entirety. It is important, then, that the **development** of CAAD programs, i.e. the design of the design aids, is seen as an architectural responsibility and that at least a selection of Schools of Architecture offer the opportunity to students to become expert in the theory and practice of CAAD. Those taking up the opportunity would become the authors of new software and the specifiers of hardware appropriate to the architectural profession and the building industry.
There is, however, a real difficulty facing Schools of Architecture that wish to get started in CAAD: money is tight, expertise is scarce and the signal to noise ratio in the architectural press is low. This paper describes the first steps in an initiative, modestly funded by the European Cultural Committee, to develop a library of CAAD course units that could, in many combinations, be used at architectural schools throughout Europe for undergraduate, postgraduate and mid-career education (Ref 1). The paper describes the pilot work to date, the set of proposals suggested by the pilot work and the likely next steps in the endeavour.

2. **PILOT WORK**

The Department of Architecture & Building Science at the University of Strathclyde and the Department of Architecture at the Technical University of Delft have been working jointly to pilot a range of course modules which might build into an appropriate modular course structure suitable for Schools of Architecture throughout Europe. With the help of a number of other Schools, notably the Schools of Architecture in Antwerp, Tilburg, Sheffield and Aberdeen, experience has been gained in running studio projects using a range of computer programs. The following subsections describe the programs and their use in three Schools.

2.1 **The Computer Programs**

To date, some five or six computer programs have been piloted. The programs used were those readily available to the investigators and do not represent a definitive or complete list of the programs which will provide the backup to the modular course structure. Those described here, are, however, typical of those which will be required.

**GOAL:** GOAL (General Outline Appraisal of Layouts) was developed by ABACUS at the University of Strathclyde (Ref 2) to allow the comprehensive appraisal of alternative design hypotheses at the earliest possible stage in design. The architect (i.e. the student) inputs (among other things) a proposed geometry and construction. Geometry (currently orthogonal, soon to include non-orthogonal) is input by floor by floor using a digitising tablet or at the terminal screen, either numerically or graphically. Constructional choices are made from an expandable constructions data base containing cost and thermal characteristics. Output from GOAL includes a range of cost and performance predictions, including:

- wall, floor and roof areas; volumes; wall to floor ratio, etc.
- measures of functional planning efficiency
- environmental conditions - thermal, lighting, acoustic
- energy utilisation - peak, annual; compliance with regulations
- costs - capital, recurring and costs-in-use

Design changes are easily made and their cost and performance consequences rapidly determined. Results from a large series of design searches can be filed and retrieved for comparison between students and between Schools. The geometry held in file can be passed to the program BIBLE.
BIBLE: BIBLE (Buildings with Invisible Back Lines Eliminated), also
developed by ABACUS at the University of Strathclyde (Ref 3), generates
perspective views of any geometry passed to it from GOAL or input to
it directly by the user. When initiated the program draws a small
plan view at the centre of the terminal screen and provides a set of
commands which allow the user, amongst other things, to:

specify eyepoint, focus point, cone of vision, etc
choose if the back lines are to be hidden, shown full or shown pecked
choose a full three point perspective or orthogonal projection
match the perspective to an existing site photograph
get the view drawn either on the screen or on a plotter

GABLE: GABLE was developed at the School of Architecture at the
University of Sheffield (Ref 4). It runs on the Tektronix 4050
series of micro-processors and allows checking of daylight, sunlight,
energy consumption and other appraisals to be carried out. Three
point perspectives of the geometry can be produced, from viewpoints
inside and outside the building envelope and the production of con-
ventional drawings suitable for the contractor is possible.

IVOGAR: IVOGAR, under development in the Department of Architecture
at the Technical University of Delft is intended to provide a general
drawing aid and to effect appropriate interfaces to, and between,
GOAL, BIBLE, GABLE and other software packages.

2.2 Use of the Programs

Some or all of the computer programs are in use, exploratively, in
a number of Schools of Architecture in the UK, Continental Europe
and elsewhere in the world. The uses described here are specifically
relevant to the development of the modular course structure.

Strathclyde: The Department of Architecture and Building Science at
the University of Strathclyde runs undergraduate and mid-career courses
and will shortly introduce an MSc in CAAD. At undergraduate level,
the differentiation is made between the needs of those who will use
CAAD and those who wish, optionally, to develop CAAD. A number of
second year and fourth year design projects have a CAAD bias including
a 5-week hotel design project in fourth year, which makes extensive
use of GOAL and BIBLE. Fig. 1 is a photoreduction of an A1 board,
one of six, submitted by a student taking the project; it shows four
of the ten or so designs he appraised using GOAL. Fig. 2 is a
photoreduction of another of his boards, showing a range of
perspective views based on the output from BIBLE.

Delft: The Department of Architecture at the Technische Hogeschool
Delft offers third and fourth year students a number of CAAD options
which provide a conceptual framework, give 'hands-on' experience of
a range of available programs and provide the opportunity to use
certain of the programs (GOAL, BIBLE, GABLE, IVOGAR and others) in a
major studio project. Projects have included a 100-bed hotel and
a central lecture room block for a University campus. Figs. 3 and
4 show perspective views of the campus with the proposed lecture
block as drawn by BIBLE.
Antwerp and Tilburg: Short courses and limited projects have been run, with inputs from Strathclyde and/or Delft, at the Nationale Hoger Instituut voor Bouwkunst en Stedebouw in Antwerp and the Akademie voor Bouwkunst in Tilburg. In the case of Tilburg, students travelled to Delft to use the computing facilities; from Antwerp, students dialled in over the international telephone network. As the time available for project work in both institutions was severely constrained, students did not generate design proposals from scratch; each was given a design proposal generated by a Delft student and asked to improve its cost/performance profile using GOAL and BIBLE. Fig. 5 summarises the comparative evaluation of design alternatives by Tilburg students.

3. PROPOSED MODULAR COURSE STRUCTURE

The experience to date at Strathclyde, Delft, Antwerp, Tilburg and elsewhere, points to a course structure with five types of unit, as follows:

1. **Exposition.** The concepts underlying CAAD, survey of the state of the art, and demonstrations

2. **Preparation.** Hands-on experience of a range of programs and discussion of their form, content and interfaces

3. **Application.** Using one or more programs in a studio design project

4. **Instruction.** Acquiring programming skills and knowledge of hardware and software systems

5. **Development.** Specifying implementing and maintaining hardware and software systems

Units 1, 2 and 3 are sufficient to prepare students for CAAD use; units 4 and 5 are needed if the student wishes to go on to develop CAAD expertise. The units are described in turn in the following subsections.

3.1 Exposition

This unit comprises lecture, seminars and demonstrations. The lecture material will include the history of computing, hardware types and trends, software concepts and artificial intelligence, the relevance of design methodology and systems concepts, a review of computer applications in architecture (management, drafting and design), economics, problems and prospects and future trends. Demonstrations may be in-house, in other Schools and, best of all, in local practices.

3.2 Preparation

This unit gives the student 'hands-on' experience in a controlled way. It is intended to introduce the student to three aspects:

i) the man-machine interface - keyboard, screen, tablet, plotter, operating systems, i.e. what button does what

ii) software logic - program, files, algorithms, documentation, i.e. how the input gets transformed into an output in various example programs

iii) data preparation - collecting, formating and inputting the data needed for a variety of example programs.
3.3 **Application**

This is the central unit in the modular course structure and is intended to take its place alongside conventional design projects in the U/G studio. Students would be expected, in addition to submitting plans and elevations at the final crit, to show the sequence of their search for a solution with explicit comparative evaluation of the range of design alternatives which were appraised during the project. For projects of five or more weeks, students would, typically, design 'from scratch'; in shorter projects, students might be given a design (say from an earlier project or from another school) as a starting point.

3.4 **Instruction**

This unit, offered only optionally, and perhaps only in certain Schools, includes discussion of program languages (including Instruction in one), databases and operating systems and of the comparative performance of micro, mini and mainframe hardware.

3.5 **Development**

Again, this Unit would be offered only optionally and only in certain Schools where the degree of access to hardware and software and to expertise was high. This final unit, with associated project time, is intended to equip graduates to fulfill a specialist role in practice - specifying, implementing and maintaining CAAD systems.

4. **THE FUTURE**

An invitation has been extended to the Schools listed in Appendix 1 to attend a meeting in Delft in October 1982, to discuss the draft proposals and to identify commitments which can be made to contribute to and/or to adopt part or all of the course structure. An appropriate response to the challenge of realising the potential of the new generation of design aids will be possible, we believe, only by collaborative action.

5. **ACKNOWLEDGEMENTS**

The authors gratefully acknowledge the financial support of the European Cultural Committee and the collaborative effort already contributed by colleagues in a number of Schools of Architecture.

6. **REFERENCES**


## Appendix

### Modular CAAD courses project

**Mailing list April 82**

<table>
<thead>
<tr>
<th>Section I</th>
<th>English Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.K. 1. Plymouth Polytechnic, Dept. of Architecture</td>
<td>Drake Circus, Plymouth, Devon, PL4 6AA</td>
</tr>
<tr>
<td></td>
<td>Attn. Prof. Graeme N. Ayling</td>
</tr>
<tr>
<td>2. Robert Gordon Inst. of Technology, The Scott Sutherland School of Architecture</td>
<td>Garthdee, Aberdeen AB2 9QH</td>
</tr>
<tr>
<td></td>
<td>Attn. Mr. Lennox, W.M. Leing</td>
</tr>
<tr>
<td>3. Brighton Polytechnic, Dept. of Architecture + Interior Design</td>
<td>Hollingdean Road, Brighton, BN2 4AT</td>
</tr>
<tr>
<td></td>
<td>Attn. Mr. Philip Ranger</td>
</tr>
<tr>
<td>4. University of Sheffield, Dept. of Architecture</td>
<td>The Arts Tower, Sheffield S10 2TN</td>
</tr>
<tr>
<td></td>
<td>Attn. Dr. Bryan Lawson</td>
</tr>
<tr>
<td>5. University of Edinburgh, Dept. of Architecture</td>
<td>20 Chambers St., Edinburgh EH1 1HZ</td>
</tr>
<tr>
<td></td>
<td>Attn. Dr. Iain High</td>
</tr>
<tr>
<td>6. Liverpool Polytechnic, School of Architecture</td>
<td>53 Victoria St., Liverpool</td>
</tr>
<tr>
<td></td>
<td>Attn. Mr. Paul Coates</td>
</tr>
<tr>
<td>Ireland 7. University College Dublin, School of Architecture</td>
<td>North Circular Road, Dublin 14</td>
</tr>
<tr>
<td></td>
<td>Attn. Prof. Dermot O'Connell</td>
</tr>
<tr>
<td>Denmark 8. Akademiet, Dept. of Architecture</td>
<td>Aarhus, Denmark 8000 Aarhus C</td>
</tr>
<tr>
<td></td>
<td>Attn. Mr. Christian Agger</td>
</tr>
<tr>
<td>Sweden 9. Tekniska Hogskolan i Lund, Sektionen for Arkitektur</td>
<td>Box 725, 220 07 Lund</td>
</tr>
<tr>
<td></td>
<td>Attn. Prof. Christer Bengtsson</td>
</tr>
<tr>
<td>10. Id. Dept. of Structural Engineering</td>
<td>Attn. Prof. Per Christiansson</td>
</tr>
<tr>
<td>11. Institutet for Verktogsteknisk Forskning</td>
<td>Stockholmsenheten, 100 44 Stockholm</td>
</tr>
<tr>
<td></td>
<td>Attn. Mr. Per Holmström</td>
</tr>
<tr>
<td>12. The Royal Inst. of Technology, School of Architecture</td>
<td>Folk, S100 44 Stockholm 70</td>
</tr>
<tr>
<td></td>
<td>Attn. Prof. Olle Wåhlström</td>
</tr>
</tbody>
</table>

Norway 13. Norges Tekniske Høgskole, Dept. of Architecture | 7034 Trondheim |
|           | Attn. Mr. L. Nordgård |

Finland 14. The Finnish Association of Architects | Eteläesplanadi 22A, SF-00130 Helsinki 13 |
|           | Attn. Mr. Matti Pöyry |

Germany 15. Technische Universität Berlin, Institut für Mechanik | Straße des 17. Juni 135, D-1000 Berlin 12 |
|           | Attn. Prof. Dr. -Ing. E. Karchen |

Switzerland 16. Institut für Bauplanung im Produktions- und Dienstleistungs- Bereich | Zürich Käferberg CH-8093 |
|           | Attn. Prof. Dr. -Ing. C. Nadeljekov |

17. Eidgenössische Technische Hochschule Zürich, Architekturabteilung | Zürich Käferberg CH-8093 |
|           | Attn. Prof. H.E. Kramel |
Section II  French Language

Belgium
18. Université de Liège, Laboratoire de Physique du Mécénat
15 Avenue des Tilleuls-BAT.D1, 3 4000 Liège
Attn. Prof. Albert Dupagne

Rue Wilmotte 76, 1060 Bruxelles
Attn. Dr. J. Masset

20. Institut Supérieur d’Architecture, Saint Luc de Tournai
Chaussée de Tournai 50, 7721 Ramengies Chin.
Attn. Mr. Alain Dequissé

21. Institut Supérieur d’Architecture
Rue Fabry 19, 400 Liège
Attn. Charles Burton

22. Université Catholique de Louvain, Unité Architecture
Bâtiment Vinci, Place du Levant I, B 1348 Louvain la Neuve
Attn. Prof. E. Verheugen

France
23. Ecole d’Architecture de Toulouse
Chemin de Mirail, 31037 Toulouse Cedex
Attn. Mr. Michel Légèle

24. Centre de Recherche Méthodiques d’Architecture et d’Aménagement
Rue M. Picherit (CSTB), Nantes 44300
Attn. Prof. J-P. Ponceau

25. Ecole d’Architecture de Grenoble
10 Galerie des Halles, F92000 Grenoble
Attn. Prof. Bertrand David

26. Unité Pédagogique d’Architecture de Marseille
70 Route Léon Lachamp, 13269 Marseille Luminy Cedex 9, Case 912
Attn. Mr. R. Billon

27. Unité Pédagogique d’Architecture no. 1
11 Quai Malraux, 75172 Paris Cedex 06
Attn. Mme. Catherine Urbain

28. Ecole d’Architecture de Bordeaux
Domaine de Raba 33405, Talence Cedex
Attn. Mr. Y. Lormant

29. Ecole Spéciale d’Architecture
234 Boulevard Raspail, 75014 Paris
Attn. Mr. Françoise Weirin, Directeur

30. Ecole National des Beaux Arts de Lyon
10 Rue Neyret, 69001 Lyon
Attn. Mr. Ph. Wahoum, Directeur

31. Unité Pédagogique d’Architecture de Lille
Le Forum – 43 Rue Gustave Delory, 59000 Lille
Attn. Mr. Pierre Eldin

Italy
32. Università degli Studi di Palermo, Facoltà di Architettura
Attn. Prof. Arch. Margherita De Simone

Via Bonardi 3, 20133 Milano
Attn. Mr. Alessandro Palistina

34. Università di Bari, Instituto di Architettura e Urbanistica
Attn. Mr. Victor Nuzzolese

35. Facoltà di Architettura, Inst. of Architectural Design
Via Monte Olivet 3, 80100 Napoli
Attn. Mr. Claudio Cujati

36. Instituto Universitario di Architettura di Venezia
Attn. Prof. Valeriano Pastor

Spain
37. Escuela Técnica Superior de Arquitectura de la Coruña
Attn. Mr. José-Antonio Franco Tebodda

38. Universidad de Navarra, Escuela Técnica Superior de Arquitectura
Pamplona
Attn. Mr. Juan Pedro Ros Martínez
Section III

Belgium
   Pleinlaan 2, B 1050 Brussel
   T.a.v. Prof. Dr. Ir. W.P. de Wilde, Ms. M. Hollaert

40. Provinciaal Hoger Architectuuriinstituut
   Gouverneur Verwijlghensingel 3, Hasselt
   T.a.v. Dhr. A. Noel, Dr. E. Vanghel

41. Stedelijk Hoger Instituut voor Architectuur en Stedebouw
   Academiestraat 2, 2000 Gent
   T.a.v. Dhr. Erik Balieu, Dhr. Marc Peraud, Dhr. Louis Nabben

Netherlands
42. Technische Hogeschool Eindhoven, Afd. Bouwkunde
   Den Dolech 2, Postbus 513, 5600MB Eindhoven
   T.a.v. Ir. Paul Dinjens, MSc 5.09

43. Academie van Bouwkunst Tilburg
   Volestraat 60, 5021SE Tilburg
   T.a.v. Drs. Jan Vaessen

44. Academie van Bouwkunst Rotterdam
   Boompolderplein 16, Rotterdam
   T.a.v. Ir. Frans Smits

45. Academie van Bouwkunst Maastricht
   Capucijnestraat , 6211RT Maastricht
   T.a.v. Ir. C. Kleinman

46. Academie van Bouwkunst Arnhem
   Sonsbeekweg 22, 6814MC Arnhem
   T.a.v. Ir. A. Vos de Wael

Section IV

47. University of Strathclyde, Dept. of
   Architecture
   131 Rottenrow, Glasgow G4 ONG, Scotland
   Attn. Prof T.V. Mayer, Director ASACUS

48. Nationaal Hoger Instituut voor Bouwkunde en
   Stedebouw
   Matsaertstraat 31, 2000 Antwerpen
   Attn. Dhr. Richard Poquad

49. Technische Hogeschool Delft, Afd. Bouwkunde
   Postbus 5043, 2600GA Delft
   T.a.v. Ir. R. Schijf, BK 8.12A
FIGURES

Fig. 1 : Comparative appraisal by a 4th year Strathclyde student of four alternative hotel designs using the program GOAL.

Fig. 2 : Perspective views of a Strathclyde student hotel design based on the output from the program BIBLE.

Fig. 3 : Perspective view of a Delft student design for a lecture block in the context of existing campus buildings, as drawn by the program BIBLE.

Fig. 4 : Another perspective view of a Delft student design for a lecture block in the context of existing campus buildings, as drawn by the program BIBLE.

Fig. 5 : Comparative appraisal by a Tilburg student of four alternative hotel designs using the programs GOAL and BIBLE.