COURSE DESCR1PTION - UNIVERSITY OF STRATHCLYDE MSc IN BUILDING SCIENCE (COMPUTER AIDED BUILDING DESIGN)

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Abstract

This paper describes a one-year postgraduate course in computer-aided building design. The course structure is outlined, together with the resources required to run such a course. Details of the course modules are given in an appendix.

1ntroduction

Computer-aided design is just one aspect of the broad subject of design in general. Any CAD course offered to UG architecture students should enable all designers to obtain the knowledge and skills required to use computer aids effectively, but, beyond this general level of CAD awareness, there is a further need to provide the possibility for the small number of designers who, taking a deeper interest in CAD, wish to develop special skills arid then participate. themselves in computer aided design, research and teaching; or act as interfaces between designers and computing specialists; or return to practice with the expertise to exploit the opportunities offered by computers and computing. This paper describes a one year, full time, postgraduate course in the techniques of computer-aided building design which aims to provide graduates from an architectural, engineering, surveying or other building

related background with those particular CAD skills.

Structure of the Course

The course contains three main themes - Design Methods, Computing Methods and CAAD Applications. The general framework is that the course consists, of two thirds formal course work and one third dissertation. The course units themselves follow a two thirds to one third split between lectures and assignments specifically related to the project unit. The Students' are also required to write an essay over each of the Christmas and faster 'vacations'.

The students are assessed upon their performance in the assignments and essays (approximately half of the total mark) and a formal dissertation which is written after the completion of the course work at Easter for submission in August. There are no formal examinations as such.

The Course Modules

The course timetable for the recently completed academic year is shown in Appendix 1. The "main course" modules develop basic principles whilst the "subsidiary" modules provide illustrative examples related to those principles. This interlinking of modules enables the students to build up their knowledge base on a broad front, with the formal lecture content being consolidated by examples and project work. The course units themselves are described in Appendix 2.

Resources

A number of different types of resources are needed to support a course of this type. The human resources are drawn from the ABACUS research unit in the Department of Architecture, whose staff include personnel with backgrounds in architecture, engineering, mathematics, operations research and computer science. These resources are extended by research students in the department acting as part time tutors; by visitors to the unit; and by visits to local offices already using computers.

The physical resources required include a wide range of computing hardware and software. The course provides computing experience across a range of hardware from desktop microcomputers through minicomputers to large time-sharing mainframes. A range of terminal equipment from simple alphanumeric terminals through storage tube and raster scan graphics screens to sophistic colour raster, graphics screens is available. Other peripherals include digitisers and plotters, various hardcopy devices and video interface equipment. The software available includes specially written

teaching packages, a wide range, of application programs, and a wide range, of system software. Students are encouraged to investigate different high-level languages and operating systems. Beyond these obvious physical requirements are two other important supportive resources. One is the presence of an active CAD research unit which adds to the authority of the course and draws visiting specialists to the Department. Following upon the presence of the research unit is the availability of a good CAD library. The specialist books, conference proceedings and journals required to support a course of this nature are not always available in most schools of architecture.

Conclusion

The volume of information related to architectural education has increased to such an extent that it is no longer realistic to expect that it can all be covered to the same depth in the course of the normal undergraduate training. Similarly, the rate of change, in theory, techniques and technology is such that the knowledge base acquired cannot be expected to serve the graduate architect throughout his professional life.

The field of computer-aided architectural design is an extreme example of both the, extension of the field of study and the fallibility of outdated information. Furthermore, many architects in practice have had little or no contact with computers in their professional education. The MSc course is designed to meet this need for postgraduate education in CAD. To the extent that the students so far have been a mix of younger architects wishing to specialise and older ones wishing to retrain, the course appears to be succeeding.

APPENDIX 1 : COURSE TIMETABLE (ACADEMIC YEAR 1982/83)

TERM 1

Week	Monday date	Main course (0930-1230) Each day	Subsidiary course(s) (1400-1700)
1	11 Oct 82	A1 Computational Methods in Building Design	-
2	18 Oct 82	A1 (cont'd)	-
3	25 Oct 82	A1 Project	Energy Fair Tu W Th
4	1 Nov 82	DM1 Introduction to Design Methodology	A2 - computer applications in architecture - predesign decisions Tu pm
5	8 Nov 82	DM1 (cont'd)	A2 - layout planning
6	15 Nov 82	DM1 Project	A2 - integrated design appraisa
7	22 Nov 82	CM1 Introduction to Computing	A2 - subsystem appraisal DM2- models in building design - new forms of building Th
8	29 Nov 82	CM1 (cont'd)	A2 - spec, b of q, management DM2- social changes
9	6 Dec 82	Fix essay topics CM1 Project	A2 - draughting systems
10	13 Dec 82	CM1 Project	A2 - current developments

Term ends Friday 17 December

Students will be required to write an essay (c. 5000 words) over the 'vacation'.

TERM 2

Week	Monday date	Main course (0930)-1230) Each day	Subsidiary course (1400-1700) (Tuesdays)
11	10 Jan 83	A3 Visual Impact Analysis	CM2 - advanced intro to computing
12	17 Jan 83	A3 Project	CM2 - cont'd
13	24 Jan 83	A4 Building Subsystem Evaluation	CM3 - matrix methods
14	31 Jan 83	A4 (cont'd)	CM3 - matrix methods (cont'd)
15	7 Feb 83	A4 Project	CM3 graph theory
16	14 Feb 83	DM3 Brief Analysis & Layout Planning (or CM5 Microcomputer applications)	CM3 - graphs (cont'd)
17	21 Feb 83	DM3 cont'd (or CM5 continued)	CM4 - computer graphics in design - display devices
18	28 Feb 83	DM3 Project (or CM5 project)	CM4 - display files etc
19	7 Mar 83	DM4 OR Applications in Design (or CM6 Databases and interfaces)	CM4 - graphics techniques
20	14 Mar 83	DM4 cont'd (or CM6 continued)	CM4 - graphics systems

Weekly seminars (Thursday pm) on term 1 essays will be held throughout the term.

Term ends Friday 16 March

An essay will be required to be written over the 'vacation'.

TERM 3

Week	Monday date	
22	25 Apr 83	External Examiner
22-30		Final Project

Weekly seminars on term 2 essays will be held throughout the term.

Term ends 24 June 1983

TERM 4

Final date for submission of dissertation Friday 12 August '83.

28 October 83 GRADUATION

Notes: Monday 15 November 1982 and Monday 14 February are mid-term and (undergraduate) holidays; MSc lectures will continue as normal.

Monday 2 May is May Day bank holiday.

Monday 30 May is a local holiday and the University is closed.

Friday 15 and Monday 18 July, Glasgow Fair Holiday

APPENDIX 2 : MODULES OF THE MSc (CABD)

APPLICATIONS 1

Computational Methods in Building Design

An introduction to the application of computer methods in architecture and building science. Covers the following areas to provide information on the basic tools available to handle typical problems.
a) general introduction to computer systems; b) brief analysis;
c) generation of design proposals; d) appraisal of design proposals;
e) building costing; f) building structures; g) energy usage;
h) building services; i) daylight evaluation; j) artificial lighting;
k) acoustics; l) solar energy; m) visualisation of design proposals;
n) visual impact analysis; o) office management applications;
p) information retrieval; q) specifications and bills of quantities;
r) computer draughting. Followed by 1 week project.

APPLICAT1ONS 2

Computer Applications in Architecture

Identifies those areas in architecture where, (i) significant use of computer techniques has been made, and (ii) future applications areas. Topics covered include the use of computers in the following areas: a) predesign decisions - i) economic studies, ii) feasibility studies, iii) brief development; b) layout planning - i) representations of architectural spaces, ii) representations of objectives and constraints, iii) characteristics of different, solution techniques, iv) MAGIC;
c) integrated design appraisal - i) representation, ii) measurement, iii) evaluation, iv) GOAL; d) building subsystems appraisal - i) energy, ii) lighting, iii) visual aspects, iv) ESP, v) BIBLE/VISTA;
e) specifications and bills of quantities - i) line and paragraph techniques, ii) master bill techniques; f) office management techniques i) job and timesheet accounting, ii) word-processing, iii) CPM and forecasting; g) automated draughting systems - i) devices and techniques, ii) commercially available systems, iii) integrated systems;
h) current research - i) ABACUS, ii) elsewhere.

APPLICATIONS 3

Computer Applications in Visual Analysis and Modelling

The use of advanced computer graphics techniques in assessing the visual

impact of proposed engineering and architectural developments. a) current visual modelling techniques; b) evaluation of traditional methods of visual analysis; c) computer potential in visual impact analysis; d) photogrammetric techniques; c) computer generated pictures and montages; f) issues of accuracy. Followed by 1 week project.

APPLICATIONS 4
Computer Applications in Building Subsystem Evaluation
An advanced examination or computer applications in the detailed evaluation of building subsystem performance.
a) detailed modelling of building interiors; b) simulation of interior lighting effects; c) colour rendering of different artificial lighting schemes; d) lighting systems; e) acoustics evaluation; f) energy modelling and energy resources; g) numerical simulation energy models, i) harmonic, ii) response function, iii) finite difference, iv) computational methods; h) numerical simulation techniques, i) climatological data; j) plant modelling; k) examples using the ESP simulation system. Followed by one week project.

DES1GN METHODS 1
Introduction to Systems Theory and Design Methodology
An introduction to a systems approach to design, together with a number of formalised design methods.
a) traditional methods of design; b) the concepts of systems theory and its relevance to building design; c) scientific methods; d) new attitudes towards design - the concept of modelling; e) formal design methods; f) statistical design methods; g) human science techniques; h) problem solving techniques; i) creative techniques; j) develop ment of design methodologies; k) new design processes; 1) computer aided design. Followed by one week project.

DES1GN METHODS 2
Models in Building Design
To develop an appreciation of the role of architectural and environmental sciences in the overall field of design practice and education.

a) new forms of building - i) problems posed by these new forms, ii) growth of scientific methods of analysis, iii) use of physical and mathematical models; b) social changes - j) effects of legislation on built forms, ii) impact of computing on design, iii) changing role of building designers, iv) the energy crises; c) summary of role of designer in practice and society, and relevance of systems approach.

DESIGN METHODS 3
Brief Analysis and Layout Planning
An exploration of the computational aspects of the fundamental architectural planning problem.
a) types of data - i) activity data analysis, ii) quantitative, qualitative and dichotomous data, iii) representations of data; b) analysis of data - i) cluster analysis, ii) multidimensional scaling; c) relationship between brief analysis and layout planning/facilities planning; d) representations of space - i) integer array, ii) dimensionless vectors, iii) point-vector, v) graph theoretic; e) representation of objectives and constraints - i) adjacencies, ii) constraint graph, iii) dimensionless formulations, v) fit problems; f) solution procedures -i) generate and test, ii) hill climbing, iii) heuristic search, iv) implicit enumeration, v) linear and nonlinear programming, vi) artificial intelligence approaches; g) layout planning programs - i) CRAFT, ii) GSP, iii) IMAGE, iv) CCIRELAP, v) SPS. Followed by one week project/ essay.

DESIGN METHODS 4
Operations Research Applications in Design
An introduction to the techniques of operations research applicable to design.
a) applied graph theory; b) probability theory; c) probability distributions; d) algebraic and differential equations; e) combin atorial programming; f) Markov chains; g) simulation modelling; h) regression and correlation; i) hypothesis testing. Followed by one week project/essay.

COMPUTING METHODS 1
Introduction to Computing.

An introduction to computer hardware and software.
a) general concepts - i) analogue devices, ii) digital computing;
b) computer hardware - i) mainframes, minis and micros, ii) peripherals;
c) using computers - i) terminal connection, ii) running a program;
d) software engineering - i) the concept of software engineering, ii) software design methodologies, iii) modularisation, iv) portability of software; e) software - i) systems software, ii) machine independent operating systems, iii) software libraries, iv) software tools, v) applications software; f) programming languages - i) review of different languages and their applications, ii) FORTRAN language, iii) writing FORTRAN programs, iv) standards. Followed by project.

COMPUTING METHODS 2
Advanced Introduction to Computing
An opportunity to study advanced computing concepts and their application in architectural computing.
a) advanced FORTRAN - i) file handling, ii) data structures, iii) inter active computing, iv) graphics; b) special problem-oriented languages - i) GLIDE, ii) CECIL; c) software tools - i) graphics libraries, ii) utility libraries, iii) I/0 conventions.

COMPUTING METHODS 3
Mathematical Methods
To thoroughly acquaint students with the mathematical techniques necessary in computer graphics applications.
a) matrix methods -i) matrix algebra, ii) diagonal matrices, submatrices, determinants, etc., iii) linear equations, iv) mappings, projections, perspectives, etc., v) matrix inversion, vi) tridiagonalisation, vii) computer solutions and further applications in computer graphics, viii) numerical analysis -accuracy and error propagation; b) graph theory - i) introduction to graphs and networks, ii) planar/nonplaciar graphs, iii) trees and directed graphs, iv) computer representations, v) applications in data storage etc.

COMPUTING METHODS 4
Computer Graphics in Design
Advanced consideration of computer graphics devices and techniques.

a) display devices; b) display files: c) transformations; d) clipping and windowing; e) interactive graphics techniques; f) graphical input techniques; g) colour graphics techniques; h) graphics systems; i) graphics languages; j) general applications; k) special applications - video montage and mixing.

COMPUTING METHODS 5
Microcomputer Applications
A more detailed examination of microcomputer hardware and software. Opportunity for hands-on experience with a wide range of microcomputers is provided in association with the Microelectronics Education Develop ment Centre.
a) central processor units; b) memory devices; c) mass storage; d) input and output peripherals; e) system programs; f) application programs.

COMPUTING METHODS 6
Databases and Interfaces
A detailed discussion of information and databases in design applications and a further consideration of aspects of the man-machine interface.
Databases - a) shape descriptions; b) topology and geometry; c) component libraries; d) conceptual models; e) logical models; f) physical models; g) date analysis; h) functional analysis; Interfaces - i) conceptual design; j) semantic design; k) syntactic design; l) lexical design; m) user interface models; n) user interface management systems.