Social Impacts of Computer Aided Architectural Design

Thomas W Maver

ABACUS
Department of Architecture and Building Science
University of Strathclyde
Glasgow G1 1XQ, UK

KEYWORDS

Architectural Practice, Clients and Users, eCAADe, Education and Training, Research and Development

ABSTRACT

In 1985 the Commission of the European Communities, as part of its concern for social adjustment to technological change, invited the eCAADe - an association of European Schools of Architecture set up to promote the effective adoption of CAAD in architectural education - to prepare a report on the Social Impacts of CAAD. This paper summarises the report and deals primarily with impacts on the practice of architecture, on architectural education, and on the architects relationship with other members of the design team and with the client and users of the building. Recommendations are made for intiatives in education, research and development.

L'impact social de la CAO en architecture.

T. Maver.

Mots clés:

Architecture, Clients et Usagers, eCAADe, Education et Formation, R et D.

Résumé:

En 1985, la Comission des Communautées Européennes, se sentant concernée par l'impact social des changements technologiques, a invité l'eCAADe - une association d'écoles européennes d'architecture chargée de promouvoir l'utilisation de la CAAD dans ces écoles (CAAD= Conception assistée par ordinateur en architecture)- de préparer un rapport sur l'impact social de la CAAD. Cette publication résume ce rapport et s'attache particulièrement à déterminer l'influence de la CAAD sur l'architecture et son enseignement ainsi que sur les relations de l'architecte avec les autres membres de l'équipe de conception du bâtiment et les clients et usagers. Des recommendations sont aussi faites quand à la prise d'initiatives pour l'enseignement et la R&D.

BACKGROUND

eCAADe

The eCAADe is an association of European Schools of Architecture committed to collaboration in the effective introduction of Computer Aided Architectural Design; its Statutes are registered in Brussels. With modest financial support in the form of CEC Grants for Higher Education - administered through the Office for Co-operation in Education - the eCAADe has been able to engage in a number of activities to promote its objectives:

Conferences : Four international conferences have been organised - Delft 82, Brussels 83, Helsinki 84 and Rotterdam 85; the fifth international conference will be held at the University of Rome in September 1986

Directory : A Directory of CAAD activities and facilities within the European Schools of Architecture has been compiled and is regularly updated.

Didactica : A set of lecture material has been compiled and translated into English, Dutch, French and Italian. A set of audio-visual aids for teaching is in preparation.

In January 1984, the Commission of the European Communities (CEC) issued a communication entitled Technological Change and Social Adjustment. Its purpose was:

'to propose a Community strategy for new technologies which, complementing those already launched in the sphere of industry, research, development and innovation, will bring a positive response to the social challenges.'

In September 1985, with funding from the CEC, the eCAADe organised a two day meeting in which sixteen experts from eight countries on four continents participated to discuss the Social Impacts of Computer Aided Architectural Design. This paper summarises the report which resulted from that meeting.

ARCHITECTURAL PRACTICE

Relevant Issues

The problems and prospects concerning the adoption of CAAD in architectural practice can be considered under three broad headings - profit motivation, professional responsibility and integrated design.

Profit Motivation. Architectural practice has been much quicker to adopt software for management and drafting than for design. The most obvious reason has to do with profitability: whereas management and drafting programs may allow the practice to carry out necessary functions more quickly or with fewer people, the use of design programs may cause time and effort to be spent on areas of decision-making which currently do not receive explicit attention. Worse, the application of design programs may result in more economical design solutions with the consequence that the fee to the practice - still proportional in most European countries to the capital cost of the building -

will be reduced. This situation can be seen to be changing : clients, increasingly conscious of life-cycle costs, are demanding evidence of more cost-effective solutions; at the same time there are moves by the professional institutions to abandon the fixed fee structures.

Professional Responsibility. Architectural practice is hedged round with regulations; professional responsibility weighs heavily on a practice and escalating indemnity premiums are a major cause for concern. Design software raises new questions of responsibility. Should the practice stick to the existing (and possibly crude) guidelines or pursue a more appropriate solution using innovative - and possible unvalidated - design software? As programs are validated and reliable results generated, existing guidelines and regulations will require to be re-written. Some will take on a wholly new form placing responsiblity on the architect to evidence - by the use of approved design programs - the achievement of a safe or efficient design solution.

Integrated Design. A unique grouping of firms comes together to design and construct a building. The probability is thus low that all firms will have the same drafting system and this makes co-ordinated design effort extremely difficult. Efforts are being made to establish and use standards (eg IGES) which will allow different 2-D drafting systems to communicate. Other engineering industries are making significant use of these standards but in building design the standards are largely untried. There is a clear need for a sustained R&D effort to specify the structure of a computer-based building description which would support management, drafting and design applications in a truly integrated manner.

Possible Impacts

Within Architecture Practice. The effect of CAAD on the employment of architects will be neglible in comparison to the response of the building industry itself to economic growth or recession. On balance it is thought that job opportunities will increase : staff savings through the efficiencies of computer aided drafting will be more than offset by the professions ability to offer a more comprehensive service - extending into facilities planning, building management and redesign, etc. There is the danger of de-skilling, particularly of those architects currently considered to be expert in technical matters and of those architects and technicians who have particular drafting skills; re-skilling will take place informally (though sometimes traumatically) within the office and more formally in Schools of Architecture. The number of very large and very small private architectural practices will grow at the expense of medium sized practices and the public sector will expand with coressponding shrinkage in the private sector.

Within the Design Team. As more integrated CAAD systems become available there is certain to be a closer understanding generated beween the various members of the design team and a blurring of their sectarian interests. There is scope for the architect - should it seem appropriate - to regain the means of communication and control, conceptually and contractually.

Within the Building Industry. Whereas an increasing proportion of design work in Europe will focus on the conservation and rehabilitation of existing building stock, the same is not true in the Middle East and in the Far East. If

European building firms are to compete and win contracts in, for example China, consortia of firms, subscribing to integrated computer-based systems will have to be formed.

EDUCATION AND TRAINING

It is important to make a distinction between training and education. There is a major requirement to set up courses for the training (and re-training) of architectural technicians in the effective operation and maintenance of CAAD systems and this topic will essentially displace the current training in draughtsmanship. There will also be an element of training required in the undergraduate and postgraduate courses for architects but it is substantively more important to establish the educational issues which underlie advances in CAAD.

Undergraduate Courses

Three levels of education and training of architectural undergraduates can be identified

i. Training students to use existing CAAD systems and educating them critically to evaluate and select between them; this will involve consideration not only of the technical merits but of the management and economic factors involved. A teaching input from practice is seen as vital to this level of course.

ii. Using CAAD systems within Schools of Architecture as a mechanism for design education. The emerging integrated design programs allow students to explore, over a wide range of competitive solutions, the causal relationships between design decisions and the resulting cost and performance consequences. There is cause for optimism that the approach to design education will reinforce the importance of a systemic (and integrated) view of architectural design based on a fully three-dimensional model of the building.

iii. Specialisation in the design of design tools. There is scope for allowing some students (perhaps only in some Schools) to specify, develop and even implement prototypical computer based design tools. It is not suggested that the outcome of their endeavours will be of direct use (- any more than it would be suggested that we build the buildings which students design!). The purpose is to encourage an explicit formulation of the design decision-making activity and to appreciate the complexity of the building model. The more able students, especially if encouraged to work on the modification of or extension to existing programs, may make a significant contribution to system development.

The determination to keep architectural undergraduate courses 'general' and project based has led to great congestion in the curriculum. Room can be found for CAAD applications by making savings on the time currently devoted to manual methods for computation, report writing and drawing, and by more effective use of case studies.

Given the opportunity which CAAD systems provide for interdisciplinary design team working the time is ripe for a more radical review of the overlapping

educational requirements of architects, structural engineers, environmental engineers and quantity surveyors.

Postgraduate and Mid-Career Courses

The concept of Continuing Professional Development (CPD) is of the greatest importance especially in the rapidly advancing field of CAAD; opportunities will have to be provided for practictioners and teachers to be brought up-to-date.

The need is to develop a series of CPD modules hosted by selected Schools of Architecture but enjoying a significant teaching input from experienced architectural practitioners, software houses and hardware suppliers. CPD credits would be given and could be aggregated for the award of a Diploma or Masters degree. The teaching should be through case studies and design project work.

Resources

The most important resource is people and the most urgent task is to teach the teachers. Summer Schools lasting one week for teachers in Schools of Architecture have been piloted and could be implemented, if resources were available, in each Member State. There would also be significant advantage in Schools sharing scarce expertise through part time or joint appointments. The problem experienced by all departments teaching in the field of IT is that of able and experienced teachers being lured away by practice; to ameliorate this problem, joint appointments between Schools and practices are suggested as are secondments in both directions.

There is also a need jointly to develop and produce high quality teaching material - up-datable lecture material, case studies, project briefs, A-V aids and, above all, applications software. A great deal of material has already been produced and piloted (through eCAADe) but a substantial effort is required to package it in a way which is appropriate to the needs of all Member States.

CLIENTS AND USERS

There can be no denying the increasing dissatisfaction of the public in Europe with the performance of the architectural profession. It is appropriate then to consider what benefits, if any, will accrue to clients and to the users of buildings from CAAD.

Client Oriented CAD Systems

Clients may have to live with the economic, physical and social consequences of building design decisions for sixty years or more. Over that period, as already noted, the building and its facilities have to be managed and modified in line with changing needs. Clearly, if a computer-based model of the building was created during the design stage it is sensible to maintain and operate on that model over the life span of the building itself. Access to the model will thus be needed by the client body and it follows that they should be involved in its establishment during the design phase.

Access to CAAD systems by clients with a large building stock will encourage the appraisal of that stock and the commissioning of design interventions by architects. Moreover as the cost/performance attributes of increasing numbers of buildings are appraised, there will emerge - for the first time in the building industry - performance specifications to which client bodies (and eventually statutory bodies) will demand compliance.

The benefits to client bodies of CAAD is thus substantial and it is likely that the stimulus for the uptake of CAAD systems will come predominantly from large clients rather than from architectural practice itself. It is important, therefore, to think in terms of developing 'client-oriented' CAAD systems.

User Participation in Design

CAAD systems hold out the hope of a more explicit understanding of the cost and performance consequences of competing design solutions. Although the information base for design decison-making is thus greatly improved, the decisions themselves will still be a matter of subjective value judgement on what balance across the range of cost/performance variables is appropriate. It is argued by some that this judgement is best taken by those who will be most affected by the design decisions - ie the building users.

This notion has been explored in at least two major conferences and in a number of real-world experiments, mostly concerned with housing. The conviction is growing that computer aided user participation in design has enormous potential in improving public satisfaction with the built environment. For this reason it is important that CAAD systems provide appropriate interfaces for non-professional users and are readily and cheaply accessible by the public. A model for this interaction can be found in the 'call for offer' system pioneered in France and Belgium in which a consortium of designers and contractors respond to a performance profile established by architects working with users.

RESEARCH AND DEVELOPMENT

When viewed in relation to the level of funding for research and development in the major European industries, the investment in building R&D is an order of magnitude lower. A number of reasons can be advanced for this, the most cogent being the absence of an appropriate theoretical framework within which complementary R&D initiatives could be located. It is suggested that the computer-based modelling of the form and function of buildings, for the first time, provides such a framework. It follows that CAAD should become not only the subject of research and development, but - more importantly - the mechanism for conducting research into the complex nature of design itself.

Substantial research and development effort is required in a number of key areas.

Design Paradigms

Herbert Simon in 'The Science of the Artificial' looks forward to the time when we "discover a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process". In the discovery of this 'science' and in the study of this process, computer-based artificial intelligence will be of prime importance. This area of research is both the most challenging and the most necessary.

Design Tools

Research is needed, to establish an integrated database holding the 'building description'; this would be the kernal of an 'object-oriented' system of 'tools'. Development of improved user interfaces, exhibiting intelligence in the absence of complete data will be necessary if the design sysems are to be client oriented and facilitate user participation in design.

Validation and Evaluation

Existing and emerging CAAD systems require to be validated (in terms of their reliability, accuracy, etc) and evaluated (in terms of their usefulness in practice). This research can only be conducted in collaboration with practice.

Knowledge Bases

Large scale parametric studies of the causal relationships between design and cost/performance variables require to be caried out using existing and emerging programs in an effort to establish the knowledge base on which 'expert' systems will draw and on which building performance specifications might be based.

Regulation and Certification

Research is needed to anticipate the implications of the emerging generation of software tools for the form and content of the building regulations and the appropriate degree of self-certification by architects and engineers.

ACKNOWLEDGEMENTS

The author, on behalf of the eCAADe, wishes to thank Andre Kirchberger of Directorate General V of the CEC for the opportunity to produce a report on such an important topic. The hard work in organising the international meeting was carried out by Geert Smeltzer (CALIBRE Group, Technicshe Hogeschool Eindhoven) and Hendrika Buelinckx (Vrije Universiteit Brussel). The participants at the international meeting were Nigel Cross (Open University, UK), Albert Dupagne (Universite de Liege), Helmut Emde (Technische Hochschule Darmstadt), John Gero (University of Sydney), Lamond Laing (Robert Gordons Institute, UK), John Lansdown (Royal College of Art, London), Frank Oswald (Greater London Enterprise Board), Matti Poyry (Rakennusalan CAD, Helsinki), Felix van Rijn (Universiteit van Amsterdam), Rik Schijf (National University of Singapore), Gy Sebsetyen (CIB), Edward Smith (University of Utah) and Harry Wagter (Technische Hogeschool Eindhoven).