The Continuing Dichotomy: Practice vs Education

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While it is apparent from the architectural literature that some practices are innovative in their use of computers for architectural design, clear evidence indicates that most architectural practices have applied computing to traditional practice paradigms. Information technology is therefore being applied to practice systems which were in place prior to computers being available. This has significant implications for architectural education in which there is tension developing between the requirements of the commercially oriented architectural practice and the innovation driven computer-aided architectural design educator. The first wishes to equip graduates for immediate and productive employment in computerised architectural practices and may be loosely interpreted as a graduate's ability to work as a CAD operator within an architectural practice environment. The second has the desire for students to be innovative in their use of information technology as an aid in informing and evaluating parts of both the design process and its outcomes. However, it is only when both architects and educators identify the architectural process as an integrated information system that these tensions can be resolved. This requires reconsideration of the function and use of information technology in both educational institutions and in architectural practices. The paper discusses how fruitful this can be in the current environment and outlines current developments at Deakin University which aim at providing a middle ground.

1. Introduction

There is evidence of a continuing dichotomy between the expectations that architectural practices have of recent graduates and the nature of education within schools of architecture. This is not new in that there has always been a desire by practices to have graduates being immediately productive within a practice environment while educational institutions are required to provide a broad general education across many disciplines. Furthermore, there has been an implicit understanding that education continues particularly during the first years of practice. However, with the continued developments in architectural computing, this dichotomy has the potential to become increasingly apparent. Evidence indicates that practices are not as highly developed in their computer use as the literature tends to suggest. The training of students as highly efficient CAD operators is likely to satisfy the immediate employment requirements of offices but is unlikely to contribute to the development of increasingly sophisticated computer use within either schools of architecture or architectural practices. The educational institutions need to be proactive in educating both students and practitioners during this transition stage which will lead to the development of practices as integrated information systems. While the manner in which this can be done is not yet fully resolved, some future directions are suggested here as a response to the evidence of the dichotomy presented below.

2. The Development of Computing in Architectural Practices

By 1988, microcomputers had been readily available for some years and the capabilities of such computing systems had increased significantly from those previously available. Despite this, the nature of much of the discussion which took place during this period assumed little prior knowledge of how computers were to be used. Nicholson (1988) went back to first principles

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when outlining the options available for the purchase and uses of a CAD system. The issues associated with their purchase were also outlined by Coldwell (1988) and methods of implementation were proposed by Lark (1988) and Schilling (1988). These issues continued to cover concerns, which had been in evidence since architectural computing was first seen as being relevant, and indicate that there was a perception, at that time, that neither architectural computing nor an understanding of computer technology were common.

Alongside discussion of the issues associated with selection and application of computer systems, there continued reviews of graphic and modelling software of varying sophistication. The development of computer based 3D modelling systems for architecture was becoming increasingly evident (see Clark 1988). Radford (1988) outlined the potential application of such modelling systems. Gold (1988) extended this and identified three-dimensional visualisation as being important to the design process. Witte (1988a, 1988b), in a review of computer usage in a number of existing offices, demonstrated the high degree of sophistication which could be attained in the use of computers in the design and visualisation process. This was supported by Findlay (1988) in a case study of a computer-aided design process. Carasco (1988) took this a step further with the use of three-dimensional computer modelling as a significant aid in the building documentation process. In this case, it was seen as particularly important in identifying areas of potential design difficulties not able to be readily determined from 2D drawings.

Crosley (1989) contended that the impact of the increasing ease of use of computer systems would have a significant influence on the manner in which architects would use computer systems. In particular, he cited the impact of computers on specification writing as a developing area. Other areas of development were primarily those which had readily defined procedural models which would lend themselves to computer application. These included shadow projection exemplified by the SR System (outlined by Roy & Owen 1989), building code compliance assistance through the BCAider expert system (Sharp 1991) and the *Cheetah* thermal performance program developed by the CSIRO in Australia.

While the discussions regarding the use of computers for the design and visualisation process were of significant interest, there had been little commentary as to how they were to be integrated into practice in an effective and productive manner. Discussion appeared to be related to either general anecdotal procedures (Cordes 1990) or software reviews (e.g. Witte 1990). One example of the substantive type of debate, which has generally been lacking, was from Findlay (1990). He expressed some concern as to the excessive emphasis then being placed on computing technology and high quality photorealist visualisation without consideration as to the meaning of what was being portrayed.

Little significant architectural computing discourse, with a few exceptions, was evident in Australian professional journals. However, some concern about the rationalisation and integration of the method of computer usage within practice structure did emerge. Cutting (1990) provided an overview of the effect of computerisation on the design and documentation process. His view was that the effect was potentially significant with its influence being felt particularly on design modelling.

On the other hand, the appearance of discussion on the use of software, which was readily available some 10 years previously (e.g. Walker 1988; Lansdown 1990), may also be seen to be an indicator that fundamental issues in computer usage had not, at that time, been addressed by practices. This points to the possibility of a lack of understanding of the application of computing in many areas of architectural practice despite evidence of the availability of very sophisticated high level 3D modelling systems (Findlay & Plume 1991; Novitski 1991) and discussion of the use of computers in design (McCullough *et al* 1990). The emphasis on modelling software continued to be evident in the literature although its use became more varied. This diversity is apparent through the discussion of building and component models for multimedia or rendering presentation (Teicholz & Yu 1993; Novitski 1993c; Buday 1993), and design and modelling (Novitski 1992). In addition to 3D modelling, there appeared to be a re-emerging interest in building performance software such as that designed to determine building code compliance (Novitski 1993b) and lighting and energy design (Novitski 1993a).

The evidence suggests the development of a highly variable model for the application of computers to practice functions. Increased emphasis on the sophisticated use of computing for visualisation and design analysis as a primary function of computer systems was placed alongside discussion of much more fundamental issues of computer use. How most practices had actually been computerising is not clear.

3. Computer Use in Practices

During 1988, and again in 1993, a survey of architectural practices was undertaken (Dawson 1996). The purpose of the surveys was to establish the nature of changes in computer use within the architectural practice population in the state of Victoria, Australia, over a five year period. Although the methodology of both surveys was similar, results from the 1993 survey only are reported here.

The Victorian practice population was defined by using the register of 372 corporate practice kept by the Architects Registration Board of Victoria. These practices were companies or partnerships registered to provide architectural services as distinct from individuals registered as architects. The mail survey methodology (Dawson 1996) used provided information from a total of 176 practices giving a response rate of 47%. This was considered satisfactory for reliable results.

The analysis of the questionnaires which were returned provided a significant amount of data relating to the organisation and operation of computing within architectural offices. Of specific interest to this paper are the responses from 130 practices as to what practice operations computers were used for. The survey returns were initially analysed with respect to the total number of staff in each practice. This was then related to the functional use of computers. From this a picture of computer use in different sized offices was obtained.

3.1 Functional use of Computers in Practices

Fourteen functional categories of computer use were apparent from the results of the analysis of the data. These categories were:

Text Processing.
Design.
Draughting.
Office Administration.
Financial Management.
Data Storage.
Project Management.
Graphics.
Schedules.
Feasibility Studies.
Contract Administration.
Rendering.
Desktop Publishing.
Other.

The functions undertaken using computers in practices were not uniform across all practice sizes (Figure 1). Generally, the smaller practices were more limited in their range of application of computers to practice functions. The functions undertaken using computers tended to become more diverse with increased practice size, with higher percentages of the larger practices showing evidence of this diversity. Only the text processing function maintained a consistently high level of use across all practice sizes with design, draughting, graphics, scheduling and other functions showing statistically significant trends toward increased use with increased practice size.

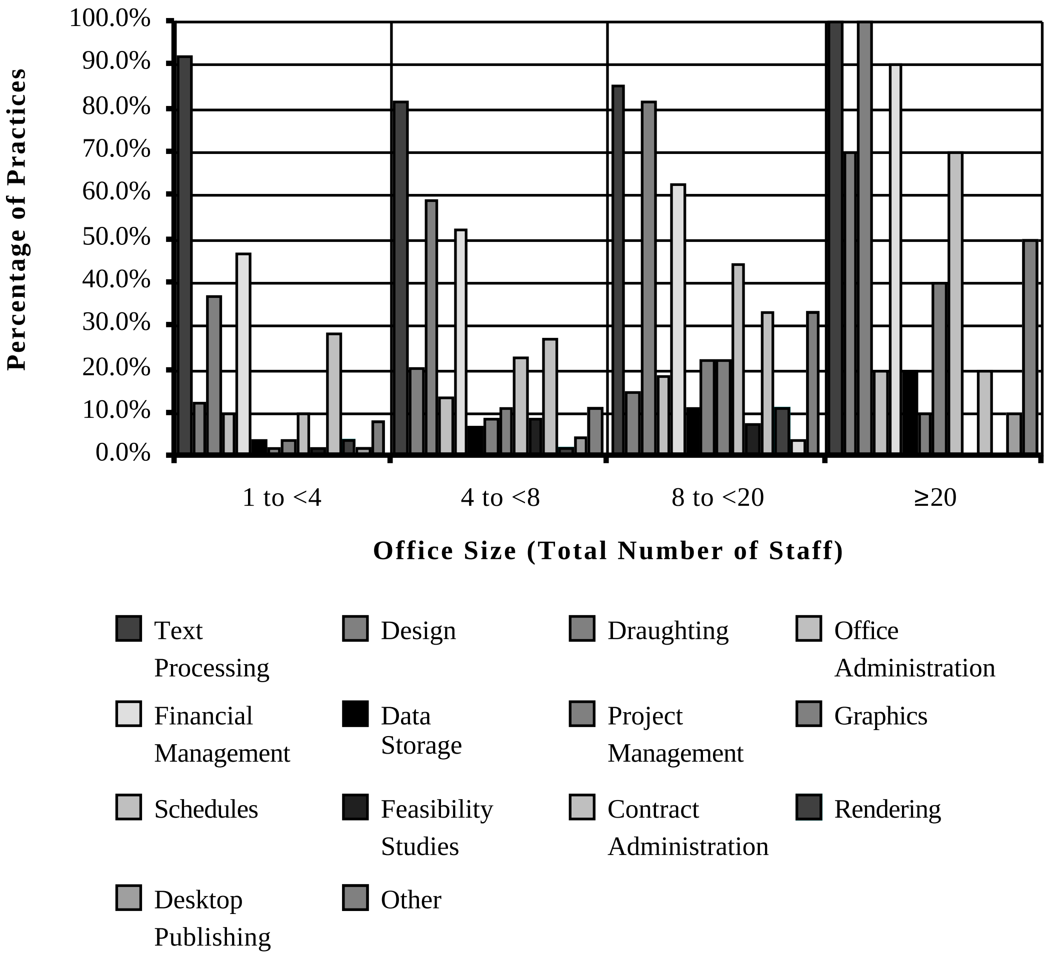

Figure 1. Functional Use of Computers

The main function of computer systems in small practices was text processing with draughting, financial management and contract administration showing lower levels of usage. As practice sizes increased, the percentage of them which used computers for draughting and financial management increased. This applied particularly to medium sized practices, although most functions also showed small increases in usage. In addition to text processing, in large practices there was evidence of a further increase in the percentage of practices which undertook draughting, financial management, scheduling and, to a lesser extent, contract administration and other functions. In very large practices, in addition to text processing, draughting, financial analysis, graphics, scheduling and other functions, the design function became significant while contract administration decreased. Generally office administration, data storage, project management, feasibility studies, rendering and desktop publishing functions occurred in less than 25% of practices in all size ranges. Their level of use tended to decrease in both the smaller and larger practices, with neither rendering nor desktop publishing functions being undertaken using computers in very large practices.

4. The Process of Computerisation

The evidence suggests that the major functions which most practices have computerised are text processing, draughting and financial management. Those functions, which have been computerised, are those having existing defined paradigms and require limited modification in order for them to be carried out using computer technology. Text processing replaces the electric typewriter, computer-aided draughting replaces the drawing board and computerised financial management replaces the office bookkeeping system. This process requires a relatively simple transfer of paradigm once the software, and an understanding of the mechanics of computer technology, is acquired.

The survey shows that practices have generally moved toward a non-design based computerised practice model. While a small number of practices have embraced computer technology to a significant extent, most have computerised only limited areas of the practice. Those offices which have computerised in this narrow way often see significant benefits. One practice reported that computing had *'. . . improved (the) method of writing specifications and correspondence due to the ability to easily make changes . . . '.* Another indicated that computers had *'. . . streamlined the production of word processing material . . . '.* There has been little development of the practice functions which are uniquely architectural and which require specific software. Even those areas which would appear to lend themselves to computerisation, such as office (project) management and information (database) storage and retrieval, have low levels of identified use, although there have been procedural models established for computerising these for some time (Reynolds 1993).

4.1 The Role of Staff in the Current Computerised Practice

The consequences of such limited visions of computer use for the role of particular categories of staff, such as draughtspersons or graduate architects, is evident. Coldwell (1985), Cooley (1987) and Stoker (1991) suggest a process of deskilling of staff as the result of increasing specialisation in duties associated with increased computer use. The use of CAD software in particular, which requires continual, highly skilled and productive use to be economically viable, results in the development of specialist operators of particular software. This supports the view of Maver (1986), who saw no breakdown of professional boundaries evident, but rather there was a strengthening demarcation of boundaries due to specialisation of CAD operators. One practice which was surveyed reported that *'. . . we have only 1 CAD station and this has made a sharper division of tasks necessary. Architect(s) used to provide all design drawings and do some documentation, e.g. setup base drawings, now the architect will just rough up some sketches and most drafting is done on the computer . . . '*(sic). While CAD operators become highly skilled through the continued use of that software, they may become deskilled at the many other facets of architectural practice. This has been identified by Stoker (1991) as a particular difficulty for architects. This view is further supported through the emphasis placed on the use of computers for draughting in the medium and large practices. Concern was expressed, by a medium sized practice, about the *'. . . danger . . . in many practices where staff are required to perform no more than a set task. This breeds discontent and therefore a nomadic CAD staffing situation exists . . . '.* The development of computer skills is therefore likely to be seen as deskilling for architectural staff.

5. Future Developments

While architectural practices continue to treat individual tasks as being discrete within practice operations, changes brought about by the introduction of computer technology will be limited. They will be primarily concerned with carrying out practice functions using pre-existing operational models applied using new technologies. This type of task model makes limited use of increasingly sophisticated information technology systems and, while practices may be seen to be computerised, the effect of this on the way practices operate is circumscribed. If, however, architectural practices are viewed as an integrated subset of a much larger information system (Mitchell 1991; Rentmeester & Bridge 1991) (i.e. the construction industry) then carrying out operations based on discrete and isolated tasks becomes less sustainable.

The idea that architectural practices perceive themselves as information systems, resulting in the recognition of the interconnectedness of tasks both within and outside the practice, is not apparent (Dawson 1996). This is despite the availability of information based computer systems, and discussions about their use and systems integration, being evident for more than 10 years (Gero 1983; Stevens 1986; ACADS 1991; Klimpsch 1991; Moore 1991; Kalisperis & Groninger 1994).

Deakin University is developing a facility (Australasian Built Environment Laboratory) which aims at seamlessly integrating architectural computing into all phases of the design, evaluation and documentation process. This will provide the concept for a model for an integrated information system which will facilitate greater interaction between architectural practice, research and education operations.

6. Towards Greater Interaction Between Practice and Education

The dysfunction between experimentation using computers within architectural education and the way they are exploited in practice is one of questionable inevitability. While the temptation remains strong for institutions to cling to studio methods (however much building science and management, for instance, are integrated within each design project), they are required to ensure that students are adequately experienced in basic computer applications. This has been typically undertaken separately and usually at the periphery of the main syllabus. Practices generally are unable to afford research and development in-house and are effectively dependent on the educators rather than software houses to introduce new or better ways to work with computers. The more forward looking institutions have secured funding for their own software development but within a time frame where good ideas are often superseded by commercial software or operating systems developed at a greater pace. Schools of architecture, however, are generally not particularly inclined to look for more efficient ways of practising architecture especially when this is at the expense of more creative investigations. With notable exceptions, contemporary architectural theory hardly deals with practice issues. In addition, with a common perception of an insidious and uncomfortable position within schools, discussion of the aesthetic issues behind formal decision making via the computer hardly takes place.

During the last five years there has been an exponential improvement in the user-friendliness of software and operating systems with a greater access to computers within primary and secondary education as well as in the home. Their relative power has increased at an extraordinary rate while their cost has actually dropped. Rather than the computer being a special medium needing active inclusion, it has silently become the norm. As such, schools of architecture can let go a little. Tuition might be replaced by expert experimentation, not within classes dedicated to ‘computer applications’, but across the range of subjects offered. For the first time, architects have a single medium with which to study and practice their discipline replacing the three manual tools of recent times: the draughting machine, typewriter and calculator. The reduction in the number of tools contrasts with the breadth of software options that go beyond being equivalents for draughting, typing and accounting. The next generation of architects could be persuaded to be well versed in a far wider spectrum of applications. Rather than emerging from schools of architecture 'deskilled' away from the romantic but expensive *Renaissance Person* model, it is argued here that they will be better informed and experienced in this more modern approach.

The forces against this shift in the paradigm for both education and practice go further than Luddite resistance; the typical school remains geared-up for a traditional studio and are unable to offer students sufficient access to computers. However, it is apparent that there is a rapid increase in the numbers of students who now have reasonable access to home computers compared with only a few years previously. The following are presented as *premises* and *strategies* in anticipation of a time when all students can be guaranteed sufficient dedicated access to computers, and a time when most practices will be geared-up and computer focused. These strategies are not especially innovative arrangements, but may be potentially novel for the way that architecture and building students might work together in tandem with the profession's own difficult adjustment to new ways of describing and procuring buildings. This paper proposes that educators, researchers, practitioners and students share a facility dedicated to the lateral application and cross fertilisation between existing software, and to learning basic scripting of macros and programming. All parties would gain an insight into an extended role of the computer in both architectural education and practice such that each informs the other of the opportunities and restrictions in an environment of shared rather than exclusive and detached learning.

A greater absorption of computing into education is based on the following premises:

- A university research facility can be styled to involve students as 'young researchers' and, at the same time, actively involve practice.
- Practices do not make full use of their existing computer applications.
- The continuing resistance to 'deskilling' a profession, away from being traditionally multi-skilled towards individual specialisation, is unhelpful to a profession facing increased competition from other building providers.
- Over specialisation within education, however, ought to be resisted as far as possible by using the computer within the curriculum to ensure a greater cross-fertilisation between courses than previously possible.
- Student access to computers is limited and not commensurate with the opportunity for their wider emphasis within typical school programmes.
- Greater reliance can be placed on students to self-tutor in Windows-based or Macintosh applications. Teaching staff expert in the use of computers can then be redeployed towards more creative use or programming within existing applications.
- Time saved by encouraging students to make greater use of CAD in *studio* (design as well as representation) could be used to make wider and more holistically based design decisions.
- Through active involvement with education and education based research practice, *dinosaurs* can be re-skilled to an extent where they can at least achieve an intimate understanding of computer techniques without necessarily arriving at the level of 'expert'.

7 Research as Part of Coursework

The quest for an improved role for the computer as a design tool is not being argued here. Rather than deliberate about activities involving a degree of synthesis, the argument is confined to the analytical potential of software which can be used to promote better design. Schools appear to focus on the vexed issue of computer-aided design representation. Indeed, by focusing on the rendering and animated walk-through, the educators are assuming that clients actually consider photorealistic renditions as *sine qua non*. Before such opportunities, clients seemed to have trusted in the professionalism of the architect to furnish, as a whole, that which had been only partially represented as perspective or orthographic projections.

By establishing a research facility as a neutral point of contact between practice, research and teaching it is anticipated that a more fluent approach to computer use will emerge. This is expected to foster a more productive dialogue between practice and education. The categories of activities being prepared are as follows:

- knowledge dissemination (design libraries)

  Student research can develop significant databases of model or worked examples of details which can be accessed as interactive CD-ROM or via the Internet. Practice collaboration will help the ensure that such collections are useful both in practice and in education (Burry et al 1995).

- relationship between measurable design decisions, environmental and structural performance and cost

  Much of the architects' typical workload are small projects beyond the scope of consultant support. While experience may factor out the need for formal cost and physical analysis for senior architects, cross-linked spreadsheets and databases allow more objective decision-making.

- resource gathering, collation, distribution and collaboration via the Internet

  Material which is not commercially sensitive can be shared via the Internet for the common-good. Equally, clients can be kept up to date with progress through reports, images and animations available on demand via computer.

- management and databasing

  Practice procedures, management and accounting can be organised through dynamically linked proprietary software. Individual practices could 'consult' students who, in the process of untangling and organising appropriate tools (liaising with applications experts), learn about the intricacies of practice management and record keeping.

- programming and scripting as a parametric variation strategy

  Most proprietary software has an associated macro and programming language which students find surprisingly simple and stimulating to learn. Repetitive AutoCAD work beyond the scope of 'blocks', for instance, can be rendered into routines which allow the user to interact 'parametrically' via the command line.

- managing of multi-author 3D modelling

  Most CAD work is 2D. Practices do not have ready protocols for management such that any participant can link into the model, navigate and collaborate in its development.

- detailed design and parametric variation

  Although high-end parametric modelling software is virtually unknown within practice, it can be shown to be an extremely effective design tool for detailed construction and repetitive detailing where small changes occur between details. To date the software has proven to be too expensive and beyond the skill base of personnel who have architectural training (Burry 1996).

- combining specification text and CAD drawings

  Release 13 of AutoCAD, for instance, has the facility to introduce text directly from files. Specification notes can be added from a database without retyping. Dynamic links can be investigated to ensure compatibility between drawing and specification after changes are made to either.

- form modelling and sectioning with physical property analysis

  High-end solid modelling goes beyond the visualisation of complex form and allows the database to be 'interrogated' for building description such as the generation of sections.

- environmental and structural analysis informing CAD detailed drawings

  Proprietary CAD software can be linked to analytical programmes, such as Radiance or EVA, assisting the student and architect in design decision making. If practitioners bring live projects into course work, relatively small projects might obtain a degree of insight which is more affordable to the client and of learning use to the student.

- rendering and animation of construction assembly

  Animating construction assembly can now be achieved relatively quickly allowing the designer to inform the client and at least negotiate the practicalities of unusual or apparently difficult assemblies with the builder.

8. Conclusions

The dichotomy which has developed between architectural practice and architectural education can only be addressed by changes in both environments.

The perception of operators of computers as being highly skilled at one function within architectural practice, and necessarily deskilled at in other areas, must be replaced with the notion that efficient computer use is a reskilling process. This requires a fundamental change in practice attitudes toward computers in two areas. Firstly, practices should develop a concept of computer use which utilises its capabilities as an information handling system. Such a change can only be brought about by an alteration in the way practices perceive their operations. Recognition that architectural practices are information systems, as well as design offices, will facilitate this and create an environment in which the links between what are now discrete and unconnected parts of practice operations, can be made. Secondly, the notion that intensive computer use necessarily leads to a deskilling of the user should be replaced by the view that it is an essential element in the range of facilities used by the architect in carrying out the functions of practice. This requires the development of the idea that learning to use a computer in an information rich environment is a reskilling rather than deskilling process.

Architectural education should seek to develop the notion of the architectural design process as an integrated information system. Rather than placing emphasis on those computer skills which seek to perpetuate the idea of the computer as a visual design medium, refocussing on the computer's ability to facilitate the linking of disparate information sources allows design analysis to take place which was not previously possible. This requires a clear development of the linkages between different elements of the architectural education curriculum. Adherence to the traditional method of education in which individual subjects are taught, with little or no reference to other subject areas, resist opportunities for integration across subject boundaries. Computer based information systems provide a significant and previously unavailable opportunity for less contrived integration within an education environment.

It is unlikely that architectural education will ever provide exactly what the profession demands, nor should it. However, with the development of sophisticated and economical computer systems which facilitate the integration of an increasingly wide range of information sources, there is a clear role for schools of architecture to lead practices in new and potentially highly fruitful directions.

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