INFORMATION TECHNOLOGY AND THE QS PRACTICE

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1. INTRODUCTION

Professional expertise in project financial management is the fundamental basis for success for a Quantity Surveying firm. This can only be achieved through proper education, "on-the-job" training and experience over a wide range of projects. Utilising Information Technology (IT) for competitive advantage is the next key ingredient for a firm's success but, quite clearly, success cannot be achieved by the latter unless the former is established. This paper examines how the Australian Quantity Surveying profession can combine these two ingredients to gain competitive advantage and create increased business opportunities both in the short term and the long term and within and outside the construction industry. The research for this paper is largely based on the results of a major IT research study conducted on behalf of the Department of Industry, Science and Resources (DISR) and three nationwide surveys of the Australian Quantity Surveying profession. The paper commences with an analysis of the general rate of IT adoption in the industry, explores future industry directions using the NSW Department of Public Works and Services (the largest client in Australia) as a case example, presents and analyses the key findings of the research studies outlined above and concludes with a series of IT-related strategies for Quantity Surveying firms to consider adopting to improve their business performance.

2. INFORMATION TECHNOLOGY ADOPTION RATE

The rate of adoption of Information Technology (IT) in the construction industry has been slow compared to most other industries despite its information intensive nature. The reasons for this slow adoption rate are many and varied. Probably the greatest problem lies in the extremely fragmented nature of the industry not only in Australia but globally. The industry is characterised by a large number of small organisations each with their own vested interests in the process. In Australia, there are over 100,000 small businesses operating in the construction industry with 98% of firms employing less than 20 people and 85% employing less than 4 people (Hutt 2000). 85-90% of construction work is subcontracted and project team consultants and contractors are typically assembled for individual projects in an ad-hoc "one-off" pattern with decisions on project team composition largely made on the basis of lowest price. Hence, project teams are assembled and disassembled on a project by project basis with little continuity of project team members over the long term. During the course of large projects, there are typically hundreds of firms (consultants, contractors, suppliers) involved during the various stages with a high level of "change-over" between the various trade contractors. Additionally, every project is a "one-off" prototype. Current initiatives to address these problems include alliance contracting, joint venturing and "single-source" delivery of services extending into the operational stages of projects.

Due to a lack of industry standards, each of these firms have their own organisational/management systems in place encompassing a wide range of technological capabilities and software usage. The wide range of software systems used and the incompatibility between many of these systems severely limit the scope for the industry to take advantage of the rapid technological advances surrounding it.

Exacerbating this situation is the generally low profit margins in the industry which inhibit the ability of firms and the industry generally to make the necessary investment in IT systems, research and development. Other key problems include the complexities surrounding information

flow on construction projects, the lack of information and process standards, the traditional "paper-based" mindset of the industry and yet to be resolved legal and contractual issues relating to electronic documentation and records.

Nevertheless, the past 5 years has seen significant advances in addressing these problems. Organisations such as the International Alliance for Interoperability (IAI), backed by major international firms and professional associations, are making major inroads in developing standards to offset the problems associated with incompatibility of computing systems and information flow. There are now many examples of major projects where entire project teams have been linked electronically and all information flow carried out electronically; the construction of the new airports in Hong Kong and Kuala Lumpur being two good examples. Major industry clients are exerting increased pressure on industry participants to more effectively utilise IT capabilities. In Australia, the NSW Department of Public Works and Services (DPWS) is the nation's biggest construction industry client and is currently implementing strategies to push the industry into the electronic era. These strategies are summarised in Section 5.

The pace of change in our society is having a concomitant effect on the industry. Gleick (1999 cited in Spigelman 2000) provides historical comparisons with our current rate of change and adaptation to new technology. Gleick examined how long it took for one-quarter of the population in the United States to adopt new technology; 46 years for electricity, 35 years for the telephone, 16 years for personal computers and 7 years to be connected to the internet. The digital revolution is occurring with unprecedented speed. This has been coupled with the phenomenon of a decreasing tolerance to delay. Delays in certain processing functions (particularly those computer-based) quickly become unsatisfactory even though this type of delay may have been acceptable as little as a year earlier. Instead of words per minute it is now characters per second. Time has consequently become more important as people increasingly try to cram as much into their days as possible. In Japan, some restaurants now charge customers by the minute and not on what they actually eat; customers clock in, clock out and the bill is calculated on the actual time spent in the restaurant. Many examples exist of the need to create the illusion that we are saving time. The "door close" button on building lifts provides a good example; on many lifts these buttons do not actually work and are in place merely to *"placate those who measure their time in seconds"* Spigelman (2000 p.5).

Current personal "off-the-shelf" computers with pentium processors are capable of performing 400 million instructions per second and, at the current pace of development, by 2012 personal computers will be able to handle 100,000 million instructions per second. In 1980 copper wire phone lines carried less than one page of information per second whilst, today, optical fibres as thin as a human hair can transmit the equivalent of over 90,000 volumes of an encyclopedia per second (de Valence 1999).

In the construction industry, the pace of change is gaining momentum. Rapid changes in the design area alone have occurred; the drafting board is quickly becoming obsolete giving way to the computer monitor. Weisburg (2000) argues that the next few years will see significant changes in how developers, designers, consultants and contractors manage the entire building process. These changes will result in not only substantial restructuring of how facilities are designed and supported but also a major reengineering of how these players do business. Weisburg further contends that the process will become substantially more information-oriented with participants being required to not only have the technological capabilities to be a part of this information flow but also, and probably most importantly, be willing to share their information. The sharing of intellectual property amongst project participants will, in itself, require major

cultural and business shifts as firms are increasingly asked to "hand over" their valuable data.

3. INDUSTRY DIRECTIONS - CASE EXAMPLE

3.1 DPWS IT Strategies

As mentioned previously, the NSW Department of Public Works and Services (DPWS) is the largest construction client in Australia and, accordingly, has a significant influence on the future directions of the industry. Current DPWS strategies therefore provide a good example of where the industry, at least in Australia, is heading.

In 1998, the DPWS launched their strategies to more effectively use IT to provide better value for money in capital works procurement. The aim is to achieve this by improving communication and teamwork through all phases of the design, construction and operation of facilities (DPWS 1998). Eden (2000) points out that these strategies are underpinned by the premise that the key to successful utilisation of current and emerging technology through the entire project life cycle and providing better value for money for clients lies in the sharing of data, information and knowledge at both industry and project levels. Eden also describes the following as the main directions necessary for the successful implementation of IT:

- focus on project specific applications
- integration of IT through the entire procurement and project life cycle process and a feedback loop to the design and briefing stages
- integration of IT through the entire supply chain including subcontractors and suppliers
- recognising the importance of and assisting in IT education and training of practitioners
- use of object-oriented project data-bases
- sharing the learning experience between clients and industry, and
- sharing the learning experience between the construction and other industries.

The DPWS vision is that, by 2005, all firms wishing to undertake future capital works projects will need to be able to communicate electronically with all project participants at all necessary levels. For the Quantity Surveying practice, this means being able to transfer and receive all project information, including drawings, electronically.

3.2 Key Elements

Eden (2000) states that the strategies evolve around the following:

<u>Object-Based Project Databases</u>
These databases will contain all the project information and will be accessible by all project participants electronically at any time from any place and in a form best suited for the particular participant. Project web technology (currently experiencing rapid development) will be used as the main communication media. The database will evolve around 3D object oriented computer-aided design (CAD) whereby each component/element of a building is set up as an object with all the necessary design and operational attributes/properties/information intelligently imbedded in the object. This will extend into the Facility Management phase of a project's life cycle (a period where traditionally the original project information is not available in any useful form). Whilst there is general consensus that the industry will eventually be driven by 3D object oriented CAD, conventional 2D CAD is currently used by well over 80% of CAD users in the industry. The shift to 3D CAD has been slow but there are now signs of this shift accelerating.

<u>Communication Networks</u>
Communication networks will evolve around internet and web browser technology with all participants accessing a central project database. This will offset the need for multiple copies, and in some cases versions, of the data/information to be held separately by each project

participant. The database will also enable access to client databases with generic information about their requirements and historic data as well as information about manufacturers, suppliers, contractors, consultants, service providers and their products.

Electronic Commerce and Electronic Procurement

Electronic procurement will require all project participants to conduct their businesses via electronic commerce. This will necessitate cultural shifts in the way these firms do business and, for many, a major re-engineering of their processes and practices. To this end, the Australian Procurement and Construction Council (APCC) have developed a "National Framework for Cooperation for Electronic Commerce in Government Procurement" for the purpose of developing a consistent approach to the use of technology in electronic procurement.

The DPWS approach to electronic tendering is of particular relevance to the Quantity Surveying profession. They are progressively developing systems that go beyond simple advertising of tenders to allow the downloading of measurable documents and to enable the entire tender process to be completed electronically. Some projects have already provided for tenderers (and their subcontractors/suppliers) to generate automatic linear and area measurements from documents available on the internet or, where downloading capabilities are limited, from computer disks.

Eden (2000) states that further developments with 3D object based documents will shortly enable tenderers to utilise these documents directly from the web to automatically generate length, area and volume measurements as well as detailed quantities for many items.

4. SUCCESSFULLY IMPLEMENTING IT

4.1 DISR Research

The following section is based on the findings of a major research program carried out in 1998 for the Australian Department of Industry, Science and Resources (DISR) to examine the current status and future directions of Information Technology use in the construction industry (DISR 1998). The research was carried out jointly by the Fujitsu Centre of the Australian Graduate School of Management and the Building Research Centre at the University of New South Wales for the primary purpose of establishing how IT can provide long term benefits for both firms and the industry generally. The research included interviews with managers of 30 firms (including Quantity Surveying firms) covering most sectors of the industry to identify the actual and potential benefits for these firms in adopting IT and the problems in doing so.

4.2 IT Adoption Phases

The study identified 3 main phases in the adoption of IT by firms in the construction industry:

Phase 1: Automation

This phase involves the use of IT to automate technical and specialist tasks that were previously carried out manually. This has led to many generic benefits which include productivity gains, increased business turnover, shorter cycle times, the capacity to manage larger and more complex projects and improved accuracy and consistency of documentation. However, the researchers found that the leaders in automating their processes enjoyed competitive business advantage only over the short term because it is relatively easy with automation for competitors to adopt the technology used by these leading firms. In many cases, these leading firms act as "guinea pigs" for their competitors who prefer to adopt a "wait-and-see" approach before investing in technology. The result for the industry has been that automation has led to increased productivity gains and lower costs generally across the board for each profession with little long term competitive advantage being

achieved by individual firms. In other words, automation really becomes a competitive necessity for firms to stay in business but, in itself, does not yield sustainable advantages over competitors. The majority of firms in the industry have remained in this phase.

Phase 2: Adding Value

This phase goes beyond using IT merely to reduce costs and to keep up with competitors and involves leveraging the information collected as a by-product of automation to improve management processes. This adds value to the automation process by typically enabling firms to provide a wider range of services for their clients which, in many cases, provide greater value for these clients. For example, a Quantity Surveying firm may invest in CAD technology for the primary purpose of utilising the automated quantities capabilities of these systems. Upon mastering this technology, this firm could further improve these capabilities by developing sophisticated cost planning CAD models which would be invaluable for clients at the conceptual stages of projects. Additionally, the spin-off effects of understanding CAD would provide this firm with opportunities to link electronically with designers and entrench themselves in the information management side of the construction process creating an array of new business opportunities. Few firms realise these opportunities.

Phase 3: Business Process Re-Engineering

The third phase is realised by even fewer firms but it is in this stage where the greatest benefits lie. This phase involves utilising IT to transform (re-engineer) the firms core business operations to optimise the use of IT. This usually requires continual investment in technological advancement and organisational change. The researchers found that the relatively few organisations that have re-engineered their business processes along with the adoption of IT have experienced significant gains in productivity and gained sustained competitive advantage. This has enabled expansion into new markets, improved ability to manage projects from a distance and the ability to compete on an international scale. Using design firms as an example, the researchers found that productivity gains (up to five times over seven years) were greatest amongst firms who moved to 3D object oriented CAD and re-engineered their processes accordingly.

On a general industry scale, the researchers found that the greatest potential for transforming IT utilisation in the construction industry lies in re-engineering the supply chain to deliver increased value for clients. Due to the fragmented nature of the industry outlined earlier, this can only be achieved through inter-organisational processes which, at present, have been limited to the automation of communications (email, electronic funds transfer and the like). However, far more sophisticated advances are required particularly in terms of software standards to achieve the necessary interoperability. The researchers contend that even more important is the need for much closer cooperation and sharing of information amongst firms, a concept which is a real challenge in an industry traditionally characterised by its adversarial nature and firms' possessiveness of their data and information.

4.3 Potential Benefits & Challenges for Quantity Surveyors

The study examined the main potential IT applications and benefits for the Quantity Surveying profession. The main applications were found to be:

- increased productivity through streamlined data entry and data management
- increased productivity through automated quantities and cost calculations
- increased productivity through the use of digitisers for measurement
- elimination of measurement in many areas through direct extraction of quantities from CAD files
- faster and more efficient transmission of quantity/cost data via email

- expanded services in relation to feasibility, time and cost planning using expert systems

It was found that the current use of IT by Quantity Surveying firms was largely restricted to:

- an emphasis on automating data entry and calculations
- use of email to send data to designers and contractors
- continued emphasis on manual measurement amongst most practitioners
- increasing non-traditional services in areas such as feasibility evaluation and time and cost planning including life cycle costing

This area is further explored in Section 5 when evaluating the nationwide surveys of the profession. However, the following conclusions drawn by the researchers in relation to the future direction of the profession are worth quoting and should serve as a pertinent reminder to the profession. Perhaps even more pertinent because they are the conclusions of industry experts with "non-QS" backgrounds and no vested interest in promoting any particular professional discipline.

"The direct calculation of quantities from CAD files represents a serious threat to the traditional role of Quantity Surveyors. This could reduce the value-added base for their traditional services to two areas. The first is 'up to the minute' market knowledge of subcontractor rates. The second is job-specific knowledge of the impact of design, construction and detailing on costs. However, even in these two areas, the provision of market information is a service that could be readily supplied in the future by a single operator establishing an electronic market. The benefits of IT may therefore only accrue to a small number of firms and only over the medium term. The future role of the Quantity Surveying profession will become limited to the area of cost adviser in an increasingly narrow area of expertise, significantly restricting business opportunities within the profession" (DISR 1998, p.6).

The saving light for the profession, in the view of the researchers, lies in the diversification of the services provided by Quantity Surveying firms. The surveys examined in Section 5 suggest that there has been a marked push towards diversification by Quantity Surveying firms over the past five years.

4.4 Key Success and Impediment Factors for IT Implementation by Firms

The study identified the key factors which drive successful implementation of IT and, conversely, the factors which impede IT implementation. The success factors were summarised as follows:

- taking an incremental approach to the implementation of IT
- ensuring new IT systems have business benefits
- changing/re-engineering the business to optimise the advantages afforded by the technology
- using individual projects to fund incremental adoption
- using individual projects as an opportunity to learn to use new technology
- proper training and development of staff so they can use the new technology successfully
- commitment of senior management to IT implementation.

The main impediments for firms were found to be:

- the high cost of innovating/learning a new technology
- low margins resulting in little scope for investment in IT innovation and learning
- fear of over-investing in IT
- resistance to re-engineering/organisational change
- lack of the necessary computing skills amongst staff

- lack of awareness by senior management of the opportunities IT presents
- belief that IT innovation is unnecessary
- client resistance
- senior partner/management resistance.

The main industry-wide impediments were found to be the lack of people with vision in the industry, the fragmented structure of the industry, the adversarial nature of the industry, the lack of trust amongst firms and the lack of a shared/standard language and technology in current supply chain processes.

5. QS SURVEY RESULTS & ANALYSIS

This following section examines in detail the general practices of Australian Quantity Surveying firms over the past 5 years with a focus on the attitudes towards and utilisation of Information Technology. It is based on nationwide surveys of the Australian QS profession carried out from 1995 to 1999 by the Construction Economics Research Unit from the University of Technology Sydney in collaboration with the Pacific Association of Quantity Surveyors (PAQS) and the Australian Institute of Quantity Surveyors (AIQS). These survey results enable evaluation of how the profession has reacted over the past five years to the challenges and opportunities that Information Technology advances and general industry changes have presented.

5.1 Survey Details

The surveys comprise a series of 3 nationwide surveys of Quantity Surveying firms carried out in 1995, 1998 and 1999. The first two surveys were conducted in collaboration with the AIQS. 77 firms responded to the first survey (out of 160 firms) and 65 firms responded to the second survey (out of 126 firms) representing response rates of 48% and 52% respectively. The third survey in 1999 was carried out in collaboration with both PAQS and the AIQS and was extended to cover Quantity Surveying practices in the PAQS member countries. Unfortunately, the response to this survey was not sufficient to enable detailed comparison between the various countries. Consequently, this paper focuses on the responses by Australian Quantity Surveying firms from whom 38 replies were received.

The surveys comprised a number of questions concerning general practice details, information technology capability and use and future directions of the profession. The questions were largely the same for each survey but there were questions added to the 1998 and 1999 surveys. Hence, it should be noted that where 1995/1998 results are not shown this indicates that the particular questions were not asked. These surveys will continue to be carried out on at least a bi-annual basis to gauge how the profession is evolving during these turbulent times. Hopefully, better response rates from firms outside Australia will enable international analyses in the future.

5.2 Respondent Profile

The following figures indicate the size and age of the respondent firms. These questions were not asked in the 1995 survey.

The respondents predominantly comprise small to medium sized organisations which is typical of the profession's (and industry's) structure. More than half had less than 10 employees which is a significant factor when analysing the survey results. Nevertheless, more than half have been in business for over 10 years which suggests that longevity of firms, at least until now, is a feature of the profession.

Fig. 1 Total Number of Employees

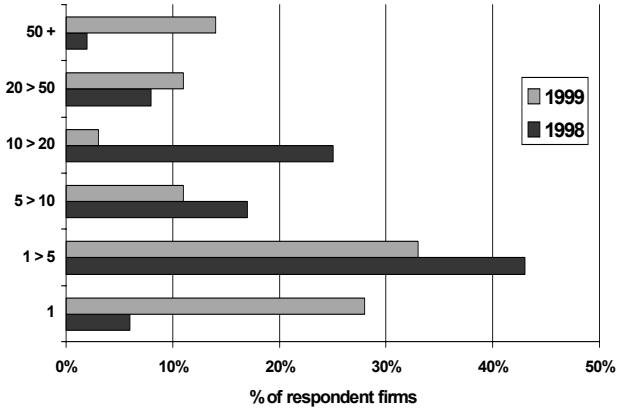
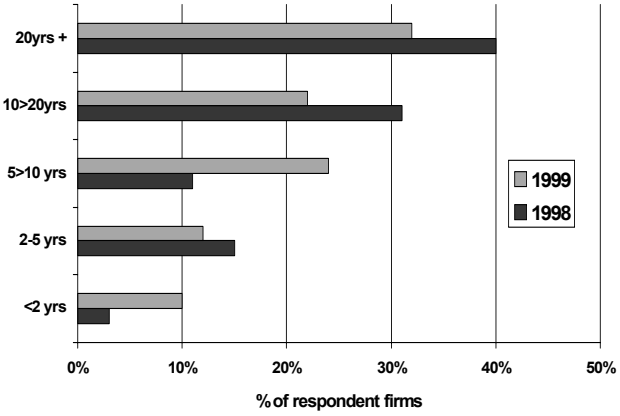


Fig. 2 Age of Firm



5.3 Services Provided

The past two decades have seen Quantity Surveying firms expand and adapt their scope of services to meet changing industry demands. The use of the traditional "bread and butter" of the profession, Bills of Quantities, has declined markedly in the Australian construction industry over this time to the point where they are rarely used. Despite this, the volume of work carried out by firms has increased over the corresponding period. Builders Quantities, whereby tendering contractors themselves (rather than the client) engage and pay Quantity Surveyors to prepare quantities have now taken over from the traditional Bill of Quantities provided and guaranteed by the client. Builders Quantities are usually prepared in a concise form with firms using their own concise standards; no standard concise method of measurement has yet been developed.

Another major change has been that Quantity Surveyors are now used much more in the "front-end" stages of projects where their expertise is of most value. Cost planning and budgeting is becoming

the new "bread & butter" of the profession. One of the largest Quantity Surveying firms in Australia[1] provides a good example of these changes; in 1980 Bills of Quantities accounted for approximately 80% of their total workload whereas in 2000 this had declined to little over 5%. However, rather than leading to the firm's demise, the firm has adapted accordingly and now provides a greater volume and wider range of services.

This section of the survey targeted the scope of services provided by firms. Figure 3 shows the percentage of firms providing traditional services (question not asked in 1995). Estimating/Cost Planning and Contract Administration are the main services provided by firms. Even though the use of Bills of Quantities has declined most firms still provide this service albeit to a limited extent. More firms prepare Builders Quantities than Bills of Quantities.

Figures 4 and 5 show the extent of non-traditional and non-building services provided by firms (questions not asked in 1995). The range of services is now clearly very broad with taxation advice (comprising mainly building Tax Depreciation Schedules) and valuations for insurance purposes the most common service.

The role of Quantity Surveyors in resolving disputes as Expert Witnesses in Arbitration/Litigation actions has escalated markedly. Australia is one of the most litigious countries in the world (measured in terms of legal cases per capita) and its construction industry is dominated by a high level of dispute. Most disputes evolve around money so the cost expertise of the QS is commonly sought.

Many Quantity Surveying firms have now also ventured into non-building areas demonstrating that the cost management skills of the Quantity Surveyor can be applied in other industries just as is the case with Project Management. The results indicate that this trend is likely to continue.

However, the provision of these services does not necessarily mean that these services account for a large proportion of firms' volume of work. Figures 6 and 7 indicate the percentage of income that these non-traditional/non-building services provide for firms. The results indicate a significant increase in these percentages over the 5 year period. In 1995, non-traditional services accounted for less than 10% of total income for over 80% of firms and no firm had a percentage higher than 50%. Non-building services were very limited; only 10% of firms carried out these services and, even then, they only accounted for less than 10% of total income.

By 1998/99 this picture had changed significantly. For over approximately 70% of firms non-traditional services accounted for more than 10% of total income and over 20% of total income for more than half of firms. For approximately 25-30% of firms these services actually accounted for over 50% of total income. Non-building services were also on the rise accounting for over 50% of total income for one firm and 10-50% of total income for approximately 20% of firms. Marked increases were noted even between the 1998 and 1999 surveys.

These results provide evidence that Quantity Surveying firms have really taken on the challenge of diversification to better meet and serve industry demands. This indicates, in part at least, a proactive approach to change by many firms.

In order to ascertain current processing technology capacity, respondents were asked to indicate their hardware platforms with the results shown in Figure 8. This provides the basis for the analysis of the survey results.

[1] The identity of this firm is not disclosed for reasons of confidentiality

Fig. 3 Traditional Services

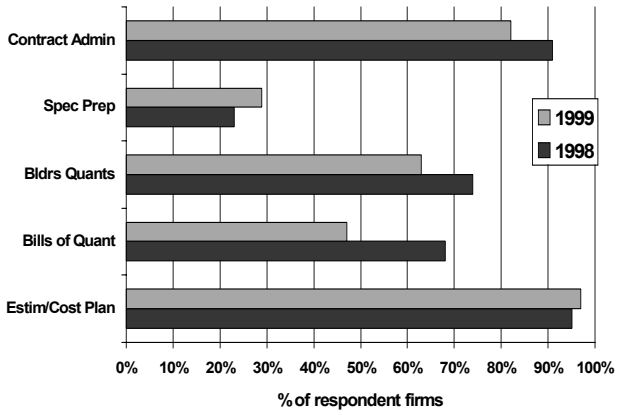


Fig. 4 Non-Traditional Services

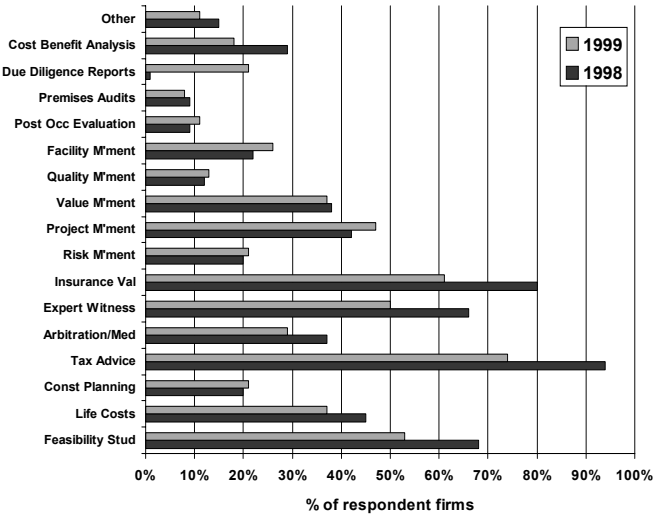


Fig. 5 Non-Building Services

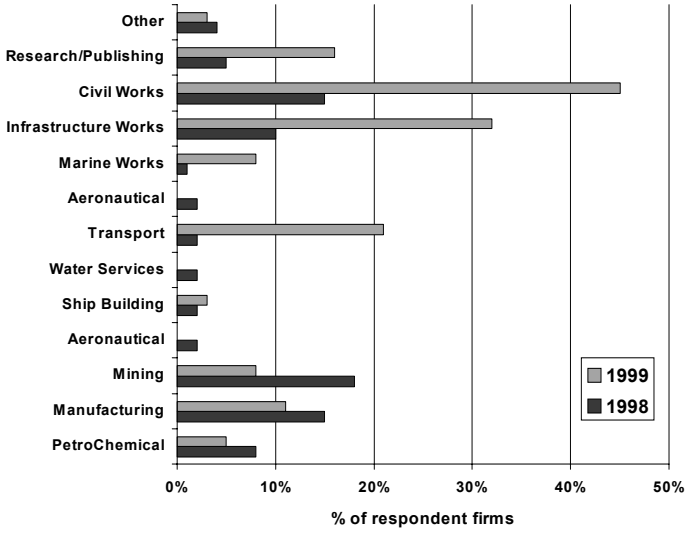


Fig. 6 % Income - NonTraditional Services

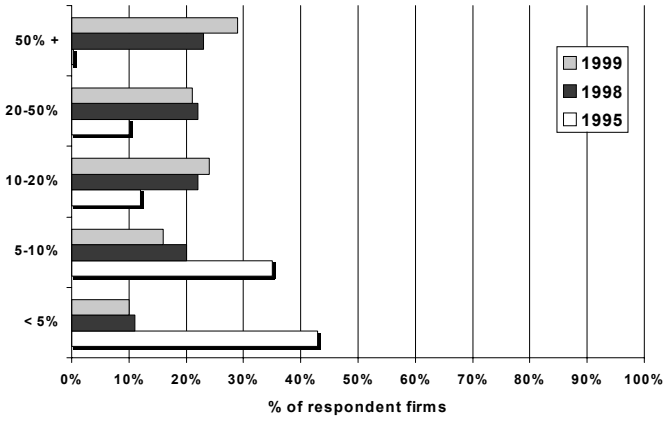


Fig. 7 % Income - Non Building Services

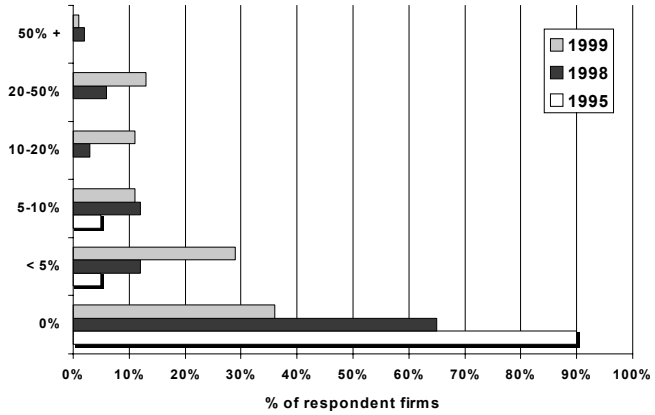


Fig. 8 Hardware Systems

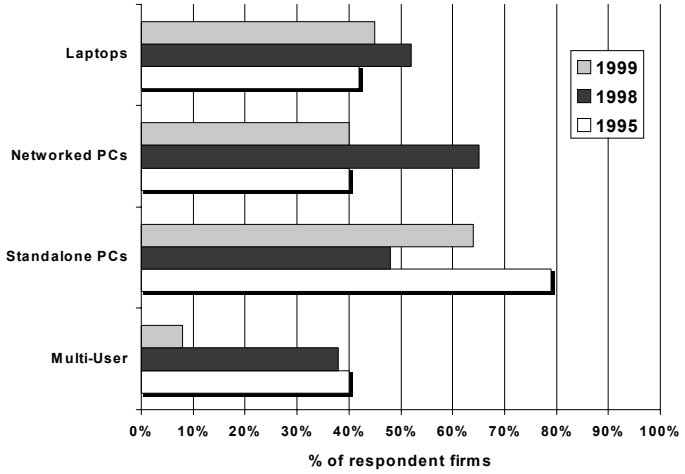


Fig. 9 General Office Applications

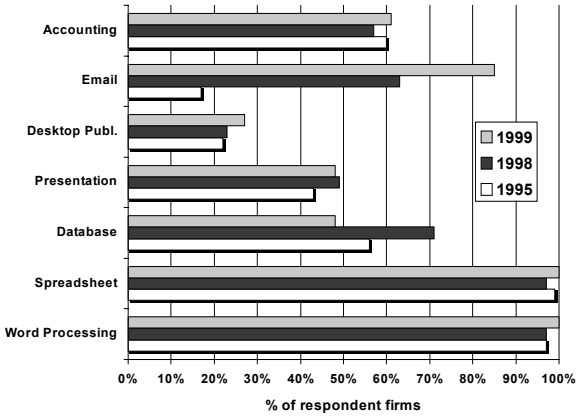


Fig. 10 Specialist Application Software

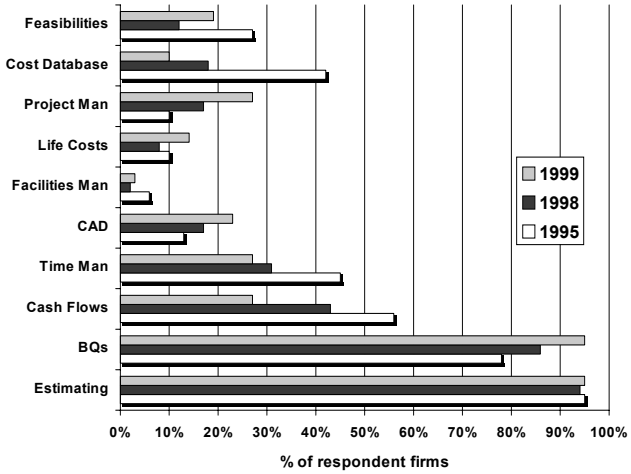
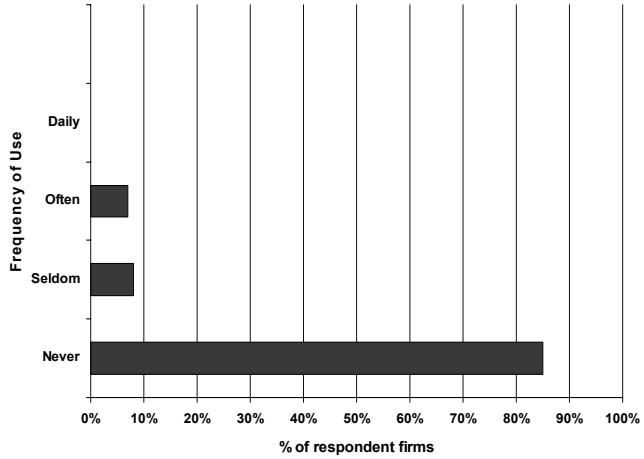


Fig. 11 Use of CAD for Measurement



5.4 Computing Systems

Operating Systems

The use of multi-user systems comprising a mainframe and dumb terminals has declined from around 40% of firms in 1995 to less than 10% in 1999. Whilst this change may be more a reflection of the large proportion of small respondent firms in the 1999 survey it does indicate that many firms are moving more towards networked computers. The use of laptop computers has remained relatively static being used by only approximately half of QS firms.

General Software Systems

The surveys revealed that the majority of firms use mainstream general office application software as indicated in Figure 9. One firm in the 1999 survey (sole practitioner) is still resisting change and has no computing facilities.

The major change has occurred in the use of electronic mail (email). In the 1995 survey only 17% of firms used email but by 1999 this figure had increased to 85%. This provides a good example of how quickly email has been embraced as a major communication tool in business.

Specialist Software Systems

Figure 10 indicates that although the majority of firms use specialist application industry software for estimating, cost planning and Bills of Quantities (BQ) preparation the same may not be said for other specialist areas such as time management, facilities management and the like. Anomalies are evident in responses to the use of feasibility, cost monitoring, cost data-base, time management and cash flow forecasting software.

The 1998/99 responses showed a decline, and in some cases, substantial declines in the use of specialist software for these areas. However, many firms have developed programs for these specialist areas in-house (largely based on spreadsheets) and many project management style programs provide "all-encompassing" capabilities. In-house software is now used by over 60% of firms.

The most alarming statistic in 1995 was that only 13% of respondents had CAD facilities. Over the ensuing 5 years this percentage has increased to 25% which indicates that some firms, at least, are venturing into the CAD area. Nevertheless, this proportion is still very low particularly if the profession is intent on remaining a key player in the project procurement cycle. Whilst some respondents cite cost as the main reason for the non-use of CAD, it is clear that the majority of Quantity Surveyors are incapable of communicating/transferring drawing information electronically with designers. This may well see these firms isolated from the chain of consultants in the not too distant future as information flow on construction projects increasingly becomes electronic.

Measurement Tools

The 1999 survey introduced a question relating to the use of electronic tools to aid the measurement process. The results in Figures 11 and 12 show that the majority of firms still cling to traditional paper-based measurement with the use of electronic measurement tools quite rare. All but one firm use measurement software programs with Buildsoft the most common. However, firms are clearly averse to using CAD automated quantities with **85% not using CAD** for this purpose, 8% seldom using it, 7% using it often and no firms using it daily. Given the low proportion of firms with CAD facilities in the first place, these results are probably not surprising. The major reasons cited for not using CAD are the cost involved in investing in the necessary hardware/software and training of staff, the incompatibility of different CAD systems and problems with the automated capabilities of these systems. There are still many problems associated with using

CAD for measurement and the time when CAD systems can automatically produce a detailed Bill of Quantities for projects generally (rather than being set up for specific projects) is still probably a long way off. But the reality is that most CAD systems have the capabilities to, at the very least, automatically generate basic quantities in terms of areas, volumes and numbers of items.

Even the use of digitisers for measurement has been very low in the profession. 79% of firms never use digitisers, 13% seldom use them, 3% use them often and only 5% use them daily. Even then, with the firms using digitisers, they are not available to all staff with no firm having more than 3 in the office. Similar findings were made in the 1995/1998 surveys. Digitisers have been around for nearly two decades and are considered by many to already be obsolete due to the advances in CAD yet Quantity Surveying firms still resist their use. Inaccurate results are cited by many as being the main reason for non-use but, in the author's experience, digitisers (particularly those that have been on the market over the past 5-10 years) are extremely accurate. Many CAD systems themselves have digitiser capabilities but, once again, are rarely used by practitioners.

The results indicate that the profession is generally not utilising and evolving with systems that can automatically produce quantities. There is tremendous scope here for quantity surveying practices to improve productivity and cost efficiency by utilising such systems.

Electronic Communication

Not surprisingly, the level of external electronic data exchange, other than by telephone or fax, is very limited. Figure 13 shows that over 90% of firms still do not receive design drawing documentation in this form. There have only been minimal increases in this area since the 1995 survey. The 1999 survey shows in Figure 14 that, even with the firms that do transfer drawings electronically, the level of transfer is very low. 3% of firms transfer 1-5% of drawings electronically, 5% transfer 5-20% and the rest transfer no drawings electronically.

Fig. 12 Use of DIGITISERS for Measurement

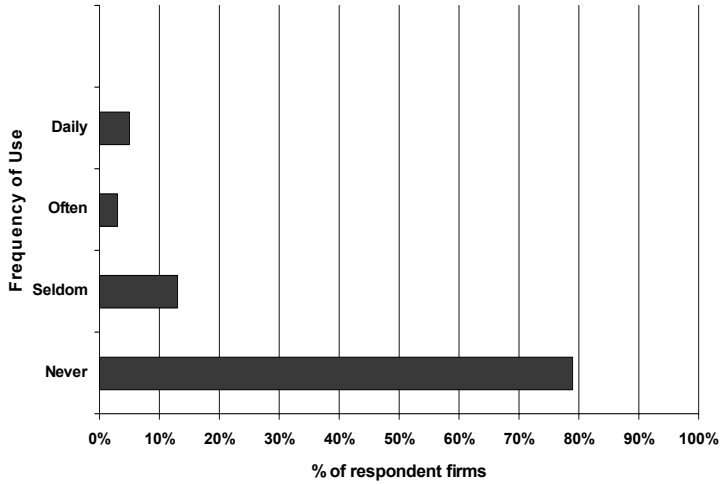


Fig. 13 Electronic Data Exchange

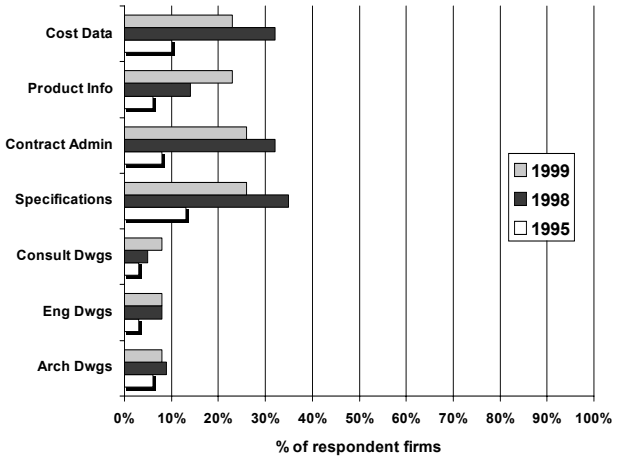


Fig. 14 Drawing Documentation Transferred Electronically

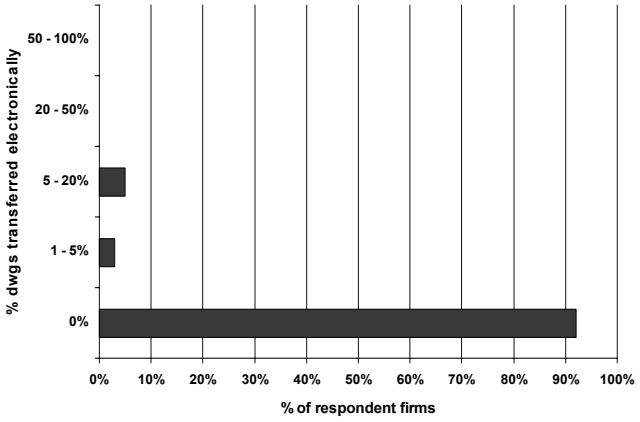
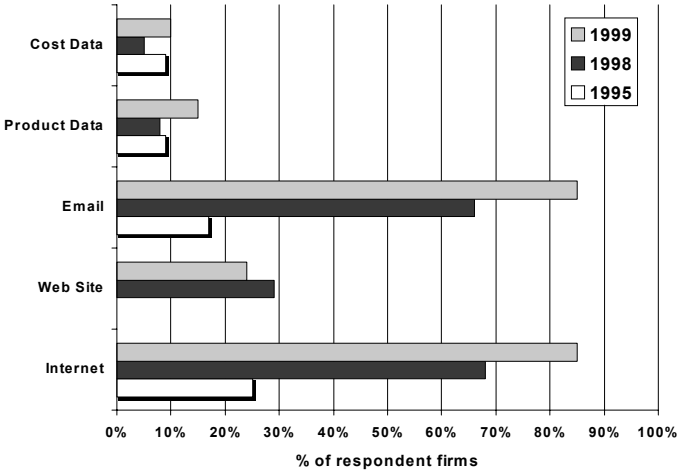


Fig. 15 On-Line Services



Some consolation though is that there has been a steady increase in the proportion of firms transferring cost data, product information, contract administration information and specifications electronically.

Inter-office communications were also shown to be limited. Whilst the majority of affiliated practices had direct electronic links, firms demonstrated little electronic communication with clients, consultants and contractors. In 1995, only 7% had links with consultants and only 1% with contractors. This had only increased to 14% and 11% respectively by 1998.

Access to on-line services has improved as shown in Figure 15. In 1995 only 17% of firms had e-mail facilities which indicated that the profession was generally not embracing information technology. This percentage has increased to 85% which is encouraging. Additionally, use of the internet has increased markedly and close to 30% of respondent firms had web-sites by 1999. This figure is likely to have increased further by now.

Videoconferencing/Telecommuting

Less than 20% of respondents to all the surveys had staff working outside their office using direct electronic links such as via a modem. The majority of those involved employees or contract Quantity Surveyors working from home. Less than 5% had electronic links with staff working on site. Videoconferencing facilities are not used by any of the firms surveyed.

5.4 Future Expectations

The next section of the surveys asked firms to give their opinions on a series of propositions relating to the possible future impact of general industry changes and Information Technology advances. The propositions and results are shown in Table 1. The predominant response for each year is shown in bold.

The predominant response categories were largely the same for each year. The responses clearly indicate that the majority of practitioners believe that information technology will have a significant influence on their future working environment. Over 74-82% agreed that greater use of IT will enable Quantity Surveyors to provide better services for their clients. Despite this, the survey results indicate a relatively low commitment to the use of IT advances.

The main disparity in results between survey years lay in two questions relating to the possible demise of the technical measurer and the decline in practitioner numbers. In 1995 opinion was relatively evenly divided on the impact that IT advancement will have on the technical QS whose main function is measurement but in 1998/1999 only 26% and 32% of firms respectively agree with this proposition. This may be prompted by continuing problems with the development of CAD automated quantities.

Nevertheless, approximately 60% of firms believe that CAD networking facilities and knowledge will be necessary in the next five years and approximately 70% believe that the profession should be actively involved in promoting, developing and utilising CAD automated quantities. This is clearly at odds with what firms are actually doing with the survey results show a low level of CAD usage by quantity surveying firms.

Although 67-77% of respondents believed that the QS is well placed to take advantage of the increased use of IT in the construction industry, the survey results show that the profession is clearly not exploiting this advantage and is largely taking a reactive rather than proactive approach.

Finally, with perhaps unfounded optimism, 76-83% of firms are of the opinion that the QS will be a key player in the construction industry in 5 years time. The current level of IT usage in the profession does not parallel such optimism.

Table 1: Future Expectations

	Strongly Agree			Agree			No Opinion			Disagree			Strongly Disagree		
	1995	1998	1999	1995	1998	1999	1995	1998	1999	1995	1998	1999	1995	1998	1999
GENERAL PRACTICE															
The role of the QS as an independent consultant will expand in the future	n/a	20%	16%	n/a	**58%**	**58%**	n/a	8%	8%	n/a	11%	15%	n/a	3%	3%
Future QSs will mainly be employed as part of a professional team in multi-disciplinary practices providing integrated "in-house" services	1%	2%	3%	19%	17%	34%	21%	8%	16%	**51%**	**62%**	**47%**	8%	11%	0%
The QS will be a key player in the construction industry in 10 years time	n/a	34%	13%	n/a	**49%**	**63%**	n/a	8%	8%	n/a	5%	16%	n/a	4%	0%
INFORMATION TECHNOLOGY															
The impact of IT on the construction industry will be **minimal** in the next **5** years	0%	3%	0%	20%	5%	3%	18%	3%	3%	**49%**	**49%**	**60%**	13%	40%	34%
The impact of IT on the construction industry will be **minimal** in the next **10** years	1%	2%	0%	5%	2%	0%	18%	5%	0%	**52%**	29%	**53%**	24%	**62%**	47%
Further advances in computing and IT generally will see the end of the technical QS measurer	4%	8%	3%	**47%**	18%	29%	4%	11%	13%	35%	**51%**	**50%**	10%	12%	5%
IT advances will lead to fewer but more highly skilled QSs	n/a	14%	6%	n/a	32%	**52%**	n/a	14%	11%	n/a	**37%**	28%	n/a	3%	3%
CAD networking facilities and knowledge will be essential for the QS in 5 years time	n/a	20%	18%	n/a	**46%**	**39%**	n/a	12%	27%	n/a	18%	16%	n/a	4%	0%
The QS profession should be actively involved in utilising, developing and promoting the use of CAD automated quantities	n/a	25%	21%	n/a	**42%**	**55%**	n/a	9%	16%	n/a	18%	8%	n/a	6%	0%
Only larger practices have the resources to take advantage of IT	6%	9%	13%	19%	20%	24%	15%	11%	16%	**42%**	**42%**	**42%**	18%	18%	5%
Greater use of IT will enable the QS profession to provide better service to clients	32%	31%	32%	**43%**	**45%**	**50%**	16%	15%	10%	9%	6%	8%	0%	3%	0%
The QS is well placed to take advantage of the changes in the construction industry which will flow from the increased use of IT	25%	23%	29%	**42%**	**54%**	**42%**	24%	17%	16%	8%	3%	13%	1%	3%	0%

6 IT STRATEGIES FOR QUANTITY SURVEYING FIRMS

The following strategies flow from the findings of the research underpinning this paper. These strategies are not intended to be exhaustive and do not provide detailed examples of how these strategies might be achieved. Rather they are aimed at providing "food for thought" for Quantity Surveying practitioners to assist in determining the IT approaches that best suit their particular firm and circumstances.

6.1 Maintain and Develop Professional Expertise in Core Competencies

The first strategy for firms has nothing directly to do with IT. Firms need first and foremost to ensure that their quantity surveyors have sufficient professional expertise in the core competencies and skills of the profession and continue to develop this expertise. Adequate "on-the-job" training should be in place for inexperienced employees and to also complement tertiary education. Too much focus on the use of IT may lead to the deterioration of fundamental professional skills that will increasingly become necessary as technological advances continue to automate technical activities thus requiring practitioners to operate at a more highly skilled and professional level. The danger of inexperienced or incompetent staff utilising sophisticated but "user friendly" software is obvious.

Nevertheless, practitioners need to be far more adaptable and willing to change their standard work practices than in the past. The pace of change will make this increasingly important. Weisberg (2000) points out that the most significant problems that firms are likely to face in implementing new technology and business changes will be people management, not technology. This may particularly be the case with older practitioners who worked through the relatively stable work environments of the 1970s and 1980s and are now confronted with unprecedented change in the workplace.

In contrast, many young (but inexperienced) construction professionals are extremely computer literate and adaptable and, in many firms, are relied upon to lead the development of technological change within the organisation. The time is not far off when school leavers/university graduates entering the industry will have spent their whole schooling and education lives surrounded by computers and advanced technology with the result that this technology will be second nature to them. However, Wesiberg (p. 12) contends that these computer "whiz kids" and the experienced "old heads" of the industry will have much to learn from each other. *"Successful companies will recognise that today's graduates know more about computers than most of their more experienced professionals. On the other hand, these young people probably have disturbingly little knowledge* (about the application of their professional training) *in the real world. Experienced professionals and new computer hotshots have much to learn from each other. Companies that are going to win tomorrow's competitive struggles are the ones that recognise how to meld their experienced staff with the computer-hip newcomers".*

6.2 Learn, Utilise and Evolve with CAD

There is no question, in the author's mind, that Quantity Surveying firms, and indeed all construction professionals, need to utilise and gain expertise in CAD sooner rather than later. CAD systems will be at the centre of future information management system and virtual projects and, consequently, professionals will need CAD capabilities and expertise just to be a player.

Whilst 2D CAD currently predominates in the industry, the industry is moving towards 3D object oriented CAD and smarter firms looking to the future will embrace this CAD format. 3D CAD also offers far more possible uses for the Quantity Surveyor.

The most obvious benefit for Quantity Surveyors lies in the use of automated quantities with enormous productivity gains already possible. The preparation of quantities in the traditional paper-based mode is tedious and time-consuming and typically accounts for over 80% of the total time spent in preparing tenders, budgetary estimates and cost plans. Lend Lease, one of the largest contracting organisations in Australia, have ascertained that their estimators spend approximately 80% of their time measuring and only 20% of their time actually pricing and compiling their tender/budget prices. Their objective is to turn those percentages around with their estimators spending only 20% of their time measuring. CAD generated quantities are seen as the means of achieving this (Legg 1998). Rather than being a threat, automated quantities actually have the potential to provide tremendous opportunities for the profession. Removing much of the technical drudgery, albeit the traditional "bread and butter", of the profession will provide practitioners with more time to focus on developing sophisticated cost management systems and a wider range of value-added services. This will provide the potential for firms to be able to provide a wider range of value-added services on a larger number of projects. The important thing is not who or what prepares the quantities (as long as they are accurate) but more what is done with the quantities.

Many practitioners are sceptical, with

good reason, about the automated quantities capabilities of CAD systems. There are still many problems with utilising commercial "off the shelf" CAD software to generate quantities. However, these problems are being overcome and most programs, at the very least, are capable of generating basic lineal, area and volume measurements with many able to produce quite detailed item quantities. Hence, it is possible now for practitioners to extract a significant proportion of a project's quantities from automatically generated quantities in spreadsheet formats which can be linked directly to many estimating/measurement programs.

6.3 Invest in Necessary Technology

Many firms cite cost and the time required to learn CAD and other software/technology as the main inhibitors to investment in the IT area. However, the greatest cost for employers usually lies in their actual workforce. The average annual salary of a qualified Quantity Surveyor in Australia is approximately $55,000 per annum which equates to approximately $80,000 when salary loadings are taken into account. CAD software and the necessary hardware can be purchased for $6000-$8000 for one licence with this figure decreasing for additional licences. Whilst time and money must be spent learning how to use these systems, the technology costs are actually relatively low when compared to salary costs. When one considers the potential productivity improvements the cost of investment in CAD may not only be negligible but may not be a cost at all in the long term due to the enhanced profitability of the firm's operations. Looking at the broader picture, CAD capabilities and expertise will more than likely result in increased business opportunities.

6.4 Form Strategic Alliances with Designers

Nevertheless, most firms remain loathe to invest in this technology due to the costs, the training required, the many problems associated with CAD and the uncertainty surrounding the level of return on investment. A strategy for these firms may be to use a small select group of employees to "test the water" and develop and explore the potential. Smaller projects could also be used to test new technology. It is easy to be dazzled by the sales pitch of hardware/software vendors but it is only through detailed “hands-on” use that firms can really evaluate the usefulness of the technology for their firm.

A smarter approach may well be to form strategic alliances with design firms and “Design and Construct” organisations at the leading edge of CAD utilisation and development. A good example of this is Woods Bagot, a major architectural/engineering firm who are at the forefront of developments in 3D object oriented CAD. CAD experts within this firm have, on many occasions, expressed the view to the author that they (and their clients) could benefit greatly from appropriately skilled quantity surveying firms or individuals who can work and evolve with them in their CAD development. This is particularly the case with automated quantities generation and linking this data to information management models. Woods Bagot are in the process of trialling some of their latest developments on some of their smaller projects and, once again, have expressed interest in linking with Quantity Surveyors.

There is considerable untapped potential with such alliances. CAD development has been typically led by designers whose main interests are not automated quantities. This component of CAD systems is often simply a by-product developed in an ad-hoc manner. However, as developments in information management systems become more sophisticated and awareness of the importance of quantities to such systems increases, the need for the input of cost management and measurement experts is being widely recognised. Alliances with organisations like the one outlined above would enable a firm to add value to their CAD learning curve and to develop niches in the marketplace.

6.5 Be Prepared to Share Information

As construction processes become increasingly automated and information management systems become more sophisticated the whole construction process will become substantially more information-oriented as we head towards virtual electronic procurement patterns. Participants will not only need the technological capabilities to be a part of this information flow but will also be increasingly required to share their information. The cultural shift that will be required of Quantity Surveying firms to allow access to their valuable cost data bases (often compiled over many years if not decades) will be considerable. This will not only be a major issue for Quantity Surveyors but for most construction professionals.

6.8 Diversification/Specialisation of Services

The survey results outlined earlier indicate that Quantity Surveying firms are diversifying their scope of services to better meet industry/client demands and to secure their long term future. The DISR research described earlier considered such diversification to be critical to the future of the profession as a whole. The survey results show that the proportion of income obtained from non-traditional and non-building work has risen markedly in the past 5 years. Facility Management and the push for more sustainable development in the built environment represent two huge new growth areas for the profession in terms of new services. The financial management skills of the Quantity Surveyor can be applied in many different areas both within and outside the property industry and many firms are beginning to realise the opportunities that this creates.

6.9 Multi-Skilled Team

Such diversification and specialisation will require firms to have employees (or consultants) with a very broad range of skills, expertise and professional training. Diversification represents considerable risk for firms without the necessary skill and expertise to carry out the new services. Accordingly, many Quantity Surveying firms are now employing construction professionals from a variety of “non-QS” backgrounds to augment their services. A multi-skilled and qualified workforce will also provide firms with greater opportunities to expand their scope of services.

6.6 Continuing Professional Development

Continuing Professional Development (CPD) is a requirement for members of most professional associations and the construction industry is no exception. Rather than relying solely on their employers, practitioners need to also take responsibility for their own professional development. IT is a classic area for CPD due to the regularity and speed of change and such personal development can be of enormous benefit to a firm.

CONCLUSION

Information Technology presents the profession with many challenges, threats and opportunities. Whatever direction the profession and IT advances take, the financial management expertise of the Quantity Surveyor will remain in demand. The uncertainty really lies in what capacity and for whom the Quantity Surveyor will be working and whether the individual independent Quantity Surveying firm will continue to exist in its current form. It is clear that computing and information management expertise will be a necessary component in the tool kit of the future Quantity Surveyor. Information Technology advances will continue to automate technical processes thus raising practitioners to a higher professional plane whereby their professional skill and expertise will be of paramount importance. The need for highly developed IT skills will also become a concomitant requirement but the former will need to precede the latter before the future Quantity Surveyor will be in a position to provide services of value. Before IT can be used at a professional level, practitioners must

develop the relevant core competencies in their chosen areas.

Nevertheless, the surveys do indicate that the Quantity Surveying profession has enormous room for improvement in terms of embracing and utilising Information Technology advances in smarter ways. The Quantity Surveyor is not alone in this respect with the rest of the industry generally in the same boat. However, due to the relatively small size of the profession, perhaps independent Quantity Surveying firms stand to lose more than most if they fail to keep in touch with developments and do not embrace the opportunities and meet the challenges as they arise.

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