ADOPTING COMPUTERS IN ARCHITECTURAL FIRMS

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ABSTRACT

This research has explored the status of computerization in architectural firms and the problems they face in adopting and using computers.

The research methodology included both, a literature search and case studies consisting of interviews and questionnaires. To gain an in-depth understanding of the status of computer use and its related problems, and to benefit from the experience of current computer owner/users, eleven Vancouver firms which currently use computers in their practice, are interviewed.

The initial decision to computerize is often based on a group of perceptions from the benefits of computer use for the practice. This decision is usually rationalized by the need to remain competitive in the market, to increase the productivity or to respond to client's/project's requirements.

The extent of planning for the process of computerization usually depends on the size of the practice and scope of computerization. Planning however, is typically short term and problems and needs are addressed as and when they occur.

Most architects select their hardware first and then their application software. The typical approach at this stage is to rely mainly on in-house resources and to select the system mainly according to price.

The issues related to implementation and use of the system are usually addressed stage by stage. In attempting successful implementation and computer use, the impact of management style and staff's attitudes appear to be significant. In most firms there is not any methods of evaluation to identify and modify the problems and therefore increase the effectiveness of computer use in the practice.

System expansion is in general due to satisfactory experience, or an initial under estimate of station requirements. This stage is often based on a more realistic understanding of both, the firm's requirements and the computers capabilities.

The most important observation is that the validity of the advantages of computerization are not examined at the initial stages nor are methods of increasing and achieving them. In addition, revenue increase through the expansion of services is seldom considered.

Following the research, a series of guidelines are developed for practising architects, suggesting that advance planning can reduce most problems or their impacts. These guidelines present some important factors to be considered in the process of computerization were developed. They are structured according to the stages of computerization.

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INTRODUCTION

This research was initiated to assess reasons for success/failure of computerization in architectural practices and to develop realistic methods of adopting computer technology.

Changes and innovations in the 'tools' used by architects have traditionally been introduced gradually with little impact on design and management tasks as in for example, the evolution of pen types. In the past two decades, however, computers have been introduced into, and had significant effect upon, the profession of architecture. While their penetration into architectural practice and management was initially rather slow, their influence is considerable and rapidly increasing.

Unlike other design tools, using computers requires extensive training, changes in the management and operational structure of firm, and it also challenges the design process.

In the early 1970s, when computer technology was introduced to architectural practice, only a few large firms had sufficient resources to experiment with computer use. Adopting computers required a large capital investment, there were few architectural software applications available on the market, and very few people were familiar with, or skilled in, computer use. Also vendors were mainly selling systems to engineers, giving minimal or no consideration to the unique characteristics of architectural practice. The technical support required for architectural practices to begin purchasing and using computers was simply not adequate.

Computer literature in architecture in the 1970s and early 1980s presented the range of technology and tried to convince architects of the benefits of computer use.

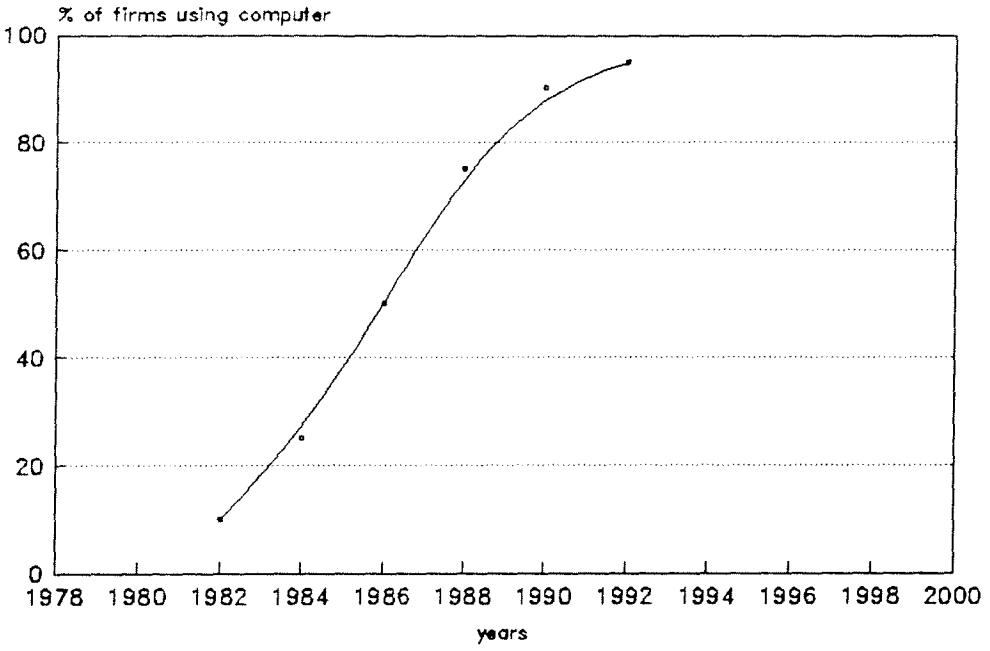
The 1980s became the decade for critically evaluating this new tool and examining its necessity for architectural practices. Attitudes towards computerization of architectural practice ranged from scepticism, and hesitation to tentative acceptance. As microcomputers became less expensive and more reliable, interest in computing gradually increased in the broader architectural community, and 'paperless' offices seemed an achievable objective. The marketplace has matured, and with this the number of products and suppliers has grown and the demand from architectural firms increased especially over the past five years (figure 01, 02). Articles on computer use in architecture increased to about 1% of the whole body of architectural literature (Stevens 1991), (figure 03).

A study by Progressive Architecture in 1987, indicated that about 95% of over 900 architectural firms sampled in North America had acquired or planned to acquire computers. The survey conducted in Vancouver by the National Research Council of B.C. (NRC) in mid-1990, presented the growth of computer use since 1984 (figure 03), and indicated that about 83% of architectural firms in Vancouver are currently using computers in their practice for at least one application.

Both surveys indicated a growth in computer use in architectural practice, presented reasons for this growth and documented the range (from administrative to more sophisticated architectural software, such as 3D presentations) and priorities of computer applications. Although the respondents

represented those most involved and/or interested in the subject, their responses merit consideration. General surveys of this type however, mainly provide quantitative data and can not accurately indicate the status of computer use in architectural firms.

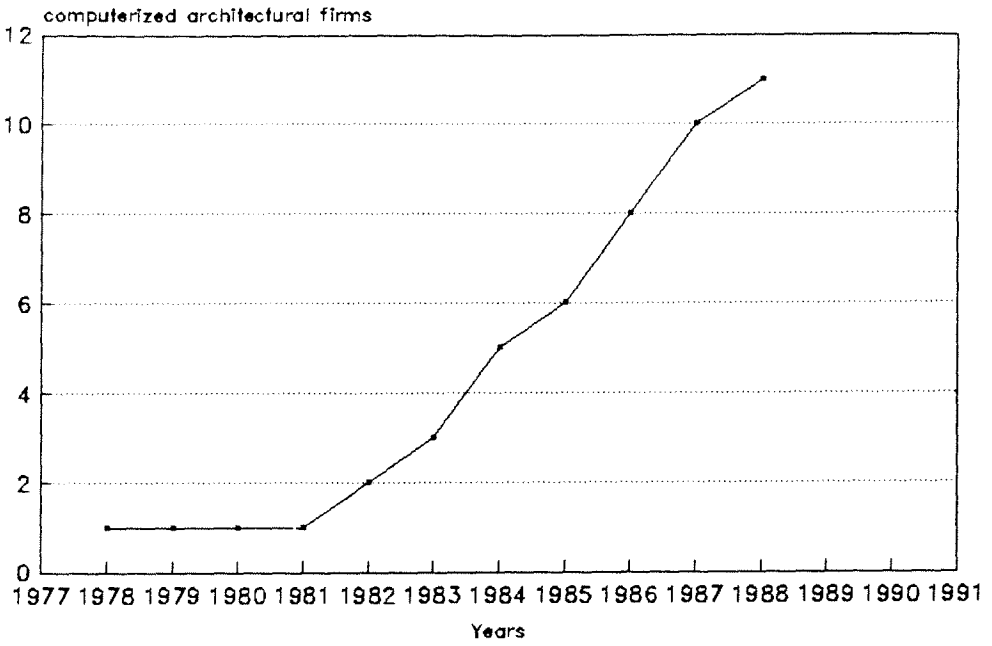
Derived from:Building & Environment 1991



Penetration of Computer Technology
American Architectural Firms

Figure 01

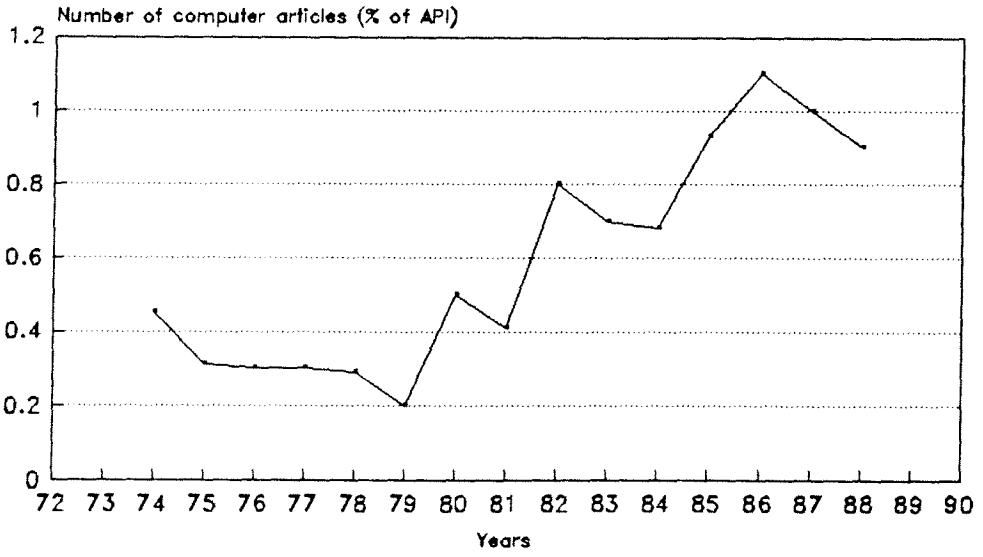
Source: Research Case Study



Penetration of Computer Technology
Vancouver Firms

Figure 02

Derived from:Building & Environment 1991



Ratio of Computing Articles
Architectural Periodicals

Figure 03

Generally, discussions surrounding computer technology exclude the social and physical context in which computers are used. Most writers assume that if a technology is economically beneficial, then effective and extensive use of the system will be assured (Kish 1991). Stevens, however, addresses the importance of the social components of technology use in architectural practice, and argues that the major drive to computerize is a non-economical, social one:

> *"The CAAD movement is a social one, and CAAD therefore carries with it an important social component. This component incorporates key ideologies or beliefs that are intended to guide decisions about what computers are good for, how they should be used, who should control them, who should have access to them, how people should work with them, and what levels of resources should be invested in them" (Progressive Architecture, 1991).*

MEDICI Seminars: In 1982, the Royal Architectural Institute of Canada initiated a cross country seminar series, MicroElectronic Development In Construction Industry (MEDICI I) to introduce a wide range of computer applications for the construction industry. The main objective of this seminar was to assist architects in overcoming the 'fearful attitudes existing toward computer technology at the time'. The original MEDICI reached five conclusions:

1. Software should form the basis of purchasing a computer system.
2. Most architectural work can be performed on a personal desk top computer.
3. There is no excuse for stalling implementation. The technology is available and system costs are affordable.
4. The computer is most effective when the user is the decision maker.
5. Preparation is the key to successful implementation of microelectronic technology.

In 1985, a second nationwide seminar on 'the Implementation of Microcomputers in Architectural Practice', presented the issues of system management, steps toward computerization, management of change, marketing, management of personnel, using ready-made software, and special applications (MEDICI II).

MEDICI II offered a step-by-step model to guide an architectural practice through the perceived difficulties of implementing a computer system. This guideline, although general, remains valid today. There has not, however, been any subsequent program to update the information provided by MEDICI II to assist architects in adopting computers.

Whereas computer aided techniques have been readily adopted for specific tasks, the notion of automated architectural practices, in which information in a variety of formats is moved electronically within the firm and between external consultants, is still a distant goal indeed:

> *"The 'paperless' office has turned out to be 'paperbound', and in most organizations the computerization of office work has taken place in precisely the opposite way to that envisaged: on a personal, piecemeal basis" (Stevens 1991).*

Although surveys suggest that a large proportion of North American architectural firms are currently using, or planning to use computers in their practice, architectural applications are often limited to Computer Aided Drafting, as most firms face problems in introducing design applications. The question now is not 'whether a system should be purchased' but 'what are the effective ways of adopting computer technology'.

Contemporary literature such as software reviews (Architectural Record), provide readers with a variety of description. However they are often narrowly focused and lack integrated descriptions.

This research examined the use of computer technology in architecture by interviewing eleven architectural firms currently using computers in order to evaluate:

- The ways different architects adopted computers in their practice
- The current status of computer use in architectural practice
- The emerging issues of computer use in architectural practice
- The factors leading to successful computer use
- The factors leading to failures
- The ways to achieve effective computerization.

Following the research interviews and data analysis, a series of guidelines were developed to assist the principals of architectural firms to:

- Develop a plan to acquire computers
- Reassess the way they are currently using their system
- Upgrade and/or increase their computer capabilities.

The present study advocates the use of a comprehensive, well planned procedure for adopting computer technology, presenting requirements and potential problems. In presenting the process

of computerization (table 01), a sequential approach corresponding with the stages of the process and not their importance, is chosen.

Table 01

A sequential process for adopting computers:

THE INITIAL DECISION TO COMPUTERIZE:	The process and criteria upon which to base the decision to computerize.
THE SELECTION PROCESS:	The procedure and criteria for the selection of specific system (hardware and software)
THE IMPLEMENTATION AND INTEGRATION STAGE:	Procedure for the implementation of the system and the continued process of optimizing use.
THE EVALUATION PROCESS:	The methodology for ongoing evaluation to assure optimal system usage, and to identify and correct any problems. Ongoing evaluation also facilitate the determining of any need for change, upgrades, or additions of software and/or hardware to fulfil the current and anticipated requirements of the practice as well as expansion of services.
THE EXPANSION:	Procedures for the expansion of computerized applications, number of hardware and/or range of current services.

Following the research, a series of guidelines (appendix B) were developed to assist practising architects in the process of computerization. In developing the guidelines for this thesis, the MEDICI II seminar (where its suggestions were supported by my own research) was of considerable use. It should be stressed, however, that MEDICI II was not the primary source of

information in this study, which seeks to:

- Update the information that MEDICI II made available in 1985
- Integrate the experience of those architects who are currently using computers in their practice
- Present important factors of computerization in the order they would usually occur.

This thesis is presented in four main sections:

Section A. Methodology of research: This section describes the process of research and reasons for selecting this approach.

Section B. Process of computerization in architectural firms: This section presents the results of the research and experience gained through the case studies.

Section C. Introduction of the Guidelines: This section summarizes the guidelines (appendix B).

Section D. Conclusion: This section summarizes the general findings of the research, and presents some areas for further research.

SECTION A

RESEARCH METHODOLOGY

This section describes the research methodology, the reasons for choosing such a method and the criteria underlying the questionnaire design.

Until now, the results of surveys on computer applications in architecture have provided only a general understanding of its use. Some surveys, like the one conducted by the NRC, addressed the status of computer use in firms, and issues and problems being faced by architects. The results, however, generally only provide statistical data on the proportion of firms currently employing computers, the type of application software implemented in these firms, their initial reasons for adopting this technology, and the priorities of application implementation.

The previous surveys do to some extent reveal current problems but they do not explore these issues in depth. For example, when firms were asked about their current computer applications, their responses provided only a list of computer applications implemented, and not the extent of their use, nor any specific problems encountered.

One of the problems mentioned often by respondents in NRC's survey is in the area of 'training' or 'learning'. Although the outcome of inadequate training and learning is the same (ill-equipped users using the system ineffectively and inefficiently), failure to distinguish between these terms makes it impossible to interpret the survey results in a meaningful way. General surveys cannot explore the

cause of a problem and provide mainly quantitative information. Although architects need the specific data on computer use, they also need assistance in effectively adopting computer technology.

This investigation included a series of case studies consisting of detailed questionnaires and interviews. It was anticipated that the experiences of current computer owners/users could provide:

1) a clearer understanding of the status of, and issues regarding, the use of computer-aided technology in architectural firms
2) directions for developing realistic recommendations for those: a) interested in introducing computer aided techniques to their firm and b) planning to improve the current state of computer use in their practice.

Following issues were instrumental in determining the general emphasis and direction of this research.

- Success in the adoption and use of computer systems in an architectural practice is increased by the use of a comprehensive plan for the 'complete process' (table 01) of computerization
- The type and scope of computer use, and associated problems, changes according to the size of the firm
- Psychological (human) factors affect the computerization process
- Successful computer use is associated with the effectiveness of training programs and learning attitudes
- Management involvement in the process of computer implementation and use is required

1. Questionnaire and Interview Design

A questionnaire with two formats was used for the interviews. This questionnaire provided the researcher with the sequence of questions and was filled in by the researcher during the interview (appendix A: I). A modified version was designed to inform interviewees of the sequence of the questions and the reasons they were asked about each topic (appendix A: II).

The five sections of the questionnaire were:

Section I. General information about the firm:

Past history, size, services, organizational management and the growth of the practice prior to and after adopting computer technology.

This preliminary section examines the effect of the size of the practice, and the type and size of its projects, had on the process of computerization, as well as the impact of computer use.

Section II. The process of computerization:

The initial reasons for introducing computer technology into the firm, the process of computerization employed, emerging problems and potential solutions.

This section examines the different approaches and problems experienced by firms which were currently using computers in their practice in order to provide directives from the experience of computer owners/users for those architects planning to acquire or improve their current use of computers.

Section III. Outside services used by the firm.

This section of the questionnaire was included to examine the different types of outside computerized services used by architectural firms, their reasons for using them, and the benefits of these services, especially with regard to:

1) Replacing in-house computer use, when computer use is mandatory for a project and its purchase is not otherwise planned.
2) Assisting architects in evaluating the benefits and issues of computer-aided techniques, prior to purchasing a system.

Section IV. Computers in the future.

This section includes the interviewees' anticipation of computer growth in their own firm, as well as views on the future of computer technology in architectural practice in general, in order to provide an understanding of the extent of advance planning in architectural firms, and the firms' views on the evolution and penetration of computer technology.

Section V. Additional information.

Suggestions by current computer owners and users not presented in the previous sections.

At the outset of each interview the interviewee was given an overview of the range of topics to be discussed. They were free to terminate the interview at any time or refrain from discussing any specific area, and were encouraged to provide any additional information if so desired.

2. Sample Selection

The case study was conducted on firms based in Vancouver, and although one may expect some minor variations in other locations due to social and economic factors, architectural firms typically face similar issues (regardless of geographical location) in adopting computer technology.

2.1 Method of Selection:

A total of eleven firms were selected for interviews:

- Nine architectural firms providing traditional services
- One architecture related firm providing non-traditional services
- One computer consulting firm providing computerized services to architects.

Eight of the firms were chosen from the NRC's survey responses, while the other three were selected according to their reputation for computer use and the type of their services.

To collect a range of opinions, it was important to capture the opinions of both the principals (as managers) and the users (principals or staff). Therefore, in different firms, one or both of these groups were interviewed. In small firms, the principal typically plays both the management and the user roles. In medium and large firms the principals mainly undertake management roles, while the staff are in charge of system use.

2.2 Criteria for Selection

The sample selection was based on the following criteria (table 02, 03):

- The size of the practice (small, medium or large: from 1 architect to a staff of 86)
- The type of services provided by the practice
- The range of computer applications adopted by the practice (from administrative to design applications)
- The type of systems (Intergraph, DOS base, Macintosh) used in the practice.

3. Confidentiality

The interviewees were given the option of partial or complete confidentiality, although little of the information collected in the case studies is of a sensitive nature.

The research concentrates on the experience of current computer owners/users, and not on the nature of the firm. There was therefore, no specific reason to publish the name of the firms, which are referred to by codes. First letter indicates the size of the firms (S,M,L), the number in the middle indicates stage of computerization (1=admin, 2=1+ special application, 3= 1+CAD, 4=3+CADD or management applic. 5=4+ others), and the last letter refers to the type of the firm (A= architecture, b= non-traditional services, C= consulting), and last digit individualizes the codes.

Table 02

Samples of Case Studies

FIRM	KIND	PROJECTS	INTERVIEWEE
S1A1	Architecture	Residential Renovations Churches	Principal
S2A2	Architecture	Residential Energy Anal.	Principal
M4A3	Architecture	Residential Institutional Ext.Care house	Principal
M3A4	Architecture	Residential Commercial	Principal CAD Operator
L5A5	Architecture	Retail Institutional Industrial Planning Project Mgnt.	System Manager
M3A6	Architecture	Multi Family Health Care Public Work	Principal
M3A7	Architecture	General	Principal CAD Operator
M5A8	Architecture	Water Front Market Place Urban Design	CAD Manager
M4A9	Architecture	Condominium	CAD Operator
M2A10	Programming	Programming	Principal
SC11	Computer Consultant	Consulting Computerized Services	Principal

Table 03

FIRM	STAFF	SYSTEM	APPLICATIONS	DATE
S1A1	1	1 PC	Administration	1990
S2A2	1	1 PC	Administration Energy analysis	1985 1985
M4A3	7	4 PC	Administration CAD CADD	1990 1990 1990
M3A4	5.5	2 PC	Administration CAD Modelling	1983 1989 1989
L5A5	86	41 PC	Administration CAD CADD Presentation Project management	1982 1989 1991 1991
M3A6	18	9 PC	Administration CAD Project Management Experimented	1984 1991 1990
M3A7	20	8 PC	Administration CAD 3D Presentations	1989 1989 1990
M5A8	13	2 PC	Administration CAD CADD Presentations	1984 1989 1991 1989
M4A9	13	1 PC 1 W. St.	Administration CAD CADD	1970's 1989 1989
M2B10	8	5 PC	Administration Programming	1978 1989
SC11	1+		Administration Computerized Services	1991 1991

SECTION B

PROCESS OF ADOPTING COMPUTERS

In examining the ways that each architectural firm adopts computer technology this research reveals some of the similarities and differences, the issues and problems they have encountered and some solutions discovered through their experience.

The results are presented in the following (sequentially listed) chapters:

. The initial decision to computerize

. System selection

. Implementation and integration

. Evaluation

. Expansion

The first two chapters deal with the selection of a suitable system. The next two chapters present factors influencing the implementation and optimal realization of the capabilities of the selected system, while the last will discuss the expansion and growth of computer use.

1. The Initial Decision Process

The perception of the principals (decision makers) regarding the benefits of computers is crucial in any initial purchase decision.

Often the validity of the initial perceptions are not examined prior to the computer's purchase and use. This chapter will present factors which contribute to and support the decision to change to the use of computer-aided techniques in the practice.

1.1 Perceived Advantages of Computer Systems

The main perceived advantage in using computers is the 'productivity increase'. Vendors typically quote productivity improvements in terms of a productivity ratio of 3.5:1 for architectural applications (Stevens 1991). They do not however, elaborate on this claim, and fail to indicate any quantitative measure, measure of comparison, time factor or even the ways and the context in which the system is used. They also refer to a productivity increase in architectural applications as a whole without differentiating between specific applications.

In most cases neither the validity of the initial perceptions nor ways to accomplish realistic benefits are examined. When asked, the interviewees admitted that, prior to their personal experience with computers, they had not explored the potential of productivity increase. Most architects found productivity improvements in administration, and some mentioned that their productivity had improved in other areas, such as drafting (M3A7), energy analysis (S2A2), and programming (M2B10). In most cases this improvement was derived from delegating repetitive tasks to the computer.

In addition, architects perceive that computers can: be used as a marketing tool, improve the image and credibility of the firm, provide architects with more time to examine more

design options, increase accuracy, increase the efficiency of individuals, enable easier changes in drawings, provide better quality output, increase the range of current services, and tighten contract documents (table 04).

Table 04

Perceived Advantages of Computers / Case Study

PERCEIVED ADVANTAGES	FIRM	S	M	L
Be used as a marketing tool	S1A1	*		
	M4A3		*	
	L5A5			*
	M3A6		*	
	M3A7		*	
	M5A8		*	
	M4A9		*	
Improve the image and credibility of the firm	S1A1	*		
	M5A8		*	
Provide more time to examine more design options	M4A3		*	
	L5A5			*
Increase the efficiency of individuals	M3A6		*	
Enable easier changes in drawings	M4A3		*	
	M3A7		*	
Provide better quality output	S1A1	*		
	M3A7		*	
Increase the range of current services	M4A3		*	
Increase accuracy	M4A3		*	
	M3A7		*	
Tighten contract documents	S1A1	*		

Failure to distinguish realistic advantages can result in unrealistic expectations of the system and system users, causing such problems as:

. Committing to unrealistic deadlines (overly high expectations)

. Not utilizing the system's potentials (insufficient expectations).

For example, one of the principals of M3A4 often deals with last minute crises, as he overestimates the speed at which the system will process the final productions.

1.2 Reasons for Adopting Computer Aided Techniques

The main reasons mentioned by interviewees as rationales for adopting computer technology are:

. To increase productivity

. To improve the quality of drawings/their services

. To remain competitive in the market place.

Other reasons are:

. Their perceptions of the advantages of computers (M4A3, L5A5)

. The availability and affordability of systems and application software (S1A1, S2A2)

. The increasing need to process a large range of information in architectural firms (M2B10, S2A2).

This is also consistent with the results of the NRC survey (figure 04).

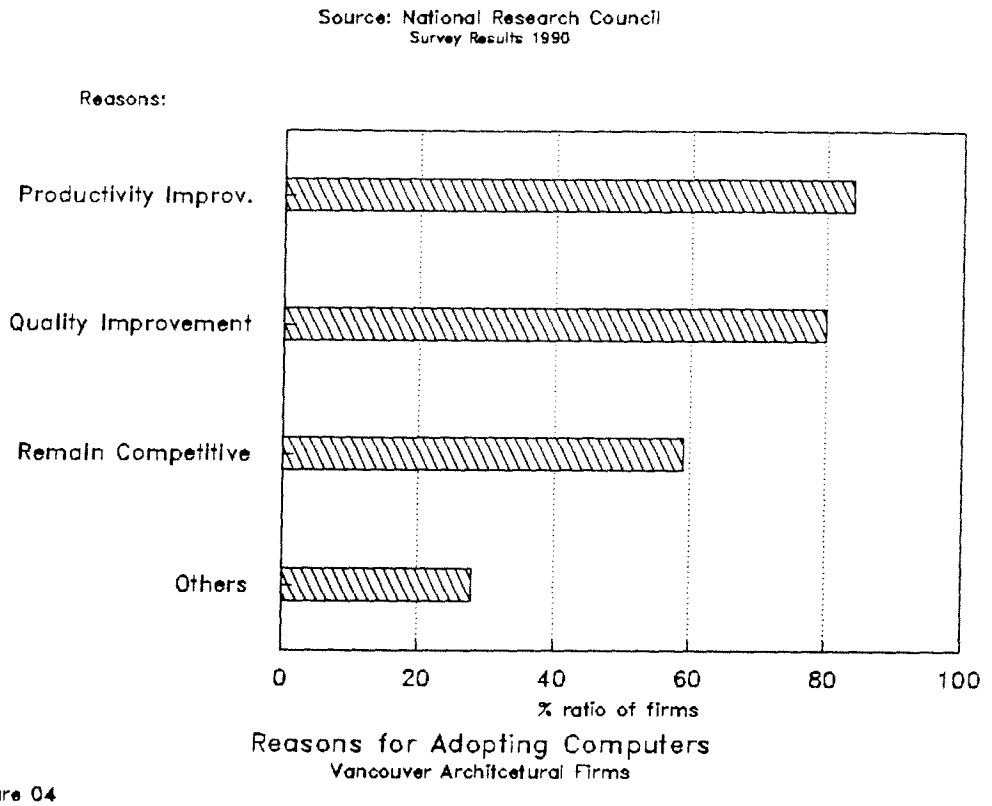


Figure 04

More recently, additional pressure to adopt computer-based techniques is emerging from:

. Specific project/client requirements (clients' pressure, M3A6)

. Staff who have prior experience (staff's pressure, M3A4)

. Vendor promotional pressure which presents computerization as an inevitable step.

Stevens argues that most 'reasons' are merely rationalizations:

> *"These justifications portray architectural firms as rational, economic units whose struggle to survive in a competitive economic environment drives them to technological innovation. There is considerable evidence to suggest that these reasons are rationalizations, and that the driving forces behind CAAD are of quite different nature" (Stevens 1991 P/A).*

He believes that the main reason for initiating computerization in an architectural firm is to increase the market share by impressing clients (Stevens 1991). This can be interpreted as the need to remain competitive in the market.

2. Selecting the System

Even though in recent years computer use has become common in architectural firms, effective means of selecting and adopting computers remain undefined.

Most firms tailor the process of computerization individually, according to their own available human and financial resources. Often the process is approached stage by stage without advance planning, so problems must be addressed as and when they occur.

The extent of the initial planning process varies, particularly between large and small firms, as the scope and cost of their investments can be markedly different. But most firms rely on 'in-house' judgement during this process and the use of external consultants is rare.

Although using the system in a way to realize its 'capabilities' is a very important factor in the success of computer use, selection of a suitable system also affects the extent and success of its use in the practice.

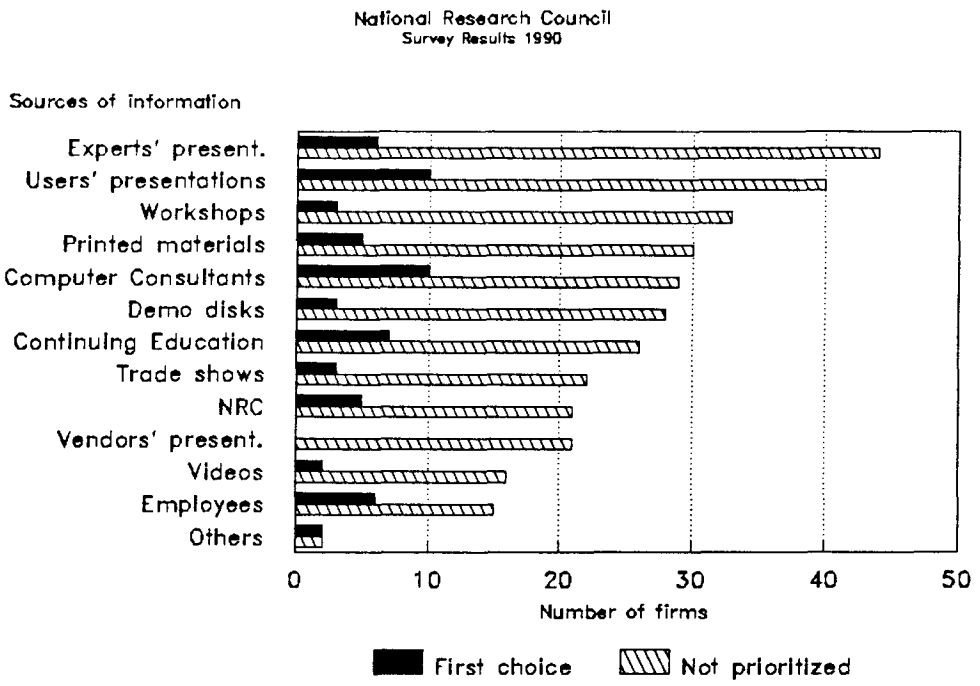
The next section presents methods of research into and selection of a computer system undertaken by architectural practices.

2.1 Searching for a Suitable System

In most cases research into an appropriate system concentrates mainly on comparing different hardware, with minimal consideration for the unique and specific requirements of the practice.

Although architects have traditionally employed consultants for their architectural projects, most of them tend to select their computer system without using the services of a computer consultant to recommend a system appropriate to their needs. About 40% of the respondents of NRC survey were interested in using computer consultant services (figure 05). This approach however, is considered to be too expensive and typically the future savings of this approach are not considered. In addition there are not many architecture related computer consultants available in the market.

Similarly, architects often attempt to train themselves to understand the advantages and disadvantages of different systems. They use different techniques such as participating in computer presentations by vendors; acquiring information from other architects; or reviewing and exploring related literature such as software reviews and seminars reports. Most of the architects admitted in the interviews that the preliminary studies require time and energy and can become confusing and frustrating. Therefore often, they purchase a system, problems ensue, and the search for solutions becomes an ongoing task (M3A4).



Preferred Sources of Information

Figure 05

Research for an appropriate system usually involves:

METHOD	FIRM
Delegating an 'in-house' member of the practice to research and recommend a system.	L5A5, M5A8
Basing the decision on previous experience of members of the practice.	M4A3, M3A4, M3A7, M4A9, M2B10
Following the advice of other architects or perceived trends of other architectural practices.	S1A1, S2A2, M2B10
Following the requirements of clients	M3A6
Adopting the suggestions of consultants	M3A6
Adopting the suggestions of suppliers	

2.1.1 Hiring a New Employee to Research and Recommend a System

Larger firms can afford to hire someone to take charge of research, selection, implementation, and integration; and to function later as a system manager (L5A5, M4A9). The related costs are justified by the scope of capital investment in hardware/software and for training the staff. Mid-size (M3A7) and small firms (S1A1, S2A2) however, can rarely afford to go beyond their own staff, or even principals for research and recommendation.

For example, in firm L5A5, the principals decided to implement design applications after two years of using computers for the production of working drawings. An architect with computer experience was hired to research and select the new systems. The system was selected according to his suggestions even though the new system is different from the one used previously.

2.1.2 Basing the Decision on the Previous Experience of Members of the Practice

Prior to computerization, staff can influence decision-making in two ways:

1) pressure from staff lobbying for the acquisition of computers in the practice
2) staff's input in the early stages.

Typically, both of these influences come mainly from those who are familiar with computer technology and mainly when the managers themselves are novices (M3A4, M3A7).

When management have experience with computer technology, they can reach a more

suitable decision based on their previous experience, the firm's requirements, and an understanding of the short term/long term goals of their practice (M4A3, M4A9, M2B10). Sometimes however, the biases of influential members of a practice will override rational planning exercises.

Management's own familiarity with certain pieces of hardware or application software may, of course, lead to biases (M4A3), but their involvement and commitment to make the system work provides a supportive and encouraging work environment for system users. In addition, management's expectations will be based on understanding the system's capabilities and, therefore, will be more realistic.

2.1.3 Following the Advice of Other Architects or Perceived Trends of Other Architectural Practices

Most architects are more comfortable relying on the experiences of those peers who are currently using computers in their practice (NRC's). This information is either transferred on an informal basis through their professional network, or in the presentations organized by vendors or institutions.

2.1.4 Following the requirements of clients

The clients expectation can influence computerization to certain extent. They may require computer use for their projects and/or expect the project data in electronic format for their future uses such as facility management.

In addition, most architects believe that the use of computers has improved both the image of their practice, and their credibility with clients.

2.1.5 Adopting the Suggestions of Consultants

Using computer consultants is considered too expensive, especially for smaller firms, although the cost could be justified by future savings. These savings would be the result of suitable selection, a well planned implementation, and a less time-consuming process.

Some architects consult their engineering consultants in selecting their system (M3A7) even though the application software used by the consultants is generally designed for engineering purposes.

2.1.6 Adopting the Suggestions of Suppliers

Although architects participate in the presentations organized by suppliers, they tend not to rely on the suggestions of suppliers as their prime source of advice. Generally it is perceived that the information provided by suppliers although helpful primarily have promotional intention and may not present all of the facts.

2.2 Hardware, Application Software Selection

Despite contemporary wisdom suggesting that the implementation of computers within architectural practice should be preceded by a clear assessment of current and anticipated needs of the firm, and that the firm should seek appropriate application software to fulfil these needs,

most practices initially commit to a particular hardware. Only when a firm is committed to a hardware and has attained a working understanding of it, do the ramifications of this approach become apparent. Comparison is mainly between workstations versus PCs, and among PCs, DOS platforms versus Macintosh. Most architects however purchase PCs for the practice.

The most common factors considered prior to selection of hardware are:

- Familiarity (staff and/or principals) with a particular platform (M4A3, M3A4, M3A7)
- Initial capital investment required to purchase the hardware (S1A1, S2A2)
- Hardware reputation (M3A7, M5A8)
- Ease of use (M4A3, L5A5)

While Software selection is generally dependent on the selected hardware, the priorities of computerized application implementation can vary because of:

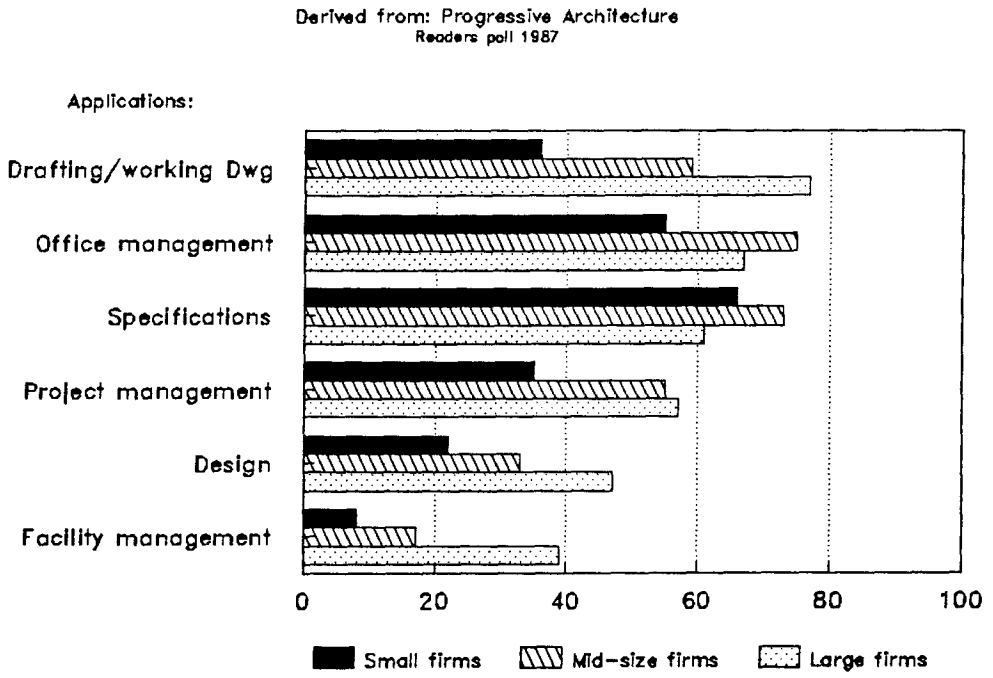
- A specialized task, which will be greatly facilitated by computerization, e.g., energy analysis (S2A2, M2B10)
- Specific criteria of the project's tender (M3A6)
- Staff familiarity with certain applications (M4A3, M3A4, M3A7)
- An arbitrary decision to start with a specific application.

Computers have applications in most areas of architectural practice: programming, urban design, project administration, project development, marketing, contract documentation, contract administration and facilities management as well as special applications.

The key decision however, is clearly on whether or not to integrate computers within design development. The distinction between Computer Aided Drafting and Computer Aided Design remains both ambiguous and contentious in practice. Computer Aided Drafting is defined as the process of creating drawings with the help of computers, as distinct from Computer Aided Design, which is the creation of a building design using computers, entailing a broader range of graphic and evaluation capabilities. Although drafting is clearly part of the project development process, it currently remains a distinct part of the project delivery process. Irrespective of the highly idiosyncratic nature of design, architects are familiar with the traditional process and techniques for its execution. By contrast, they are still exploring computer-aided design. At present, computer-aided design is very much one of understanding which aspects of design are best done manually and which should be automated. This is mentioned by most architects who are not using CADD applications and even by some current users of these applications (S1A1, S2A22, M3A4, M3A6, M3A7,M5A8).

While few firms (M4A3, L5A5, M5A8) use design applications, software generating 3D architectural representations is becoming more common. In most cases this is primarily because they are excellent marketing tools and impress clients. This attitude appears independent of the size of the firm. In firms like M4A3, M3A7, M5A8 and L5A5, soon after or prior to mastering their CAD applications, and some of their project administration applications, they are either inquiring about (M4A3) or actually using (L5A5, M3A7, M5A8) image generating applications. They all indicated that the impact on the client justifies the use of these applications.

P/A poll results indicate that large and small firms have different priorities in computerized application selection. For smaller firms (1-9) specifications preparation is the most important area of computer use. The largest firms, however, use computers heavily in drafting and preparing working drawings, for project and office management, for design and facilities management (Figure 06). These results comply with the results of NRC's survey (table 05, figure 07).



Priotities of Computerized Applications
According to firms size

Figure 06

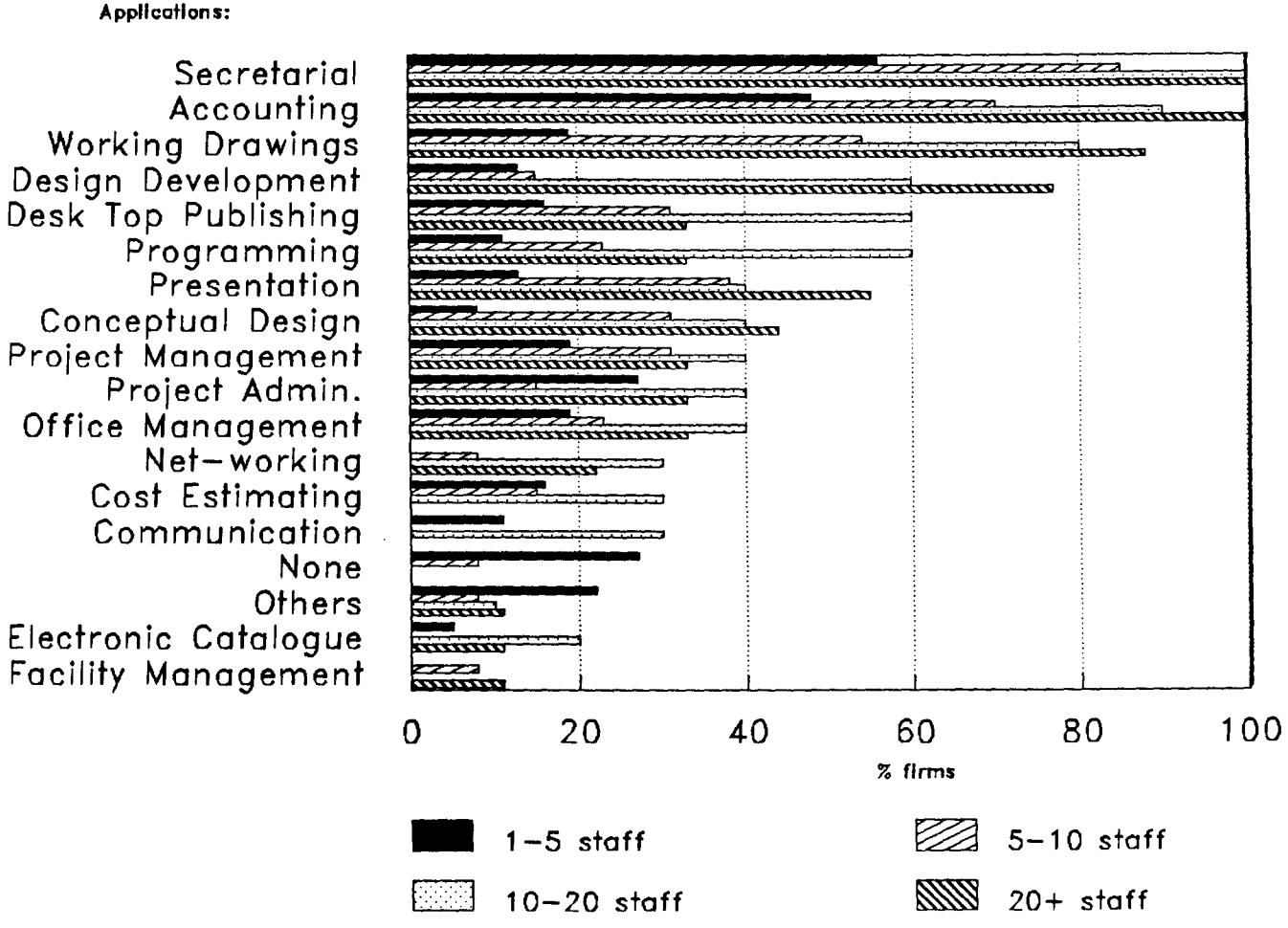
Table 05

Application Priorities

National Research Council 1990

/	Number of Respondents	37	13	10	9	69
#	APPLICATION / STAFF	1-5 #-%	5-10 #-%	10-20 #-%	20+ #-%	TOTAL #-%
A	Secretarial	21-56	11-84	10-100	9-100	51-73
B	Accounting	18-48	9-69	9-90	9-100	45-65
C	Desk Top Publishing	6-16	4-30	6-60	3-33	19-27
D	Office Management	7-18	3-23	4-40	3-33	17-24
E	Project Programming	4-10	3-23	6-60	3-33	16-23
F	Cost Estimating	6-16	2-15	3-30	0-0	11-15
G	Conceptual Design	3-8	4-30	4-40	4-44	15-21
H	Presentation	5-13	5-38	4-40	5-55	19-27
I	Design Development	5-13	2-15	6-6-	7-77	20-28
J	Electronic Catalogues	2-5	0-0	2-20	1-11	5-7
K	Working Drawings	7-18	7-53	8-80	8-88	30-43
L	Project Administration	10-27	2-15	4-40	3-33	19-27
M	Project Management	7-18	4-30	4-40	3-33	18-26
N	Communications	4-10	0-0	3-30	0-0	7-10
O	Facility Management	0-0	1-7	0-0	1-11	2-2
P	Networking	0-0	1-7	3-30	2-22	6-8
Q	Others	8-21	1-7	1-10	1-11	11-15
R	None	10-27	1-7	0-0	0-0	11-15

National Research Council
Survey Results 1990



Priorities of Computerized Applications
According to firms' size

Figure 07

Administrative applications (e.g. word processing, accounting) are the most commonly used (Figure 08). Most architectural practices start the computerization process with these applications (Figure 09). This priority of application implementation may be due to:

- The wide range and market availability of different administrative applications
- Administrative applications being more commonly used and improved than architectural applications software
- The productivity increase of adminstration tasks being more tangible
- The lower initial investment, training time and costs of administrative application compared to architectural applications
- The greater availability of qualified staff to use administrative software
- The lack of demand for architects' involvements (no threat to architects).

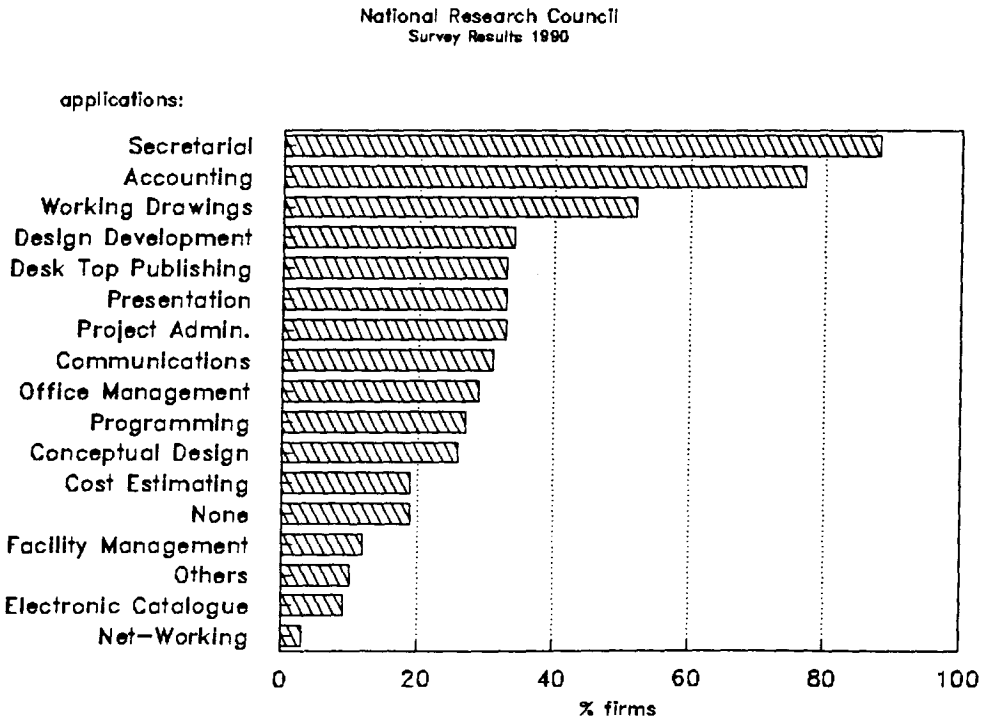


Figure 08

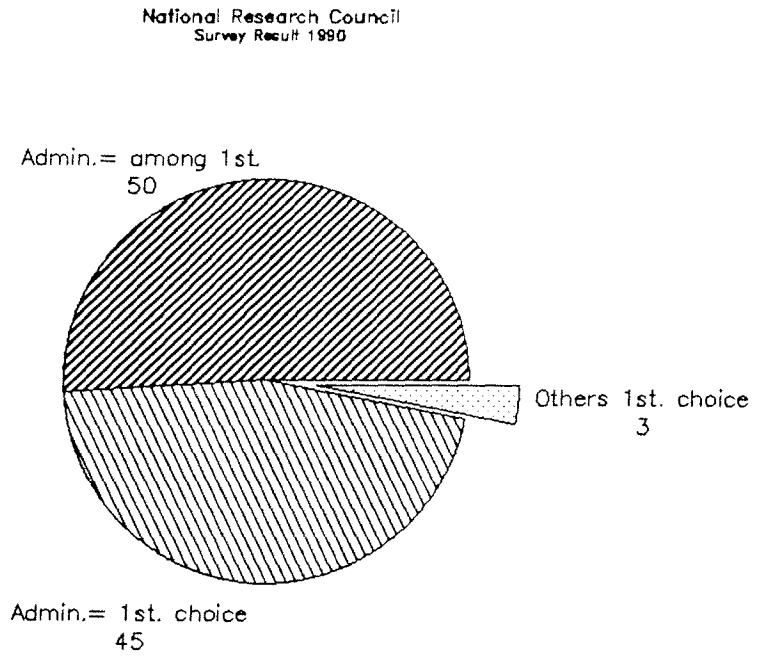


Figure 09

2.3 Technical Considerations

Many architects, having spent time learning to use system, only then come to realise the importance of technical factors, such as power. When initially selecting their system, often architects are not sure of the way they should compare the suitability of different system for their practice.

2.3.1 Technical Issues

Current computer users mentioned the importance of considering the ease of learning and use (user friendliness); and its power and capabilities to respond to the practice's requirements.

For example, the principal of M4A3 believes that their hardware is the most appropriate choice for architectural firms, based on its ease of use which increases its use. In contrast, some architects, like M4A9 and S2C11, pointed out that the less sophisticated systems often have limited capability to allow users to explore and customize their applications, and that once users become familiar (concentrating on **what** they are doing rather than **how** it is done) with a system, its ease of use is not a major consideration although training time for different systems can vary.

2.3.2 Technical Support

The availability of technical support from vendors is rarely considered when comparing different systems. A system's 'down times' and 'trouble-shooting' can however, be very time consuming and frustrating in the absence of adequate local support. In some situations lack of support causes the loss of information and, therefore, time and money (M3A7).

Some firms have selected to purchase an alternative system to reduce the impact of the absence of local support. Firm M5A8, for example, has strong in-house support (system manger and principal). However, as their system does not have any local supplier support, serious problems can become very time consuming and a 'back up system' has been purchased to cover the system down-time.

2.4 Financial Consideration

Financial factors are significant considerations in computer selection. The scale of financial

planning varies according to the size of the firm.

Financial planning is typically short term and thus cost of implementation, on-going costs, and expansion expenses are seldom considered (S1A1, S2A2, M3A4, M3A7). For example, firm (M3A4), purchased a number of stations according to their financial capabilities and not their requirements. Soon after the system was in use, the need for more stations became apparent. The decision to purchase more stations however, was also cost dependent and was delayed by financial considerations. so the use of computers was reduced.

A more significant observation is that often alternative methods of financing and the potential for revenue increases generated by computerization are not explored. Among architects interviewed, only two indicated that they are evaluating the potential for providing additional services in Project Management (M3A7) and Facilities Management (M3A6).

3. Implementation and Integration (Ongoing Use)

The preliminary planning for computer applications in most firms does not include the issues related to implementation and use of the system.

Although selecting a system suitable to the practice's requirements affects its successful use, realizing the capabilities and achieving the benefits of computer use mainly depends on the ways and in the context that the system is used. When the system is purchased, the practice confronts new challenges, and so it is important to establish new methods of work.

This chapter will introduce issues that are encountered after the system is purchased:

- Physical space requirements.
- Organizational management.
- Social and psychological issues.
- Educational issues.

3.1 Physical Space

Though architects are in the profession of space design, space requirements for computer stations and users are seldom considered prior to computer purchase.

Often computer users work both with computers and in traditional ways, and so need adequate space for both new and previous equipment as well as ergonomically suitable working space and furniture.

Some architects assume that less space (M3A4, M3A7) and light (M5A8) are necessary for the system users and do not provide them sufficient and ergonomically designed space. For example, in M5A8, system users were located in a tight space, far from any windows; the inadequate space and lighting could reduce their effective working time and productivity.

Even when the system is used to impress clients, and is placed in a prime location for an impressive visual impact (M4A9), the space may still not be designed according to new needs.

In addition, in most cases the work stations are not designed with designated space for disks, back ups, hard copies and other related equipment, which causes difficulty in access to information and reduces the speed of work, especially in medium and large firms. For example In M3A7 and M4A9 the users face problems due to lack of an organized space for the current and back up diskettes, which leads to material being misplaced and occasionally lost.

3.2 Organizational Management

While it is generally accepted that management involvement in the process of adopting computers is required, the nature of this involvement is neither clearly defined nor well understood. Some believe that senior management must be trained for CAD and understand its limits (McDonald 1987), but the importance of management involvement lies in their ability to integrate the new requirements with the traditional ones.

In effectively playing their managerial role, familiarity of architects with computers is useful but may not be essential. It is mainly Their management capabilities, style, and attitudes which enhance the success of computerization. In playing twin roles of manager/architect however, their familiarity with computer technology is helpful and even necessary, especially in smaller firms.

Organizational management includes:

. Management style

. System management

. Human resources management

3.2.1 Management Style

Management style should be responsive to the new situation created by the implementation of computers in the practice. This is mainly influenced by:

1) Management's capabilities to perform their managerial tasks
2) Management's attitudes and commitment to the success of computer use in their practice.

Once the system is in place, a new generation of issues are introduced to the practice, requiring the extensive involvement of management in the day-to-day operation of the firm. This involvement must include awareness of different aspects of system implementation and use and regular evaluation of the progress and problems of implementation and integration. Management should be problem solvers who provide initial and ongoing training and support for system users, promote dedication and commitment to system use, reduce human problems, expand the realistic potentials of the system, and, create a work environment that increases the effectiveness of system use in the firm. There are three different groups among management:

. Those familiar with computers
. Those in the process of learning
. Those not interested in learning and using computers.

Those familiar with computer technology influence the early stages of decision making and are committed to making the system work in their firm (section B: 2.1.2). In M4A3, M4A9

and M2B10, for example, the management had prior experience with computer technology, and as they believed in the benefits of computer use for their practice, they were committed to providing a supportive environment for its use and effectiveness. They also acted as trouble-shooters when required, and reduced the impact of unexpected problems.

Most architects, however, belong to the second group, and are exploring, evaluating and learning computer technology (S1A1, S2A2, M3A4, M3A7, M5A8). The results of this process vary, depending on the method and pace at which management learns, selects, and implements system use. In small firms this process can be swifter, as the scope of computer applications is smaller, but in medium and large firms, it can be a prolonged process.

Those architects who are not personally interested in computer use often allocate the responsibility of system selection and management entirely to one of their staff, on whose abilities the effectiveness of the system rests. Once the system manager moves out of the firm, new problems may follow (M3A7, M5A8).

3.2.2 System Management

System management typically refers to directing and coordinating those matters related to computer implementation and use in the firm.

In smaller firms, the principal usually functions as the system manager (S1A1, S2A2, M4A3), which reduces the problems of relying upon the system management of a possibly

non permanent staff member.

In most middle size practices the system management is unofficially assigned to one or more personnel (M3A4, M3A6, M3A7, M5A8, M4A9). These firms often face difficulties because of lack of a clear chain of command. Typically, there is no one officially in charge of system related needs and issues such as development and implementation of clear work procedures. Most importantly there is no one officially designated as a 'trouble-shooter' (M3A7).

In larger practices, an individual is often designated as the system manager/trouble-shooter (L5A5). In these firms usually the scope of computerization, capital investment, and the range of computer use justifies this expense.

Typical responsibilities of the system manager are:

i. Establishing training programs.

Training programs include the initial training, evaluation of educational requirements, and ongoing training.

ii. Preparation of work procedures.

Developing clear work procedures prevents or reduces problems with safety, access to information and the system's down times.

iii. Standardization.

It is necessary to establish standardization for data entry and retrieval, to assure consistency and easy access to information. This is essential when more than one person is involved with the projects and system use (M4A9, L5A5). For example, one of the most critical initial

steps in CAD use is setting graphic standards (McDougall 1987). When different people are manipulating the data, data entry should be standardized to provide a homogeneous final product.

iv. Information management.

Maintenance of electronic information should be assured by a proper working procedure, including data saving and regular back ups with designated locations for the back up copies. Architects have on occasion lost their data (hours of work) due to lack of back ups (M3A7). Access to information and security of data is especially critical in medium and large firms (M3A6, M3A7)

v. System use schedule

System use should be scheduled according to the requirements of projects, the system's capabilities, the availability of computer time and the priority of projects. The system manager in L5A5 for example, determines the system schedule in discussion with project architects. The deadlines, importance and requirements of each project determine who has priority to use the system. The deadline of a project may be delayed, as in M3A4, because its principal was not acquainted with his system's time requirements and availability.

3.2.3 Human Resources Management

A common assumption among architects is that less personnel are needed for a computerized firm. In fact, in cases such as in M3A7, since computer implementation, the need for staff has increased, and the firm doubled in size, in only two years. This growth however, could be the result of other factors too.

Most architects agree that recruiting staff with previous computer experience has two main advantages: 1) it reduces the required time and cost of training, and 2) it provides in-house support for the system users. The majority of those interviewed, have chosen to hire personnel with previous computer experience (M4A3), often in conjunction with some training programs (M3A7). However, there are not many architectural staff with computer experience available in the market, and even those who are available may not have experience with the specific system that is used in the practice. Therefore, engaging qualified staff remains a major problem for most architectural firms.

As with other aspects of work, after introducing computers in the firm human resources management should incorporate the required changes . Staff are faced with different problems when the system is in place and therefore require different types of support.

The support and attitude established in the work environment is in large dependent on management style (section B: 3.2.1). Human problems may be reduced or solved by involving the staff in the planning and decision making process by developing well defined work procedures for using the system and manipulating data (M4A3, M2B10), by promoting the spirit of team work (M3A7), by conflict solving (M5A8, SC11), and most of all by valuing the staff (M4A9).

3.3 Social and Psychological Issues

Probably the most significant issues affecting the adoption and implementation of computers in architectural practices are the host of complex human issues associated with the introduction of new technologies into an existing work pattern. This important issue is the one least covered by computer related architectural literature, and the least explored by architects.

Although computer literature in architecture often portrays computerization as simply consisting of tools and equipment, computer technology can only be successfully evaluated in the social context in which it is used (Stevens 1991). The importance of the human issues often only becomes apparent to architects during implementation or use, when the attitudes of individuals towards computer technology, their professional status, and social interactions in the firm begin to impact system use.

In addition to management style and attitudes, social and psychological components can be influenced by:

- Staff attitudes and social interactions
- The size of the firm and the status of computer use in the practice.

3.3.1 The Staff's Attitude

In some cases the architects and architects-in-training who use computers find themselves performing those tasks that were, traditionally, the role of technologists or technicians (M5A8). For example, they function as system operators providing services such as printing

labels for those who are not familiar with computer use (M5A8). They may also face comments like: "good architects don't use computers" (M5A8) which are products of social conflicts with those not using the system.

On the other hand, most technicians and technologists who use computers benefit from more involvement in the projects than they traditionally would have (M3A6, M3A7), sometimes with gains in respect and income also (M4A9). They can become involved in the project at the planning stage, instead of at the stage of design development and working drawings production, as often happens.

In some medium and large firms, after the system is in place and in use, social conflicts develop in the practice (M5A8). Staff will be grouped into: 1) computer users, 2) those who do not use the system but agree that it is a required tool for their firm (or architecture), and 3) those who do not believe in the benefits of computer technology for their firm or in architecture. Tension and conflicting discussions between these groups can develop, which would affect the team-spirit traditionally existing in architectural firms.

Staff perception (prejudgment) and attitudes towards computer use has different origins:

. Feeling threatened by technology.

If the staff feel that computer use is threatening to their performance (by reducing their productivity during the learning period or by changing the quality of their product), or

to their job security, they can develop negative attitudes towards system use.

. Not being sure of their own ability to learn computer use.

Fear of learning computer technology often results in a lack of desire to learn or use the system.

. Previous experience with computers.

Those who previously used computers and could not learn their use or did not find it responding to their needs, could develop negative attitudes towards computer use.

. Philosophically against the automation of architecture.

This attitude potentially creates social conflicts in the firm. Often those resisting computer use either continue to perform in traditional ways or find their professional career in those architectural firms using traditional methods of service delivery. The growth of computer technology in architecture will determine the period of their survival in the market.

3.3.2 Size of the Firm and Status of Computer Use

Social conflicts can increase according to the size of the firm and the number of the staff.

In small firms, staff typically become involved with the process of computerization from the outset. More direct communication reduces social conflicts.

In a large firm, individuals are often influenced by the psychology of the work environment, instead of affecting it. Therefore, once a supportive attitude is established for system use, it will be followed by the present and (especially) new staff (L5A5).

Middle size firms typically face more problems than small and large firms (M5A8), as there are usually sufficient numbers of staff to create social conflicts and often no one is officially in charge of system management and problem solving.

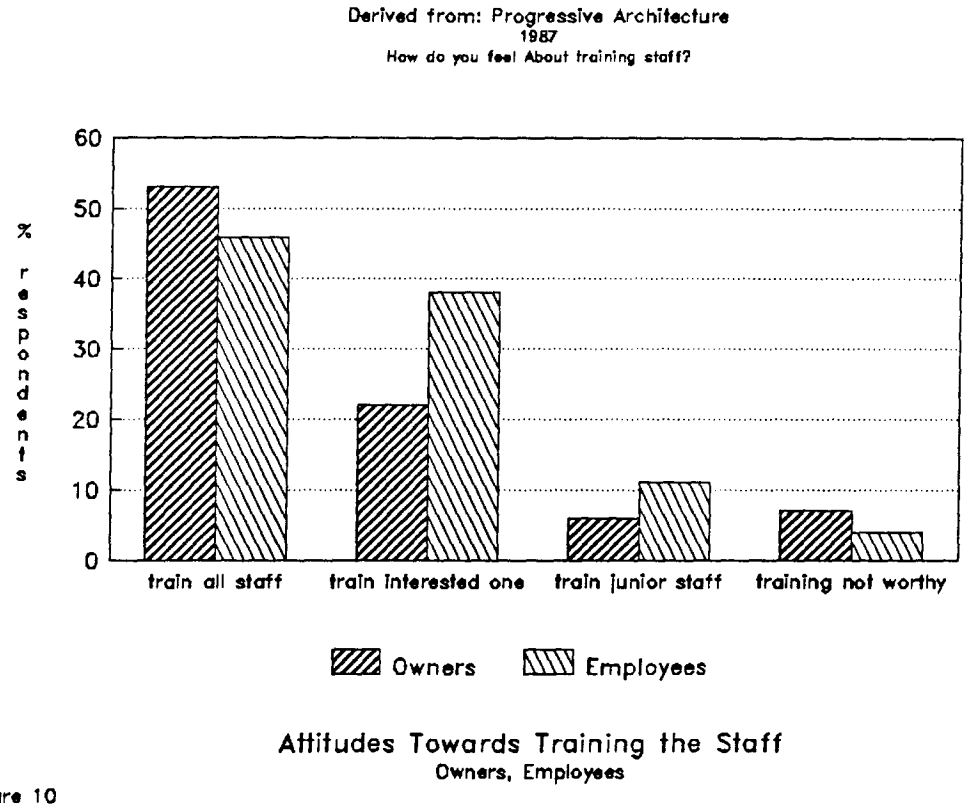
In addition to the size of the firm, the length of time and extent of computer use in the firm changes user attitudes. After the system has been in use for a period of time, most of the problems related to implementation and initial use of the system have been dealt with, and methods of dealing with most ongoing problems are developed. Therefore, the staff can concentrate on the use of the system rather than upon system related problems. The required time to achieve this stage varies from one system, and one firm to another. It is typically independent of the size of the practice and is related to the availability and effectiveness of training programs; the extent of computer use and problem solving supports.

3.4 Educational Issues

Architects often initially commit to the training of all staff, perhaps due to their urgency to keep up with computer technology and their competitors (figure 10). However they warned against **'force feeding computer technology'** to the unenthusiastic (P/A poll 1987). Training often follows the implementation of the system in an informal manner. Most architects mentioned the

need for a customized training course organized by suppliers, user groups, or institutions (NRC).

Learning and training are, as many architects indicated, a major concern and they are both affected by effectiveness of educational programs. A supportive environment for 'learning', however, increases the effectiveness of the 'training' program. Learning however, is mainly a product of an individual's ability and desire to learn and use the system.



Attitudes Towards Training the Staff
Owners, Employees

Figure 10

In addition to staff's attitudes, other factors that can affect the effectiveness of training are:

- Suitability of the system
- Supplier's training and support programs
- Training policy and tactics of the firm
- Impact of the size of the practice on education.

3.4.1 Suitability of the System

When a system is selected on the basis of the firm's requirements, it will be more responsive while in use (M4A3, M4A9, M2B10). User friendly systems can reduce the time of initial training (M4A3), and increase use, but may also provide less capabilities.

3.4.2 Supplier's Training and Support Programs

Often the availability and extent of vendor's training and support programs are not examined (M3A7, M4A9).

3.4.3 Policy and Tactics of the Firm for Education

The educational program should include initial training and ongoing training and educational support. It is essential to quickly provide the staff with an organized and well targeted initial training, followed by ongoing training programs.

In situations where the time for training of the staff and the integration of the electronic working habits is prolonged:

- The technology is perceived to be difficult to learn (M3A4, M3A7, M5A8)
- The job description of system users gradually becomes that of service personnel (M5A8), to provide computer services to non-users
- Division between the system users and non-users can create social conflict (M5A8, S2C11)
- Keeping up with computer technology advancements becomes a difficult if not an impossible task for the practice
- Most importantly, the time taken to entrench the system can demoralize workers in the practice.

In addition to training, ongoing educational programs can be established by providing:

- Support for staff to participate in seminars and computer courses (M3A7)
- Suppliers manuals and customized in-house guidelines. These include: rules of system use, in-house work procedures and standardization
- The possibility of a 'hands on' approach to experimenting and learning computer use (M4A3). Very often, in an attempt to minimize the initial investment, extra computers are not purchased, and the available systems are shared between different projects and users (M3A4). In this case there is little time for novices to explore and learn the system
- Vendor's presentations to inform the staff about new developments in computer technology

. An in-house trouble-shooter.

This can greatly facilitate the training as well as the effective use of the system. In many cases users are hesitant to explore a system's capabilities because there is no one available to answer their questions (M3A4, M3A7, M5A8). If there is one or more staff member familiar with the system, staff feel more confident to explore and learn more about it (M4A3, L5A5, M4A9, M2B10)

In addition, existing pressure to use the system increases the desire of staff to learn and use computers (M4A3, L5A5). When system use is optional, the learning curve and system use decreases (M3A4, M3A7, M5A8).

3.4.4 Impact of the Size of the Practice on Education

The size of the firm can influence the extent of training programs, their results and to some extent the learning attitudes.

i. Small practices:

Advantages of small firms are:

. As the extent of computer application implementation is small, less new information have to be absorbed by users

. Usually the extent and type of computer applications implementation is less threatening to architects

. There are less personnel and more direct communication which provide more possibility

for information exchange

. Direct involvement of the principals as users will promote efficient training, and create a reliable source for trouble-shooting.

The problems however, could be:

. More tasks are allocated to less people, resulting in less time available for learning and exploring the system (S1A1).

. Smaller projects, like individual residential, provide fewer opportunities for the users to explore the system potentials and applications.

. Users are exposed to a limited variety of projects and so fewer system abilities will be discovered

. There are fewer personnel, resulting in less expertise and exchange of opinion

. The limited budget of the practice does not allow much financial support for the training of staff.

ii. Middle size practice:

Typical advantages of size in middle size firms are:

. The scope and number of the projects are more than in small firms and therefore present a greater challenge for system users to explore and experiment

. There are more resources available to finance the training program and to assign an individual to system management

. The level of the initial investment, the scale of the projects, and the number of staff may

justify a customized training program (in-house or external)

. There are more personnel in the practice who can interact to provide a variety of opinions and new ideas.

Disadvantages could be:

. The impact of an inadequate training program on a larger staff

. Architects using the system may be under-utilised by performing simple tasks such as printing labels.

iii. Large firms:

In most cases the large practices have an advantage with regard to the training process. Once management is committed to the success of the system and is convinced of the importance of training is a major role player:

. Initial training is provided on a more formal basis

. Adequate resources exist to assign an individual to system management who can undertake the organization of training programs

. The expenses for an in-house and/or external training program is both affordable and justifiable

. Learning the system can become a requirement for the staff

. More information resources available to the users

. Suppliers are inclined to provide better services for large firms.

. A larger range of projects leading to a wide range of system capabilities.

The problems could be:

- Training a large number of staff could be more difficult than training few people
- A system problem has a greater potential to escalate.

4. Ongoing Evaluation

Most discussions of computers in architecture focus on their initial introduction, and the transition from traditional to automated techniques. In most cases regular and clearly defined evaluation methods are not in place. Typically, architects did not have any method ongoing, or otherwise, of evaluation for effectiveness, efficiency, or economy of system use.

It is important to distinguish evaluation from control, for once evaluation becomes a process for controlling staff and financial resources, it becomes merely an extra task for the practice. The evaluation process examines:

- Effectiveness of computer use
- Efficiency of system use
- Economic gains.

4.1 Effectiveness of Computer Use

Increased productivity, both of individuals and the practice, is a key measure of the value of computer use. The usual areas of productivity gains are in reductions in the amount of time spent on re-drawing, in correcting errors, and in exploring more design options, along with quicker

access to information. When questioned, however, most architects had no satisfactory measure of improved productivity, and assumed the advantages of computerization without attempting to modify or quantify them. Many also believed (also unmeasured) that, while productivity had improved in administrative applications, their CAD and/or CADD had reduced the productivity of production at the beginning (M3A7). Others linked productivity increase to the use of the computers for special applications, such as energy analysis (S2A2).

4.2 Efficiency of System Use

Three of the main elements in the promotion of efficient system use are:

- Attitudes toward computer use
- System's capabilities
- Time management for system use

Both, staff and management attitudes can impact the extent and efficiency of computer use in the practice. In firms where system use is optional (M5A8), its use may increase very slow and its capabilities are not explored. In other firms (M4A3), where increased computer use is required, the system's capabilities to respond to the practice needs can affect its efficient use, as can the initial and extended training programs which introduce the system's capabilities to users.

When there are fewer stations than projects, scheduling system use becomes necessary (L5A5, M3A4). Sometimes a minimal extra investment to purchase more computers can improve and increase system use (M3A4).

4.3 The Economic Gains

Most architects perceive that computers improve the productivity and hence relate that to economic gain. However, computer owners/users have not been able to measure the productivity increase, or turn it into to economic gain.

The evaluation of the economy of computer use entails:

- The cost amortization versus economical gains
- The increase in the number and size of projects
- The increase in the type of services provided.

When evaluating the economics of system use, the real cost of adopting computers should be evaluated against both direct benefits, such as saving time by doing repetitive jobs on computer, and indirect benefits, such as increasing the credibility of the practice or control over finances.

4.3.1 Cost Amortization and Economic Gains

Architects use different methods to amortize the cost of their system. Examples are:

- Charging clients for system use on an hourly basis:

  Firms investing in expensive equipment have at times billed clients for its use on an hourly basis. However, most architects agree that clients will not accept having to pay for computer time, as opposed to design expertise (Moreno 1987). In fact, sometimes clients expect a fee reduction due to increased productivity, (M3A6, M2B10).

. Computer cost as overhead expenses:

Overheads in architectural firms have risen considerably over the past fifteen years, while recent graduates provide a large pool of inexpensive labour to the profession, labour that will remain cheap well into the next century (Gutman 1988). Substituting cheap, mobile, and easy to replace labour with expensive inflexible capital investments simply does not make economic sense (Stevens 1991).

. Computers as a required cost:

Some architects however, consider computers as simply a required tool for their firm. They believe that the effective and efficient use of the system (as with any other tool, e.g. telephone systems) will justify its cost (M4A3). In this case a simple calculation by the principal indicates that as each system is used on a full time basis (200 h./year), over the first five years of purchase, the system will cost the firm about $1.00/hour (appx. cost of each system= $10,000).

4.3.2. Increases in the Number and Size of Projects

The participation in more and larger projects, (both through new clients or standing clients with new requirements), is mentioned as an economic gain by architects (M3A6, M4A9, M2B10).

Most architects indicated that having computers improves the practice's professional image, and therefore increases the firm's market share. They also indicate that using the system for marketing can increase the economic gains.

4.3.3 Additional Services Provided by the Firm

In most cases the potential of additional revenue by extending the services of the practice, are least examined. For some architects (S2A2, M2B10), special services, like energy analysis and programming, were a purchasing requirements, but only a few (M3A6, M3A7, M4A9), explored the possibility of providing services like project and facility management extensively.

5. Expansion

In this thesis, expansion refers to the growth of computer use and its expansion in the firm.

Expansion in computerized applications is usually due to satisfactory experiences (M4A3, L5A5) and/or need to improve the situation. Expansion in the number of hardware however is mainly because of increased requirements (M3A4), or initial under estimate of station requirements.

Selection at the expansion stage is often based on a clearer and more realistic understanding of the firm's requirements and the technology's capabilities than at the initial purchase stage. Financial and the compatibility issues are the main concerns at this stage.

In most cases, regardless of the size of the firm, expansion is not an integrated part of the initial purchase planning, despite the fact that most architects have a vision of future computer applications.

SECTION C

AN OVERVIEW OF THE GUIDELINES

This research explored some of the issues faced by architects during the adoption and use of computers in their practice. As thesis research reviles some firms are facing problems due to lack of clear planning. Most of these problems and/or their impact can be reduced by advance planning. A series of guidelines are developed and included in appendix B of this paper, to present some important factors to be considered in the planning for the process of computerization, to:

. Assist architects who have little or no experience with computer technology to initiate and develop a plan for implementation of computers in their practice

. Assist those who are in the early stages of computerization of their firm to reevaluate and if necessary modify their approach

. Assist architects who are currently using computers in their practice to review and if necessary modify their approach

. Assist architects in using their computer consultant's time and recommendations more efficiently and effectively.

These guidelines are developed based on the findings of the research, the experience gained from the case studies, and suggestions of MEDICI II seminars. Their structure follows the sequence of the stages of computerization which is the way the process is typically addressed by architects (stage by stage, with no advance planning undertaken). Although the guidelines do not present all the factors in detail, the intent is to introduce those issues that appear to be most important.

Obviously the recommendations included in the guidelines will be of different value for firms at different stages of computerization (those at early stage may find it more useful). However a review of the recommendations may uncover some factors overlooked even by those more advanced in computer use.

This section will briefly introduce the guidelines.

1. The Initial Decision to Computerize the Practice

Most unrealistic expectations from system use are the result of an initial misjudgment of the firm's requirements and of the computers capabilities to respond to them. Once management decides that computerization is consistent with their philosophy and objectives, they need to develop a clear understanding of the benefits of computer use for their practice and establish realistic expectations accordingly.

2. System Selection and Implementation

The guidelines explore the selection stages in more detail as it often appears to be fairly confusing for architects. This stage of the process includes application definition and selection, hardware selection, and financial planning. Architects typically select their hardware first (mainly according to financial considerations) and then decide about their application software. This approach could lead to the purchase of an inappropriate system. Therefore it is suggested that system development follow the application requirement studies.

3. System Implementation and Ongoing Use

Realizing the system's capabilities and increasing its effectiveness in the practice, depends on the way the system is adopted and used. Management's ability and desire to identify and respond to new requirements and problems could influence the attitudes towards, and status of, computer use in their practice. A well planned implementation reduces the time and cost required for making the system productive, it can also diminish unexpected problems. Important requirements to achieve effective implementation are space design, initial training, organizing existing data, preparing for system installation, availability of a system manager, effective human resources management, clear office procedures and ongoing educational programs. These are presented in the guidelines.

3.1 System Management

There should be at least one person officially in charge of system management to coordinate the development and implementation of work procedures, standardization, evaluation methods, and maintenance procedures. The system manager can be in charge of all system related issues such as problem solving, scheduling the system use and recommending on the time and requirements for expansion of computer use.

To prevent problems that may occur in case the system manager leaves the firm, either this person should be selected from the permanent members of the practice (e.g. partners) or at least one other person should be involved.

3.2 Human Resources Management

It is important to realize that the staff are the key to effective and efficient computer use. Effective human resources management is important which includes involving staff to the process of computerization, allocating tasks to the right people, providing clear job specifications, conflict solving, responding to staff problems and most importantly valuing the staff.

3.3 Office Procedures

Developing clear work procedures defining new methods of work including standardization, information management; and security of system and generated data is essential. This could reduce repetitions, confusions, errors, loss of information, and damage to system and data. It could therefore, increase the efficiency of individuals, improve the quality of products, and provide easy access to information.

3.4 Educational Programs

The guidelines present initial and ongoing educational programs necessary to reduce the 'fear' of computer use, to introduce the benefits of computerization for the individual and to the firm, to teach the system to staff, and to improve the efficiency of system use on an ongoing basis.

4. Evaluation

Evaluation process can examine effectiveness of system use according to the firm's objectives, productivity of different applications, efficient use of system capabilities and equipments, and can

help identify the need for expansion. Ongoing evaluation can also assist management to recognize and remove problems and therefore increase the effectiveness of computer use. The guidelines present the need for developing and using evaluation methods and a series of general considerations in this regard. They do not however, define any specific method.

5. Expansion

The guidelines include this stage in the initial planning process so the selected system will be responsive in the firm's long time requirements (up to expansion). In addition, at the stage of expansion, current and anticipated requirements of the firm should be examined again. Although the cost considerations are important, it is more important to respond to this need soon after it is recognized. If the initial system is not suitable to the firms requirements this could be a good time to consider the change to a more suitable system and prevent the potential future dissatisfactions.

6. Making the System Profitable

In addition to productivity improvement that is typically considered as economic gains, the guidelines concentrate on the profitability improvement through revenue increases. Additional revenues can be generated by increasing the number of projects and most importantly increasing the range of current services.

SECTION D

CONCLUSION

There is little doubt that the use of computers will influence the nature of both, the architectural design process and management practices. The rate and extent of these changes will depend on the capabilities and cost of computer technology, as well as the ability and desire of architects to understand and apply the benefits of computing in their practice.

This thesis has explored the status of computer use and its related problems through a literature search and case studies consisting of interviews and questionnaires. Eleven firms in Vancouver were interviewed providing in-depth information about their approach in adopting computers in their practice and the problems they faced at different stages. Their experiences were useful in exploring the status of computer use and developing a series of guidelines for architectural firms. The information however, could perhaps be improved by providing the questionnaires to the interviewees in advance, dividing the interviews in two sessions, and observing the computer use in the practice for several days.

For the specific stages of adoption of computers the following general conclusions can be derived.

1. Process of Computerization

For most firms the transition from traditional processes to computerization, for which usually little serious planning is undertaken, is both slow and frustrating. Often decisions are based on

the limited expertise of the members of the practice, and the full range of requirements such as time, dedication, education, commitment, evaluation, regular supervision and involvement are seldom present. The general process is to simply commit to a system, and then evolve.

1.1 Reasons for Computerization

The decision to adopt computers is usually rationalized by the need to:

- Increase productivity
- Increase quality of firm's services
- Remain competitive in the market

Other reasons are:

- The improved availability and affordability of computer technology
- The increasing need to process a larger range of information
- Project/client requirements
- Staff pressure
- Vendors promotional pressure, which presents computerization as inevitable.

1.2 Initiating a Computer Strategy

The extent of initial planning varies between firms, particularly between large and small practices. It is however, usually short term with the main reliance on in-house judgement. Few firms use external consultants to evaluate their unique requirements and direct them through the complete process of computerization as this is often considered too expensive.

1.3 Factors Affecting Computerization

In most cases the three primary factors affecting the selection of a system are financial, technical and human.

Financial planning is typically short-term, and most architects simply weigh the initial investment for purchase of a system against their available budget. On-going and expansion costs, alternative methods of financing and cost amortizing are seldom considered. A more significant observation is that often the additional potential revenue increases generated through computerization (such as indirect income increases and extra services) are not considered in the planning process. This indicates that computerization is seen as a replacement technology rather than one capable of offering new opportunities for architectural practice.

The technical attributes of a system appear to be the most widely explored criteria prior to selection despite the fact that they are the criteria the least understood by practising architects. There is a clear need for objective, architectural-related sources of information.

In addition, in attempting the successful introduction of new technologies into an existing work pattern, the impact of the attitudes, experience and commitment of management and personnel is highly significant.

1.4 System Selection

Although the implementation of computers should follow a clear assessment of current and anticipated needs and selection of the type of application software appropriate to fulfil them, most architects initially commit to a particular type of hardware.

Usually the two major considerations in selecting a system are the initial cost of the hardware and the ease of learning and using the system. Clearly, the nature of these considerations depends on the size and priorities of the practice, and the extent of research for suitable systems.

Although many other realms of architectural practice offer considerable potential for computerization and indeed represent the larger part of the computerization, the decision as to whether to implement computers within design development is considered as key in most firms. Administrative applications however, are generally the first or one of the first applications implemented in the practices.

1.5 System Implementation and Use

Generally the issues of implementation are addressed after the purchase of the system. Once the system is installed, most firms face the requirements for adequate and appropriately designed space, qualified staff, effective training programs and the necessity of providing clear office and work procedures for staff. Often the problems are addressed as and when they occur.

1.6 Evaluation

Seldom there is an established method of evaluation to examine the effectiveness and efficiency of system use, to identify and correct problems, to explore the potential of revenue increase by increasing the range of projects and services, and to identify the time and requirements for expansion.

It is generally assumed that computers will increase the productivity of individual members (and therefore of the practice). When questioned, however, most architects have no satisfactory measure of improved productivity due to the adoption of computer techniques.

The evaluation process can also examine the efficiency of system use which comes from the extent to which the system (hardware/software) and its capabilities are being used. In addition to suitability of the system and effectiveness of training programs, a number of human issues impact the extent and efficiency with which a computer system is used.

1.7 Expansion

Although initial implementation is often a frustrating process for most architects, it represents a technological 'gate' that the practice is unlikely to retreat from.

Need for expansion can be due to:

. A requirement for more computer stations, due to an increase in the number of computer users or an initial misjudgment

- An increase in computerized applications due to satisfactory experience or a hope to achieve more (or improve the situation).

Expansion is often conducted with a better understanding of both the firm's requirements and the capabilities of computer technology. Often cost and the compatibility of the new system with the existing one, are the main considerations.

2. Value of Planning

Most of the problems that are faced by architectural firms, can be either reduced or methods of dealing with them can be established by advance planning. Although selecting computers is an area architects are not trained for, by developing and following a clear plan they can increase satisfactory results. Issues incorporated in computer implementation and use are those that mainly impact its effectiveness in the firm and are directly dependent on sensible management style and planning procedures. Despite the haphazard nature with which architectural practice has introduced computers, the successful implementation of computerization still derives from:

- Assessment of the current and anticipated requirements of the practice, with different systems evaluated accordingly
- Realistic expectation of the system
- Involvement of management in the process of research, selection, implementation, and use
- The computerization process extending beyond the initial purchase, with commitment to system design, implementation and development
- Considering the importance of human issues and responding to them

- Educational programs (initial and ongoing training, and ongoing support for learning)
- Established work procedures
- Having an individual in charge of system management and related issues
- Having a method of evaluation to examine and help realize the system's capability, and to increase its effective, efficient, and economical use.
- Availability of technical services.

3. Guidelines

Following the research a series of guidelines were developed for practising architects (Appendix B). These guidelines are based on the experiences of the current computer owners/users, findings of the research and suggestions of MEDICI II. The guidelines suggest that advanced planning is required to increase the success of computerization and present a series of factors to be considered in the process of planning.

4. Further Studies

The continued penetration of computers into architectural practice will raise many challenging questions for the profession. Further studies could include:

- Developing methods of evaluation of effectiveness, efficiency, and economy of system use
- Developing methods of cost amortization and standardization of fee charges
- Exploring different potentials and requirements for increases in the range of services
- Examining issues of security, liability and royalty (electronic data).

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APPENDICES

APPENDIX A

CASE STUDY

Adopting Computers in Architectural Firms

A research for Master of Advanced Studies in Architecture
University of British Columbia
School of Architecture
1990-1991

Advisors: Dr. Ray J. Cole, U.B.C.
Dr. John C. Dill, S.F.U.
By: Mitra Kiamanesh

NAME	POSITION	DATE

COMPANY:
ADDRESS:
PHONE: FAX: #
CONFIDENTIAL: All..... Part..... None.....

CONTENT:

3. OUTSIDE SERVICES

4. THE FUTURISTIC VIEWS

   4.1 Computers in the firm

   4.2 Computers in architectural practice

5. ADDITIONAL INFORMATION

1. GENERAL INFORMATION ABOUT THE FIRM:

START DATE	Ar.	D	A	O	PROJECTS	$VALUE	COMPUTER APPLICATIONS

COMMENTS:

APPLICATIONS: Administration, Design, Drafting, Project Management, Estimating, Others.
NUMBER OF STAFF : Ar. Architects **D.** Design **A.** Administration **O.** Others

2. THE RANGE OF WORK IN THE FIRM:

#	TASKS	Before Comp. M	O/M	O/C	After Comp. M	C	O	Added by Computers	COMMENTS
COMMENTS:									

TASKS: Adminstration, Marketing, Accounting, Contracts, Tracking of the information, Etc.
M. Manual, **C.** Computerized, **O.** Outside services

The Range of Services:

#	SERVICES	After Computers M C	Possible Due to Computer Use	COMMENTS
COMMENTS:				

STAGES: Predesign, Schematic design, Design development, Construction documents, Bidding and negotiations, Construction contract administration, Post construction,
SERVICES: General architectural services, Extra services, Other related services.
M. Manual **C.** Computerized

1.4 The Organizational Management and Work Flow.

QUESTIONS:

1. The flow of work in the firm?
2. The changes to the organizational management required or produced by computerization?
3. The interaction within the organization before and after computerization?

THE ORGANIZATIONAL MANAGEMENT:

THE FLOW OF WORK:

1.5 Future Plans.

#	OBJECTIVE	PLANNED	TIME	COMMENTS

COMMENTS:

OBJECTIVES: Expansions, Location, Organizations, Projects, Human resources, Clients, ...

2. THE STATUS OF COMPUTERIZATION:

2.1 Reasons for Computerization:

#	THE REASONS FOR COMPUTERIZATION	ACHIEVEMENT	REASONS	SOLUTIONS

COMMENTS:

2.2 The Process of Computerization.

2.2.1 Decision making:

Starting date:

#	RESOURCES	POSITION	DM	Inv	Exp	ISSUES	COMMENTS

COMMENTS:

DM Decision Makers, **Inv.** Users (**Involve**), **Exp.** Experts

2.2.2 System development:

#	PLANNED	RESULTS, +&-	SOLUTIONS	COMMENTS

COMMENTS:

System Development:

A) Feasibility study _____

B) Desired changes to the practice _____
- Projects _____
- Size _____
- Clients _____
- Organization _____
- Others _____

C) Required changes to the firm _____
- Environmental _____
- Organizational _____
- Human resources _____
- Management style _____

D) Selection _____
- User requirements _____
- Systems specifications _____
- Cost _____

E) Finances _____
- Loan _____
- Other projects _____
- Available cash _____
- Others _____

F) Cost amortization _____

G) Implementation & Integration _____
- Environmental Changes _____
- Customizing _____
- Staff changes _____
- Training _____

H) Application _____

I) Time milestones _____

J) Ongoing issues _____
- Maintenance _____
- Upgrading _____
- Education _____
- Evaluation _____

K) Future expansion of the system _____

2.3 The System Configuration.

Date	System Hard/Soft ware	Reasons Selected	Applications	Users	Issues	Solutions

COMMENTS:

THE SYSTEM CONFIGURATION:

2.4 The Effect of Computerization.

#	Affected Area	Nature of the Change	Issues	Solutions
Comments:				

Effects of the... Practice (Philosophy, Size, Staff, Organization, Location), projects (Kind, Size, Quality, Quantity etc..), Clients (Number, Kind, Impression), Finances, Others

2.5 The Expectations from the System.

#	By	Past	Present	Future	Expectations

Comments

BY: Senior management, architects, design staff, administrative, clients, information resources.

5. OUTSIDE SERVICES:

#	Applic.	Manual	Comp.	Reasons for Use	Date	Issues	Solution

Comments:

6. THE FUTURISTIC VIEWS:

6.1 Computers in the Firm.

1. Future Plans.
2. Time Forecasts.
3. Requirements to Achieve Them.
4. Approach.
Comments:

6.2 Computers in Architectural Practice

What is your futuristic view of computer applications in architectural practice?

NOTE:
1. Word of advice:
2. General reasons for success or failure?
3. What can help you to improve your system use?

Appendix A: Questionnaire II

CASE STUDY

ADOPTING COMPUTER IN ARCHITECTURAL FIRMS

A Research for Master of Advanced Studies in Architecture
University of British Columbia
School of Architecture
1990-1991

Advisors: Dr. Ray J. Cole, U.B.C.
Dr. John C. Dill, S.F.U.

By: Mitra Kiamanesh

NAME	POSITION	DATE
		March 13th 1991

COMPANY:
ADDRESS:
PHONE: FAX: #
CONFIDENTIAL: All..... Part..... None.....

INTRODUCTION:

The main objective of this research is to provide an insight about computerization of architectural practice.

The purpose of this interview is to explore the present status and evolving issues of computerization in Architectural Practices in Vancouver.

The size of the firm and the extent of its computerization are the two main criteria in selection of the firms for the case studies.

The results will indicate the evolving issues of computerization. They can also provide some solutions for effective computerization of architectural practice.

The collected data can remain partially or completely confidential. If agreed by the interviewee, the results will be included in the thesis and subsequent publications.

I thank you in advance for your cooperation.

Mitra Kiamanesh

CONTENT:

1. GENERAL INFORMATION ABOUT THE FIRM:

In order to assess the current status of computerization in an architectural firm, it is important to identify the characteristics of that individual firm.

1.1 Milestones in the Firm's Development.

Objectives:

The purpose is to identify:

a. The growth path of the firm in general, and/or related to computerization;

b. The first time computer was implemented in the practice;

c. The sequence of applications implemented;

d. The impact of computerization on the firm.

QUESTIONS:
1. Date of the firm's incorporation:
2. Number and configuration of the human resources:
3. Type and value of the projects:
4. Important changes in the firm:

1.2 The Range of Work in the Firm.

1.2.1 Ongoing tasks:

Objectives:

The objective is to investigate the:

a. Nature of the tasks performed in the firm;

b. Areas that computers are integrated;

c. Potential impacts of computerization on the tasks and performance;

d. Unexpected tasks introduced to the work after computerization.

QUESTIONS:
1. What are the tasks performed in the firm before and after computerization?
2. How was the approach to perform the above before and after computerization?
3. Which tasks became possible due to computer application?
4. Is there any extra work created due to computerization?

1.2.2 The range of the services:

Objectives:

The objective is to explore:

a. The range of architectural services provided by the firm;

b. The range of the extra services provided;

c. The possibility of extending the services to other related areas by computer applications;

d. The impact of the computers on the above.

QUESTIONS:

1. What are your general architectural services?
2. What are the additional related services?
3. What are the impacts of computerization on the above?

1.3 The Organizational Management and Work Flow.

Objective:

To identify the organizational management of the firm and therefore to explore the issues of computerization accordingly.

QUESTION:
1. Describe the organizational management and the flow of work in the firm? (please use the next page)
2. What are the changes to the organizational management required or produced by computerization?

THE ORGANIZATIONAL MANAGEMENT:

THE FLOW OF THE WORK:

1.4 Future Plans.

Objective:

The future plans of the firm will indicate:

a. The short term and long term objectives of the firm;

b. The status of computerization in the planning process;

c. The overall impact of the computers as viewed and/or planned. (On the size of the firm and projects, clients, human resources etc...).

QUESTION:
1. What are the firm's objectives for the future?
2. The time forecasts?
3. What are your plans to achieve the above?
3. What will be the role of computers in the firm and in achieving the above?

2. THE STATUS OF COMPUTERIZATION:

2.1 Reasons for Computerization

Objective:

To explore the:

a. Initial reasons for computerization;

b. Level of satisfaction in achieving the goals;

c. Identified problems and issues;

d. Suggested and/or experienced solutions.

QUESTION:
1. Why did you decide to implement computers in your firm?
2. Did you achieve the expected outcome?
3. What were the reasons for success or failure of the initial plan?
4. What are the potential solutions in your opinion?

2.2 The Process of Computerization.

2.2.1 Decision making:

Objectives:

To explore the:

a. Duration of decision making;

b. People and issues involved in the decision making process;

c. Resources and personnel supporting the process.

Therefore to identify the:

d. Impact of the initial planning on the system implementation and use;

e. Issues of planning process;

f. Different planning and decision making processes.

QUESTION:
1. When did you start to explore computer implementation in your firm?
2. Who were the decision makers?
3. Your resources for information?
4. What were the issues?
5. How did you overcome them?

2.2.2 System Development:

Objectives:

The purpose is to recognize and compare:

a. Different approaches to system development;

b. Different issues and solutions;

c. Reasons for any problems;

d. The impact of the process on the firm and the system use.

QUESTION:	
1.	What was your process of system selection, implementation, integration and application? (please use the next page)
2.	Was the process planned, and improved accordingly?
3.	What are/were the evolving issues?
4.	What are/were the reasons initiating these issues?
5.	How did you resolve the problems?
6.	What are the solutions for the remaining problems?
7.	Given the benefit of hind sight, what would you do differently next time?

THE PROCESS OF SYSTEM DEVELOPMENT:

2.3 The System Configuration.

This section will mainly provide the required information to identify the status of computerization in architectural firms of Vancouver.

It will also indicate the:

a. Systems and applications most commonly used in the profession.

b. Reasons for selection of the different systems, and computerization of different applications.

c. Time span between implementation and integration.

d. Issues and potential solutions with different systems and/or applications.

QUESTION:

1. What is your system configuration? (please use the next page).
2. The sequence of computerization?
3. The reasons for selection of the computerized applications?
4. The reasons for selection of the system configuration?
5. The previous and present issues?
6. The implemented and/or suggested solutions?

THE SYSTEM CONFIGURATION:

2.4 The Effect of Computerization.

The objective is to explore the impact of computerization on the:

a. Firm's organization, direction, size, staff, etc;

b. Scope and nature of projects;

c. Clients (kind, number, impression);

It will also investigate the changes in productivity.

QUESTION:
1. What were the impacts of computerization in your practice?
2. What are/were the pros and cons of those impacts?
3. What are/could be the solutions?

2.5 The Expectations From the System.

The purpose is to identify:

a. Present and future expectations of different groups from the system (pre and post computerization);

b. Criteria for the comparison of different planning and application processes;

c. Reasons for over/under expectation from the system.

QUESTION:
1. What are/were the senior management's expectations from the system?
2. What are/were the staff expectations from the system?
3. What are the differences between the planned expectation and the reality?
4. What do you expect from your system in the future?
5. What do you think the computers can do for you and in general?

3. OUTSIDE SERVICES:

Objective:

a. To establish the range of outside services currently used by the architectural firms;

b. To identify the advantages and disadvantages of the above services.

QUESTION:
1. Outside services used before and after computerization, and in the future?
2. the reasons for using them?
3. the related issues?
4. The solutions?
5. What kind of services do you believe will be of use?

4. THE FUTURISTIC VIEWS:

4.1 Computers in the Firm

How far will the architects go...?

QUESTION:
1. What are your plans for computer use in the future?
2. What is your time forecast?
3. What is necessary for achieving this objective?
4. What are your plans in this regard?

4.2 Computers in Architectural Practice.

How far will the computerization go ...?

QUESTION:

WHAT IS YOUR FUTURISTIC VIEW OF COMPUTERIZATION IN ARCHITECTURAL PRACTICE?

NOTE:

APPENDIX B

GUIDELINES

The following guidelines will present a structure for the process for adopting computers in architectural firms. They are presented according to the sequence of the computerization process and not the importance of different stages.

These guidelines should be customized according to the particular situation of your firm. They advocate the importance of following a clear and complete planned process in adopting computers in the practice. To do so they present one approach for, and some important factors to be considered in, this process. The following six chapters discuss:

1. The initial decision to computerize your practice
2. The process of computerization
3. Making your system operational
4. Evaluation
5. Expansion
6. Making your system profitable

1. The Initial Decision to Computerize Your Practice

Before you decide to use computers in your practice, you need to evaluate if computerization is consistent with the philosophy and objectives of your firm. If the answer is favourable, you should explore:

. Characteristics of computer systems

- The advantages of computer use for architectural practices
- The advantages of computer use for your practice.

1.1 Characteristics of Computer Systems

You need to have a clear and realistic understanding of the capabilities of computers for both architectural firms in general and your specific needs.

1.1.1 Computer Capabilities:

A computer is very effective as a tool for repetitive work and can process data quickly and accurately. A computer will not, however, think, create, organize material stored in it, make value judgement, give you the skills you don't have; or manage your business. In making a spreadsheet, for example, it can neither validate your data, nor interpret the results.

1.1.2 Requirements for Effective Computerization:

Some requirements to increase the effectiveness of computerization are:

- Some changes in organizational and office management
- Financial investment
- Time commitment
- Changes in the office layout
- An organized approach to work and delivery of architectural services.

1.2 The Advantages of Computer Use For Architectural Practices

A review of this information will establish your understanding of the benefits of computer use for architectural practices and will suggest its potential benefits in the short and long term (example: table A).

Table A

Perceived Advantages of Computers

I. True for architectural firms in general

II. Applicable to your firm

PERCEIVED ADVANTAGES OF COMPUTER USE	I.	II.
Required to remain competitive in the market		
Can be used as marketing tool		
Improve the image and credibility of the firm		
Improve the productivity		
Provide more time for architects to examine design options		
Increase the efficiency of individuals		
Reduce employee hour/project		
Achieve quicker projects turnover		
Increase accuracy		
Reduce the number of errors		
Enable easier changes in drawings		
Provide better quality services		
Increase the number of current projects		
Increase the range of current services		
Achieve better time management		
Tighten contract documents		

1.3 The Advantages of Computer Use for Your Practice

a. List the advantages of computer use for your practice

b. Examine their validity in different areas of work in your firm.

c. Select the reasons for adopting computers in your practice, in order of priority.

d. Identify the computerized applications (specific or generic) which can enhance each advantage.

Weigh these reasons against the requirements for computerization of your practice (this evaluation is, of course subjective) (example: table B).

Table B:

Advantages of Computer Use for Your Practice.

a. ADVANTAGES FOR YOUR PRACTICE	b. FOR WHICH APPLICATIONS	c. reasons	d. application
Example: productivity increase	administration: letters contract administration etc.		Word Processing

The results of the above will help rationalize the decision for computerization, indicate what to expect from computerization, and help evaluate the effectiveness of computer use.

If you have a temporary need for computer use (due to a specific project's requirement, or you need to examine computer technology prior to purchasing a system), you could either use outside services, which would give a general idea of computer advantages and problems, or lease a computer, with an option to buy, which would allow you to evaluate a particular system.

Once you are committed to computerization, designate or hire an individual to take charge of the process, and develop and follow a clear plan.

2. System Selection and Implementation

A clearly defined process for computerization will increase the probability of success. The process of computerization includes:

- Application definition
- System selection
- Financial planning
- Making your system operational

2.1 Application Definition.

You should identify your needs and priorities for computerized application implementation. In doing so the intention should be to improve the way work is done and/or the result achieved. A computers should not be considered as a tool to perform tasks the way they are presently done.

2.1.1 Current Application Requirements

Evaluate your current services and tasks (example: table C):

- What, precisely, do you do?
- Is everything that is done necessary?
- Is some or all of it computerized?
- Does anything need improvement?
- Can computers improve the way things are done, and/or the results?

Table C:

a. Current Services and Tasks.
b. Is it necessary?
c. Is it computerized?
d. Does it need improvement?
e. Can computerization improve the process or the results?
f. What are the priorities?
g. Which applications? (generic or specific)

a. PRESENT SERVICES:	b	c	d	e	f	g
Building evaluation						
Facility requirement study						
Feasibility study						
Project management						
Programming						
Conceptual design						
Design development						
Construction management						
PRESENT TASKS:						
eg. writing memos, specification,..						

2.1.2 Wish List and Anticipated Application Requirements

List your anticipated services and tasks (example: table D):

- What do you want to do in future?
- Is this necessary?
- What do you have to do in future?
- Can computers accommodate this?

TABLE D:

a. Anticipated Services and Tasks.
b. Is it necessary?
c. Can computers accommodate it?
d. What are the priorities:
e. which applications (generic or specific)?

a. ANTICIPATED SERVICES:	b	c	d	e
Facility evaluation				
Facility management				
Energy analysis				
Consulting services to architects				
Computerized services to architects				
Etc.				
ANTICIPATED TASKS:				
Bulk mailing				
Etc.				

Indicate the priorities for computerized application implementation:

1) Applications that can improve the current services, both methods and results.

2) Applications that can accommodate future expansion.

The results of Table C and Table D will:

- Indicate your current application requirements in priority
- Indicate your anticipated application requirements
- Provide some criteria for system selection, such as the current and anticipated expectation of the system
- Help you in planning for the expansion of current services
- Assist you in evaluating system effectiveness
- Assist you in the expansion stage.

2.2 System Selection

System selection includes the selection of application software and hardware. You first need to identify the application software that can, respond to your present requirements, and accommodate your future tasks; and then select hardware that can run those programs.

2.2.1 Selection of Application Software

Software consist of two types: system and application. System software manages the hardware (eg. reading data from a disk) and provides services like file handling to the application software. IBM PCs generally use a system called DOS, APPLE Macintoshes use Macintosh Operating System (MOS), and workstations generally use UNIX. Application software deals directly with the user's interest.

When selecting your application software, you should have a clear idea of what you are

looking for, and should also understand what different programs are intended to do, and learn what they can be extended to.

i. Understand what different programs are intended to do:

Software applications are often suitable for several work functions. When selecting your package (Word processing, Spreadsheet, Data Base, A/E or Business Accounting, Graphics, CADD, etc.), explore what else they can do in addition to what you expect them to do.

Software Work Functions Recommendations:

- *Word processing:*

  Contract administration
  Specifications
  Simplified working drawings
  Marketing
  Secretarial

- *Spreadsheet:*

  Engineering calculations
  Contract administration
  Simplified working drawings
  Design programming
  Schematics
  Design development
  Project management
  Executive management

  Estimating
  Bookkeeping/Accounting
  Office management
  Financial management
  Marketing

- *Data Base:*

  Office management
  System drafting material
  Product information files
  Marketing and client/contact information files

- *A/E or Business Accounting:*

  Bookkeeping/Accounting
  Office management]
  Financial management

- *Specialty programs:*

  Engineering calculations
  Document checking
  Specifications
  Estimating
  Design programming
  Schematics
  Design development

- *Graphics*

  Simplified working drawings

- *CADD*

  Design drawings
  Simplified working drawings
  Working drawings

It is often preferable to purchase word processing and spreadsheet software first, as they have the most varied uses. In addition:

. There are more choices available in the market than architectural applications

. It is easier to recruit and replace staff who can use them

. They are no threat to architects

- They can be applied to the most repetitive tasks
- It is an easy and relatively inexpensive way to introduce the benefits of computer use to your firm and staff
- It is a simple way to start organizing your information and office management
- They reduce the administrative time of architects and increase their time for architectural tasks.

ii. Know what you are looking for:

Based on your requirements studies (2.1), you should develop some realistic specifications for software application, indicating the capabilities your software must have, and those you would like it to have.

Examples of criteria for your Application Software

1. What capabilities must your software have?

2D drafting
Technical report writing
Manage supporting documentation
Data compatibility: DXF and/or IGES
Auto-dimensioning of drawings
Number of associated drawings
Programmability
Parametric design
Mirroring
Construction lines and removal
Symbols library
Ease of use
Local training and support
Sketching
Specification tracking

Bills of materials
Support various input methods
Support HPGL and HPGL2
Graphic user interface or command line

2. ***What capabilities do you like it to have?*** *For example:*

3D drafting
Wireframe
Hidden line removal
Surfaces
Multiple light sources
Rendering ability for presentations
Interface for survey/site data for civil engineering
    digital terrain mapping
    site planning
    road/street design
    land development
Facility management
    space planning
    design and layout
Structural engineering
    design and analysis
Heating, Ventilation and Air conditioning design
    duct work and piping
    energy analysis
Landscaping
Custom build user interfaces for your applications
Colour PostScript support
Spreadsheet and database compatibility
Heads-up drafting or menu oriented

3. ***Make a wish list.*** *For example:*

Visualization and walk-through capabilities
Ultra-realistic 3D rendering
Interactive walk-through
NISC and PAL video production facilities
Freehand drawing and illustration
Audio integration
Automated raster to vector translation

Get home earlier!
Virtual reality design environment

iii. Locate suitable software

In selecting suitable software, you should:

. Consider the suitability of the software for your applications

. Limit your search to architectural packages for your architectural application (mechanical and electrical CAD software are not suitable)

. Evaluate the availability of local support.

Some sources of information for low cost generic software are:

- *Retail computer stores,*
- *Computer magazines (eg. PC magazine)*
- *Architectural journals (eg. Architectural Record, Progressive Architecture)*
- *User groups: hardware and software (AutoCAD group)*
- *Swap meets*
- *Data base networks*
- *Other computer users*
- *Trade shows (A/E Computer shows)*

2.2.2 Hardware selection

To select and purchase your hardware, you need:
. To have an understanding of computer technology
. To explore hardware choices
. To determine your computer and work station requirement
. To select your supplier

i) Have an understanding of computer technology

It is important to learn a few words and be conversant with sales representatives, when comparing competing equipment.

The basic parts of a computer system are

*- **INPUT**: Card, Keyboard, Digitizer, Light pencil, Mouse, Voice, Scanner, Track ball*

*- **MEMORY AND PROCESSING**: Chips, Central Processing Unit (CPU), Circuit Boards, RAM, ROM, Cache, Math Co-processor*

*- **STORAGE**: Tape, Hard disks, Diskettes, CD ROM, RAM.*

*- **OUTPUT**: Printer (Terminal, Laser, Dot Matrix), Plotter (Pen, Ink-jet, Electrostatic), Video, Display, Sound*

Some other terms are:

- ***CAD**: Computer Aided Drafting or Computer Aided Design*
- ***CAAD**: Computer Aided Architectural Design*
- ***CADD**: Computer Aided Design and Drafting*
- ***BIT**: The smallest "on/off" measurement of data. Eg. the amount of data that can be processed simultaneously (8 bits, 16 bits, 32 bits).*
- ***BYTE**: One character, letter or number, representing eight bits of information.*
- ***CPU**: Central Processing Unit. The brains of the machine.*
- ***KB/MB**: Memory capacity is usually stated in the thousands, Kilobytes, and also often stated as Megabytes (millions). (Kilobyte means 1024 bytes but is sometimes rounded to a thousand in general usage).*
- ***MICROPROCESSOR**: "chip" Central Processing Unit. Identified by manufacturer's numbers: 280, 6502, 8088, 68000.*
- ***MIPS**: Millions of Instructions per second; a crude speed bench mark*
- ***MFLOPS**: Millions of floating point operations per second; a measure of the CPU's performance*
- ***HARDWARE**: Input, storage, processing and output equipment.*
- ***APPLICATION SOFTWARE**: Programs for specific tasks such as word processing.*

- ***OPERATING SYSTEM:*** *Internal instructions that operate the equipment. CPM, MS-DOS, UNIX. Operating systems determine the compatibility of software.*

- ***RAM****: Random Access Memory.*

- ***ROM****: Read Only Memory. Built in memory; non-programmable*

- ***PORTS****: A pin connector to hook up peripheral equipment. (RS-232-C and SCSI are industry standards for port connectors.)*

- ***PROGRAMMING LANGUAGES****: Basic, C, Pascal, Cobol, Fortran.*

- ***NETWORKING****: To access common data. 1) cable connecting two or more computers, allows one computer to access the files on another. 2) several computers cabled to a central computer that deliver file to any user.*

- ***FILE TRANSFER****: 1) through an electronic hookup, 2) by saving and transferring data disks.*

ii. Hardware choices:

Choices of hardware for architectural firms are limited to Workstations and Personal Computers (PCs). You can also consider the purchase of Portable (lap top) computers for some applications out of your office.

Workstations: *"Hewlett Packard, Intergraph, IBM, DEC, SGI, Sun Microsystems and NeXT".*
- high performance computers which use UNIX operating system
- multi-user/multi-tasking
- high-speed math/graphic
- network ready.

Personal Computers (PC):
"Apple, IBM, IBM compatible".
- one user at a time
- stand alone
- networkable.

Portable: *"Apple, IBM".*
- battery operated,
- less powerful than desk tops
- not a primary work machine.

In evaluating different hardware, make sure it will actually run the software you need (software selection section 2.2.1). It is important to verify the claims of sales people by trying them out on a task that you will use it for. Be aware also that your needs will grow as you become familiar with the system and plan for this growth. It is clearly important that in your evaluation you include maintenance (Is a service centre available? What are the costs? What if your machine goes down at a critical point? Can you get a repair or replacement within 24 hours? Or should you have a back up machine?).

When comparing the cost of different systems, examine what you get for the quoted price, and compare systems with similar capabilities. You do not want the speed of the system to slow you and your thinking/creating process. Therefore you should shop for a system that can respond to your near future requirements as well as your initial expectations. It is also important to evaluate the graphic capabilities which are critical for CAD and CADD applications, and the Networking capabilities which provide the possibility of high speed communication between computers for file sharing, back ups and shared printing plotter.

iii) Determine your computer and work station requirement

- Number of required stations will be affected by:

. Type and number of applications to be computerized

. Number of hours each application will use computers

. Physical layout and size of your office, and

. Basic work flow in your office.

One method to determine the rough number of required work stations is presented by MEDICI II (this method clearly provides an approximate estimate and not the exact number):

To determine your current computer needs estimate computer time you require to deliver current work functions:

- For office business, management, administrative tasks, assume 25% of current hours required.

- For technical task (engineering calculation, specification writing, schedules) : assume 50% of current hours required.

- For graphic production tasks: assume 75% of current hours required.

- Include any office tasks which are already computerized: 100% of current hours required.

- Estimate non-productive system hours for learning, experimentations and system down-time.

Add approximately 25% to total time that system will be in use.

iv. Select your supplier

In choosing your supplier you should examine:

. Their business record

. Their reputation (check with other architectural firms)

. Their financing terms

. The support and maintenance they offer, and

. The possibility of working with them in the long term.

Most importantly, compare and negotiate the rates and terms of different vendors. Computer business is a very competitive market and there is room to negotiate discount, terms of contracts, additional support and/or accessories on your deal, and maintenance contracts such as repair, replacement, and unusual conditions of use (e.g. night, weekends).

2.3 Financial Planning

The true cost of computerization is not limited to hardware and software. Hardware package prices generally include a terminal with a very minimal amount of memory and no means of getting hard-copy output. There are also some indirect expenses that determine the true cost of computerization. In addition, there are some ongoing expenses associated with the use and upgrading of computers that should be included in financial planning.

Typical expenses determining the true cost of computerization are:

A. Research and Development Costs:

Initial and ongoing:
- In-house
- Consultants.

B. Capital Costs:

* ***Hardware Costs:***

- *Display monitor*
- *Central processing unit*
- *Additional memory*
- *Keyboard*
- *Disk*
- *Printer, Plotter*
- *Modem*
- *Additional function boards*

* ***Software Costs:***

- *Application software*
- *Programming*
- *Standardization*

* ***Accessory Costs:***

- *Anti-static mats/rugs*
- *Dust covers*
- *Furniture (desks; seating; storage for documentation, disks and paper; etc.)*
- *Other*

* ***Renovation Cost:***

- *If necessary, to renovate the office to accommodate the space requirements*

* ***Financing Costs:***

- *Loan*
- *Lease*

* ***Installation Costs:***

- *Delivery*
- *Set-up, testing*
- *Electrical*
- *HVAC*

* ***Training Costs:***

- *Course/seminars*
- *Tutorials/training programs/tapes*
- *Magazines, books, etc.*

C. Operating Costs:

* ***Power***

* ***Supplies (paper, disks, etc.)***

* ***Maintenance Costs:***
- *Hardware*
- *Software*

2.3.1 Explore different sources of financing the system cost

Some of the ways cost can be financed are through available cash, proceedings of projects, loans, and Grants.

2.3.2 Develop methods of cost amortization

Different methods could be considered for cost amortization. Examples are:

. Billing clients based on hourly use of the system

. Charging the system use as part of overhead

. Considering an additional fee for those projects requiring computer use

. Charging the system costs for tax exemptions

2.4 Implementation

Your management attitude is critical to the success of computer technology in your practice. Advance planning will reduce unexpected problems and increase the effectiveness of system use. You should realize that:

. The nature of business may change somewhat, becoming e.g. less labour intensive and more capital intensive

. People are still the key to productivity

. Products the firm sells will stay the same

- You should examine and question the existing patterns
- Question change objectively
- You should be receptive to evaluate proposed changes
- You should be committed to reasonable changes
- You should look for opportunity with change
- You should keep a realistic view of change
- Stress in the work place may be created and you should develop methods to reduce it.

To reduce the problems associated with change and increase the benefits of change, you should:

- Establish goals for the system based on your business
- Develop and follow a management plan
- Establish a strategy for the process of introducing and using computers in the office, by scheduling the process, determining the true capital investment to be spent, and allocating the responsibilities
- Get your staff to understand and support what you are doing
- Exchange ideas with your staff
- Consider outside input, such as consultants, other professionals, clients, building officials, and contractors
- Encourage experimentation
- Monitor the process, which includes reviewing the results considering intangible results such as faster turnaround, useful by-product, and employee responses; encouraging improvements,

and supporting the efforts

- Plan for new requirements in advance
- Establish and follow a clear office, system and information management policy

In your planning process you should consider space design, staffing requirements, training, use of existing information, and installation.

2.4.1 Space Design

Prior to purchase of system, suitable work space should be designed and prepared. Space design should provide designated space for:

- equipment: computer, disk drive, screen, keyboard, printer
- Additional accessories: wires, cables, proper electronic power
- Paper
- Disk storage: current and previous electronic information
- Software storage
- Current and previous hard copies
- Back ups (in the office and out of the office)
- Manual and references
- Different incoming and outgoing memos and notes
- Room to post reminders (saving and back up procedures);
- Room to post notes
- Visual attraction to relax eyes from constant looking at computer monitor.

The main considerations are:

- Availability of required physical space
- Position of user to the input devices and display
- Lighting
- Noise
- Ergonomic office furniture, and
- Flexibility to accommodate further changes.

2.4.2 Staffing

'Good staff' are the key to effective use of your system. Although the number of people copying, tracing and performing repetitive tasks will reduce, qualified personnel are needed to operate your system. You can therefore, either train present staff or recruit new staff already familiar with computer use (preferably your system).

There are some benefits in recruiting qualified staff for computer use, in that you will save time and cost of training, the new staff will provide training and trouble-shooting services for others, and it makes your system operational soon after installation.

2.4.3 Training

Initial training plays an important role in reducing the 'fear' of computer technology, increasing the desire to use your system and, most importantly, reducing time for making the system operational.

Soon after it is decided that computerization is a suitable choice for your practice, initial training should take place to introduce your staff to the basics of computer technology, the advantages of computerization for architectural firms, and the benefits of computer use for the individuals and for your practice.

Once your system is selected you can initiate targeted training programs for your staff. Training should teach the system to the staff, and target its use to the firm's requirements. Different sources of training will be:

. Presentation by supplier

. Outside courses

. In-house courses

. Manuals and computer literature

Learning time can be affected both by individuals' attitudes, and the environment in which individuals perform. To decrease the learning time:

. Plan a campaign to reduce the fear of automation;

. Keep staff informed, and welcome their input

. Emphasize benefits of computers primarily for individuals, and then for the firm

. Plan the teaching sessions short

. Use office policy as a guide and not an order

. Provide a variety of possibilities for staff's interaction with the system (hands on approach is very effective)

. Be open and not judgmental to hear and understand staff's problems.

However, you should not tolerate staff who resist learning and using computers and sabotage your effort. If they are key staff and valuable to your firm, they can perform in traditional ways without using computers. Otherwise, they should be replaced as soon as possible to reduce the training cost and diminish the development of negative attitudes toward system use in the practice.

2.4.4 Use of Existing Data

Previous projects and information will be useful in future. You should select those that should be transferred to electronic format and those which can be used as they are (hard copy). In both cases the filing and access to information is critical, therefore, the previous filing system should be reevaluated and re-organized if necessary.

2.4.5 Installation

To reduce the installation and initial set up time, you will rely to some extent on your supplier's support. Make sure your supplier is performing according to his responsibilities and time commitments. A proper preparation prior to installation will speed this process (check the requirement with your supplier).

3. Ongoing System Use

For an effective ongoing system use you should:

- Plan a step-by-step process within the framework and objectives of your practice, where you develop clear office policies, and establish consistent patterns for work functions
- Anticipate new problems, errors and unexpected situations
- Plan problem solving procedures, and provide an ongoing source of trouble-shooting
- Establish a process for overlapping the old and new procedures

3.1 System and Office Management

One individual should be in charge of system management. All computer related issues should be communicated to the system manager and related to the appropriate sources through him/her. The system manager should coordinate:

- The development of new work procedures
- The design and development of standardization
- The process of change and overlapping procedures
- Problem solving procedures
- The security of information
- The ongoing educational and training programs
- The efficient use of the system (schedule, capabilities)
- The development and use of the evaluation methods

  (quality, efficiency, effectiveness and economy)

- The maintenance of system and information
- Scheduling the system use
- Evaluate the growth requirements and time.

3.2 Human Resources Management

Psychological matters are one of the most important considerations in management of personnel. These issues should receive considerable attention, to promote interest, dedication and job satisfaction among the staff. Typical problems are:

- Resistance of staff to new technology and new work requirements
- Dissatisfaction from the professional status quo (eg. architects functioning as system operators)
- The slow learning curve
- Fatigue due to system use
- Intensity of work
- Social conflicts among system users and non-users

Most of the human issues can be addressed, solved or reduced by:

- Involving your staff especially the key members of the firm in the process of computerization from the early stages
- Explaining the reasons for adopting technology, and potential problems/solutions to the employees
- Having a proper initial and ongoing training program in place

- Trying to remove the bugs and problems of system use as soon as they are identified
- Developing clear work procedures
- Developing clear job specifications
- Using the right people for the right tasks
- Dedicating responsibilities with clear expectations
- Responding to your employees problems and needs
- Valuing your staff
- Expecting the staff to learn and use the system

3.3 Office Procedures:

You should develop and implement clear office procedures. These procedures should be flexible and modified on an ongoing basis, and should include a chain of command in the practice, sources of information, and sources of problem solving. They should address work procedures, standardization, information management and security.

3.3.1 Work Procedures

A large portion of office procedures are repetitious (necessary or unnecessary). To reduce problems and errors, you need to develop clear work procedures, by establishing clear and unified patterns for performing tasks (such as backup), and eliminating repetitions and unnecessary tasks.

3.3.2 Standardization

Your practice is already performing most or all of a computer's capabilities in traditional ways: Typewriter, calculator, file cabinets, phone, memory etc. What the computer introduces are new methods, and it is up to you to develop new work functions.

The concept of 're-usable' work/data is **the key** to increased productivity. It is important to realise that hardware and software are designed to reuse data. Therefore the user must operate the system to increase the reusability of effort and reduce the repetitive tasks.

There are many forms of repetitive work in an architectural firm:

- Repetition within the industry: code checks, specification, numbering systems, government forms and standards etc.
- Repetition within an office: Transmittal letters, change orders, Memos, field reports, agendas, contracts, proposals, invoices, time sheets, pay checks, etc.
- Repetition from job to job: General notes, consultants lists, titles, specification sections, schedules, etc.
- Repetition within a job: Names, addresses, project directory etc.

Standardization provides easy access to available information, and increases the 're-usability' of this information. For example, in using a word processor, many standard letters and documents can be saved, customized, and used for different purposes. They can be modified more quickly and easily than with conventional tools. Other examples are saving the

standard details, labels, logos, layers etc. in CAD, which, with easy and fast modification can be used for different drawings or projects.

3.3.3 Information Management:

When using computers, different kinds of errors and problems may occur:

1. Sometimes it is harder to identify input errors on the screen than on paper, and proof reading hard copy is necessary.
2. A disk may occasionally crash.
3. The user may loose the sight of the whole project while concentrating on the parts. As using computers sometimes requires more accurate information, the user may loose the sight of the importance of a part of design, as opposed to the whole project. For example, at the early stage of conceptual design, a user might concentrate on the details of a door rather than the layout of the building.
4. Different people have access to information, and may manipulate data by accident.
5. Access to information sometimes becomes difficult and sometimes even impossible.

You need to establish clear methods for storing information, and accessing and retrieving information.

i) Storage of information

a) A rational storage system:

1. You should build your own reusable information data base to be able to use them in

long term, and

2. The storage system should accommodate a rational and easy search and retrieve existing information and established patterns.

Data management (hard data and electronic data) is a very basic, fundamental and vital step in work procedure development. You should organize your data files carefully to avoid confusion, difficulties in accessing data, loss of information or unnecessary duplications.

In doing so you should consider the data that is common in different stages of a project, in different projects or for other purposes, such as, contract documents, and build up a data base of this information for future use. Your storage system should be designed in a way that makes sense and is clear to users.

b) A 'separation-template- assembly' system

1. Separation: distinguish unique data from standard patterns.
   - Unique data-'job specific' active information: this is the information that is used specifically for certain projects.
   - Standard patterns- 'task specific' passive information: this information could be used in different projects (eg. firm's logo, details of door)
2. Template: create job specific elements, such as overlay standard patterns with unique data (combine the project information with these general information that you wish to use from existing patterns).

3. Assembly: compile completed work function. Combine layers of unique and standard patterns.

ii) Access to information:

In accessing information, a standardized storage system accommodates easy access to information. When storage of the information follows a clear pattern, confusion is reduced and file names and locations are clear to users. There should however, be control (eg. by having password for individuals) of sensitive data so it doesn't get damaged or misused. The access plan must maintain enough flexibility to allow work to be done, so that your data is protected but access to information is available for those who need it.

3.3.4 Security

Security exists to protect your system (hardware and software) and the data and programs you have generated. In order to protect your system, you should have one person in charge, develop clear procedure for system maintenance, and schedule the access demand. It is important however, to encourage entire staff to use the system, as the hardware and software are only tools. To protect your data, you should develop a storage system that back up all of your work, and use active and archive files (duplicated 'off-site' in case of fire).

3.4 Ongoing Educational Programs

Ongoing educational programs are essential for your practice. Some sources are:

. Suppliers

- Continuing education courses (UBC, BCIT, VCC)
- User groups (for exchange of information)
- Schools of architecture
- Technical schools (BCIT, Capilano College, VCC)
- In-house customized training programs.

In addition to the initial and ongoing training, existence of following will improve the results of educational programs:

- An in-house trouble shooter and access to an external problem solver in access
- Manuals and references
- An evaluation method to examine different methods of training and their effectiveness
- Methods for improving the efficiency of system use.

4. Evaluation

Ongoing evaluation will help identify and remove problems and increase the effectiveness of computerization. It will:

- Recognize and reevaluate your computer objectives
- Establish a quantitative method for evaluating individual and firm productivity (prior to and after computerization)
- Consider evaluation for improvement, and not for control of staff and financial resources
- Evaluate individual productivity in different tasks and in different situations
- Evaluate system productivity for different applications and performed by different individuals

. Correct the problems as soon as they are identified.

5. Expansion

The desire for change should not be confused with the need for expansion. While market oriented changes are regularly taking place in computer products, your system will always do the task it can do now. However, if your system is not responding to your requirements, you should consider improvement or replacement as soon as possible.

The need for expansion may be caused by:

. A requirement for more computer stations

. The need to increase the number and type of computerized applications, or

. An increase in the range of the current services.

In planning for expansion, you should base your decision on both your current requirements; the need to purchase a new equipment and/or application software which is compatible with your present system; and your anticipated requirements for further expansion. To do so it is necessary to repeat the requirement study once again.

6. Making Your System Profitable

The most important benefit of computerization in your practice should be on increase in profitability through an increase in revenue, as opposed to a reduction in expenses. This can be achieved by

improving productivity, increasing the number of projects, or increasing the range of current services.

6.1 Improving Productivity:

Productivity increase is the result of individual and firm productivity improvement. To evaluate and improve productivity, you should:

- Use computers for those tasks that benefit most from computerization
- Allocate the right people to use computers
- Establish a quantitative measure for evaluating the productivity of individuals in different tasks
- Identify the problems reducing the productivity of individual and practice
- Solve the problems as soon as they are identified
- Recognize and appreciate any improvement in productivity.

6.2 Increasing the Number of Projects

You can increase your market share by capturing new clients, holding on to present clients, and recapturing the previous clients.

In introducing your practice's computerized capabilities, emphasize the benefits of computer use to your clients, benefits such as:

- The improvement in the quality of information
- The possibility of interactive design with the client
- The availability of the past data

- The availability of the project's data for their future use in facility management
- The reduced time for working drawing production
- The reduced fee for the production stage
- More time available to design or construction phase for the existing fee
- More accurate estimating
- The increased quality control for construction due to accuracy of construction documents
- The improved coordination at construction stage
- The reduced time for construction due to reduced errors and omissions, and the development of grids and plans in early stages making the fast tracking possible
- The reduced cost of construction due to reduced errors, omissions and conflicts
- The flexibility and speed of changes
- The increase in the quality of services and finished products
- The possibility of providing more presentation material in less time
- The provision of promotional material

6.3 Increasing the Range of Current Services

An effective method of increasing your revenue is to explore and evaluate the potential of increasing the range of your current services.

In addition to traditional architectural services, firms could consider such services as:

- Building evaluation
- Facility requirement studies

- Feasibility studies
- Programming
- Project management
- Construction management
- Facility management
- Special services such as energy analysis
- Consulting services to other architects
- Computerized services to other architects.