IMPLEMENTING AN INTEGRATED MANAGEMENT INFORMATION SYSTEM IN A MEDIUM SIZED CONSTRUCTION FIRM

SONIA BLAZA

A thesis submitted in partial fulfilment of the
requirements of
Sheffield Hallam University
for the degree of Master of Philosophy

OCTOBER 1995

School of Construction, Sheffield Hallam University
in collaboration with Weaver Construction Limited.

ABSTRACT

Implementing An Integrated Management Information System In A Medium Sized Construction Firm

Sonia Blaza

This thesis describes a Teaching Company Scheme Project between Weaver Construction Ltd and Sheffield Hallam University (formerly Sheffield City Polytechnic) to implement an Integrated Management Information System (MIS) in a medium sized construction firm.

The construction industry is considered and the particular problems it has to face with respect to applying Information Technology (IT) during the construction process.

Methodologies used to implement computer based information systems in organisations are considered together with the development of an appropriate implementation model for Weaver Construction Limited. The model developed uses the traditional software systems life cycle as a framework, within which, other development tools are used.

An initial investigation revealed that the level of information technology awareness within the company was extremely low. In order to address this problem pilot Schemes were introduced whereby stand-alone systems were developed for several functional areas. These served the purpose of increasing the level of IT awareness within the company and also acted as a catalyst for the design of an integrated MIS, incorporating the standalone systems. The reasons behind partial integration as opposed to a fully integrated system are examined. The integrated MIS was never realised, and only partial integration was achieved.

The reasons behind partial integration are examined in a post implementation review. A critical and analytical evaluation is provided of the implementation methodology used and a revised model is proposed. Whilst it is acknowledged that this may not be entirely appropriate for every medium sized construction firm, the research highlights many important areas which must be addressed by companies wishing to successfully implement integrated systems.

ACKNOWLEDGEMENTS

I would like to thank my two research supervisors, Dr. Paul Stephenson and Mr. Ken Elliott who provided me with their expert help and advice without which this project could not have been completed. My thanks also goes to the staff of Weaver Construction Limited and the Teaching Company Directorate who also supported the project.

CONTENTS

CHAPTER 3 IMPLEMENTING TECHNOLOGICAL CHANGE IN ORGANISATIONS

CHAPTER 4 SYSTEMS ANALYSIS AND PROBLEM IDENTIFICATION OF THE COMPANY

CHAPTER 6 POST IMPLEMENTATION REVIEW: DATA COLLECTION AND ANALYSIS

CHAPTER 7 DEVELOPMENT OF A NEW IMPLEMENTATION MODEL

CHAPTER 8 CONCLUSIONS

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The integration of construction processes using Information Technology offers considerable potential for construction firms as they meet the challenges of the 1990s. To date this potential has not been widely exploited. Most construction firms operate standalone computers which are usually dedicated to a particular business function with little integration between departments.

The benefits of integration have long been realised in other industries, particularly manufacturing, and much has been published which discusses the opportunities offered by technologies such as Computer Integrated Manufacturing. However, despite the promises offered by technology, the literature(1)(2) also suggests that there are a number of significant implementation problems which restrict the ability of firms to exploit the full potential of the integrated manufacturing technology. The implementation process is essentially multi-faceted and includes technical, business and organisational aspects. Both the technical and business dimensions are well documented. The organisational dimension, however, is the least documented and is something that is perceived as an interference and is usually dealt with after the system has been installed. It is in fact the lack of attention to this organisational dimension that has been the dominating factor in poor implementation of integrated systems that do not realise the goals they originally set out to achieve.

It can be suspected that there will be some degree of commonality between the problems of implementing integrated systems experienced within different industries. If this is so, it would seem both sensible and appropriate to apply the experience of other industries to the construction industry, instead of wasting valuable time trying to re-invent the wheel.

1.2 AIMS AND OBJECTIVES

The aims of this thesis are to investigate the organisational problems associated with implementing an integrated Management Information System (MIS) in a medium sized construction firm and identify the elements of a successful implementation methodology.

In achieving these aims, a number of objectives can be identified :

(i) To investigate the structure and operation of the construction industry and its current use of information technology.

(ii) To examine methodologies used in the implementation of information systems and select the most appropriate to the problem at hand.

(iii) To apply the selected methodology in the implementation of an integrated management information system within a construction organisation.

(iv) To conduct a post implementation review in order to determine attitudes towards computerisation in the company and highlight problems in the implementation.

(v) To critically evaluate the methodology in order to determine its strengths and weaknesses.

(vi) To establish a model which can be used for the successful implementation of an integrated management information system into medium sized construction firms.

1.3 RESEARCH METHODOLOGY

In order to achieve the aims and objectives of the research, Weaver Construction, a medium sized construction firm was used as a case study for the research. The bulk of the research was carried out in the time period between December 1989 and June 1991.

This section outlines the methods used in collecting and collating relevant information used in the investigation and production of a system implementation model.

1.3.1 Literature Search

The literature search provided an insight into the 'state of the art' regarding computing in the Construction Industry and also provided a better understanding of the construction process within a typical construction organisation. Information was also collected from Weaver Construction such as company brochures and marketing information in order to appreciate the management structure, the products of the company and market within which trading took place.

1.3.2 Structured Systems Analysis of the firm

Once the background knowledge had been acquired and the boundary of the research was established with senior management it was possible to specify a domain of work thus ensuring that relevant and appropriate information was collected. The most appropriate method for collecting this information was structured interviewing. Information gathering using this technique was used at two points during the research. Firstly in conducting a structured systems analysis of the firm and secondly in the post implementation review.

Company staff from all levels of the organisation were interviewed in order to collect data regarding the business processes of the company. Structured Systems Analysis, by

Gane and Sarson (3) was used to produce a model of the organisation as a business system consisting of data flows, data stores, processes and external entities.

1.3.3 Design and Implementation

The model developed from the Structured Systems Analysis was used as a basis for problem identification. Many of the business processes lent themselves to improvement with the application of IT. Several of these processes were computerised in a pilot study. Following this an integrated database was designed to fully incorporate the pilot systems and all other business activities in the company. This formed the framework for further systems development.

1.3.4 Post Implementation Review

Following the implementation of the new information system a post implementation review was conducted in order to determine staff attitudes to computerisation and assess the success of the implementation process.

Two techniques, that of structured interviews and observation were used to collect the required information. The responses from the interviews were analysed in order to draw conclusions regarding the effectiveness of the new information systems. The analysis also provided the recommendations made for revisions to the implementation model.

1.4 STRUCTURE OF THESIS

Chapter 2 of the thesis provides an insight into the Construction Industry in Great Britain with regards to its products and structure. Computers in the Construction Industry are also examined together with the reasons for the industry having been reluctant to accept the new technology. It is shown how these barriers have with recent developments been removed and the necessity for construction companies to exploit this technology particularly through the integration of their business activities in order to achieve a competitive edge and to maintain profitable positions in both national and international markets.

Chapter 3 examines current methodologies used in the implementation of information systems. A methodology is devised for use in the case study company. This methodology uses the Software Development Life Cycle as a basic framework and incorporates ideas and tools from other methodologies.

Chapters 4 and 5 give an account of the stages of systems implementation at Weaver Construction. Included are details of the initial analysis and pilot schemes introduced into the company. The design of the integrated system is discussed and the subsequent implementation of a partially integrated system. Related implementation issues such as staff training, conversion procedures and the post implementation review are also highlighted.

Chapter 6 focuses on the examination of the implementation problems which were mostly related to staff attitudes. An attitude measuring instrument is developed, application of which provides useful data for a detailed analysis of implementation problems.

Chapter 7 uses the results provided in the previous chapter to provide a critique of the implementation methodology and recommend extensions in order to overcome the identified problems. Thus the model developed as a result of this investigation should be of assistance and guidance to construction firms who are considering the introduction of an integrated MIS into their company.

Chapter 8 highlights a number of areas important in the management of the organisational dimension of implementing an integrated MIS and the need for these items to be taken into consideration is emphasised.

CHAPTER 2

THE CONSTRUCTION INDUSTRY

2.1 INTRODUCTION

Today's construction projects are becoming increasingly dependent on new innovation with regard to the methods of construction and the use of efficient communication systems. Projects are constrained by time, quality and cost. The people involved in the construction process therefore need the best possible assistance to enable them to complete projects within these constraints whilst at the same time achieving the objectives of their organisation. Whatever form a construction company takes, it is likely to have the following objectives in common with other organisations(1) :

(i) to provide a fair return to shareholders;

(ii) to satisfy clients' requirements;

(iii) to utilise resources efficiently;

(iv) to improve the company's position in its markets;

(v) to develop products which can be sold profitably.

In order to examine how computer technology can be used as a strategy to achieving these objectives, it is first necessary to consider construction in Britain today and the problems facing the industry.

2.2 THE CONSTRUCTION INDUSTRY IN BRITAIN

In Britain, buildings are one of the nation's most important assets. In 1989 they were estimated to be worth £1,160bn in comparison with civil engineering assets which were estimated to be worth only £31bn. Buildings account for nearly 90% of the nation's wealth and the construction industry's output amounts to over 10% of gross domestic product in Britain. In 1989, £52.5bn was invested in building works. Approximately one million people are employed in the industry (including apprentices) which accounts for approximately 4.5% of the employed labour force.(2)

The Construction Industry covers a wide range of loosely integrated groups and organisations and comprises a large number of small firms and a small number of large ones. In 1989 there were nearly 219,000 legal units involved in construction work which generally includes the production, renewal, alteration, repair and maintenance of capital goods such as factories and domestic dwellings, social type buildings, together with civil engineering works. These goods are produced by combining land with a variety of raw materials and semi-processed components.(3) The end products being used for direct consumption by the private and public sectors. There are several characteristics displayed by the Construction Industry which make it unique in comparison with any other Industry.

These characteristics fall into four major groups:(4)

(i) The Physical nature of the product;

(ii) The structure of the Industry, together with the organisation of the construction process;

(iii) The determinants of demand;

(iv) The method of price determination;

These groupings can be described as follows :

(i) The Product

The construction product is large, immobile and expensive. The value is usually high in comparison to the income of the purchaser. It is usually built to customer requirements, making it difficult to alter and allowing little scope to develop mass production techniques. The Product has a long life, hence existing stocks of buildings are large and a high percentage of construction output is in maintenance and repairs.

(ii) The Industry

The Construction Industry embraces a number of parties to a contract. These include the architect who designs the product; the building contractor who offers a service in consulting and managing projects; the builder's merchant who distributes materials; and the small jobbing builder who confines activities to repair and maintenance work. Table 2A analyses the distribution of employees in relationship to size of firms. The largest number of employees in the industry are with small firms employing seven or fewer people. Medium sized firms employing between 115 to 599 people account for only 0.34% of firms yet are responsible for some 20% of the output of the industry.

Number of Employees (£m)	Number of Firms (m)	%	Work Done	%
1 - 7	186,391	92.70	2,432.40	24.74
8 - 24	10,081	5.01	1,204.20	12.25
25 - 114	3,807	1.90	1,947.50	19.80
115 - 599	683	0.34	1,890.10	19.22
600 - 1,200	114	0.05	2,359.40	23.99
Total	201,076	100.00	9,833.70	100.00

Source: Housing and Construction Statistics, 1991

TABLE 2A ANALYSIS OF PRIVATE CONTRACTING FIRMS AND OUTPUT FIGURES THIRD QUARTER 1989

Within the building process, members of different professions, such as the architect, the quantity surveyor, the structural engineer and the service engineer are brought together to form a complementary team to design the project. It is usual that after the design stage, the contractor is appointed. These teams are generally temporary arrangements. Once the project is complete, the various teams are disbanded and the experience and efficiencies gained are often lost.

Adversarial attitudes between parties to a contract are also common within the construction industry. In a recent government review of the industry(5), Sir Michael Latham proposes the development of better relations through partnering or partnership arrangements and suggests that the contract document is adapted to place emphasis on teamwork and partnership.

(iii) Demand

The demand for construction work has four distinct categories. These can be identified as :

- housing
- industrial and commercial buildings
- social buildings including, schools and churches
- infrastructure

The Government, either central or local, is a major client of the construction industry and has a major influence on the demand for work. This tends to be mostly in the public sector but the government also indirectly affects demand in the private sector. To maintain an equilibrium between demand and supply for goods and services, the government adopts a combination of monetary and fiscal policies in order to control inflation and unemployment. This often results in fluctuations in demand according to the state of the economy with the consequent effects on the construction industry.[6] Construction activity is cyclical and the output of the industry closely follows the growth pattern of the gross domestic product. Table 2B the construction industry output, shows a large increase over the period from 1985 to 1989, in which time a boom was experienced. Output has subsequently fallen as the industry is now suffering from depressed demand.

For construction firms, the fluctuations in demand causes variations which may affect all parts of the organisation. In times of inadequate demand there may be reduced earnings or a reduction in the work force. This may also have the effect of reduced profitability and possible bankruptcy. In times of excess demand, there will be a shortage of labour and materials, loss of competition and a decrease in standards due to hastily completed work. Consequently, both reduced and excess demand can affect construction firms considerably.

	1985	1986	1987	1988	1989
Output of the Construction Industry	27,850	30,123	34,580	40,546	46,174
GDP (£m)	325,266	356,216	382,947	420,617	468,208
Output as Percentage of the GDP	8.56	8.46	9.03	9.64	9.86

Source: Economic Trends, March 1991

TABLE 2B THE OUTPUT OF THE CONSTRUCTION INDUSTRY AND GDP 1985 - 1989

Latham[7] in his construction industry review proposes a productivity target of 30% real cost reduction by the year 2000 and recommends that government should establish benchmarking arrangements to provide pressure for continuous improvements in performance.

v) Price Determination

Because of the nature of the product, the structure of the industry and the characteristics of demand, the industry fixes its prices largely by competitive tender for each contract. This may take the form of open, selective and negotiated tendering. In each case a price is established prior to the finished product which may not always reflect the true cost of construction.

The pattern of demand and supply tends to make the construction industry fragmented, labour intensive and an irregular employer. This results in relatively little investment in new technology as the benefits of economies of scale cannot be fully realised. With the advent of information systems it may be possible to harness some of the wasted vitality.

2.3 DEVELOPMENT OF COMPUTERS IN THE CONSTRUCTION INDUSTRY

Whilst the characteristics identified do present problems for the construction industry,

there are commonalities that relate to all companies. In all construction organisations certain processes have to be carried out. Such processes relate to estimating, planning and control. Initially all projects have to be priced as accurately as possible. Once a tender has been won, correct planning procedures have to be adopted so that building operations can take place and production and cost control procedures can be effectively introduced. This allows variations from the planned programme to be identified and remedial action taken where necessary, thus facilitating projects to be completed on time to the required quality and cost. It is these common processes where information technology can offer assistance and where systems development can take place to ensure the efficient generation of management information.
Despite the problematic characteristics of the industry, computers have been used in construction to provide information at the various stages of the construction process. The Construction Industry was amongst the first users of computers. Structural engineers used them in the nineteen forties as aid in analysis. However, to date construction is not an industry which has readily adopted and exploited computer technology in comparison with other industries. With the few exceptions of mostly larger firms, the industry has been slow to embrace the new technologies and available software and still relies heavily on traditional methods.

The structure of the industry itself and its peculiarities in comparison with other industries have been used to explain why there has been a reluctance to accept the new technology. In the recent past:

(i) Small firms, employing less than 25 people, found it difficult to justify the relatively large expenditure involved in purchasing a computer system. Specialist staff were also required to operate, maintain and program computer systems.

(ii) Site conditions were not suited to the protective, clean environment required for the then traditional computer equipment. The size of the computer also presented problems of finding suitable housing other than head office.

(iii) The large number of different types of construction firms each have differing requirements, has inhibited standardisation and formation of a large market for a specific application.

Other factors may have contributed to the reluctance of smaller firms to purchase equipment, however, the three major reasons can be defined as :

- cost
- portability
- availability of software

Although the industry's structure remains the same, advancements have been made in technology which have changed the face of computing beyond all recognition. The most significant advancements are :

(i) The development of microelectronics and the integrated circuit. This has brought great reductions in terms of the size of the computer. The emergence of the personal portable computer has provided a tool, tolerant of harsh conditions and which can be easily transported from site to site. Communication links can also quickly be established via modems and telephone lines, to head office.

(ii) An increase in software availability for the PC user in the construction industry.

(iii) The dramatic fall in costs of computer hardware. This has made computers more widely available to all and has also brought a boom in the home computer market, providing an increased awareness of computers and their capabilities.

(iv) The development of 4th generation languages and software development environments. This has greatly simplified programming, removing the need for specialist staff to maintain and program a conventional computer.

(v) The use of open systems. This enables programs and data to be transferred between computers with different processors thereby facilitating integration of different systems.

Today, technology is not a limitation and the construction industry can no longer use the arguments of it being different from other industries as an excuse not to exploit the new technology. The barriers which may have been real or imagined have been removed. The firms within the construction industry cannot afford to ignore IT if they are to remain competitive and survive in international markets.

2.4 USE OF COMPUTER SYSTEMS IN THE CONSTRUCTION INDUSTRY

The role of the contractor in the construction process, irrespective of the size of the company, is to provide and manage the resources necessary to produce the required goods. For the contractor the areas in which a computer is useful are :

- Estimating
- Planning
- Purchasing
- Surveying
- Accounting
- Administration and office automation

Table 2C shows the use of computer software by contractors. The table indicates that computers are used extensively for accounting and contract costing. About 45% of contractors have computer systems for buying and order processing, and estimating and valuations software have shown an increased usage over the past three years. Storage, retrieval and management of documents is problematic given the vast amount of data associated with a construction project, yet with only 35% of contractors are using document management systems.

Application	Approximate Percentage of available users
Word processing	97
Electronic publishing	39
Document management	36
Image processing	10
Spreadsheets	91
Databases	66
Management info sys	42
Project management	66
Accounting	94
Property management	15
Asset management	35
Contract costing	90
Buying/order processing	45
Estimating	79
Valuations	66
Plant management	49
CAD/Drafting	30

Source : Building IT for Quality, CICA & KPMG Peat Marwick

TABLE 2C Computer Software : Contractors

Investments have generally focused on providing IT support for specific activities within the construction process. Integration of various functions through electronic sharing and communication of information is not widespread at present, and is a major area of opportunity.(8) The next section will take a closer look at the actual applications available to the contractor.

2.4.1 Applications for the contractor

On examining the CICA software list[9] and the Software Guides in Construction Computing[10] one can see the wide range of software that is currently available for the contractor.

For the contractor the starting point in the construction process involves the estimating function where the contractor receives the contract documents in order to produce an estimate of how much the contract will cost to complete. The pricing of bills may be carried out using a computerised estimating system. A bill of quantities can be scanned into the computer and priced using a computerised library of price details for each item of work. Once the contractor has produced a tender the priced bill will be returned to the quantity surveyor.

With the advent of open systems it is also possible for the client to send a disk containing the bill of quantities for direct input into the contractor's computer for pricing. This facility, however, has not been widely exploited. Some software developers are now producing estimating systems which can interact with other of their systems such as Valuations and Job Costing systems.

The planning function is a vital part of the construction process in order to complete a job within a certain time period. It is necessary before the start of a job and also during the construction stage so that potential problems may be identified. The most common techniques used by computer systems to relate activities by time is network analysis using the critical path method (CPM) or the project evaluation and review technique (PERT). Most planning packages are capable of producing high quality graphical outputs in a number of formats which the user may select to satisfy their requirements.

Systems for purchasing are limited and typically include facilities which allow the contractor to produce orders, check deliveries and invoices and monitor how much money is being spent in materials on a contract. Applications for the surveying function are also limited and typically involve the production of valuations and final accounts.

As mentioned earlier, accounting applications show the greatest use amongst contractors. Almost all contractors are now using computers in this area. Budgeting and financial modelling, cash flow, VAT systems, payroll are a few of the packages available to assist in the accounting function.

Again, certain office automation applications are widely used by the contractor for general administration purposes. Typewriters are being increasingly replaced by word processing packages. Electronic mail shows a limited use amongst contractors, which is to be expected given that many firms are operating standalone systems and are apparently loathe or unable to operate integrated systems.

Overall the use of IT on site is generally restricted to telephone, fax and some standalone systems. Investment is hindered by the environment and security risks associated with the use of IT hardware on construction sites.[11]

IT suppliers have succeeded in developing many of the applications required by their customer by providing specific solutions to problems but they must now move forward and deliver integrated tools that support the complete construction process.[12]

2.4.2 Current Developments

Research[13],[14][15] indicates that the majority of the systems highlighted tend to be standalones dealing with only one management function and few, if any of these companies have integrated these management functions. Very little data is transferred directly from one system to another as often the various functions require the data to be presented in a different format. The potential savings in manpower arising from integrating these functions is, by any estimate, substantial[16]. Perhaps then, one of the most important areas for consideration is that of integrating systems both within and external to an organisation. This facilitates data sharing between different applications which offers many advantages including inputting and updating data only once, production of management information which was not previously possible and more accurate and up to date information. At present telephone and fax dominate informal communication between companies. Technologies such as e-mail, virtual project networks, groupware and video conferencing are not widely used even though they offer various advantages over telephone and fax.[17]

Recent years have seen an increase in activities which help the exchange of data between systems and organisations.[18] These include the development of open systems interconnection (OSI Seven Layer Model) and the work of EDICON, looking at how data may be transferred at a number of stages in the construction process, particularly between suppliers and contractors and between the Quantity Surveyor and contractor. CITE (Construction Industry Trading Electronically), an initiative led by a group of contractors and suppliers, has been set up in order to produce standards for the transfer of the most frequently exchanged documents in the construction process.[19] Although a number of standards and conventions have been developed to achieve successful sharing of industry information, they do not have widespread support.[20] The results of a recent survey show that levels of use of EDI in the construction industry is 6%, though this figure is expected to rise in the near future.[21]

Current research relating to integrating applications within the construction company itself includes the development of a 'Product Model'. This will use a central database which comprises all the data required at each stage in a construction project.

In order for data to be shared it is logical that some kind of exchange mechanism is required. Most personal computers now have networking capabilities thus allowing what was once used as a standalone machine to communicate with other computers, sharing valuable data and both hardware and software resources. Networking also offers the added advantage of E-Mail, enabling users to communicate electronically. Other developments include the ability to access on line external databases such as BCIS providing cost information from the Building Cost Information Service, Context providing information on building products, codes of practice and British Standards and BRIX providing Building Research Station data.

2.4.3 The Way Forward

As highlighted previously, there is a wide variety of computer systems available for the contractor and many developments are taking place in the field of information technology in construction. However, computer systems have not yet altered the way in which the industry functions. The industry still comprises of a myriad of small to medium sized companies mainly operating on a local or region basis, usually under capitalized, highly competitive and facing an uncertain and widely fluctuating market demand. This model is different to most other manufacturing industries which have amalgamated to form a small number of large companies as for example the motor car producers. The fragmented nature of the industry and its lack of client focus and established IT standards have inhibited an integrated approach to IT.[22]

Other industries have used computer technology as a competitive edge, using it to broaden their perception of how things can be done and changing their working methods. The market leaders in IT developments have increased their market share and when their competitors have tried to follow in their footsteps they have only recovered part of their lost market share. In many industries it appears firms are having to use IT merely for competitive survival rather than competitive advantage.

A recent report commissioned by the Department of the Environment and BT[23] regarding the use of IT in the Construction Industry, outlines an IT strategy for the industry and provides an IT vision for the future. This vision includes an integrated project communications framework, based on key technical and commercial information relating to a project on a project database and integrated industry wide information comprising standard component listings, building performance benchmarks, best practices, etc to improve and inform construction projects. The Construction Industry in Great Britain must keep up to date and exploit the computer technology available, especially if construction firms are to compete in international markets and Sir Michael Latham's challenge[24] of a 30% cut in costs by the year 2000 is to be achieved. Information is the lifeblood of any organisation. In order for a piece of information to be useful it must have certain attributes such as timeliness, conciseness and relevance to the recipient. IT can be used to effectively manage information in order to improve efficiency and help an organisation pursue its business goals and achieve competitive advantage. Dramatic improvement will however, require a business strategy based upon teamwork, integrated processes and a renewed focus upon meeting client's needs.[25]

2.5 SUMMARY

The construction industry is one of the most oldest professions known to man and as such has developed standard practices which have been slowly refined over time; the products of the construction industry are durable and remain for long periods of time. This has resulted in an industry which has been slow to embrace and exploit new ideas. This cautiousness can be offered as one of the reasons why the acceptance of IT in the industry has been slow. However, this chapter has illustrated that the major factors which have inhibited progress are:

- cost
- portability
- availability of software

With developments such as the personal computer and the increase in availability of software for the contractor, these restrictions have been largely overcome and the reasons for not using IT have been removed. All firms within the construction industry both large and small can and should gain the benefits from the use of computer systems in the management of information; a firm's most important resource.

IMPLEMENTING TECHNOLOGICAL CHANGE IN ORGANISATIONS

3.1 INTRODUCTION

As highlighted in the previous chapter, the construction industry faces many external pressures over which it has little influence. As it cannot control the environment then it is vital that construction companies adapt and change in order to meet the challenges presented to them. This chapter briefly examines the nature of change focusing in particular on technological change and the implementation of a computer system. It explores a range of methodologies which can be used to implement computer based information systems and proposes methodology for the implementation of an integrated Management Information System in a medium sized construction firm.

3.2 THE NATURE OF CHANGE

The need for change in an organisation can originate from both external and internal pressures. Externally there may be pressures such as changing markets, technological development and government policies and internally pressures may arise such as the realisation of an inefficient system. Ultimately all changes should be driven by business demands. Change can occur in one of three forms:[1]

(i) structural - new rules, decision systems

(ii) technical - new computer systems

(iii) social - attitude change

All these variables are interdependent, for example, a technical change such as the introduction of a new computer systems may alter the tasks staff perform and the skills they require. Therefore technological change cannot be considered in isolation. It is important that the resulting social and structural impact is also taken into account.

Implementing change in an organisation is a slow and difficult process often accompanied by resistance. It is therefore useful to follow a methodology or use a model which provides a structured approach to managing change and can contribute to the successful execution of the process. Finding a suitable implementation model is no easy task. Indeed, there is no ideal implementation model. Different situations and problems require different approaches and solutions. The following section seeks to examine the different available methodologies for the implementation of a computer based information system which would bring about change of the technical form.

3.3 METHODOLOGIES FOR IMPLEMENTING COMPUTER BASED INFORMATION SYSTEMS

Early data processing systems in the 1950s were implemented without the use of any formal methodology. Programmers would carry out all tasks involved with the development of a system. The programmers, although highly technical people, did not often have the skills required to be able to translate users needs into a satisfactory system. As computerised information systems became more important it was recognised that regardless of how good the design of a system and the skills of a programmer were, unless the user requirements had been understood the resulting system would be inappropriate. As a result the role of the systems analyst was created so that more emphasis could be placed on the analysis and design of a system. The need for a methodology for the development of systems was also recognised. In response to this need, the systems development life cycle emerged in the late 1960s. This documents the stages involved in developing a system. This model consists of the following steps or phases :

(i) Requirements Specification
(ii) Feasibility Study
(iii) Systems Analysis and Design
(iv) Implementation and Testing
(v) Maintenance

Figure 3.1 shows the stages of the life cycle. The details of each sub stage identified within the life cycle can be explained as follows :

Requirements Specification

This is a specification of company objectives and system requirements, including reasons for implementing a new system.

Feasibility Study

The systems implementor must ensure that the requirements are realistic and feasible. A study is therefore conducted to investigate the proposed project. At this stage the development of a new system must be justified or the project abandoned.

Systems Analysis and Design

At this stage an in depth study is conducted into the existing system to determine current methods and future information requirements. A new information system is designed in accordance with the requirements specification. When the design has been approved, a system specification is produced, detailing all features of the system.

Implementation and Testing

This involves translating the design into a format which the computer can understand. The software system then needs to be tested to ensure that it operates correctly and in accordance with user requirements. Staff training also occurs at this stage.

Maintenance

There are two types of maintenance:

- where software errors are found after the system has been implemented that require

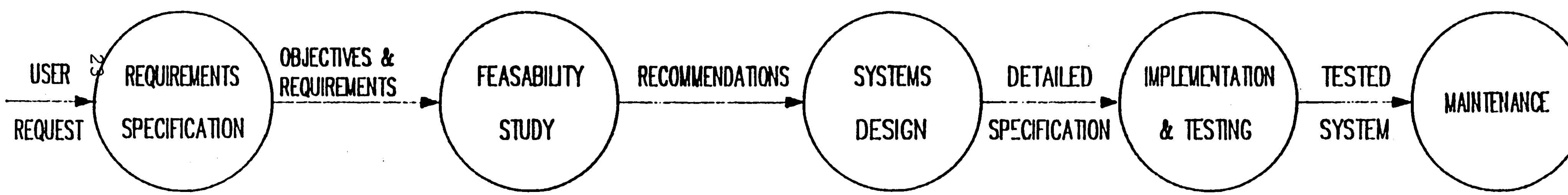


Figure 3.1. THE SOFTWARE SYSTEM DEVELOPMENT LIFE CYCLE.

correction;

- where enhancements required in order to continue meeting company requirements and objectives that change to meet the demands of an unstable environment.

Although the systems development life cycle is well known, it does have its limitations. Many users have questioned the productivity of the process and the quality of the product[2]. Users feel that the development of systems is slow, expensive and still do not adequately meet their requirements. Since the development of the systems life cycle a number of other methodologies have emerged all attempting in some way to address the problems of the traditional approach to developing systems.

A methodology is essentially "a collection of procedures, techniques, tools and documentation aids"[3]. It is also based on a philosophy which will emphasise a theme throughout the stages of development. Avison and Fitzgerald[4] identified four themes which are prevalent in various methodologies. The themes are :

(i) the systems approach
(ii) planning approach
(iii) participation
(iv) prototyping

These themes will now be discussed in the following sections.

3.3.1 The Systems Approach

Systems theory emphasises that it is important to view a system as a whole rather than concentrating on the subsystems that constitute the whole. Focusing merely on the subsystems would lead to a condition known as sub-optimalisation, where the subsystems work effectively but pursue their own goals to the detriment of the goals of the whole. The principle of holism is also an important concept in systems theory that states that the output of the whole is greater than the sum of the output of the individual parts. This theory can be applied to an organisation which can be viewed as a system with the functional departments acting as the subsystems. Equally it can be applied to the implementation of an information system. It would be pointless to computerise a department without first considering the needs of the organisation as a whole and the interconnections between different departments. If a socio technical perspective is taken then technology, the organisation, and people could be viewed as the subsystems which must work in harmony to optimise the operation of the system. Although the technological subsystems is predictable, the people and organisation subsystems are extremely complex and unpredictable. Applying the systems approach would mean all these subsystems need to be considered.

Checkland's Soft Systems Methodology[5] is loosely based around systems theory. The theme in this approach is that analysts are dealing with an unstructured problem defined by different individuals with differing views which all need to be considered. As such the problems are "fuzzy" and solutions are not apparent and straightforward. Thus Checkland's methodology should result in a better understanding of the problem area and hence user requirements. The methodology also focuses on other important issues and implications of the implementation of an information system such as structural changes in the organisation.

3.3.2 Planning Approaches

Methodologies based on this approach emphasise the importance of planning at the strategic level prior to the development of any system. The organisational objectives and business strategy should first be determined and only then should an information system strategy be derived to support these.

To understand why planning is becoming more important the "three era" model of information systems [6] will be outlined. In the first era (1960s onwards), which is known as the data processing era, systems were essentially transaction processing systems which computerised routine, operational tasks. The second era (1970s onwards), known as the management information systems era, was characterised by systems which aimed to provide more and better management information to support decision making. The third and current era (1980s onwards), known as the strategic information systems era is characterised by systems which aim to increase competitive advantage. The systems characteristic of the first era were developed in a piecemeal fashion to meet the needs of functional business areas. The IS strategy was rarely considered as a part of the system of a business strategy in the same way as for example a marketing strategy and a production strategy would be included. However, where the aims of implementation are those of increasing organisational effectiveness and competitiveness this approach to systems development becomes inappropriate. A different approach is required to produce systems characteristic of the second and third era. Typical types of strategic information systems include [7]:

(i) systems that link the organisation's technology directly to important external organisations and individuals, such as customers and suppliers;

(ii) systems that integrate and disseminate information in an organisation over established barriers such as different roles or departments;

(iii) systems that enable organisations to develop new products or services based on information;

(iv) systems that provide top executives with information to assist strategic activities.

These systems will affect the competitive position of an organisation and also depend on internal information being integrated. Unless such systems are carefully planned and managed, organisations run the risk of eroding their competitiveness by poor investments in their information systems. It is therefore vital that top management who are responsible for formulating strategies have an understanding of strategic information planning. In a survey on information planning, by Galliers(8), out of 130 companies surveyed, only 10% said they had merged their IS planning with their business objectives. Top management were seen to be unambitious about systems planning and gave low priority to proposals which attempted to seek out opportunities which would give the business a competitive advantage. The potential contribution of information systems is too important to corporate success to be left to the technologist alone.

Planning approaches therefore emphasise the involvement of top management as well as the technologist in planning how information systems might best meet the organisational objectives. Methodologies based on the planning approach include Business Information Analysis and Integration Technique (BIATT), Business Systems Planning (BSP) and Stages of Growth Model. BIATT concentrates on analysing the information required to support the business objectives and then looks at the type of systems which could provide this information. BSP is similar to the traditional approach but emphasises strategic planning in the early stages and an organisation wide perspective. The data becomes a corporate resource which is available to everyone rather than being owned by departments.

The Stages of Growth is more of a framework to review the maturity of IS and help an organisation plan for the next stage in the development of IS. The original model developed by Nolan and Gibson(9) documented four stages which an organisation is said to progress through in its implementation of IS. Nolan(10) later revised the model breaking down stage four into three stages, thereby producing a six stage model. The model is a contingency theory which presents a set of features for each given stage.

The features that can identify an organisation as being at a particular stage are the applications portfolio, DP organisation, DP planning and control and user awareness. The model is based on the assumption that an organisation must move through each of the stages. Stages can not be skipped as at each one a process of organisational learning occurs, without which it is not possible to progress to the next stage. Briefly, the stages in the model are:

(i) Initiation
(ii) Contagion
(iii) Control
(iv) Integration
(v) Data Administration
(vi) Maturity

Initiation

At this stage the organisation acquires its first information system. Systems characteristic of this stage focus on automating well defined clerical procedures, for example payroll. There is no strategic interest shown by management.

Contagion

This is a period of rapid growth in which users demand more applications. There is a high level of investment in information systems in an attempt to satisfy the user requests.

Control

This represents a period of a tightly controlled investment in IS and the enforcement of strict policies and standards due to management concerns about cost and return on investment. This action may produce a backlog of applications and an increasing number of dissatisfied users.

Integration

This stage focuses on integrating existing systems through the use of databases.

Data Administration

The focus is now on managing information. Information is viewed as a corporate resource to be shared within the organisation.

Maturity

At this stage the development of information systems is closely integrated with the business strategy.

Nolan identified one particularly important transition period. This occurred sometimes in stage three, where an observable shift can be seen in orientation from management of the computer to management of the company's data resources. Throughout each stage management response to the growth of IS may be observed in the use of two levers, namely slack and control. Slack is allowing flexibility and the commitment of resources regarding IS. Control is the monitoring of IS efficiency. The balance between these two levers is important and will take a different form at each stage. For example in the Contagion stage slack is high and controls are low, users are allowed the freedom to explore with very little monitoring of their activities by senior management.

Although this model was developed in the era when mainframes were dominant, and its appropriateness today may be questioned, the model still provides a useful framework for information systems planning.

3.3.3 Participation

One criticism of the traditional approach has been that systems did not often meet user requirements. Users had little involvement in the development process and systems analysts were often highly technical people who did not have the necessary skills to communicate effectively with the user. Many information systems although technically correct, fail because of the people problems encountered in the implementation process. Many of these problems could be overcome by greater involvement of all staff to be affected by the system. The involvement of users in the development and implementation of systems is known as the participative approach to systems implementation. The arguments for using a participative approach in systems implementation are as follows :

(i) the systems implementor who is often an outsider to the company has the opportunity to communicate and build rapport with the user which helps to break down barriers created from the mistrust of a 'foreigner' who is introducing change;

(ii) the user is the expert at doing the job and is the best person to inform .the systems implementor of what the job entails and the problems associated with it;

(iii) users have a right to control their destinies and should have some say in the future of their jobs;

(iv) involvement acts as a motivator and also leads to a greater level of acceptance of the system since the user has played a part in the evolution of the system;

(v) involvement at the design stage means that problems surface sooner and are dealt with more easily. It also provides a learning experience for the user and enables a better understanding of how the system works.

Enid Mumford(11) is a great pioneer of participative approaches to systems implementation and specifies three types of involvement :

(i) consultative - whereby the users are consulted about their needs but the bulk of the decisions are left to the systems design group;

(ii) representative - whereby an elected group represents the needs of their colleagues. The group also participate in the design process;

(iii) consensus - whereby the users make the decisions and are fully responsible for their implementation.

Effective Technical and Human Implementation of Computer Based Systems (ETHICS) is one methodology devised by Enid Mumford based on the participative approach.

3.3.4 Prototyping

A prototype is a working model of a system which will usually have some but not all of the features of the proposed system. Prototyping of information systems has only recently become popular with the development of fourth generation languages which have made it much quicker and cheaper to produce prototypes. Senn[12] states there are two primary uses of application prototyping. Firstly it can be used to identify and clarify the user requirements and secondly prototypes are useful in verifying the feasibility of a systems design. Analysts can provide the user with a working model which the user can experiment with and offer feedback as to how well the design meets their requirements. The prototype can then be refined, possibly undergoing several iterations until it proves satisfactory to the user. There are certain situations in which prototyping would be suitable. These are [13]:

- requirements are not known
- requirements are known but need verification and assessment
- high costs are involved both financially and in terms of human effort and time
- high risk is involved and inaccurate evaluation of system requirements could place an

organisation in jeopardy

- new technology in which the organisation has no experience

When any of these situations arise then prototyping should be considered as part of the implementation process. Prototyping can be seen as a much improved form of systems investigation and analysis, as well as an aid to design(14).

3.4 SUMMARY OF INFORMATION SYSTEMS METHODOLOGIES

This section has examined a number of themes prevalent in information systems methodologies. These methodologies are composed of tools and techniques some of which may be common to several methodologies. Within each methodology the software systems life cycle can be identified but the various phases have been adapted according to the philosophy underpinning the methodology. So far the discussion has centred around implementing an information system. The issue of a special purpose methodology for implementing an integrated management information system will now be addressed.

3.5 METHODOLOGIES FOR IMPLEMENTING INTEGRATED TECHNOLOGY

To date little research as regards implementing an integrated management information system in a construction firm has been conducted. However, this has for sometime been an area of ongoing research in other industries particularly manufacturing. Whilst it is acknowledged that construction is a unique industry, there are valuable lessons that can be learnt from other industries further in their IS maturity that could apply to any company implementing integrated technology. Tranfield and Smith(15) have carried out extensive research into the implementation of Computer Integrated Manufacturing (CIM) and identified key elements of a successful methodology. These elements include:

- Business driven. The reason for investing in IT should be to improve the competitiveness of the company.
- Back to basics rethink. Implementation should involve step function change. This

requires an analysis of the business and reappraisal of its objectives. An organisation redesign should accompany the change.

- Top management driven. The best way to achieve step function change is top down.

- Front end- back end. Business and managerial functions should be considered at the front end of the change process. The technological issues should be at the tail end of the process.

- Integrated change strategies. Successful implementation requires changing the company on a wide variety of fronts such as structural and culture changes.

- Investment in people as well as technology. People require training in order to acquire new skills and new attitudes required for new technology.

- Everybody on board. Step function change can only be achieved with the support of the entire organisation, particularly the management.

Smith and Tranfield[16] also suggest that the implementation should take place in short bursts of revolutionary change which is known as a 'sprint'. The sprints focuses on a few key areas of the business identified in a systems analysis and requires vision building, involving all company staff. When a plateau is reached change is implemented on an incremental basis and long term goals are set, this known as the 'performance ratchet'. The success factors identified must be applied and adapted to the context of the problem and implementation environment.

3.6 DEVELOPING AN IMPLEMENTATION METHODOLOGY FOR A CONSTRUCTION CONTRACTOR

The purpose of using an implementation model is to try and make the implementation process better structured and manageable, thus enabling implementors to deliver accurate systems which meet users' requirements. It is therefore necessary to find the most suitable methodology and use it to solve the problem at hand. However, how does an organisation select an appropriate methodology?

Certain methodologies are more suitable for certain situations. For example, in a situation where there may be many 'soft' issues a methodology such as Checkland's SSM[17] may be most suitable as it attempts to resolve these issues as part of the analysis phase before the actual design of the system. It must be noted that in an ideal situation an organisation could select the most suitable methodology to the problem at hand. However, in practice, selection of a suitable methodology is not as simple as it might first appear, and the process may be subject to certain constraints. In this particular case study three factors, namely existing skills base, cost and 'organisational fit of the methodology' were important factors in the selection process.

(i) existing skills base - the systems implementor will usually be conversant with one or more methodologies and probably have a preferred methodology. If anything not within their portfolio of skills was selected training would be required which could be very costly depending on the popularity of the methodology. This would also delay the implementation process whilst the implementor is being trained in the chosen methodology and this could be time an organisation can ill afford.

(ii) cost - some methodologies may involve stages that require particular tools or processes that are costly in terms of human effort, time and organisational finances.

(iii) organisational fit - some methodologies or elements of them may simply not be appropriate to the culture of an organisation. For example in participative approaches it would be reasonable to assume that the consensus form of participation might be the most effective. However in a traditional, bureaucratic organisation where roles and responsibilities are clearly defined and there are strict controls this form of participation would clearly be inappropriate.

Consequently, it is not always possible to choose the methodology that appears to be the most appropriate. These factors influenced and played an important part in shaping the implementation model adopted. In this research, an experimental approach was adopted whereby the traditional systems life cycle was used as a basic structure. Within this structure suitable tools and themes were employed from other methodologies and used in the production of systems.

The systems life cycle model is of course very general and some of the phases had to be broken down into a number of suitable sub stages. The approach adopted was continually reviewed and the resulting feedback applied in an attempt to improve the model. Flexibility and adaptability were key characteristics of the model as the company had limited experience of IT and there was no prior experience that could be used to inform the implementation of the new system.

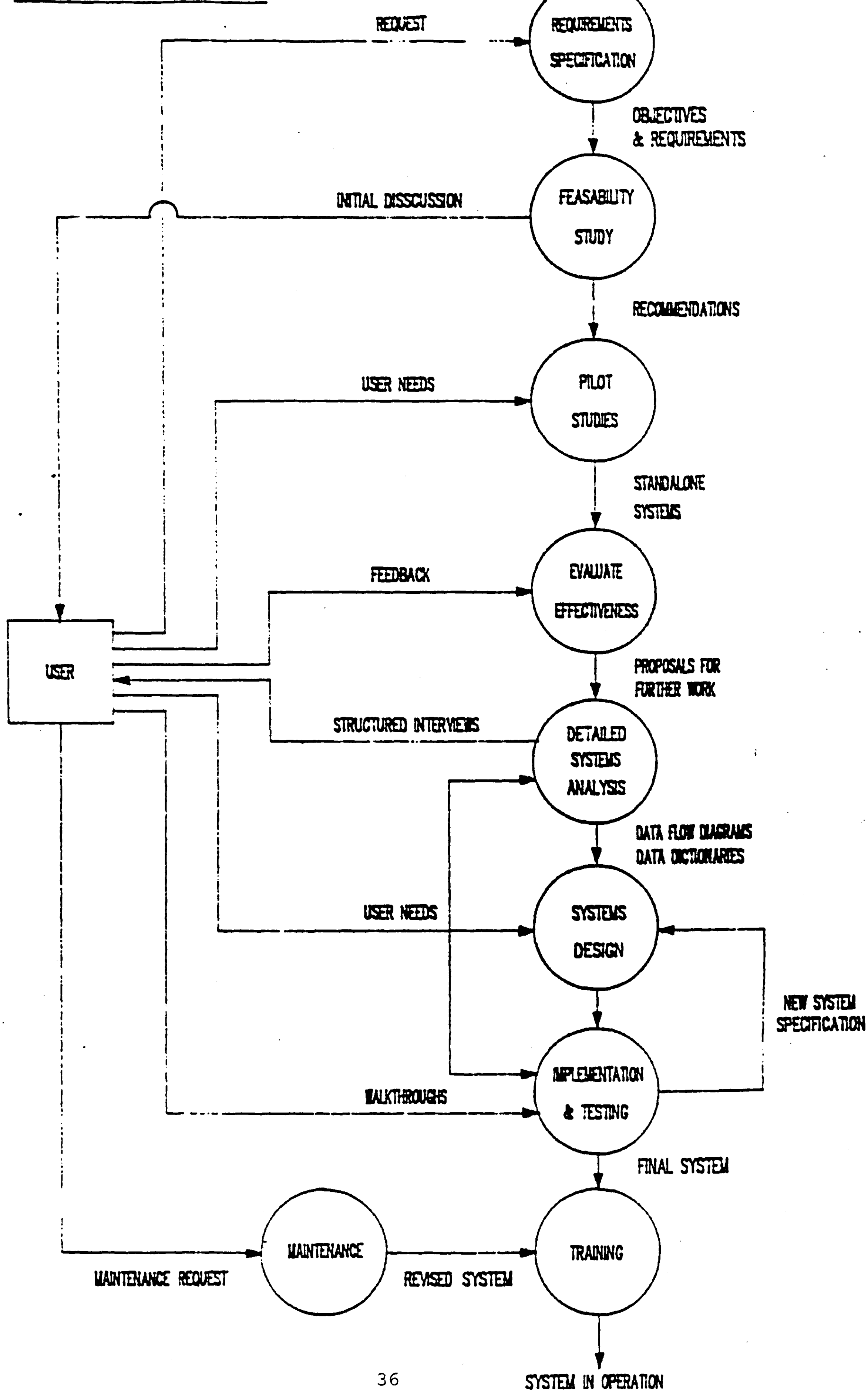
Figure 3.2 shows the sub stages of the revised model. Phases 1, 2 and 5, The Requirements Specification, The Feasibility Study and Maintenance are as described in the traditional life cycle. Phases 2 and 3, Systems Analysis and Design and Implementation and Testing were broken down into a series of smaller and more manageable sub stages appropriate to the task at hand. The revised model will now be described in further detail.

3.6.1 The Requirements Specification and Feasibility Study

The user makes a request for a computerised MIS in the form of a requirements specification outlining the objectives and features that the system must perform.

A feasibility study is carried out in order to determine whether the proposed system is in

SUB-STAGES OF LIFE CYCLE



fact viable and the requirements achievable. The feasibility study must be conducted in close conjunction with the management to gain a better understanding of the existing system and its perceived problems and also to acquire management commitment to the project. At this stage a decision must be made as to whether the objectives may met with or without amendments or to abandon the project.

3.6.2. Pilot Schemes

Priority applications are selected for computerisation and small prototypes with limited functionality are developed. These pilot systems provide a learning mechanism to discover problems in introducing new technology into the company and experiment with different ways of managing the implementation. They also generate initial interest in computers in a company with no technology and act as a catalyst for further and more complex systems implementation.

The effectiveness of the systems must be evaluated by obtaining feedback from users and using this to inform further development work.

3.6.3 Systems Analysis and Design

A systems analysis of the company is conducted in order to gain a more detailed understanding of working methods used and to identify problems within the company. Data are collected using structured interviews with members of staff at all levels. Data flow diagrams and are used to describe the company, additionally Nolan's Model as described earlier is applied to assess the current maturity of IT and how the company should progress to further maturity. In some cases business processes need to be redesigned in order to increase efficiency and effectiveness. It is important that business processes drive changes and not technology. One must first explore how IT might facilitate a business process rather than see how existing processes might be modified in order to apply IT.

Once the analysis has been completed the data flow diagrams must be translated into a format and language that a computer can understand. The system implementor must ensure that the system design does not conflict with company policy and objectives.

3.6.4 Implementation and Testing

This is an iterative process whereby prototype systems are developed, the user then has a trial run of the system to ensure it meets their individual requirements. The system is altered if required, which may mean carrying out further analysis and altering the original system design. The system is then tested to ensure efficient operation and information generation.

The system is implemented using a 'bottom up implementation' approach. This involves implementing simple modules first, as in the pilot schemes. These modules are then integrated to form more complex systems which should satisfy all company information requirements.

Staff training also takes place before the system is finally installed. Documentation needs to be completed for programmers, giving detailed descriptions of how the system works, and for users giving operational instructions for the system. During the implementation a participative approach is used in each of the four stages. From the three types of involvement discussed the consultative approach was considered the most appropriate.

3.7 SUMMARY

Change can occur in one of three forms, structural, technical and social. The introduction of an integrated management information system would imply change of a technical nature but in reality involves both social and structural change. The social or organisational dimension is often ignored and unaccounted for leading to sub-optimal implementations.

In order to manage the organisational dimension appropriate measures must be introduced into the implementation process. A review of research conducted into implementing Computer Integrated Manufacturing systems revealed a number of success factors These have been incorporated into the traditional systems development life cycle where possible in order to produce an implementation model for a medium sized construction firm which addresses the organisational dimension of technological change. This model will be applied in the following two chapters.

CHAPTER 4

SYSTEMS ANALYSIS AND PROBLEM IDENTIFICATION OF THE COMPANY

4.1 INTRODUCTION

This chapter aims to show how the first two phases of the implementation model developed in chapter 3 were applied to Weaver Construction Limited, a medium sized construction contractor. Weaver Construction and Sheffield City Polytechnic formed a temporary partnership via the Teaching Company Scheme (T.C.S.) in December 1987 when the company was considering the implementation of information technology. In this chapter, the aims of computerisation are considered, the company is analysed and the departmental systems are assessed. Problem areas are also discussed and potential areas for computerisation are identified.

4.2 AIMS AND OBJECTIVES OF COMPUTERISATION

The initial aims of the company in considering computerisation were to :

(i) reduce the amount of paperwork involved in completing routine tasks;

(ii) increase the productivity of staff;

(iii) produce timely and consistent information.

In order to achieve these aims several objectives were identified :

(i) to conduct a systems analysis of the company to examine the present systems in operation;

(ii) to design a new improved system having identified the problem areas, deficiencies and additional management information requirements;

(iii) to apply appropriate information technology to the revised system proposals.

In assessing the viability of the proposals put forward, an initial analysis of the company had to be conducted.

4.3 INITIAL ANALYSIS OF THE COMPANY

In the initial analysis phase, problems, objectives, requirements and constraints of an environment are examined. Solutions are proposed and evaluated in terms of cost benefits and time requirements.

In order to identify the problems and determine the feasibility of solving them, the following strategy was used:

(i) determine what information would be useful and how to collect it;

(ii) identify information sources;

(iii) collect and analyse the information;

(iv) describe the current systems;

(v) identify the problems in the current system;

(vi) propose alternative solutions;

(vii) evaluate costs/benefits of proposed solutions;

(viii) summarise findings and decide on further action.

The method adopted to obtain information was by structured interviews, observations and the analysis of company documents. The interviews provided an interactive method of obtaining information and allowed the interviewer to guide and assist the interviewee to focus on any specific problem areas. The objectives of the interviews were as follows :

(i) to determine company background, the existing communication system and evaluate its effectiveness;

(ii) to obtain suggestions as to possible changes to the system;

(iii) to determine staff opinions on introducing new technology into the company.

The interviews concentrated on the managers and supervisors who possessed an overview of the business, its problems and information needs. This provided a background of information at this stage of the analysis. The intention was to interview staff at lower levels of the organisation as the project progressed and more detailed information was required. This method of collecting information also allowed the build up of rapport with staff in order to gain their support for the research work.

The interviews encompassed the surveying, estimating, buying, contracts, planning and accounts departments of Weaver Construction. Company brochures and documents were also collected to assist in understanding internal procedures and systems that were in operation. The following sections detail the findings of the interviews.

4.3.1 Company Background and Structure

The history of Weaver Construction dates back to 1919 when the company began as a family repair business by the name of O.Weaver and Sons Ltd. The company soon expanded to enter different markets and undertook its first local authority housing contract in 1926, and progressed to build 2,500 dwellings for various local councils by 1939. The company also played a leading part in the post second world war reconstruction of South Yorkshire. Currently Weaver Construction is part of Weaver Holdings which also includes Weaver Homes, Clover Plumbing & Heating and Weaver North West Ltd, all trading as independent limited companies. Some of the directors hold seats on more than one board, and have a direct involvement with the running of the companies. A diagrammatic representation of Weaver Holdings is shown in Figure 4.1.

The group has experienced both a boom and slump in demand for their products and services during the period of the project. The demand has fluctuated according to the

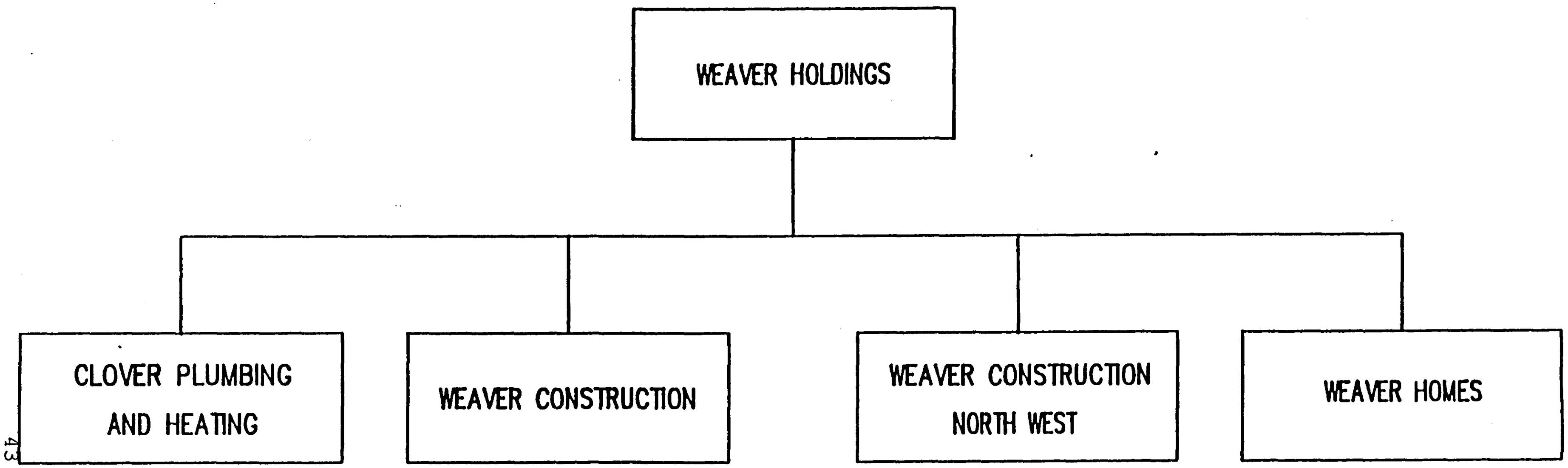


Figure 4.1. WEAVER HOLDINGS LIMITED

state of the economy and the social and economic policies of the government. In response to the boom of 1988 and 1989 Weaver Homes which had for a time been inactive, expanded to undertake several speculative house building projects. However in the recent recession of the early 1990's the group has suffered the loss of the Joinery Manufacturing Division of Weaver Construction which was closed down in December 1990 after fifty six years of trading.

Weaver Construction is a medium sized construction firm employing approximately 40 managerial staff and 200 operatives. It has an annual turnover of approximately £20 million. The types of contracts undertaken by the company include New Housing, House Improvements, Sheltered Housing, Public, Industrial and Commercial Buildings, Factories and Schools. Typically the company can be involved in around twenty contracts at any one time ranging from a value of £100,000 to £4M in an area covering South Yorkshire and the North Midlands.

Figure 4.2 shows the organisational structure of Weaver Construction. The organisation is based on a hierarchical form also known as a tree structure. Certain characteristics can be identified as follows:

(i) division of labour or task specification - staff concentrate on sub tasks of the complete construction process. Each member of staff has well defined roles and responsibilities.

(ii) scalar principle - This is the chain of command principle. The company is run by the Managing Director and a group of Directors each of which has responsibility for a particular department or departments. The chain of command passes from the Managing Director, to the Directors, down to Seniors who are responsible for the personnel below. Decisions are passed down the hierarchy, and problems are passed up until they reach a level

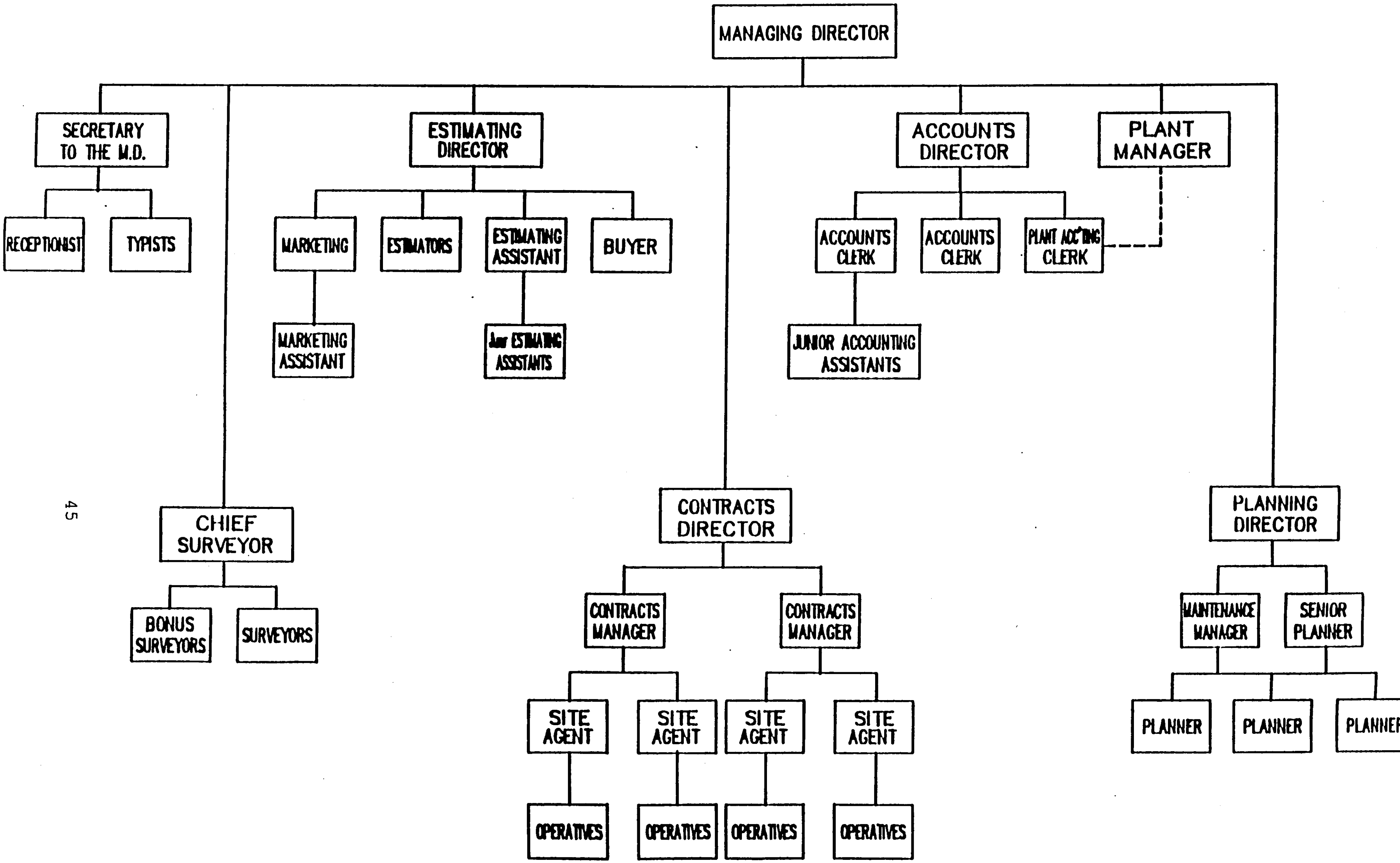


Figure 4.2. ORGANISATIONAL STRUCTURE OF WEAVER CONSTRUCTION LIMITED.

where they can be solved.

4.4 RESULTS OF INVESTIGATION

This section discusses the investigations into the use of data within the company and the identification of problem areas within the company. From the interviews it was possible to determine company activities and the movement of data through the organisation. This information can be represented by the use of data flow diagrams. Figure 4.3 represents the context diagram illustrating the processes that are carried out at Weaver Construction and the data flow through various departments. The processes that occur in each department are described in the following sections together with the problems that were identified from interviews with Weaver Construction operated an annual labour control system based on staff.

4.4.1 The Surveying Department

The surveyors' tasks revolve around the income and expenditure involved in executing the contract. This financial control falls into two categories; that undertaken for the benefit of the client, and that performed for internal company monitoring. In addition to these two, the surveyors also have the responsibility for the control and payment of domestic and labour only sub-contractors. The data received, the data not used, and the data generated in the surveying department can be defined as follows:

(i) Data Received

Data received from the estimator

- analysed bill
- tender information
- subcontract quotes
- subcontract enquiries
- standard targets

Data received from the planner

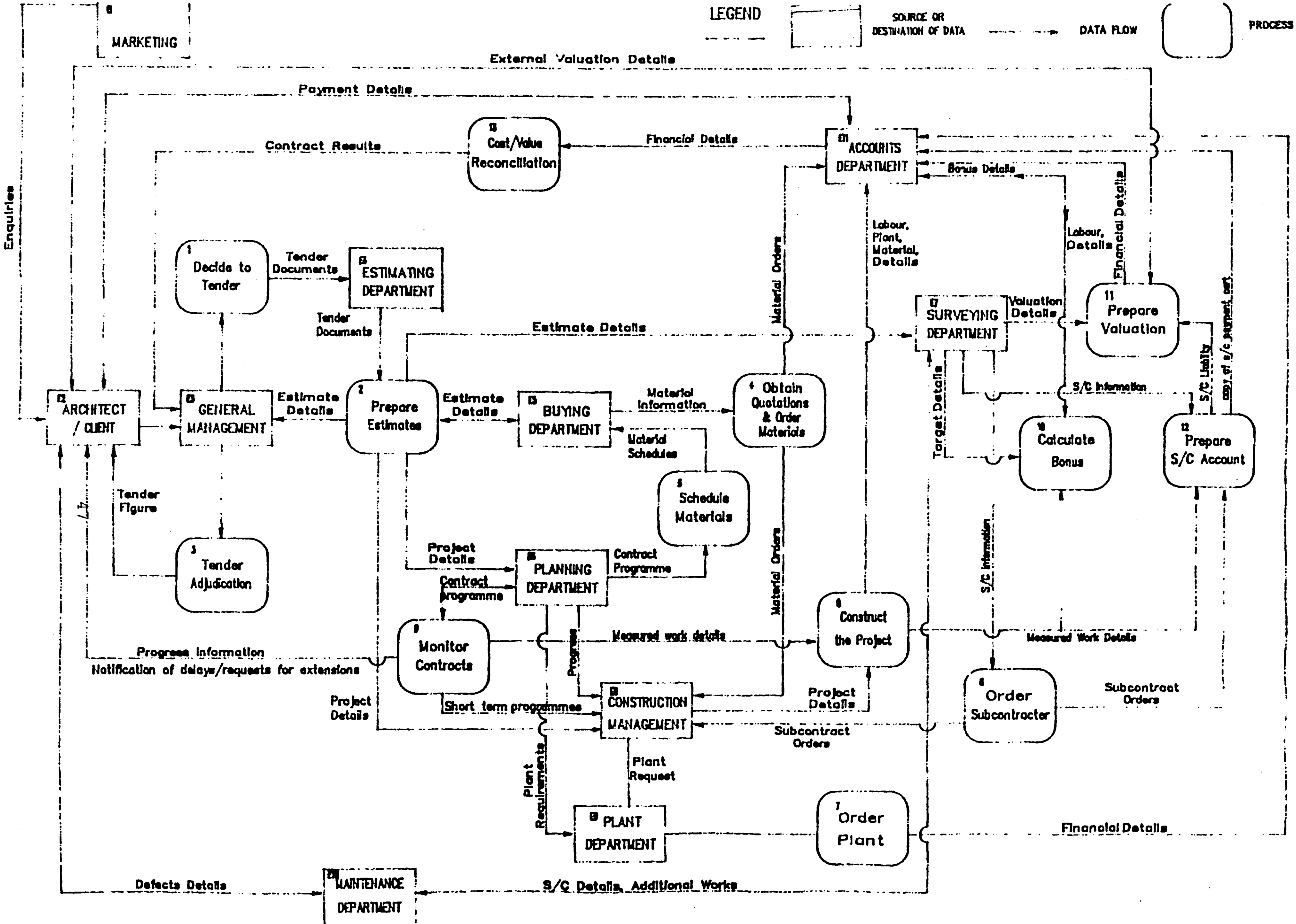


Figure 4.3. CONTEXT DATA FLOW DIAGRAM

- contract programme

Data received from accounts

- plant costs
- site labour costs
- materials costs
- monthly contract costs

Data received from site

- site labour returns
- bonus analysis sheets
- dayworks
- confirmation of verbal instructions (c.v.i.)
- measured work details

(ii) Data Not Used

- preamble items

(iii) Data Generated

- bonus targets; issued to site
- valuations; done in conjunction with P.Q.S.
- internal valuations; produced monthly to monitor profitability
- sub-contractors orders
- sub-contractor payments; issued to accounts
- bonus payments; issued to accounts
- bonus reconciliations
- claims; issued to clients
- variation costs; issued to clients
- preparation of final accounts

4.4.1.1 Problems identified within the Surveying Department

From the interviews, a number of problems were highlighted in this department, the most significant being that of the bonus system. Weaver Construction operated a manual labour control system based on allocation sheets which required completion by surveying staff every week. In order to do this, surveyors had to visit sites, record in a book the weekly work completed by each gang, return to the office and re-enter data on a pro-forma for each gang and enter all the targets and bill values against each item of work. A number of standard calculations then had to be carried out to obtain the bonus payable. This provided senior management with information on labour costs, value of work completed and bonus earnings.

Whilst the final information was very useful in controlling labour, its production was very time consuming for surveying staff. Seven out of eleven surveyors were spending a specific day each week re-entering data at head office. Bonus sheets had also to be completed on a specific day of the week and the time available for the surveyors to carry out other tasks was often limited. A system which would reduce routine work and at the same time increase flexibility was therefore required.

Another problem encountered within this department was that of subcontract payments. This was also a time consuming task as the details of each subcontractor had to be written out on each payment certificate, together with the previous certificate details, discounts, retentions and required tax figures. A system was required which would allow surveyors to simply enter the subcontractors name and the gross amount to be paid. The remaining information could then be retrieved from a database and the calculations automatically performed, thus reducing the amount of routine work involved in producing the payment certificates.

Other problems that came to light were as follows:

(i) a cost summary sheet for each contract was given to the surveyors for each month end; the purpose of which was to highlight any problem areas on site. However a more detailed breakdown of costs was required, the production of which involved searching through a large amount of paperwork.

(ii) there was a general lack of control over materials with no wastage checks and no record of losses on material costs.

(iii) there was no formal system for highlighting progress problems on site, and a general lack of teamwork between planning, surveying and site work.

Considering the above, the advantages of computerised systems in the areas of bonus, subcontract payments and materials control were clearly identifiable.

4.4.2 The Estimating Department

The tasks performed by the estimating department involve the measurement and pricing of construction work to in the preparation of tenders. Data received and generated in this department can be defined as follows.

(i) Data Received

- Bills of Quantities comprising materials to be used and measured items comprising description and net quantity of items of completed construction works.

- drawings from which the BQ has been prepared.

In some instances the estimator may receive the tender documentation as a set of drawings and specification in which case a bill of quantities is prepared in-house by the quantity surveyors.

(ii) Data Generated

The estimator produces a tender figure for each project based on a priced bill of quantities which comprises the following :

- unit rates; each unit of measurement is given a price which, when multiplied by the total quantity of that item, gives the total item price

- unit cost of labour including an allowance for wasted time

- unit cost of plant including an assessment of standing time

- unit cost of material including an assessment of wastage

- sub-contract quotes; works that are to be wholly executed by the sub-contractor. The estimator generally obtains a quote for the works from several sub-contractors.

- preliminary prices; an assessment of the financial effect that the preliminary items in the tender have on the construction of the works.

- margin; an addition is made to the estimate to allow for company overheads and profit usually agreed at tender meetings.

These generated data are used to complete the form of tender returned to the client. If the tender is successful a priced copy of the BQ is submitted to the client and the estimate and project details are passed on to the surveyor, the buyer, the planner, and the site manager.

4.4.2.1 Problems Identified within the Estimating Department

The staff views in this department were closely related to the findings in the surveying department. The bonus system was again highlighted. It was felt that there was insufficient feedback from this system. Information such as running totals on items such as wet time and dayworks derived from the bonus sheet would be useful to incorporate into future tenders. There was also a lack of feedback on material wastage. No comparisons were made between material costs and the tender which would be useful information in the production of future tenders.

Other problems included that of material and subcontract enquiries. This was very time consuming, involving repetitious tasks such as typing out standard enquiries and names and addresses which could be easily stored in a database for automatic retrieval.

It was felt that computerised systems would be advantageous in the areas of bonus, materials control, material and subcontract enquiries. However the director of the department considered that a computerised estimating system to price bills of quantities would be of little use due to the time involved in entering the bill of quantities into the computer.

4.4.3 The Buying Department

The buying department is responsible for the purchasing of all materials and equipment for site. The data received, data not used and data generated can be defined as follows.

(i) Data Received

- contract documentation; including preambles and blank BQ to allow material enquiries to be sent out

- the estimate; as received from the estimator, including the analysed BQ to allow a comparison of bill rates and actual costs

- material schedules; as received from planning

(ii) Data Not Used

- labour costs
- plant costs
- preliminary items and costs
- preamble items referring to workmanship

(iii) Data Generated

- material quotations; as passed on to Estimating for inclusion in the tender
- material orders; as passed on to Accounts and site

4.4.3.1 Problems identified within the buying department

One of the major problems encountered within this department is the lack of feedback achieved on either losses or gains that are being made when purchasing materials. With an annual material turnover of around £5M per year, this is obviously a large area to be neglected. Both labour and plant have their own methods for providing cost/value reconciliations, whereas up until now, materials have not.

4.4.4 The Planning Department

The planning function involves the programming of the construction of the works, monitoring the progress of the works, monitoring the progress of the works, and scheduling the materials for the works. The data received, data not used and data generated within this department can be defined as follows.

(i) Data Received

- contract documentation; as received from the estimator
- the estimate; as received from the estimator
- progress returns; as received from the site
- c.v.i.'s; as received from the client
- A.I.'s as received from the client

- correspondence; as received from the client

(ii) Data Not Used

All data relating to the costs of the works.

(iii) Data Generated

The planner co-ordinates the construction works in the first instance, ensuring that the works sequence is allowed sufficient time while remaining within the contract period. This works sequence is expressed in the from of a programme, generally in the form of a bar chart and incorporating a line of balance chart from which to monitor progress. The programme is issued to the site manager and surveyor.

Material schedules are produced in conjunction with the contract programme, showing quantity and type of material, and date required on site. This information is issued to the Buying Department. Internal progress reports are issued to site, surveyors and higher management. These indicate the reasons for any delays, the effect on the overall contract programme and the necessary remedial action. External progress reports are issued to the client at monthly site meetings. These provide the basis for any extension of time claims.

4.4.4.1 Problems identified within the Planning Department

The problem highlighted in this department was with the method of controlling contract progress. It was considered that a better system of weekly reporting was required to determine delays as soon as possible to allow remedial action. This could be linked into a system of resource planning to allow better labour control for the company as a whole.

The director of this department was enthusiastic about the use of new technology but was unsure of how a computerised system could solve the above mentioned problem.

4.4.5 The Contracts Department

This department's work revolves around on site construction works and liaising with client's representatives to ensure that the client's requirements are being fulfilled. The data received and data generated may be defined as follows.

(i) Data Received

- contract documentation ; including the drawings and an unpriced copy of the BQ
- contract programmes; as passed on by planning and including progress reports
- material orders; as passed on by surveying
- bonus targets; as passed on by surveying

(ii) Data Generated

- weekly site returns
- progress returns
- bonus analysis sheets
- variations to the works
- plant requisitions
- surpluses or shortfalls in materials ordered
- sub-contract requirements
- indications of delays, difficulties experienced on site

4.4.5.1 Problems Identified Within the Contracts Department

There were several problems encountered within this department. The staff considered that there was a lack of inter-departmental communication, whereby each member of staff was interested only their own area of work and as a result contract progress would tend to suffer. One possibility here was to create project teams in which each staff member would be responsible to a project head as well as their departmental head, thereby facilitating communication within the project.

The contracts managers and site agents felt that a more detailed cost breakdown was required including more tender information and a better feedback on labour surplus/deficits. A better method of contract programming and progress control was also required, whereby delays could be immediately shown and short term programmes produced.

The staff in this department could therefore see a use for computerised systems in the areas of bonus, internal valuations and contract programming.

4.4.6 The Accounts Department

The accounting function is concerned with the processing and production of financial data. The data received and data not used and data generated can be defined as follows:

(i) Data Received

- material orders, delivery sheets and invoices
- plant orders
- labour returns
- internal valuation details
- sub-contract payment details
- bonus payment details
- labour only payment details
- external valuation details

(ii) Data Not Used

- programming and progress information

(iii) Data Generated

- cost/value reconciliations; passed on to surveying and higher management
- material costs; used specifically by surveying in the preparation of valuations

- budgets/cash flows; for use by higher management
- material, plant and sub-contract payments
- wages/salaries
- preparation of accounts; for auditors, tax returns

4.4.6.1 Problems Identified within the Accounts Department

The director of this department felt that there was little room for improvement to the existing communication system and only two problem areas were identified. The first being a lack of liaison between the buying department and creditors. It was considered that the terms of payment and credit limits with suppliers should be agreed at order stage to prevent confusion at a later date when payments were due.

The second problem related to the existing Burroughs computer system where it was felt that any proposed systems development would be difficult to integrate.

4.5 WEAVER CONSTRUCTION AND NOLAN'S MODEL

As described in the above section, accounts was the only department which was using a computer system to assist with basic accounting functions. Table 4A shows an inventory of the existing office equipment that was being used at the start of the research project. As can be seen, IT has had little impact on the company.

By locating Weaver Construction on one of the six stages of Nolan's Stages of Growth Model described in chapter 3, it is possible to determine the next stage of IT maturity and how the company should progress to further stages. Certain features may be identified in Weaver Construction which are characteristic of a company in stage 1, that is the initiation stage. The current applications portfolio comprises of a limited number of accounts packages. There is no formal IT department, the accounts director is the most computer literate member of staff and is currently responsible for the acquisition of hardware and software. There is very limited user awareness of IT related issues with

Equipment	Department	Use
Burroughs B94	Accounts	Nominal Ledger
		Purchase Ledger
		Subcontract
		Payroll
IBM PC with Lotus spreadsheet	Accounts	Management Accounts
		Standard Targets
		Budgets/Forecasts
Wyse PC	Accounts	Internal plant hire system
Telephones (50 extensions)	All Depts.	Mainly external use but up tp 25% for internal comms.
Photocopiers(3no)	All Depts.	A4,A3,A1
Word Processor (1No)	Secretarial	
Typewriters (5 No)	Secretarial	
Desk Top Calculator	Estimating	Office use only
	Accounts	
Hand Held Calculators	Surveying	Office use only
	Planning	
Franking Machine	Secretarial	
Fax Machine	All Depts.	External use

TABLE 4A AUDIT OF CURRENT EQUIPMENT

the exception of the accounts staff and in this department activities involve the input of data using menu driven systems. No formal IT planning has occurred to date and management do not appreciate the importance of having an IT strategy to guide the future exploitation of IT in the company.

According to Nolan the next stage which Weaver Construction must progress to on the maturity model is contagion. This should be a period of rapid growth for the company in which IT applications become wide spread throughout the company. As users become more aware of IT they will request more applications, in turn this will lead to an increased level of investment in IT in an a attempt to satisfy user demands. Without passing through this stage and the other that follow, ie, control, integration and data administration the company cannot reach the ultimate desirable stage of maturity. At each stage a valuable learning experience occurs which is necessary to progress onto further stages.

4.6 SUMMARY OF FINDINGS

As shown from the interviews with staff and subsequent analysis each department was experiencing a number of common problems. These can be summarised as follows :

(i) Certain tasks were routine, repetitious, time consuming and laborious. For example the weekly process of producing bonus calculations involved collecting and recording data from site and then re-entering this on a pro-forma in the office.

(ii) There was much duplication of data as a result of the same piece of data being required for different purposes both within and by other departments. For example, sub-contract payments required data such as names and addresses and previous payment details from various sources.

(iii) Lack of feedback making it difficult to control costs. For example, a better system of weekly progress reporting was required by planning to exert more effective control of labour. Losses/gains on purchasing materials was not monitored by the department. The limited feedback arose from the inability to produce more detailed information due to lack of staff time.

(iv) Lack of teamwork between departments with staff only being involved in their own area of work. Loyalties appear to be to the department for which a member of staff works. Limited loyalty was evident to a project team comprising of staff from several departments, who come together to form a temporary group for the duration of the project.

The following chapter examines how some of these problems were solved and looks at the approaches used and the outcomes achieved as a result of the efforts employed.

CHAPTER 5

DESIGN, DEVELOPMENT AND IMPLEMENTATION OF COMPUTER SYSTEMS WITHIN THE COMPANY

5.1 INTRODUCTION

In the previous chapter an analysis of the current operations in Weavers was carried out and the problems facing each department were examined. Several application areas were highlighted by staff in which they felt IT could be applied to solve some of these problems. Initially a number of standalone systems were piloted. Following the success of these systems the implementation plan was to design an integrated MIS incorporating the standalone developments in order to realise the benefits to be gained in sharing data between departments. This chapter concentrates on the design, development and implementation of those systems for Weaver Construction and the problems experienced during this period.

5.2 INTRODUCING INFORMATION TECHNOLOGY INTO THE COMPANY

The interviews indicated that the level of awareness of information technology within the company was extremely low, with the exception of the accounts department. It was evident that any systems implementation to solve the problems identified could not take place rapidly. The implementation of an information system first required sub-division down into manageable, functional components. In this way staff could be shown results at an early stage in the project, thus enabling them to evaluate the progress and value of computer systems which would facilitate the acceptance of gradual changes. Based on the developed implementation model, new system developments for the company was through the pilot scheme approach. This involved introducing standalone applications in several departments to solve some of the problems that had been identified.

The objectives of implementing the standalones were to:

(i) Introduce technology gradually into the company and provide a basis for further implementation at a later stage;

(ii) Increase the level of awareness of technology and convince staff of the potential benefits of computerisation;

(iii) Provide a learning mechanism to discover the problems of introducing new technology into the company.

The two options available for introducing the standalones was either to purchase off the shelf packages or to develop the software in-house. The package option appeared to be an attractive solution in that an immediate system would be provided and documentation, training and support would be readily available. However further investigations into adopting this approach revealed that it was not a suitable option for Weaver Construction.

Standard construction packages available on the market were evaluated. It was found that these packages did not match current working practices that were used in Weaver Construction. The company was prepared to make only minor changes to their working methods and requested that computerised systems closely matched existing manual methods wherever possible. The standalones were therefore to be developed in-house to comply with the request of the company.

A starting platform from which the applications could be developed was therefore necessary. Following research into various tools a decision was made to obtain software development tools which could be used to develop `tailor' made applications which would meet the company's requirements. The package used was the SMART integrated package which links together a database, spreadsheet and a word processor. SMART allows the interchange of information between each module. The package also has its own programming language and is suitable for networking.

From the interviews many problems areas were identified, some of which, could be solved by the application of IT. One of these areas was the manual bonus system which was highlighted by both the surveying and estimating departments. The proposed advantages of a computerised bonus system in terms of savings in labour costs and improvements in working arrangements, made this area of work an important priority. As such this was the first application to be computerised.

The problems with this system and the manual operations are described in chapter 4. The computerised system will now be outlined in the next section.

5.3 THE BONUS SYSTEM

After gaining an understanding of how the manual system operates (see figure 5.1 for dataflow diagram) and the problems with it, work began on the design of a computerised system. The company had requested that manual procedures be adhered to as closely as possible. In this system large numbers of identical records had to be stored and manipulated. Consequently the nature of the problem lent itself to a solution using a database. The computerised solution involved the use of two database files, the first database (see Fig 5.2) was used to store the computerised bonus sheet and the second database (database 2) was used to store what used to be the contents of the standard targets book. These files were stored on portable computers which were then used to capture the necessary data on site. This eliminated the need for the site book and hence the double handling of data. The data captured on site in process 1 (see figure 5.1) is input by the surveyor directly onto the bonus sheet (database 1), however in place of the description of the item of work a reference number is entered. The database system is capable of performing a lookup which attempts to match this reference number to an identical number in database 2. On finding a match the description of the item of work, the unit and target and bill values are automatically retrieved and inserted into the appropriate fields in database 1. The surveyor is then required to enter pay rates for the operatives and the data necessary for process 5 (see figure 5.1).

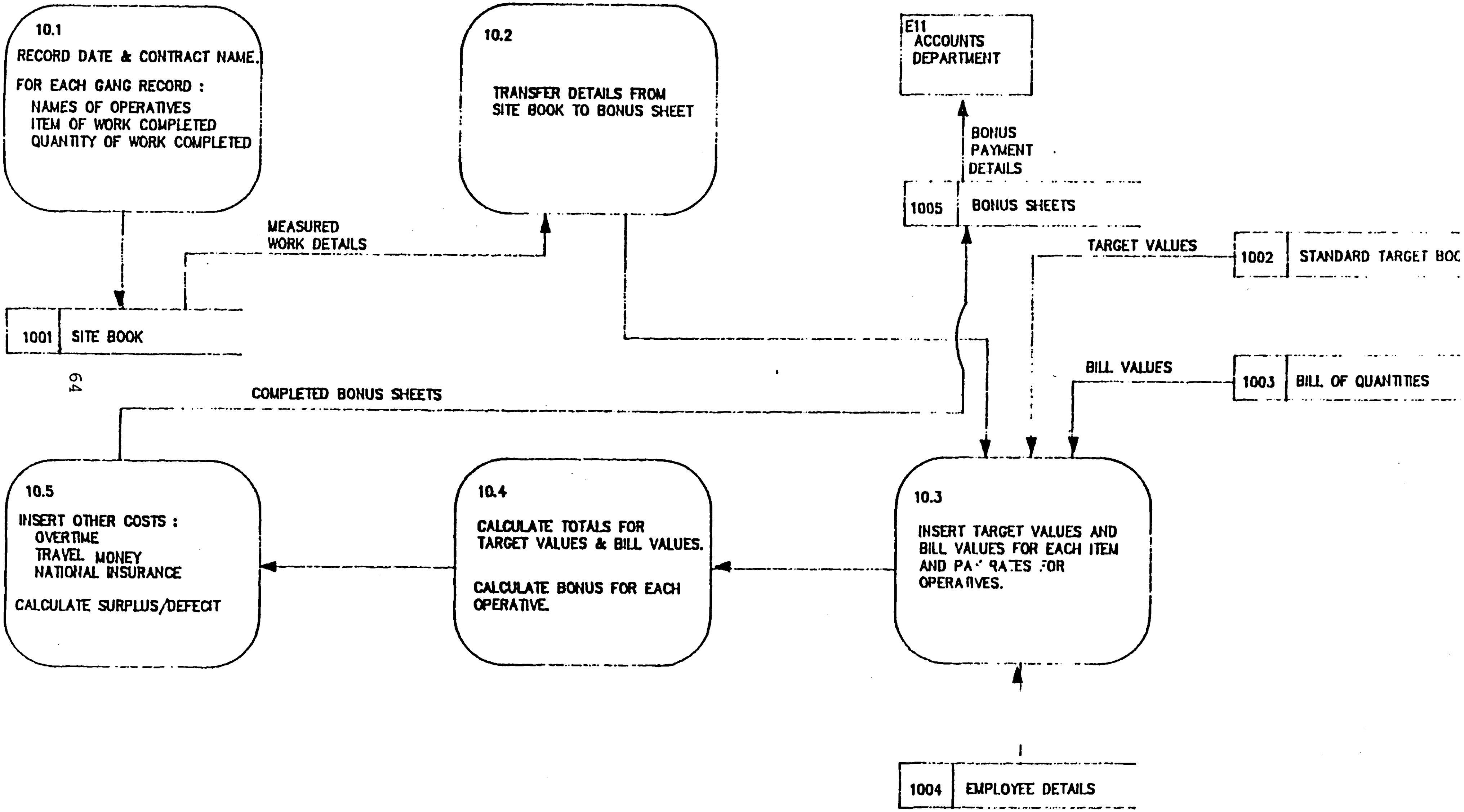


Fig 5.1 Calculate Bonus

SHEET NO.	1	W/E	10/12/89
CONTRACT	HEMSWELL	CONTRACT NO.	18158
AGENT	J.BRENNAN	NO. IN GANG	2

NAME	EMPLOYEE NO.	TRADE TYPE	HRS	RATE	TOTAL
1. R.EYRE	503	JNR	39.00	3.080	120.12
2. G.SMITH	1912	JNR	39.00	3.080	120.12
3.	0		0.00	0.000	0.00
4.	0		0.00	0.000	0.00
					240.24

PLOT	REF	DESCRIPTION	QUANT	TARGET	TOTAL	B/V	TOTAL
181	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
182	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
183	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
184	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
185	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
186	1672	Facia & soffits	1.00 No	117.00	117.00	137.00	137.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00
	0		0.00	0.00	0.00	0.00	0.00

TOTAL TARGET	702.00	TOTAL B/V	822.00
BONUS	461.76	DIRECT COST	82.20
		BILL VALUE	739.80

BONUS	1	230.88
BONUS	2	230.88
BONUS	3	0.00
BONUS	4	0.00

OVERTIME	0.00	
N.H.I.	63.18	
TRAVEL	35.20	
STAMP	30.80	
APPRENTICE COST	0.00	
TOTAL COST	831.18	

O/TIME 1	0.00	hr
O/TIME 2	0.00	hr
O/TIME 3	0.00	hr
O/TIME 4	0.00	hr

SURP/ DEF -91.38

Figure 5.2 Computerised Bonus Analysis Sheet

Consequently processes 3 and 4 are automated. The computerised bonus system allows the bonus earned by operatives to be calculated immediately and made available to site staff. This application was extremely successful as it resulted in a much more flexible bonus system in addition to producing time savings in performing routine calculations.

In addition other pilot systems were developed in the estimating department. Subsequent to the pilot schemes it was appropriate to review and appraise these systems and refresh on the original aim of the project which was to implement an integrated MIS.

5.4 APPRAISAL OF PILOT STUDIES

The development of standalone applications resulted in time savings for both surveyors and estimating assistants, allowing more work to be completed hence increasing personal efficiency.

The stage had now been reached where several applications had been developed. This included the bonus system and the individual estimating applications. The pilot schemes made staff aware of the advantages of computers and planted the first seeds which it was anticipated would grow and develop, thus bringing about a culture change.

The next stage of development was to proceed with the design of an integrated database to produce the integrated Management Information System (MIS). This was important so that the standalones could be developed as an integral part of the integrated system.

The initial company analysis whilst showing the overall flow of information from the various departments, needed to be expanded at a lower level to show more detail in order to produce a detailed database structure.

5.5 DETAILED SYSTEMS ANALYSIS

A more detailed systems analysis was carried out using a top down approach and levelled DFDs. Processes on the context data flow diagram were partitioned into subsystems, thus producing a lower level of detail. This process was repeated until the required level of detail was achieved. Information regarding each data item was entered into a data dictionary.

The data dictionary can be used to describe any part of the data flow diagram, including any data files and processes. From the data flow diagrams and data dictionaries it was possible to identify data interfaces between management functions. Additionally it was also possible to establish:

(i) data which were to be used in their original form;

(ii) data which needed amending to suit specific tasks and suitable formats for processing purposes;

(iii) data which were redundant;

(iv) data which were repetitious;

(v) the extent to which new data would be created by the management functions.

A selection of data flow diagrams and data dictionary are included in Appendix 1 and Appendix 2 respectively.

5.6 DESIGNING AN INTEGRATED DATABASE

The data flow diagrams and data dictionaries form a basis for the initial design of the integrated MIS and allow data files to be identified for computerisation. The integrated database was to comprise a collection of data files which can be linked together using common data fields. The database was to encompass the functions of estimating, surveying, planning, buying, bonus and management accounts. The previous developments of standalone applications were not to become redundant but were to be incorporated into the database design.

These data files had to be analysed to ensure that the data held could be linked and integrated to other parts of the database structure. In some cases the file structures had to be amended in order to establish the required links into the integrated database. The integrated database design was to be developed using the SMART development software and implemented on a computer network as this would allow the computers in each department to be linked to a central database housed on one computer. Within the SMART database system several facilities exist to relate data and obtain various combined forms, thus allowing management information to be generated which was not previously possible.

Implementing the integrated database design on a network would bring many benefits. Data would only need to be entered into the system once, and all the users would have access to the same data for their information requirements. Similarly for maintenance purposes, data updating would only be required once, after which, all users would gain access to the same updated information. Additionally, with a centralised database, it would be possible to generate reports that had not already been identified in addition to creating ad hoc files to suit specific information requirements. Time savings would also result as there would be no need for data to be transferred from one department to another.

5.7 PROPOSALS FOR FURTHER IMPLEMENTATION OF TECHNOLOGY

Prior to pursuing a networked system utilising the central database, an assessment of costs and benefits was made. Concerns were expressed about the extent of computerisation and changes brought about by the new technology and mode of operation.

Consideration at the same time was made of further standalone system developments and costs and benefits were made of these alternatives in addition to the integrated management information system. An outline of these assessments are shown in Appendix 3.

The costings shown in the Appendix indicate that the differences in cost between the standalone route and the integrated design were minimal. In fact the integrated database would be the cheaper route in the long term if the company was to expand its computing facilities.

5.8 A PARTIALLY INTEGRATED SYSTEM

Based on an assessment of further system development, the work carried out was the development of a partially integrated system. This comprised a continuation of developing standalones only with limited exchange of departmental data. It was therefore decided to use the integrated database design, but only to develop certain sections.

By using this approach standalones could be developed using the appropriate files specified in the database design. Partially integrated systems could also be developed using data in files from different parts of the company.

Appendix 4 contains details of some of the systems developed using the integrated database design.

5.9 IMPLEMENTING THE SYSTEM

After each system had been designed and developed, the implementation of systems followed three main stages:

(i) Training personnel

(ii) Conversion procedure

(iii) Post Implementation Review

These stages will now be discussed in the following sections.

5.9.1 Training the Staff To Use the System

All staff involved in using computer systems at Weaver Construction had to undergo training. This included in-house training and a general computer appreciation course. In-house training took place before the final installation of the system. The purpose of in-house training was to:

(i) provide staff with an understanding of the systems they were operating. This involved familiarisation with application, data capture, data handling, and information retrieval from the systems;

(ii) inform the staff of the tasks they would perform and the responsibilities to be undertaken in order to maintain the integrity of data.

The general appreciation courses were run at a much later date in the project when many of the system had been implemented. The courses were administered by experienced trainers at Sheffield City Polytechnic and covered the topics of databases, spreadsheets and MS-DOS operating system. The purpose of the general appreciation course was to:

(i) to give current users of the systems a broader perspective than they might have gained from the in-house training and to cover aspects other than their own area of work;

(ii) provide users with additional training in areas which they appeared to be experiencing frequent problems;

(iii) to provide future users with a background knowledge of the systems installed and allow them to establish confidence in using computers.

Staff were classified into one of three groups: expert, average and novice according to their experience. Staff with similar amounts of expertise in the subject areas were grouped together. The siting of the training courses at Sheffield City Polytechnic removed the problems of interruptions which occur in the work environment and also ensured that adequate resources which were in short supply and in great demand in the company, were available for all the members of staff. Subsequent interviews with the staff regarding the general appreciation courses indicated that they had perhaps taken place at the wrong time. Current users felt that courses would have been more beneficial prior to systems installation, or soon after. Some users felt that the courses were too early and the procedures they had learnt would be forgotten by the time their systems were installed.

However, positive feedback was also received. The current users of the systems felt they had a better understanding of how the applications they were using worked. The prospective users felt their level of awareness of computer systems had been increased.

5.9.2 From manual to computerised systems.

System conversion is the process of changing from the old system to the new system. It is a very complex process requiring careful planning and preparation. This situation is highlighted in a similar study(1) of ten small companies operating in the UK construction industry also implementing computerised MIS.

In this study all systems were piloted, and based on feedback, changes were made and systems refined until they satisfactorily met user requirements. A transition phase was also required where systems would then be run in parallel with the old systems to fully ensure correct operation of the new systems. Other activities that took place during conversion were to convert all manual files to computerised files. In some cases the new files required additional data and involved a extra work to input data into the computer. Batch control methods were employed to ensure that all the necessary records had been entered onto the computer.

A post implementation review was also necessary to obtain feedback on all systems implemented to determine if they were operating correctly and how the system had been accepted into the company. The results of the post implementation review are discussed in chapter 6.

5.10 SUMMARY

In this chapter the design, development and implementation of the computerised MIS was described. Because the level of awareness of IT in the company was low, technology was introduced gradually into the company by means of pilot systems. These proved to be successful in terms of increasing staff productivity and facilitating a more flexible approach to working. Following the introduction of the standalone pilot systems, work proceeded on the design of an integrated database which incorporated the existing systems. At this stage the management of Weaver Construction decided that they did not want to proceed with the implementation of the integrated MIS and were satisfied with continuing along the standalone route. A costing exercise was carried out comparing the costs which would be incurred for both the standalone and integrated database approaches to further systems development. The differences in cost were in fact minimal, however the company were still determined to continue with the standalone approach. Further work was on the basis of the integrated database design but developing only the required sections. This meant that if the company did decide at

CHAPTER 6

POST IMPLEMENTATION REVIEW: DATA COLLECTION AND ANALYSIS

6.1 INTRODUCTION

As discussed in chapter 5, Weaver Construction have managed to achieve only a limited implementation of their integrated system. Many standalone modules have been successfully implemented together with 'mini' integrated systems.

In chapter 4 we see that Weaver Construction was established over seventy years ago and has developed expertise in managing successful contracts. The skills and methods developed have been based on manual operations which tend to be separated into various departments and sub-sections. One of the largest inhibitors to systems implementation was the attitudes of the people working at Weaver Construction. This chapter describes the development of a suitable attitudes measurement instrument and the analysis of the information derived using the instrument. These results, together with data collected from observations, meetings and informal discussions provides a large database of information which forms a basis for problem identification.

Before discussing the development of the attitude measuring instrument it is important to identify the constituent components of an attitude in order to understand how it was formed and how it may be measured.

6.2 ATTITUDE FORMATION AND CHANGE

Attitudes can be described as having three components(1):

(i) a cognitive component i.e. an attitude based on real or assumed knowledge about the object;

(ii) an effective component i.e. an attitude includes a feeling or emotional response to the object;

(iii) a behavioural component i.e. an attitude implies a predisposition to act in a particular way towards the object.

In developing an attitude measuring instrument it was important to ensure that all three attitude components could be determined. The first two components can be measured directly by using the instrument and the third component by observing staff behaviour. The ways in which attitudes are formed are now examined. There are three main sources of attitude formation [2]:

(i) early socialisation - attitudes that can be traced back to childhood;

(ii) group affiliation - attitudes formed through influence of friends and colleagues;

(iii) personal experience - events which occur and mould views and perceptions.

Attitude change involves replacing an old attitude with a new one. Attitudes are difficult to change because they are normally associated with reward. Unless the adoption of a new attitude will bring greater reward then people will be reluctant to change their attitudes.

Armstrong and Dawson suggest the following reasons for attitude change[3]:

(i) additional Information - the likelihood of additional information leading to attitudes change is significantly affected by the source and the nature of that information;

(ii) changes in group affiliation - attitude change as a result of change in group affiliation is affected both by the centrality of the attitude to the group and the importance of group membership to the individual;

(iii) experience - experience can be a very powerful source of attitude change.

Having discussed the components of an attitude and its formation, the development of a suitable method to determine attitudes towards computerisation will now be discussed.

6.3 METHOD USED TO DETERMINE ATTITUDES TO COMPUTERISATION

Initially various existing instruments that had been developed for measuring attitudes towards computer systems implementation and user satisfaction were examined. Doll and Torhzadeh [4] developed a twelve item instrument to measure End User Computing Satisfaction which can be used to evaluate the effectiveness of the design and implementation activities. A five point Likert scale is used where 1 = almost never and 5 = almost always and respondents are asked to indicate which response best describes their satisfaction regarding each of the twelve items e.g. Does the system provide accurate information? Davis[5] developed a scale for measuring perceived usefulness and ease of use which are hypothesised to be fundamental determinants of user acceptance. This instrument also requires respondents to indicate their response using a Likert scale. The use of both measuring instruments involves complex statistical analysis to enable the researcher to draw useful conclusions.

These instruments are therefore appropriate in studies where a large sample is available on which the statistical calculations can be performed. In this study the sample size is small and therefore the instruments described are unsuitable.

The most appropriate method of collecting data for this small sample size was that of structured interviews which allow analytical generalisations to be made. Structured interviews offer a number of advantages that make them a popular attitude evaluation tool[6] :

- new lines of inquiry can be pursued on the comments of the respondents;
- they also allow for an estimation of the strength of an attitude.

In order to design and conduct effective interviews the following guidelines proposed by Henerson et al were used (7):

(i) identify the attitude objective(s);determine what useful information the interview might provide;

(ii) decide on the structure and approach of the interview;

(iii) decide on the number and sequence of questions;

(iv) draft questions and critique them;

(v) decide how interview is to be summarised and reported;

(vi) add the introduction and probes, and choose a recording method;

(vii) perform a test run.

Because the information required had been predetermined the interviews were highly structured with a set number of questions to be answered in a particular sequence.

A mixture of open and closed questions were used, open questions allow for a wide range of responses whereas closed questions produce specific answers. A sufficient number of questions were asked as was necessary to derive the required information. The questions were grouped into four sections. These were:

- use of computers; the questions in this section served the purpose of determining staff knowledge on the use of computers i.e. the cognitive component of an attitude.

- implementation and training; the questions in this section were designed to determine the staff feeling and response to the implementation and training aspects of the computer systems i.e. the effective component of an attitudes.

- advantages of computers; these questions were designed to determine how the user felt regarding using the computer, what were the perceived benefits, disadvantages and problems i.e. the effective component of an attitudes.

- future; these questions were designed to determine the users perception of the growth and development of computer systems in the company i.e. the effective component of an attitudes.

Each section consisted of specific questions as described, arranged in a logical sequence which were designed to measure specific variables. Care was taken to ensure that the questions were appropriate, unbiased and gave the opportunity for the interviewees to express their feelings and opinions.

Two interview scripts were designed, one being appropriate for the current user and one for the prospective user. In order to analyse the data the responses from each interview were summarised and grouped together for the different categories of respondents as shown in Appendix 5. This allowed patterns among the attitudes to be identified.

The questions were pre tested on several people who were not participating in the interviews to ensure against ambiguity and that the questions provided the required information.

When administering the interviews the respondents were informed of:

(i) the purpose of the interview;
(ii) how the information was to be used;
(iii) what was expected of the respondent.

Each interview was recorded on tape and later transcribed. This enabled the interviews to be summarised using exact quotes from the respondents and ensured that data was correct and a true record of what had been discussed.

The issues of reliability and validity of the data derived from use of the instrument are also important and will now be addressed.

6.4 RELIABILITY AND VALIDITY OF DATA COLLECTION METHOD

Reliability relates to the methods ability to yield consistent results i.e. to produce the same results every time it is administered[8]. In this study it is not however possible to assert reliability since the interviews were conducted at a particular time during an event i.e. at a particular stage during the implementation of the system. Whilst the results provide valuable information and insights, it would not be possible to achieve similar results at a different time as attitudes may have changed.

Validity refers to the methods appropriateness for what is being measured. Henerson et al [9] describe several approaches to determining if a method is valid. Two of these approaches are those of construct validity and concurrent validity.

6.4.1 Construct Validity

Construct validity refers to how well the method measures what it claims to. To ensure construct validity the interview questions were shown to various individuals without informing them of their purpose. The individual conclusions about what the method was measuring closely agreed to the actual construct being measured. i.e attitudes towards computer systems and implementation.

6.4.2 Concurrent Validity

Concurrent validity is determined by comparing the data obtained from the method with results from other methods to measure the same thing. This validity was ensured by comparing observed behaviours, data derived from informal discussions and meetings with the results from the measurement method. It was found that these compared favourably thus demonstrating concurrent validity.

6.5 APPLICATION OF THE ATTITUDE MEASURING INSTRUMENT

A number of staff were interviewed in order to determine the perceptions and attitudes of different groups and individuals towards systems implementation and how successful they felt it had been.

The staff were interviewed after the pilot studies had taken place and the integrated database had been designed and include:

(i) five current users of systems that had been implemented;

(ii) six prospective users of systems at the Mexborough office;

(iii) informal interviews and discussions took place with the directors of Weaver Construction. Data was also collected from management meetings.

Although the sample size appears to be very small, the firm involved is rather small and the sample therefore represents a relatively large proportion of people. From the interviews it has been possible to distil the general attitudes and opinions of staff regarding the computer systems. These have been summarised in Appendix 5. The interview results together with data collected from informal discussions, meetings and observation provide a platform of information for the identification of the implementation problems. This information will now be discussed in three separate sections : current users, management and prospective users.

6.6 CURRENT USERS : ANALYSIS OF DATA

6.6.1 Response to new computer systems

The majority of respondents enjoyed using the computers, the reasons being that it produced a more professional output, added variety and interest and was much quicker than performing the job manually. Only one user, a quantity surveyor felt indifferent about the use of computers, largely due to the problems he had experienced with the subcontract payment system. The subcontract payment system had undergone a number of post implementation changes in order to meet the requirements of other departments. Previous to the installation each surveyor had been responsible for manually processing their own subcontract payments certificate. When the system was installed only one surveyor was delegated the responsibility of processing all certificates. However due to the extra workload it had not always been possible for this one person to process all the certificates required. Consequently some surveyors who had no training were using the system and accidentally corrupting data files. Others were still processing the certificates manually. This caused many problems in maintaining data integrity. Due to the large number of problems experienced with the subcontract payment system, the user mistrusted the system and felt indifferent about using it. This example highlights the importance of informing users exactly what is expected of them before the system is installed. The user and other surveyors were confused about the new duties which led to a crossing of areas of responsibility. This highlights the importance of clarifying new system boundaries. Failure to do so can result in conflict and ultimately can lead to system abandonment.

In the case of the bonus system, changes had been made to allow the system to be integrated with systems in other departments. This involved inputting more data than had previously been required. The user did not welcome this change as the increased workload did not equate to any reward. However he felt that once the systems were integrated, the benefits of sharing information would become more apparent. The majority of users felt the computers had made their jobs easier by speeding up tasks that were previously performed manually. All the interviewees felt the computer systems had increased the competitiveness of the company, particularly the estimating department. Their ability to tender for more jobs was crucial in the recession because their hit rate had decreased as there was increased competition for a fewer number of jobs. Also because competitors in the industry were introducing I.T. it was perceived important for the company to also respond and exploit computers to remain competitive. All the interviewees felt that their job prospects had been enhanced. Most modern offices were using computer systems and they believed it was vital to keep abreast with current trends.

Sixty percent of staff were happy with their systems and could not suggest any changes. The members of staff that were using the bonus system and the subcontract system suggested the following changes, increased reporting facilities to provide better feedback on site progress and more validity checks on input data respectively.

It was not envisaged that computers would play a major part in the company's growth and development. This was largely because progress could only be made if top management support was given to a project of this nature. Staff felt support was lacking due to the minimum amount of information that had been imparted down from senior management regarding the new system implementation.

Developments might occur in the departments where the departmental director was aware of the potential of computer systems and therefore in a position to exploit information technology. The staff were aware that the majority of the directors were unconvinced of the benefits of I.T. and felt that until this occurred there was little hope that further systems implementation would occur in the company.

One interviewee suggested that the recession had held back I.T. developments due to a lack of resources and did not envisage any further developments until an economic boom.

6.6.2 Knowledge of IT

Almost all respondents had previously used computers at school or college. However for most interviewees a considerable time period had lapsed since having last used a computer. They therefore felt that any previous training could be disregarded as they were unable to recall what they had learnt and had also had little opportunity to gain any practical experience.

Although the respondents perceived that their previous experience of computers was irrelevant, it was noted that they initially found it easier to adapt to using the new computer systems and were less apprehensive than the staff who had never used computers.

Because the company had stipulated that computerisation follow existing manual methods, there was little scope at the system design stage for staff participation except to provide information as to how the current system operated. The staff were also unaware if the present system was the right one to computerise as they did not have the necessary expertise to realise what would be technically feasible. During the development stage the staff were encourage to contribute to items such as the layout of their screens and the format of their reports.

In all cases the respondents felt they had made sufficient contributions to the systems development work. However one interviewee, having never used computers found it difficult and was afraid to make any significant contribution. Consultations regarding systems implementation took place largely with the systems implementor, though the estimating director had informally discussed the prospective developments with the departmental staff.

The users felt they had been adequately trained how to use their systems but unaware of the developments occurring in other departments. They suggested an awareness course on I.T. developments in the company as a whole would increase their ability to exploit I.T., enable them to help users in other department with implementation problems and encourage more inter- departmental teamwork. All the users received in house training before the systems were implemented and formal training on spreadsheets, databases and MS-DOS at the polytechnic after systems implementation. Many felt the formal training had increased their understanding of the systems they were currently using. However the staff felt that they should have attended these courses prior to systems implementation even though it was thought that they would have not performed the training exercises as successfully as they had done. Some felt training on troubleshooting and problem solving would be beneficial. The users were aware that the systems implementor was in the company only for a short period of time, after which there were no formal plans to recruit I.T. staff who would provide systems support. Several staff were particularly concerned about this and therefore were eager to learn as much as possible about the systems operation and to attempt problem solving themselves before consulting the systems implementor. In the surveying department the view had often been expressed that once the systems implementor left the company and problems occurred with the computers that staff would return to manual methods. The concern about the lack of post implementation support may have hindered progress and willingness to use the systems.

6.6.3 Impact on job functions

The organisation assuming a hierarchical structure dictates that job functions within the company exist as well defined roles which follow rules and procedures. Staff know exactly what is expected of them and understand their function within the company. None of the staff felt that the computer had brought about a job redesign. The computer was seen as a substitute for manual methods which would simply speed up tasks. The implementation within the company was intended to follow the manual systems wherever possible. However in some cases the input data had to be converted into a form suitable for the computer to process. It was also necessary that additional data be entered in order to establish links between files and generate additional management reports. This was true in the case of the bonus system. The new systems demanded a change in the well defined role. The staff now needed to know how to accumulate and exploit information in a wide variety of ways rather than in one particular area.

The staff did not welcome this change. They found it difficult to anticipate the benefits of the new systems, did not feel it was of relevance to themselves and therefore were unhappy about doing extra work.

6.7 MANAGEMENT: ANALYSIS OF DATA

6.7.1 Response to new computer systems

Whilst standalone systems were being implemented in the company the management were happy to leave the design, development and implementation aspects to the systems implementor and the users. The managing director and estimating director were the project champions and had originally proposed the introduction of I.T. into the company. These two members of staff would attend quarterly meetings at which developments to date and the strategy for the following quarter would be discussed. Progress would then be reported to the board of directors. The management gave their full support for the pilot schemes but preferred to have minimum involvement and assumed a consultative role. Subsequent to the implementation of the standalone systems the accounts director assumed the role of the project champion, taking over the estimating director.

When the integrated system had been designed and a proposal put forward to implement it, much resistance was presented particularly from the accounts director. The accounts director was keen to see an assessment of tangible benefits in monetary terms. Many of the benefits from the system were of an intangible nature, such as increased staff job satisfaction and a perception of increased efficiency to outside companies. These benefits were impossible to quantify. Without the support of top management support, particularly one of the project champions, it was impossible to proceed with the implementation of the integrated system. The accounts director felt that the system would be too expensive and was concerned about management of the database and ensuring data integrity. Although the integrated system was not implemented the result was a partially integrated system. This was an option half way between standalone systems and a fully integrated system.

6.7.2 Knowledge of IT

Only two directors attended just one of the three training courses that were organised for the company staff. Many appeared reluctant to gain the knowledge required to be able to realise the potential I.T. could offer. They had been with the company for many years, had little exposure to computers and so far reached top management positions without the use of I.T. Many of management perceptions of I.T. were somewhat outdated, however without the appropriate training it was impossible to change those perceptions. Management did not see the need for them to become IT literate and felt it was only necessary for the staff operating the systems to attend the IT training courses.

6.7.3 Impact on job functions

The prospect of an integrated system presented a perceived threat to management job functions. The standalone systems did not require any change to the organisational structure whereas the integrated system demanded a change in the organisational boundaries as it required the information to be shared and exploited in different ways. Some of the management were using information as power. They wanted to control the information coming in and going out of their departments. An integrated system required information to be shared and viewed as a corporate resource. Control would be inherent in the system and effectively transferred to the computer. Managers would no longer retain the same level of control over information. It is not surprising that the proposal of the integrated system encountered so much resistance.

6.8 PROSPECTIVE USERS ANALYSIS OF DATA

6.8.1 Response to new computer systems

The respondents attitudes to using computers in their jobs were very mixed. Forty nine percent wanted to use computers because they felt the company should be advancing with technology so that they would not fall behind their competitors in the industry and also believed the computer would perform the tedious parts of their work. Seventeen percent, did not want to use a computer in their job. They felt the introduction of a computer would remove control they had over the job and be any mistakes made on the computer would be magnified. The computer was perceived as a threat to job security and so barriers were presented as to why the systems implementation should not continue.

Another surveyor felt that the computer would impose a tighter control on operations and it would be more difficult to hide mistakes. As such he only wanted to use the computer for a limited number of functions, for example subcontract payments. All respondents however, expressed that they would do whatever was required of them by the company even though they may not particularly be in favour of computerisation.

Eighty three percent of the interviewees perceived that the system would make their jobs easier, of these thirty three percent expected difficulties in the initial installation period whilst learning the new system.

The general feeling was that the systems would not bring about a job redesign. The systems were viewed as a tool for speeding up manual tasks. It was perceived by most respondents that the computer systems could increase competitiveness of the company by increasing productivity. The interviewees did not envisage each department having its own computer system and did not believe that integration would occur in the company. They felt that unless a departmental director was prepared to encourage developments and was in favour of computerisation, little progress would be made in that department.

6.8.2 Knowledge of IT

The majority of respondents, namely eighty-three percent had previously been exposed to computers. Sixty percent of these had used computers in further education. However they could remember very little of what they had learnt because of the lack of practical experience and the time period that had lapsed since having using the computers. This was over two years for the majority of respondents. They perceived their knowledge of computers to be extremely limited. Only one respondent had never used a computer and could not perceive how a computer could be used in his job.

Thirty three percent of respondents were aware that rapid advancements are taking place in I.T. and felt that they were being left behind other firms in the construction industry. The staff felt pressurised by the external environment to adopt and participate in the developments in I.T. The lack of knowledge displayed by the respondents was due to the limited exposure to computers at school and in their previous workplaces. This was not a problem amongst more recent school leavers who use computers at an earlier age as part of their education.

6.8.3 Impact on job functions

Although it was not perceived that job functions would change, some interviewees who had experienced systems implementation in other firms, envisaged that computerisation would be accompanied by an increase in workload in converting the data to a suitable input format. They were concerned that too much time would be spent inputting information and were unsure if they would reap any of the benefits to be gained by their increased effort.

6.9 CHAPTER SUMMARY

This chapter has focused on reporting the attitudes and views of current users, management and prospective users of the systems implemented in Weaver Construction. The information was collected mainly through use of an attitude measuring instrument designed to capture the cognitive and effective components of an attitude whilst behavioural component was recorded largely through observation.

Current users perceived the systems implemented in Weaver Construction as being computerised versions of the manual systems that were previously in operation. The majority of staff viewed their systems favourably as they had increased productivity and enabled them to acquire new skills thus increasing job prospects. Throughout the interviews the lack of awareness of a company I.T. implementation plan was highlighted, the users being informed only of what was occurring in their own departments. Consequently they found it difficult to conceptualise an integrated system and any future I.T. developments in the company. This also caused problems in the cases where additional data was required for the computerised systems, because the user could not visualise any benefits and reward associated with the increased workload.

Many of the manual systems at Weaver Construction had been introduced by the current directors of the company. As such they felt a sense of ownership over these systems. These methods had been seen to work well in the past and had brought rewards without the use of I.T. The directors therefore felt that in implementing I.T. into the company it was not necessary to change the systems but to simply computerise the manual methods. An integrated system would have required information to be shared and exploited in a different way to the manual system. The directors were unconvinced of the potential an integrated system had to offer. It required the individual departments to become a part of a larger system that would destroy individual established departmental empires. Whilst the standalones were accepted and used, there was a strong resistance to the proposed integrated system from top management.

The majority of prospective users welcomed the prospect of using standalone systems in their jobs. They had seen other members of staff using computers and felt that they too should be given the opportunity to learn new skills and adopt the new technology. Some perceived the computer would make their jobs easier by performing the more mundane tasks and increasing productivity. Others felt it would impose tighter control and hence it would become more difficult to hide mistakes. The staff did not envisage an integrated system for the future. They felt that they had little control over systems development work and this would be something the departmental directors would decide.

A similar piece of research identified earlier and undertaken by Wroe[10] to determine the variables relating to successful implementation of computerised MIS in construction companies supports the findings. The variables derived are categorised as organisational, application and system developmental variables and the study examines how each variable influenced the selection, implementation and live operation phase. Organisational variables include internal skill and support level, administrative and managerial slack. Application variables include functional systems gap, ie degree of change, functional simplicity, systems support base. Systems development variables include MIS strategy and involvement of staff. Hence Wroe's research identifies many variables common to this study.

DEVELOPMENT OF A NEW IMPLEMENTATION MODEL

7.1 INTRODUCTION

In Chapter 6 the results of interviews with staff regarding the implementation of the integrated management information system were discussed. These results were analysed in order to identify the problems associated with implementation.

In this chapter the advantages and deficiencies of the implementation model are examined. Extensions to the model are proposed in order to overcome the problems identified in chapter 6.

7.2 THE MODEL EXAMINED

7.2.1 The Positive Attributes Of The Implementation Model

The positive attributes of the implementation model can be classified under a number of headings as follows :

7.2.1.1 The Pilot Scheme

As discussed in chapter 2 the model adopted involved user participation wherever possible in all stages of the Software Systems Life Cycle. Having interviewed staff it was evident that they were unsure as to what their requirements for a new system would be. The users did not have the necessary knowledge and experience to understand how to exploit IT. Several pilot schemes were introduced in the estimating and surveying departments which were prototypes of applications identified as being suitable for computerisation. The pilot systems were extremely successful in that they increased the level of awareness of IT and acted as a catalyst for further and more complex systems implementation. The pilot systems also removed the perceived threats to the users, generated by fear of the unknown. The users were then in a better position to identify their requirements and contribute to the design of the integrated system. The pilot schemes had also equipped staff with the appropriate knowledge and experience for further computer usage. The pilot schemes was therefore of great value in involving all prospective users. This indicated that staff cannot be expected to make any significant contribution to systems design and development without first being given the opportunity to explore and discover the potential of I.T.

7.2.1.2 Staff Training

In addition to the pilot schemes, staff training was organised at the stage when the integrated system was being designed. The training encompassed MS-DOS, spreadsheets and databases and involved current users, prospective users and management. The prospective users felt more confident about using computers and become more receptive to the idea of the new systems. However, the prospective users felt that they would need re-training as in some cases there was a considerable time gap between the course and the time of installation of the system. They felt that after a period of longer than three weeks subsequent to training, they would be able to recall little of what they had learnt.

The current users of the system felt that having already gained confidence in using the systems, the courses had provided them with the knowledge and understanding of how to exploit their systems. They also expressed the view that a brief introductory course to spreadsheets, databases and MS-DOS would have been beneficial prior to implementation, followed by a more detailed course after implementation. This suggests that training should be an ongoing part of the systems development that occurs at various stages of the software systems life cycle, as training needs continuously change.

7.2.1.3 Systems Designed Using A Logical Model

The systems developed subsequent to the design of the integrated database used a logical approach as opposed to the traditional physical design approach. The physical design model is essentially a piecemeal approach to systems development whereby systems are designed on an ad hoc basis as and when required. This approach does not facilitate integration of systems and consequently exchange of data without re-modelling in order to meet individual system needs. By using a logical approach to design, data is in a centralised store which is accessed by all the department's systems rather than each system having its own data files. As described in Nolan's Model in chapter 3, the stage of maturity is the ultimate goal to achieve, where full integration of company systems is achieved. This occurs not only in the physical sense, ie a computer network linking departments together, but also at an organisational level where staff view data as a corporate asset where departmental barriers to sharing data no longer exist.

It would be foolish of any company not to consider an integrated system even if at the outset only efficiency gains and the computerisation of only limited functions were a priority. Any standalone systems should be designed with a view to future integration with other systems. Adopting this approach should avoid costly enhancements which would need to be made at a later stage in order to achieve the desired exchange of data. Indeed, this has been a common problem in many firms and has served only to damage user confidence and re-inforce the belief that computer systems do not yield value for money.

Integration and the sharing of data both inter and intra companies is the way forward for the construction industry. If integration cannot be achieved internally then sharing data externally becomes extremely complicated if not impossible.

7.2.2 The Negative Attributes Of The Implementation Model

The negative attributes of the implementation model can be classified under a number of headings as follows :

7.2.2.1 Resistance To Change

Although resistance to change was anticipated at the start of the project, it was expected to be mostly from the staff at lower levels of the hierarchy who were using the systems. This problem was addressed by the use of pilot schemes and user involvement which led to acceptance of the systems implemented by the majority of staff. All the staff stated that they were willing to do whatever the company required of them with regard to training and using new systems. This attitude, coupled with the introduction of the new systems using pilot schemes and appropriate training, adequately dealt with the resistance to change at the lower levels of the hierarchy. What had not been foreseen was the reluctance from senior management towards the integrated system. When the implications of the integrated systems were realised several directors and senior managers opposed the development and requested that further developments were to be on a a standalone basis.

The proposed integrated system presented a challenge to the established departmental boundaries. A number of the directors had been with the company for over ten years and had introduced many of the working practises in operation and as such felt a sense of ownership over certain manual systems. The new system involved a change in working methods and required information to be exploited in a different way. Certain managers perceived a threatening situation by the prospect of storing all company data on a centralised database to which all staff could have access. With manual system, management could control what information came in and out of their respective departments. A centralised database would have removed ownership from individuals and would have removed traditional departmental boundaries. The standalone systems were acceptable because they did not present a challenge to the normal working methods. By using the computers as standalone systems the company was not reaping the full benefits and potential that could have been available with the integrated approach. The implementation model, although giving adequate attention to resistance from users, had failed to address the problems experienced by management. The threats to the manager's existing powerful positions within the company had not been considered and appropriately addressed and hence they resisted the implementation of a fully integrated system.

7.2.2.2 Lack Of Planning and Communication

There was a lack of both long term planning and communication of short term goals. The construction industry being one which is reactive to the economic climate is not a proactive industry which is accustomed to long term planning.

The implementation was conceived as a short term project of two years' duration. Little consideration had been given to what would happen after systems implementation. The interviews with staff revealed that they were concerned about the absence of any in-house user support once the systems implementor had left the company. In one case a user held the belief that once problems occurred with the system, staff would return to using manual methods. Some users were eager to learn more about the system shooting in order to be able to solve their own problems. However for the user of the sub-contract payment system, the concern about lack of post implementation support had hindered acceptance of the system. The user did not want to invest time and effort in mastering and exploiting the potential of the system in order to provide better and more accurate information, as it was perceived as being a short term investment.

The short term goals were also not communicated throughout the company. Staff were unsure about what was expected of them. In the case of the sub-contract system this led to a crossing of areas of responsibility about who should be entering data into the computerised system. As such data were corrupted and had to be restored before usage which damaged user confidence.

7.2.2.3 Systems Not Viewed Cross Functionally

One problem that occurred concerned the sub-contract payment system. This had been revised after implementation to meet the requirements of the accounts department who were the recipients of the information generated. This indicated that during the design, systems must be viewed cross functionally. The perspective gained by interviewing each member of staff involved in using a particular system was too narrow. This suggests that prior to finalising design, systems must first be viewed cross functionally in order to satisfy user requirements. This point re-inforces the value of adopting a systems approach which was highlighted in chapter 3. It is important to examine all aspects of interaction between sub-systems assessing the nature and strength of the interaction.

7.2.2.4 Lack Of A Shared Vision

Many of the staff also felt that they knew little about developments occurring in other departments or the development plans for the company as whole. The lack of teamwork between departments had been highlighted in the initial systems analysis. It was felt that more teamwork would have helped the staff gain a shared vision of the integrated system. Staff could have also supported each other with system problems and gained a increased understanding of how to utilise the new systems.

7.3 EXTENSIONS TO THE MODEL

Having identified both positive and negative attributes of the implementation model used, further extensions to the model can be proposed in order to overcome the problems encountered.

Although the technical capability existed to realise the fully integrated system, the company staff were not ready to make the change from standalone to a fully integrated system. With reference to Nolan's Model, the transition from 'Computer Management' to 'Information Management' had not occurred. Whilst the technical aspects of the implementation were effectively managed, the organisational dimension was not.

By far the most significant problem was resistance to change from senior management and their lack of participation in the implementation of the integrated system. Without top management commitment, finances will not be committed and the enthusiasm and motivation vital for a successful implementation will not be transferred to staff at lower levels of the organisation. Although measures to overcome resistance to change were put in place, these were insufficient and a more effective organisational change programme was required.

The following measures aim to revise the original implementation model discussed in chapter 3, building upon the strengths and minimising the weaknesses highlighted earlier in this chapter, thus allowing the transition from 'Computer Management' to 'Information Management' to occur. The new implementation model incorporating the proposed extensions is shown in figure 7.1.

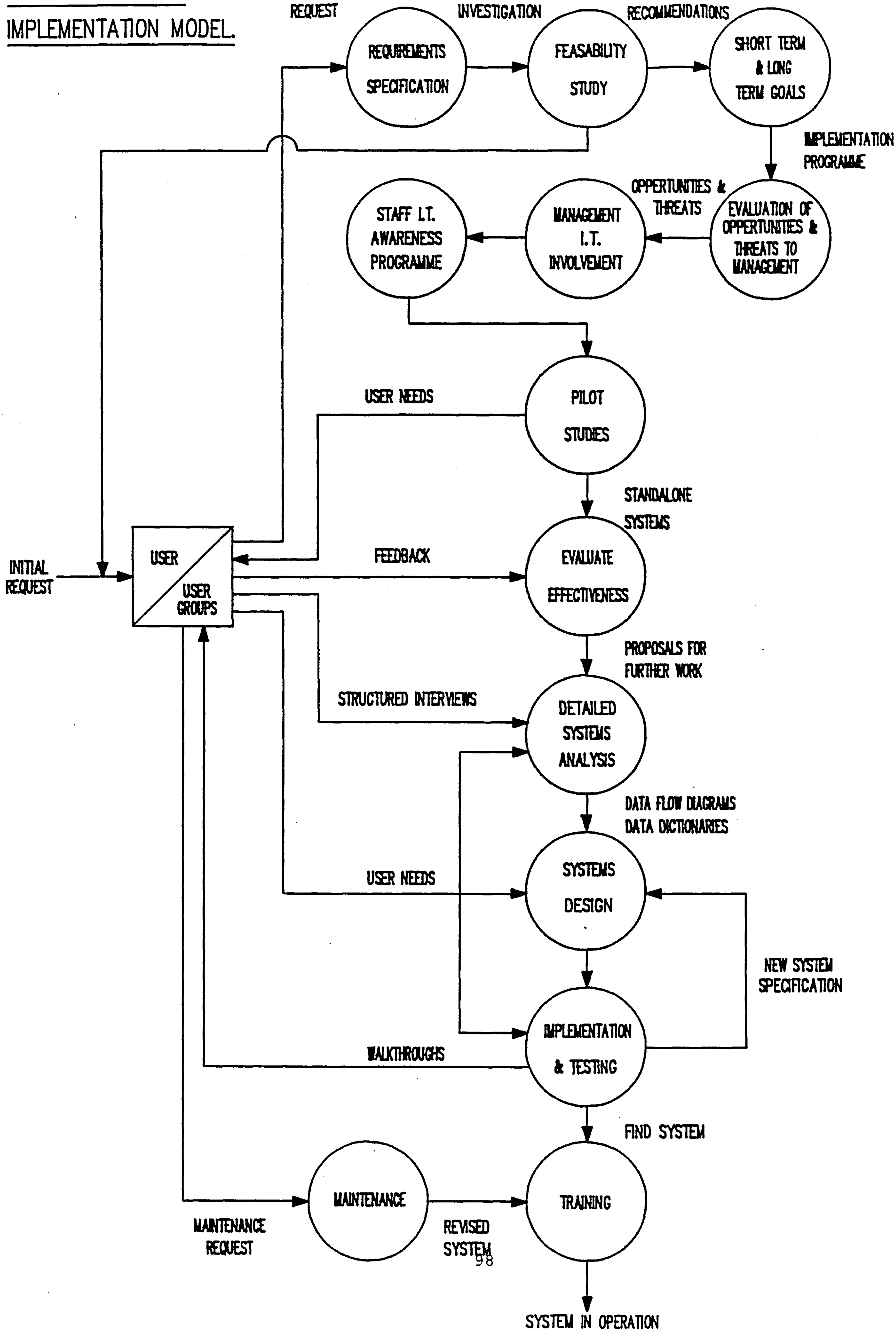
7.3.1 Evaluation of opportunities and threats to management

Opportunities and threats to managers regarding the new system should be evaluated. Each manager should be interviewed individually in order to determine the perceived threats. An IT awareness programme specifically designed for management should be aimed at removing these threats. Some of the managers felt that staff training was not relevant as it concentrated on operating the system and the managers themselves were merely recipients of the output. The IT awareness programme should outline the opportunities of an integrated system, and convince management of the strategic potential in increasing the competitiveness of the company. The programme should examine what competitors in the industry are doing regarding IT developments and managers should be shown how to keep pace with IT developments. Management should also be aware of the consequences of failure to adopt the new technology.

7.3.2 Initial Awareness Programme

Many of the users were unaware of developments that were taking place in other departments, and the implementation plan for the company as a whole. An initial awareness programme, conducted before any systems design would have been useful, explaining the aims and objectives of the proposed new systems and the role staff play in the new developments. Regular briefings should then take place addressing all staff and informing them of developments occurring in each department. These proposals will

IMPLEMENTATION MODEL.



then enable staff to share a vision of IT developments across the company.

7.3.3 User Groups

User groups should also be created with members from each department. The user groups can provide a forum for information exchange, generation of ideas, discussion of problems, and an opportunity to voice opinions regarding any new systems implementation. The user groups would provide the company with synergy to further exploit IT, and facilitate the development of cross functional systems. The pooling of energy within the company will create a driving force for systems acceptance and integration.

7.3.4 Planning

In the same way a company produces business plans, IT planning should also form part of management activity. In addition to proposing long term objectives, it is important to set a number of short term goals, the achievement of which will realise longer term goals. These should be communicated throughout the company so each individual is aware of what is expected of them. Progress should be evaluated by assessing the extent to which short term goals have been realised. In this way horizons of change are perceived as being smaller and achievable. The long term goals should be clearly communicated throughout the company to remove any perceived threats or fear of the unknown which will inhibit systems implementation. All company directors need to assume a role in IT planning so that they feel a sense of ownership of the plan and hence will be more willing to pledge commitment to the advancement of IT within the company.

The plan must also be reviewed at regular intervals. The construction industry operates in a volatile and fast changing environment and IT plans must constantly be reviewed to ensure they are responsive to business needs.

7.4 SUMMARY

An analysis of the results from the post implementation review identified both positive and negative attributes of the implementation model used at Weaver Construction. A revised model has been proposed, retaining those features that were deemed beneficial and including additional features to overcome the deficiencies of the original model. As can be seen by comparing the new implementation model with the actual implementation model used in Figure 3.2, the majority of changes have occurred in the initial stages. This indicates that the initial groundwork was inadequate and far more preparation and planning was required before commencing the actual implementation of any systems.

The key problem areas that need to be addressed that were omitted from the original model are those of communication, planning and gaining top management commitment. Greater communication is required both laterally and vertically. Staff at lower levels need to communicate via user groups and also need to be informed by senior management of proposed changes. Planning needs to take place whereby realistic and measurable short term goals are set in order to realise longer term goals.

Resistance to change at a management level requires special attention. Threats and opportunities facing managers with respect to the new system need to be evaluated and dealt with accordingly. It is vital to win the hearts and the minds of senior management for a successful implementation.

The accompanying social change which must occur in order to embrace integration cannot happen of its own accord. It must be an integral part of the implementation process if staff are to make the transition from 'Computer Management' to 'Information Management'.

CONCLUSIONS

8.1 INTRODUCTION

The difficulty in integrating systems used in different functional areas of a business is certainly a common problem in many industries. Indeed, the construction industry because of its fragmented nature has greater problems than most as it cannot totally use the benefits of economies of scale. The initial aims of this project were to implement an integrated M.I.S. and to this end many methodologies used in implementation models were analysed before one was selected and the system developed for Weaver Construction. Having succeeded in developing a theoretical model, Weaver Construction failed to achieve the main objective but succeeded in adopting a partially integrated system. However valuable lessons were learnt, the most important being that logical argument failed to convince entirely the conscious or subconscious prejudices of some of the senior management.

Whereas it is not possible to prescribe a 'recipe' of how to manage the organisational dimension, the following elements are vital for the successful implementation of an integrated M.I.S.

8.2 IT STRATEGY PLANNING

IT planning needs to assume greater importance in construction companies. The planning process should involve an assessment of the current usage of IT in the organisation and the future direction of IT in supporting the business. The plan should give details of what systems are required to meet the business goals of the organisation, how these systems will be implemented and who will be responsible for all the various aspects of systems implementation. Ideally the plan should be broken down into a short, medium and long term plan setting objectives at each stage which are both achievable and measurable. The short and medium term plan will essentially form the sprint for success whereas the long term plan will act as a 'performance ratchet', tweaking the systems already in place. In formulating the plan, the maturity of information systems in the organisation, the organisational structure and proficiency of staff with regards to IT are important factors which will influence the implementation. The planning process should involve both IT specialists and management representatives from all the different functional areas of the business.

Obviously, once the plan has been formulated it is vital that it is communicated, if not sold to all members of the organisation, so everyone understands clearly what changes are to take place, what is expected of them and the benefits to be gained by the new systems implementation.

8.3 AN INTEGRATED ORGANISATIONAL CHANGE PROGRAMME

In chapter 2 the use of computers in the Construction Industry was explored. It was found that with recent advancements in technology the external barriers that prevented the Construction Industry exploiting IT no longer exist. The barriers now lie with construction companies themselves. In order for a company to truly embrace integration it must undergo the transition from 'Computer Management' to 'Information Management' where data is perceived as a corporate asset to be shared by all for the benefit of the organisation. This represents an important transition in attitude for all organisational members and hence a culture change.

The computer systems implemented within the organisation will imply the organisational structure within which they function. Therefore the installation of an integrated Management Information System needs to be accompanied by an 'integrated' philosophy or a culture change. The desired change in attitude required to accept integration does not occur of its own accord, it must be planned and managed through appropriate organisational change programmes such as staff IT awareness courses and user groups which will help to break down the departmental barriers and encourage a shared vision.

In order for staff participation to be effective in the implementation process, staff require the necessary knowledge and training to understand how to be able to exploit and take advantage of the technology presented to them. An audit of staff skills and knowledge in the IT area will reveal the deficiencies and give some guidance as to what training is required. An initial awareness programme should take place before any systems are implemented. This will serve the purpose of keeping staff informed of what changes are to take place and will also equip staff with basic IT skills if appropriate. Such a programme will enable staff participation to be more effective and alleviate many of the initial fears of the unknown and aid in the acceptance of any changes resulting from the new systems implementation.

It is extremely difficult if not impossible to devise a training programme that will suit each member of staff and would obviously not be feasible in terms of time and money. It is however possible to categorise staff loosely into categories of user, ranging from the expert to the absolute beginner. In this way, a basic core training course can be used but targeted in different ways to suit the audience. Certain areas may be emphasised and the trainer having some idea of the audience can set an appropriate pace to deliver the training material.

Of course training on how to use the new systems is essential and should occur prior to systems implementation. If at all possible it is recommended that training take place off site, thus minimising disruptions and problems of releasing computer resources within the organisation for the training course.

8.4 TOP MANAGEMENT SUPPORT

Participation of as many members at all the different levels of the organisation is vital in the implementation process. In particular the implementation must have top management support as they must be the driving force behind organisational developments and will communicate their enthusiasm throughout the organisation.

Resistance to change at the management level is a significant problem to manage in addition to resistance to change at lower levels of the organisation. Several existing implementation models seek to increase user participation and hence overcome resistance to change from users but largely ignores staff in managerial positions. It is assumed that because most new system developments are instigated at top level, then management must be in favour of the new system. It is often the case that management may not fully understand the implications and organisational changes required in order to ensure the success of an integrated system until the project is well advanced. At this stage fears and reservations emerge which hamper and destroy the momentum achieved earlier on in the project. This fear is cascaded down to lower levels and enthusiasm declines, making further progress difficult. The departmental managers of a company have much at stake, they have often put manual systems in place and naturally feel vulnerable if traditional procedures are challenged with new computerised systems which have no respect for the traditional departmental boundaries. It is therefore necessary to devise specific programmes for management in order to address their fears and concerns. Management needs to be aware of how IT can be exploited to gain competitive advantage. They must also be aware of the possible resistance to change that could occur amongst their staff. Above all they must be committed to the systems implementation, anticipate and be prepared to deal with disruptions in their departments which will almost inevitably occur during systems implementation.

8.5 A HYBRID PROJECT CHAMPION

The implementation can not be driven by the IT specialist. This is particularly true if he/she does not hold a managerial position and reports to the Managing Director via a departmental director, which is often the case in a with IT personnel in a construction organisation. The project champion who is appointed to lead the systems implementation should be one who can view IT as an investment and not as a cost. Ideally it should be a hybrid, which is someone who has knowledge and understanding of both business and IT as they will be in a good position to identify and take advantage of opportunities to exploit IT. Unfortunately the demand for hybrids is high and the supply is short. The hybrid could be acquired by selecting and training a suitable existing member of staff which would be both costly and time consuming and a successful outcome could not be guaranteed. Alternatively the hybrid could be acquired externally which would also be a costly process and it would also take some time for them to become acquainted with the business.

8.6 SUMMARY

In this chapter a number of important areas were highlighted that need to be taken into consideration when implementing an integrated management information system. Some of these may see obvious or common sense but nevertheless frequently overlooked. Failure to pay attention to areas such as strategy planning, the expected culture change and staff training will result in a difficult if not an unsuccessful implementation.

Although the work has involved only one medium sized firm operating in a particular aspect of the Construction Industry, the major obstacles to change defined appear common to most firms. It is hoped that the recommendations will enable other implementors of change to increase their chance of successfully implementing a Management Information System by learning from this experience and not unnecessarily re-inventing the wheel in an effort to overcome implementation problems.

REFERENCES

Chapter 1

1 Tranfield, D. and S. Smith. "Sprinting For Success: Making Rapid Changes In Manufacturing Companies", Management Decision Journal, Spring 1988, Vol.20, No 1.

2 Smith, S. and D. Tranfield. " A Catalytic Implementation Methodology for CIM", International Journal of Computer Integrated Manufacturing, 1989,Vol 2, No 3.

3 Gane, C., and Sarson. Structured Analysis and Systems : Tools and Techniques Prentice Hall, p1979.

Chapter 2

1 Fryer, B. The Practice Of Construction Management. Collins, 1985. p33

2 Britain 1990, HMSO Publication

3 Goodall, B. and W. Lean. Aspects Of Land Economics. The Estates Gazette Ltd, 1983.

4 Hillebrandt, P.M. Analysis of the British Construction Industry. Macmillan, 1984.

5 Latham, M. Constructing The Team. HMSO, 1994.

6 Hillebrandt, P.M. Economic Theory And The Construction Industry. Macmillan, 1985.

7 Latham, M. Constructing The Team. HMSO, 1994.

8 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

9 CICA Program List. January 1992.

10 Construction Computing. Software and Peripheral Guide. Quarterly Publication.

11 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

12 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

13 Mc Caffer, R., Baldwin, A., Carrillo, P., and A. Thorpe. "The Future Of IT in construction - an academic viewpoint", CIOB Technical Information Service,

August 1991.

14 Mehmet Hakseuer, A. "Contractors Come Of Age", Construction Computing, Spring 1992.

15 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

16 McCaffer, R. and C. Pasquire. " The interchange and use of data by contractor's management functions", International Journal of Construction Management and Technology, 1987, (4), pp48- p65.

17 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

18 Wager Denis. "Where is the EDI 'Bucket'?", CICA News and Views, Construction Computing, Summer 1992.

19 Watson Kathy. "CITE Launched", Construction Computing, Summer 1995.

20 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

21 CICA & KPMG Peat Marwick McLintock. Building on IT for the 90's.1990.

22 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

23 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

24 Latham, M. Constructing The Team. HMSO, 1994.

25 Andersen Consulting for DoE & BT. Construct IT , Bridging The Gap. HMSO, 1995.

Chapter 3

1 Burns, T. and G.M. Stalker. The Management Of Innovation. Tavistock Publications, 1966.

2 Avison, D.E. and G. Fitzgerald. Information Systems Development : Methodologies, Techniques and Tools. Blackwell ScientificPublications, 1988.

3 Avison, D.E. and G. Fitzgerald. Information Systems Development : Methodologies, Techniques and Tools. Blackwell ScientificPublications, 1988.

4 Avison, D.E. and G. Fitzgerald. Information Systems Development : Methodologies, Techniques and Tools. Blackwell ScientificPublications, 1988.

5 Checkland, P.B. Systems Thinking, Systems Practice. Wiley, 1981.

6 Ward,J., Griffiths,P. and P. Whitmore. Strategic Planning For Information Systems. Wiley, 1990

7 Ward,J., Griffiths,P. and P. Whitmore. Strategic Planning For Information Systems. Wiley, 1990

8 Galliers,R.D. "Information Technology Planning Within The Corporate Planning Process : Controlling Projects within an Integrated Management Framework", Infotech State of the Art Report, (Duling & Berry (eds). Pergaman, 1987.

9 Gibson, C.F. and Nolan, R.L. "Managing the Four Stages of EDP Growth", Harvard Business Review, Jan-Feb 1974

10 Nolan, R.L. "Managing the Crisis in Data Processing", Harvard Business Review, Mar-Apr 1979

11 Mumford, E. "User Participation In A Changing Environment - Why We Need It", Participation In Systems Design Seminar, London Business School in collaboration with The BCS Database Specialist Group and Computer Weekly, April 1987.

12 Senn,J.A. Analysis and Design of Information Systems. McGraw Hill, 1989.

13 Senn,J.A. Analysis and Design of Information Systems. McGraw Hill, 1989.

14 Senn,J.A. Analysis and Design of Information Systems. McGraw Hill, 1989.

15 Tranfield, D. and S. Smith. "Sprinting For Success: Making Rapid Changes In Manufacturing Companies", Management Decision Journal, Spring 1988,Vol.20, No1.

16 Tranfield, D. and S. Smith. "Sprinting For Success: Making Rapid Changes In Manufacturing Companies", Management Decision Journal, Spring 1988, Vol.20, No1.

17 Checkland, P.B. Systems Thinking, Systems Practice. Wiley, 1981.

Chapter 5

1 Wroe, B. Contractors and Computers, Why Systems Succeed or Fail. Doctoral Thesis, Loughborough University of Technology, 1986.

Chapter 6

1 Lawrence P.R. and J.W. Lorsch. Developing Organisations : Diagnosis &

Action. Addison Wesley, 1969.

2 Lawrence P.R. and J.W. Lorsch. Developing Organisations : Diagnosis & Action. Addison Wesley, 1969.

3 Armstrong, P. and C. Dawson. People In Organisations. Elm Publications, 1988, 4th Ed.

4 Doll & Torhzadeh, " Measuring End User Computing Satisfaction", MIS Quarterly, Decemebr 1986

5 Davis et al. "User Acceptance of Computer Technology :"A comparison of Two Theoretical Models", Management Science, August 1989, (35:8), pp983-1003.

6 Henerson et al. Program Evaluation Kit, Vol6, How To Measure Attitudes. Sage, 1987, 2nd Ed.

7 Henerson et al. Program Evaluation Kit, Vol6, How To Measure Attitudes. Sage, 1987, 2nd Ed.

8 Henerson et al. Program Evaluation Kit, Vol6, How To Measure Attitudes. Sage, 1987, 2nd Ed.

9 Henerson et al. Program Evaluation Kit, Vol6, How To Measure Attitudes. Sage, 1987, 2nd Ed.

10 Wroe, B. Contractors and Computers, Why Systems Succeed or Fail.. Doctoral Thesis, Loughborough University of Technology, 1986.

BIBLIOGRAPHY

Ashworth, A. "The Computer and The Estimator", CIOB Technical Information Service. 1987, No 81.

Baldwin, A.N. "Why An Information Technology Strategy is Important", Chartered Builder. July/August 1990.

Bochner, J. "Impact Of I.T. On the Structure Of Construction", Construction Management & Economics, Summer 1990, 8, pp 205-218.

Bresnen, M. "Insights on site : research into construction", Doing Research in Organisations, Edited by Alan Bryman. Routledge, 1988.

Brook, M. "The Use of Spreadsheets in Estimating", CIOB Technical Information Service, 1988, No81.

Caulfield, D.A. "The Human Factor In The Systems Development Equation", Proceedings of the CIB W-65 4th International Symposium on Organization and Management Of Construction, Waterloo, Canada. July 1984, Vol 2.

Dunican, P. " The UK Construction Industry", Management of New Technology. Thomas Telford Ltd, 1987.

Flynn, D,J. Information Systems Requirements: Determination and Analysis. McGraw Hill, 1992.

Forster, G., Construction site studies - production administration and personnel. Longman Technician Series, Construction and Civil Engineering, Longman, 1981.

Grindley, R.E. "How Computer Networks Help Provide A Competitive Advantage", Management of New Technology. Thomas Telford Ltd, 1987.

Hamilton, B. "Project Management - Key To Characteristics", New Builder. June 21 1990. pp26-27.

Handy, C. Inside Organisations : 21 Ideas For Managers.
BBC Books, 1991.

Handy, C. The Age Of Unreason. Arrow, 1990.

Hollingworth, J.W.N. "The Impact Of I.T. On Construction Management", CIOB Technical Information Service. 1986, No66.

Kearney, A.T. "The Barriers and The Opportunities of Information Technology - A Management Perspective", A Report For The D.T.I., 1984.

Norman, A. "Management Research Needs - Information Technology", International Journal of Construction Management & Technology, 1987, 2(3), pp 41-47.

Oppenheim, A.N. Questionnaire Design and Attitude Measurement. Heinemann, 1984.

Potter, D. and D. Scoins. "Computer Aided Estimating", CIOB Technical Information Service, 1982, No2.

Powers, M.J., Cheney, P.H. and G. Crow. Structured Systems Development. Boyd & Fraser, 1990.

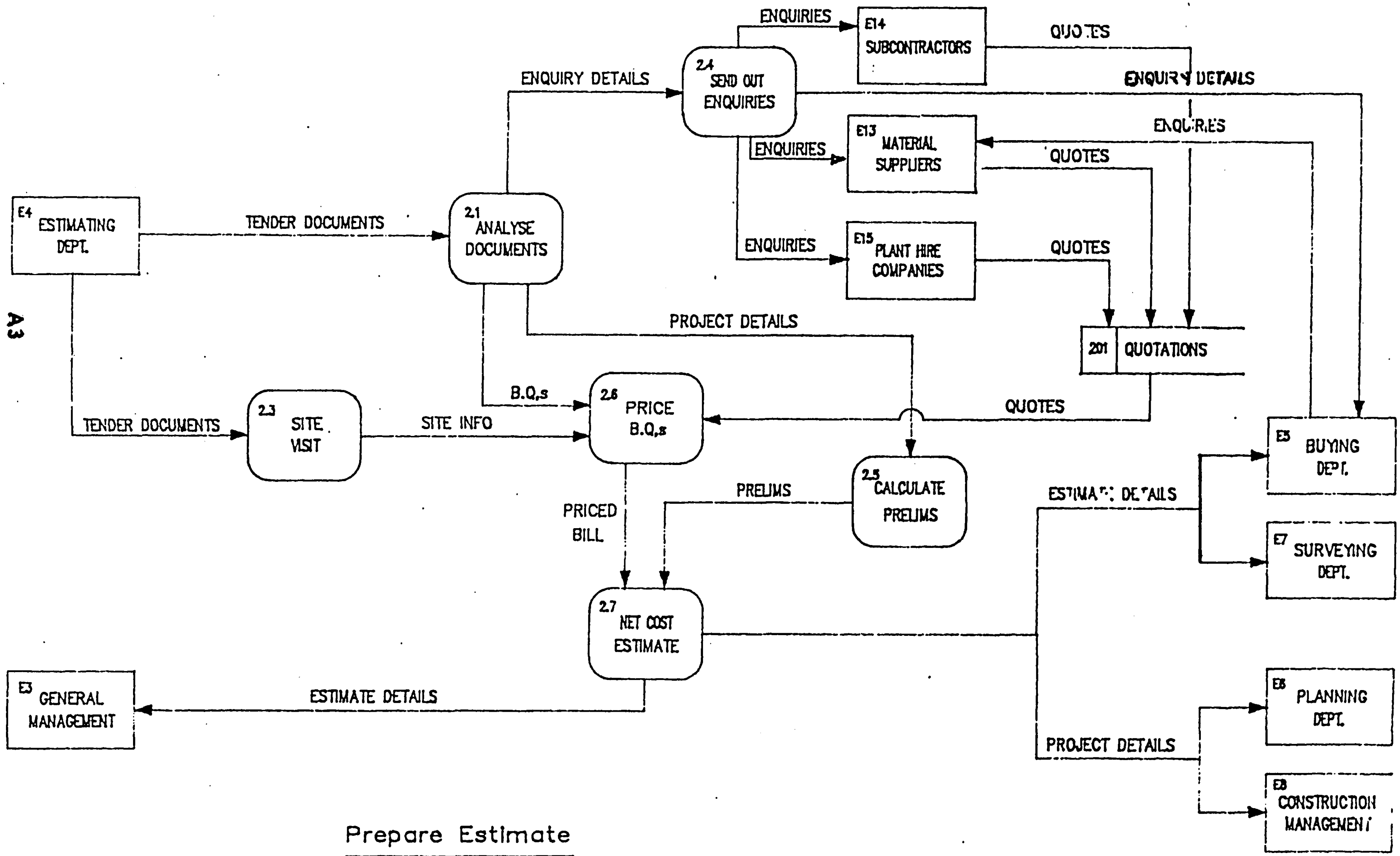
Pugh, D.S, Hickson, D.J. and C.R. Hinings. Writers On Organisations. Penguin, 1988.

Stanworth, M.F. "Computers in survey, planning and management - in control on site", Management of New Technology. Thomas Telford Ltd, 1987.

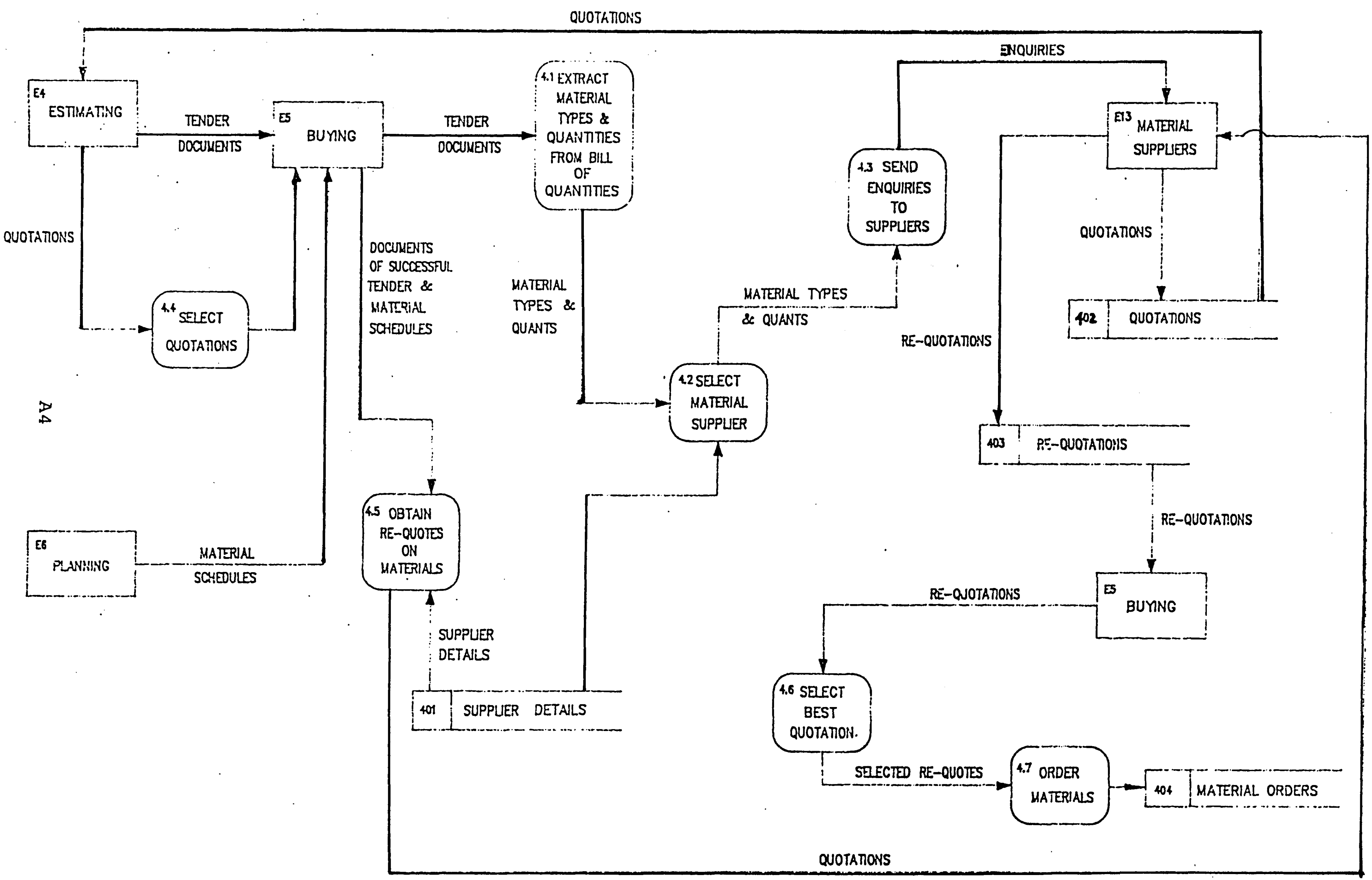
Sommerville, I. Sofware Engineering. Addison Wesley, 1982.

Tatum, C.B. "Organising To Increase Innovation In Construction Firms", ASCE Journal of Construction Engineering & Management, December 1989, 115, pp 602- 617.

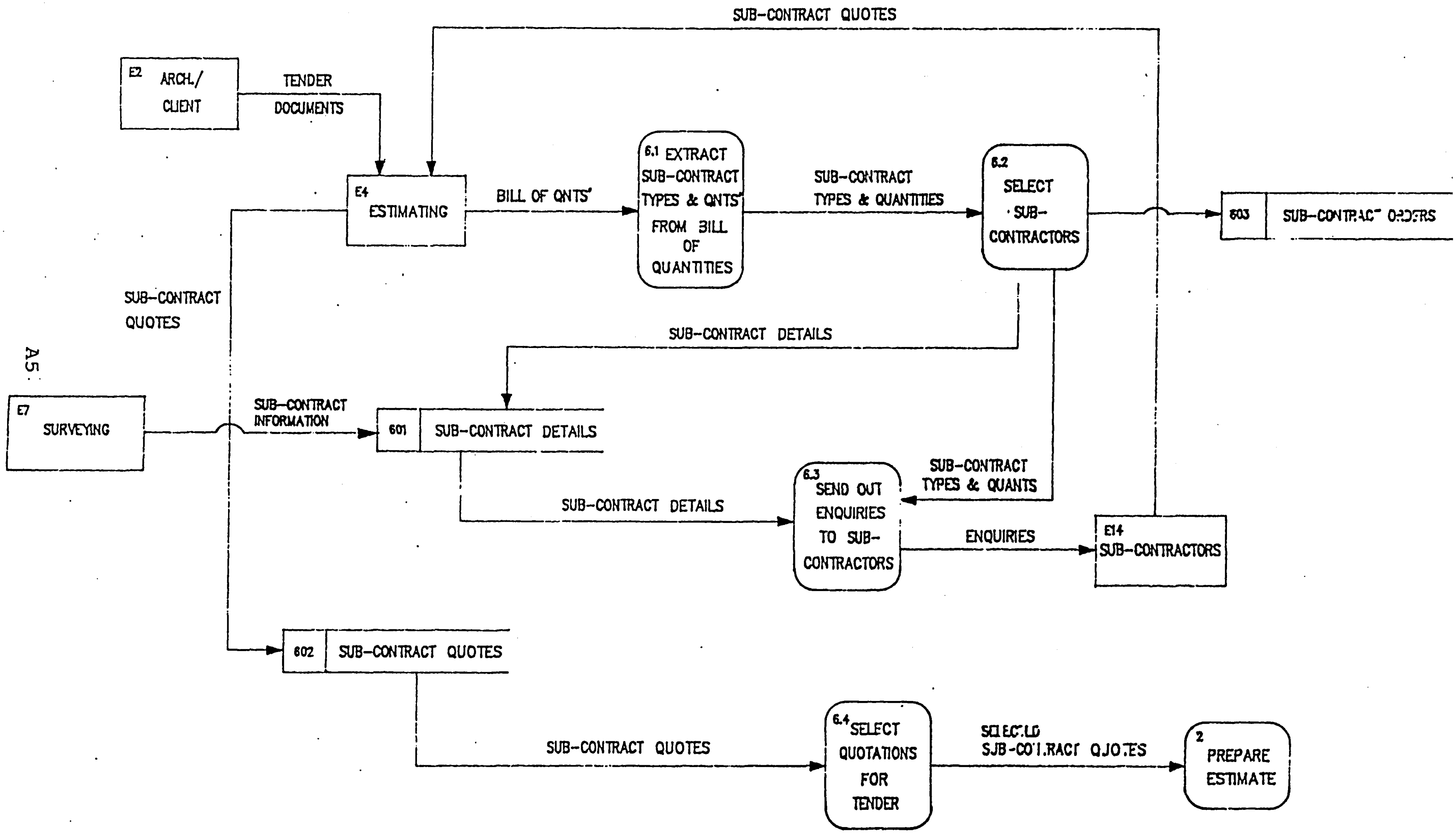
A3



Prepare Estimate

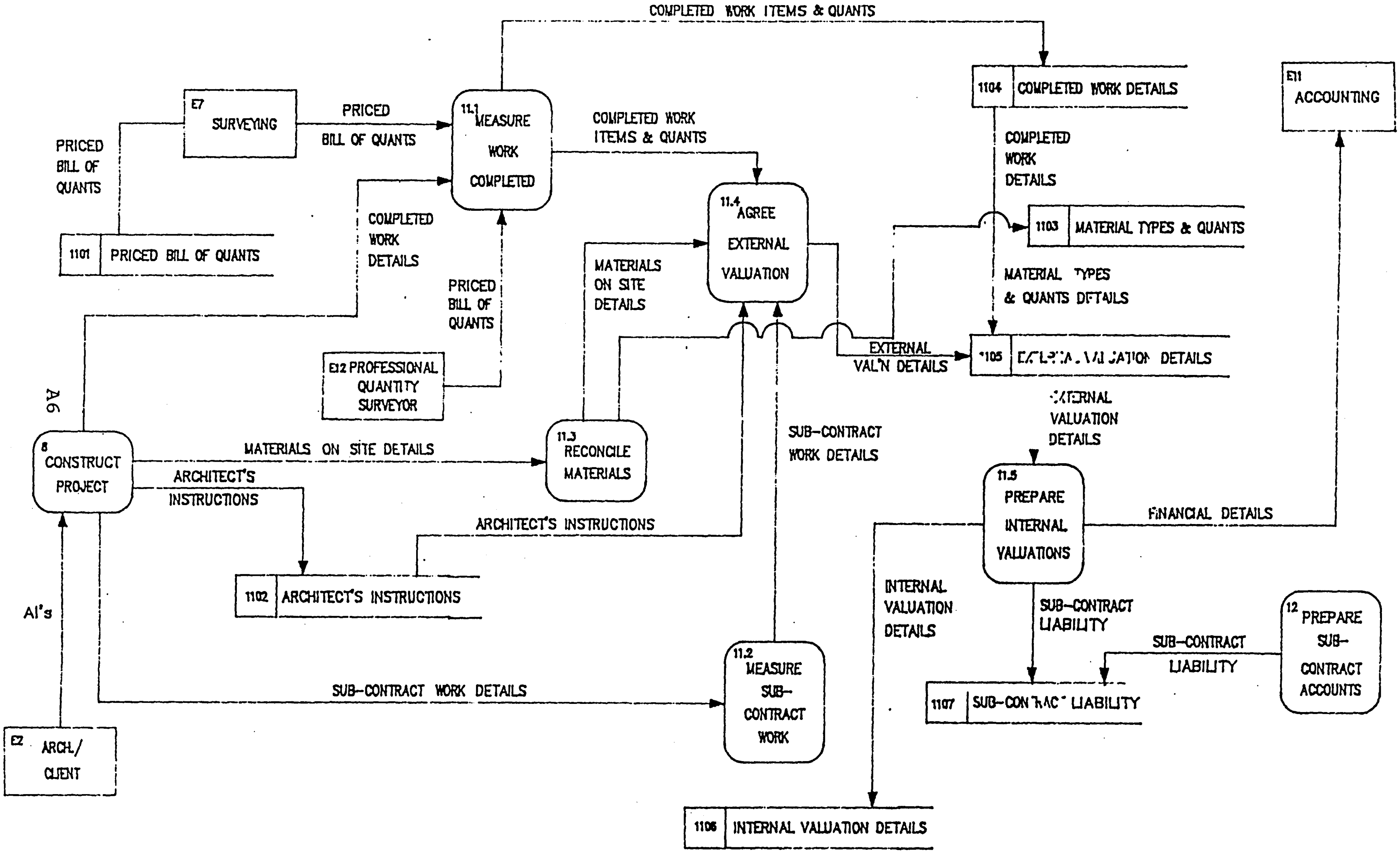


Obtain Quotations and Order Materials

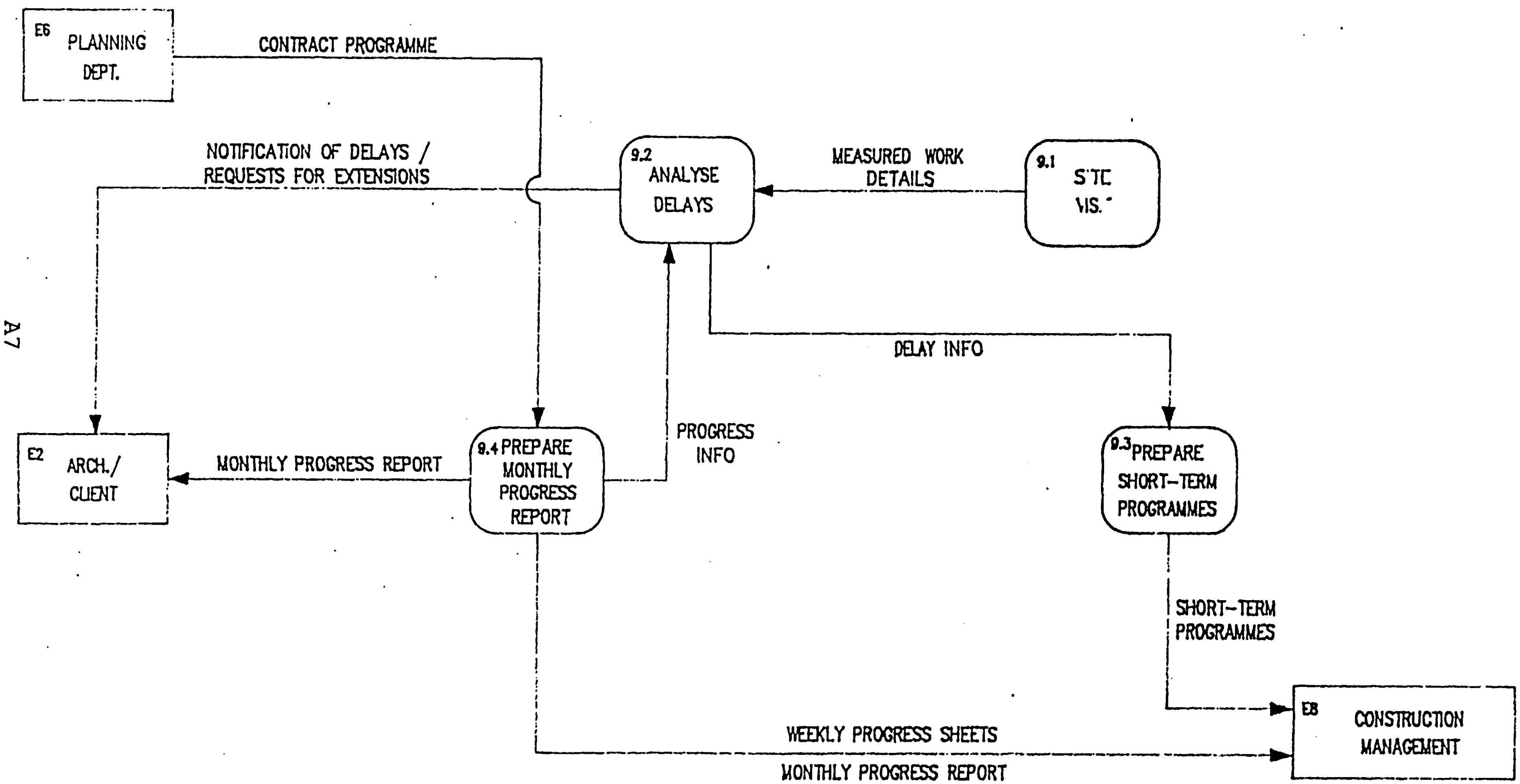


Order Sub-contractors

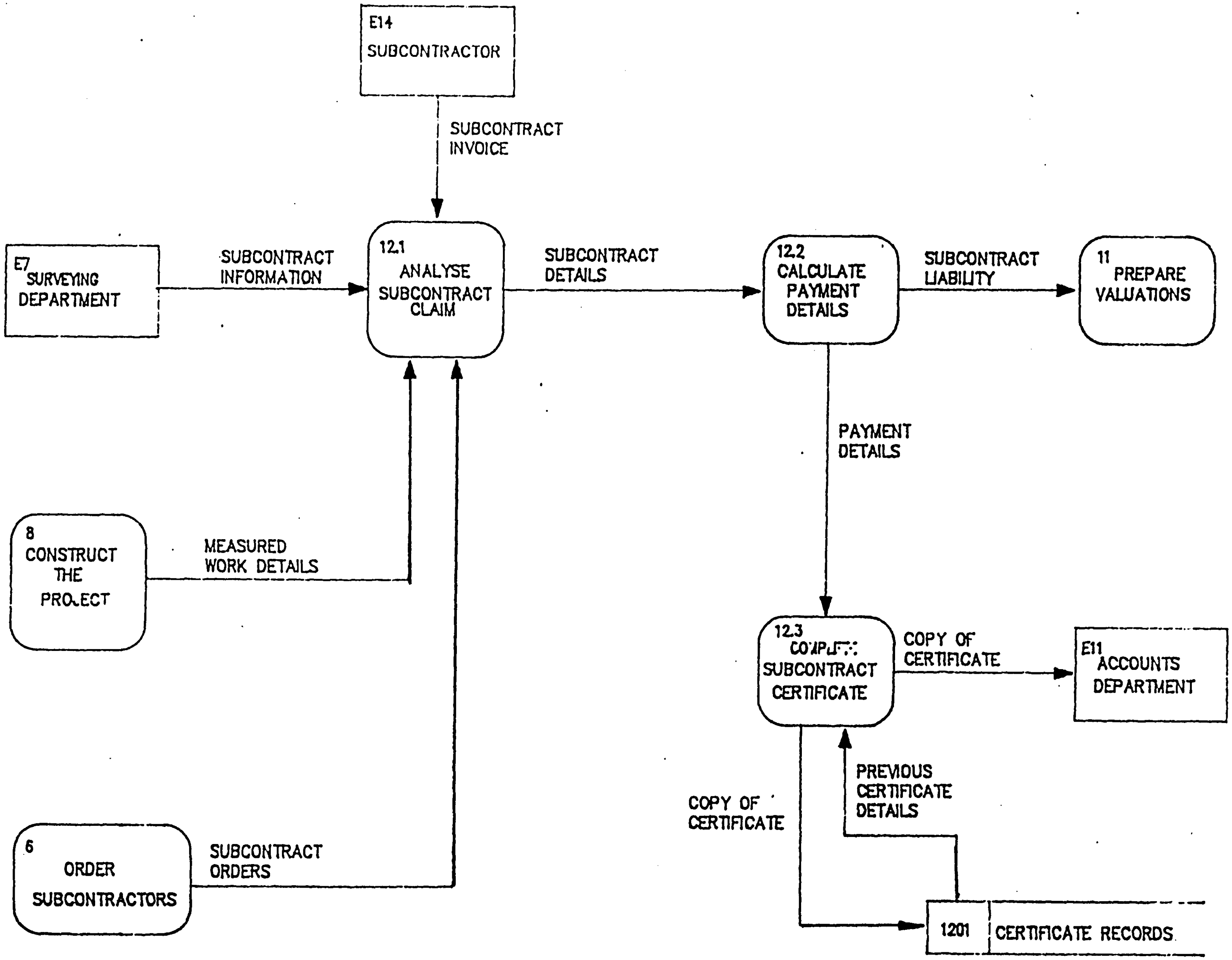
A6



Prepare Valuation



Monitor Contracts



Prepare Subcontract Accounts

ESTIMATING DEPARTMENT

Data Flows

Bill of Quantities
Drawings
Unit Rates
Sub-contract quotes
Preliminaries prices
Margin

PLANNING

Data Flows

Contract Documents
Estimate Details
Progress Returns
Confirmation of Verbal Instructions (CVI)
Architect's Instruction (AI)
Other Correspondence
Operation Duration
Contract Programme
Material Schedule
Internal Progress Report

BUYING

Data Flows

Contract Documents
Estimate Details
Material Schedule
Material Quote
Material Order

SITE MANAGEMENT

Data Flows

Contract Documents
Contract Programme
Material Orders
Sub-contract Orders
Bonus Targets
Weekly Site Returns
Progress Returns
Bonus Analysis Sheet
Variations
Plant Requisitions
Surplus/Shortfalls in Materials Ordered
Sub-contract Requirements
Delays/Difficulties

SURVEYING

Data Flows

Completed Work Details
Materials on site
External Valuation
Internal Valuation
Sub-contract re-quotes
Sub-contract orders
Bills of quantities (unpriced)
Bills of quantities (priced)
Sub-contract orders
Sub-contract payment certificates
Materials ledger
Plant ledger
Bonus analysis sheet
Bonus summary sheet
Labour only payment sheet
Site labour returns
Tender information
Sub-contract quotes
Sub-contract enquiries
Materials enquiries
Material quotes
Standard targets
Site meeting minutes
Internal valuation
Monthly contract cost
Valuations
Valuation certificate
Contract drawings

ACCOUNTING

Data Flows

Material Delivery sheet
Material Invoices
Plant on-site sheets
Plant Invoices
Labour Returns
Internal Valuation Details
Sub-contract Payment Details
Bonus Payment Details
Labour only Payment Details
External Valuation Details
Cost/Value Reconcilations
Budgets
Cash Flows
Material Payments
Plant Payments
Sub-contract Payments
Wages Details
Salaries
Accounts Details

Data Flow: Bill of Quantities

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Estimating

Expanded Description:

Included Data Structures/Elements:
Preambles, preliminaries items, Measured work sections: page no,item ref, item description, quantity, unit, rate, total

Other Information:
Information varies depending on the type of project and the method of measurement used

---

Data Flow: Drawings

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Estimating

Expanded Description:
Drawings and plans of the scheme showing construction details and dimensions

Included Data Structures/Elements:

Other Information:
Includes plans and sections of the construction project. The number and extent of detail depends on the client/architect.

Data Flow: Unit Rates

Source Ref: **Description:** Estimating

Dest'n Ref: **Description:** Client/Architect
Surveying
Buying

Expanded Description:
The priced rate for a measured work item, comprising the cost of labour, plant and materials, or sub-contract rate

Included Data Structures/Elements:
Labour cost, plant cost, material cost, sub-contract cost

Other Information:
Data structures can be further broken down into a unit labour cost

---

Data Flow: Sub-contract quotes

Source Ref: **Description:** Sub-contractors

Dest'n Ref: **Description:** Estimating
Surveying

Expanded Description:
Description and cost to be carried out by sub-contractors

Included Data Structures/Elements:

Other Information:
Dependent on type of sub-contractor. Can be labour only or labour and materials

---

Data Flow: Preliminaries prices

Source Ref: **Description:** Estimating

Dest'n Ref: **Description:** Site management
Surveying

Expanded Description:
Description and cost of items from preliminaries bill relating to site-on costs.

Included Data Structures/Elements:

Other Information: --

Data Flow: Margin

Source Ref: **Description:** Board of Directors

Dest'n Ref: **Description:** Estimating

Expanded Description:
The mark up representing overheads and profit additions to the net cost estimate.

Included Data Structures/Elements:
Overheads addition, Profit addition or lump sum adjustment

Other Information:
Addition may be sums or percentages based on the net cost estimate. Additions will vary from tender to tender at the discretion of the Board of Directors

---

Data Flow: Contract Documents

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Estimating
Planning
Buying

Expanded Description: Documents relating to the project including bills of quantities, drawings and schedules

Included Data Structures/Elements:
Bill of Quantities, drawings, schedules

Other Information:

Data Flow: Estimate Details

Source Ref: **Description:** Estimating

Dest'n Ref: **Description:** Surveying
Planning
Site Management

Expanded Description:
Description and cost of priced work items

Included Data Structures/Elements:
Page no., item reference, item description, quantity, unit, rate comprising: labour, materials and plant or sub-contract rates

Other Information:
Extent of detail to be verified by estimating department

Data Flow: Progress Return

Source Ref: **Description:** Site management
Surveying

Dest'n Ref: **Description:** Planning

Expanded Description:
Details of work progress on site

Included Data Structures/Elements:

Other Information:
Returns can be weekly and monthly

Data Flow: CVI

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Site Management

Expanded Description:
Client's variation instruction relating to amendment in the design of the project

Included Data Structures/Elements:
Amended Item Description, Amended Item Quantity

Other Information:
Frequency dependent upon the client

Data Flow: Architect's Instruction

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Planning

Expanded Description:
General correspondence in relation to project which may influence project details

Included Data Structures/Elements:

Other Information:

Data Flow: Operation Duration

Source Ref: **Description:** Planning

Dest'n Ref: **Description:** Site Management

Expanded Description:
The time period for carrying out an operation of construction work

Included Data Structures/Elements:
Operation description, Operation duration

Other Information:
Number dependent on size of project and overall contract period

---

Data Flow: Materials schedule

Source Ref: **Description:** Planning

Dest'n Ref: **Description:** Buying
Site management
Surveying

Expanded Description:
Schedule of materials requirements relating to a project

Included Data Structures/Elements:
Material typeMaterial quantityDate required on site

Other Information:

Data Flow: Internal Progress Report

Source Ref: **Description:** Planning

Dest'n Ref: **Description:** Surveying
Site Management

Expanded Description:
Report on the progress of a project with regard to time

Included Data Structures/Elements:
Delay to work operations, Effect on programme duration, Remidial action required

Other Information:
Provide basis for possible claim

Data Flow: Contract Documents

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Buying
Estimating
Planning

Expanded Description:
Documents relating to the project including bills of quantities, drawings, schedules, etc.

Included Data Structures/Elements:
Bills of quantities, Drawings, Schedules

Other Information:

Data Flow: Estimate Details

Source Ref: **Description:** Estimating

Dest'n Ref: **Description:** Buying

Expanded Description:
Description of the cost (material element) of priced work items

Included Data Structures/Elements:
Page no., item reference, item description, quantity, unit, rate (material) item total

Other Information:
For comparison of bill rates and actual cost

Data Flow: Material Schedule

Source Ref: **Description:** Planning

Dest'n Ref: **Description:** Buying

Expanded Description:
Schedule of material requirement relating to a project

Included Data Structures/Elements:
Material type, Material quantity, Date required on site

Other Information:

Data Flow: Material Quote

Source Ref: **Description:** Material suppliers

Dest'n Ref: **Description:** Buying
Estimating

Expanded Description:
Quotation of material prices from material suppliers

Included Data Structures/Elements:
Material description, Material quantity, Material price, Total cost, Discounts

Other Information:
Additional information on conditions of purchase

Data Flow: Materials Orders

Source Ref: **Description:** Buying

Dest'n Ref: **Description:** Accounting
Site manangement

Expanded Description:
Orders placed for materials relating to a project

Included Data Structures/Elements:
Material description Material quantity Material price
Date required

Other Information:
Additional information with reference to quotation, delivery details, site, etc.

Data Flow: Contract Documents

Source Ref: **Description:** Client/Architect

Dest'n Ref: **Description:** Site management
Buying
Planning

Expanded Description:
Documents relating to the project including bills of quanitities, drawings, schedules, etc.

Included Data Structures/Elements:
Bills of quantities, Drawings, Schedules

Other Information:

Data Flow: Contract Programme

Source Ref: **Description:** Planning

Dest'n Ref: **Description:** Site Management

Expanded Description:
Diagrammatic representation of the project duration showing operations and durations in bar chart and/or line of balance format

Included Data Structures/Elements:
Operation description, Operation duration

Other Information:

Data Flow: Material Orders

Source Ref: **Description:** Buying

Dest'n Ref: **Description:** Site management
Accounting
Surveying

Expanded Description:
Orders placed for materials relating to a project

Included Data Structures/Elements:
Material description, Material quantity, Material price, Date required

Other Information:
Additional information with reference to quotation, delivery details, site, etc.

Data Flow: Sub-contract Orders

Source Ref: **Description:** Surveying

Dest'n Ref: **Description:** Sub-contractors
Site management
Accounts

Expanded Description:
Order placed to sub-contractor for work to be carried out in connection with a project

Included Data Structures/Elements:
Work description, quantity of work, price quoted, date work to be carried out

Other Information:
Additional information with reference quotation conditions etc.

Data Flow: Bonus targets

Source Ref: **Description:** Surveying

Dest'n Ref: **Description:** Site manangement

Expanded Description:
Bonus targets set for operatives in relation to work operations

Included Data Structures/Elements:
work item, work item quantity, unit/total, time/value, time taken to complete

Other Information:

Data Flow: Weekly site returns

Source Ref: **Description:** Site management

Dest'n Ref: **Description:** Surveying
Accounting

Expanded Description:
Details from site on the types of resources and quantities used

Included Data Structures/Elements:

Other Information:
See Std form

Data Flow: Progress Return

Source Ref: **Description:** Site management

Dest'n Ref: **Description:** Planning
Surveying

Expanded Description:
Returns from site on progress of construction work

Included Data Structures/Elements:

Other Information:
Check std forms for data structures

Data Flow: Bonus Analysis Sheet

Source Ref: **Description:** Site management
Surveying

Dest'n Ref: **Description:**

Expanded Description:
Analysis sheet showing work items and quantities completed and bonus earned by operatives

Included Data Structures/Elements:

Other Information:
Check bonus sheet for data structure, completed by operative and verified by site management

---

Data Flow: Variations

Source Ref: **Description:** Site management

Dest'n Ref: **Description:** Surveying
Planning

Expanded Description:

Included Data Structures/Elements:

Other Information:

Data Flow: Plant Requisitions

Source Ref: **Description:** Site Management

Dest'n Ref: **Description:** Plant Management

Expanded Description:
Request for plant on site

Included Data Structures/Elements:

Other Information:
Check std form

Data Flow: Surplus/Shortfalls in materials ordered

Source Ref: **Description:** Site Management

Dest'n Ref: **Description:** Buying

Expanded Description:
Details of types of materials and quantities in surplus or deficit

Included Data Structures/Elements:
Material type, Material.quantity

Other Information:
Check standard form

Data Flow: Measure of materials on Site

Source Ref: **Description:** Surveying

Dest'n Ref: **Description:** Accounting
Site management

Expanded Description:
Materials which have been delivered to site, but not yet incorporated in the building.

Included Data Structures/Elements:
material description, material quantity, unit

Other Information:
This data will be obtained at the same time as the measured work on site. Certain materials may be phsycally measured whereas others may be identified from the bill of quantities measure.

Data Flow: External Valuation

Source Ref: **Description:** Architect/Client's
Surveyor

Dest'n Ref: **Description:** Surveying

Expanded Description:
An interim external valuation representing the value of work to date.

Included Data Structures/Elements:
Based on the data structure/elements of the Completed Work Details, Architect's Instructions, and Materials on Site

Other Information:
The external valuation represents an interim valuation as agreed on site by the client's surveyor and the company's surveyor.

Data Flow: Sub-contract requirements

Source Ref: **Description:** Sub-contractors

Dest'n Ref: **Description:** Site Management

Expanded Description:
Request from sub-contractors for specific requirements to carry out work items

Included Data Structures/Elements:

Other Information:
Data structures vary depending on type of sub-contract and type of work

---

Data Flow: Completed Work Details

Source Ref: **Description:** Surveying

Dest'n Ref: **Description:** Accounting
Site Management

Expanded Description:
Details of completed work on site to date.

Included Data Structures/Elements:
Contract no, contract name, date, section no, section description, page no, item reference, item description, quantity, unit, rate, item total, section total, work value total.

Other Information:
The details represent the amount of work completed which are measured for valuation purposes. The measure for items may be in the form of a quantity of percentage of the total quantity in the bill of quantities.

Data Flow: Delays/Difficulties

Source Ref: **Description:** Site management

Dest'n Ref: **Description:** Surveying
Planning

Expanded Description:
Delays and difficulties experienced in relation to work operations during the construction process

Included Data Structures/Elements:

Other Information:
Check std form for data structures

Project Processing File MAT-ENQ.

Introduction

This program uses the database file MAT-ENQ which contains the records of names, ref numbers, addresses and trades of material suppliers. A menu is displayed for the user to select one of the following options (i) Enter new supplier records, (ii) Update records, (iii) Print enquiries, (iv) Print labels, (v) Browse and (vi) Exit the program. If the user selects option (iii) a query must be defined to select the material suppliers to which enquiries are to be sent. The format of the enquiry must then be defined before the letter can be printed. If the user selects option (iv) the query that was defined in option (iii) is used to select the material suppliers whose addresses are to be printed.

Main Program

Introduction

The main program loads the required database file and calls procedure men which displays the menu. The user selects a menu item and the appropriate procedure will be called according to the users response. When the user decides to exit the program, the database MAT-ENQ is unloaded and the screen is cleared.

Variables Used

Name	Type	Description
$selection	character	users menu choice

Description

1 The database file MAT-ENQ with screen mat-enq-screen 1 is loaded.

2 Procedure men is called to display the menu and allow the user to select a menu item which is stored in variable $selection.

3 If $selection = 1 then procedure enter is called.

4 If $selection = 2 then procedure update is called.

5 If $selection = 3 then procedure enq is called.

6 If $selection = 4 then procedure lab is called.

7 If $selection = 5 then procedure browse is called.

8 If $selection = 6 then control of the program is transferred to label end. Go to step 10.

9 Control of the program is transferred to label men ie the start of the main program, so that the menu is displayed again. Go to step 2.

10 All database files are unloaded and the screen is cleared.

Procedure men

Variables used

Name	Type	Description
$selection	character	users menu choice

1 This procedure is used to display the menu and allow the user to select a menu item. The users response is stored in variable $selection, a return is then made to the main program.

Procedure enter

Introduction

This procedure is used to enter new records into the database file MAT-ENQ.

Description

1 The ENTER command is executed to allow the user to enter new records. When data entry is complete the file MAT-ENQ is ordered by the key field [no] which is the material suppliers reference number.

2 The KEY UPDATE command is executed to merge all newly added records into the existing key fields. A return is then made to the menu.

Procedure update

Introduction

This procedure is used to update the database file MAT-ENQ.

Description

1 The UPDATE command is executed to allow the user to update existing records in the file MAT-ENQ.

2 The KEY UPDATE command is executed to merge all newly added records into the existing key fields.

3 The file is ordered by key field [no]. A return is then made to the menu.

Procedure enq

Introduction

This procedure is used to define the format of the enquiry, select the material suppliers specified by the user to whom enquiries are to be sent and print the enquiries.

Description

1 The file MAT-ENQ is ordered by key field [no].

2 The QUERY command selects records from the file MAT-ENQ based on selection criteria. The QUERY DEFINE command allows the user to specify which records are to be selected by typing in the reference numbers of the required records. The QUERY PREDEFINED command executes the defined query MAT-EN and the selected records are stored in an index MAT-EN. The file is then ordered using the index MAT-EN.

3 The REPORT command is used to define and print the form for the enquiry letter. The page must first be defined. This specifies the file to be used in the report, whether it is a form, a table, or both and the page layout. Form allows the user to design the layout of the information to be printed on the pre-printed enquiry letter. The REPORT PRINT command will print the form as defined by the user. Only the records that were selected by the query COMMAND will be used as the file has been ordered by the index MAT-EN containing these records. The file is then ordered by the key field [no] and a return is made to the menu.

Procedure lab

Introduction

This procedure is used to select the material suppliers specified by the user to whom enquiries are to be sent and print the address labels.

Description

1 The file MAT-ENQ is ordered by key field [no].

2 The QUERY PREDEFINED command executes the defined query MAT-EN. The query selects records from the file MAT-ENQ based on a predefined selection criteria and stores the records in an index MAT-EN. The file is then ordered using the index MAT-EN. The REPORT PRINT command is used to print the forms to be used as address labels as defined in MAT-ENQ. The file is then ordered by the key field [no] and a return is made to the menu.

Database File MAT-ENQ

Field No	Field Title	Type	Length	Key	Total	Status
1	no	N2	5	Y	N	N
2	name	A	26	N		N
3	add1	A	26	N		N
4	add2	A	26	N		N
5	add3	A	26	N		N
6	add4	A	26	N		N
7	add5	A	26	N		N
8	work	A	26	Y		N
9	phone	A	26	N		N

Material Supplier Record

Ref No	13.01	[no]
Name	Pioneer Mortars (UK) Ltd	[name]
Address	Styrrup Quarry	[add 1]
	Styrrup	[add 2]
	Doncaster	[add 3]
		[add 4]
		[add 5]
Work category	Mortar	[work]
Tel No	0302 771940	[phone]

Project file MAT-ENQ

```
load MAT-ENQ screen mat-enq-screen1
label mmen
call men
if $selection = 1
     call enter
elseif $selection = 2
     call update
elseif $selection = 3
     call enq
elseif $selection = 4
     call lab
elseif $selection = 5
     call browse
elseif $selection = 6
     jump end
endif
jump mmen
label end
unload all
clear
end

procedure men
menu clear 0 0
menu print 5 5 15 0 Options :-
menu print 9 5 15 0 1.  Enter new supplier records.
menu print 11 5 15 0 2.  Update existing supplier records.
menu print 13 5 15 0 3.  Print enquiries.
menu print 15 5 15 0 4.  Print labels.
menu print 17 5 15 0 5.  Browse.
menu print 19 5 15 0 6.  Finish.
menu input 20 24 15 1 1  $selection
return

procedure enter
enter
order key [1]
key update
return

procedure update
update
key update
order key [1]
return

procedure enq
key update
order key [1]
query define MAT-EN
query predefined MAT-EN index MAT-EN
order index MAT-EN
report define MAT-EN form
```

51 Nunmill St
York
YO2 1NT

27/11/96

Sheffield Hallam University
Research Office
City Campus
Pond St
Sheffield
S1 1WB

Dear Sir/Madam,

Please find enclosed a copy of my amended MPhil thesis (as requested by the examining team following my viva voce of 27th November 1995).

Yours faithfully,

Sonia Blaza

Sonia Blaza

```
report print MAT-EN printer
order key [1]
return

procedure lab
key update
order key [1]
query define MAT-EN
query predefined MAT-EN index MAT-EN
order index MAT-EN
report print MAT-ENQ printer
order key [1]
return

procedure browse
browse all
return

```

Project file CONTRI

Subcontract Item Entry

```
call loadem
label startmain
call mainpaint
if $select = 1
     call enterd
elseif $select = 2
     call updata
elseif $select = 3
     call printd
elseif $select = 4
     call additms
elseif $select = 5
     call delfile
elseif $Select = 6
     jump finish
endif
jump startmain
label finish
unload all
lookup remove X1
close
repaint
end

procedure enterd
goto file SUBITM2 screen standard
order key [Item number]
split horizontal 11 2
goto window 2
goto file SC2 screen sc-screen 2
```

```
zoom
enter
key update
zoom
close
return

procedure updata
split horizontal 11 2
goto window 1
goto file SUBITM2 screen standard
order key [Item number]
goto window 2
goto file SC2 screen sc-screen2
zoom
update
key update
zoom
close
return

procedure loadem
load SUBITM2 screen standard
load SUBITM2 screen subitm-screen
load SC2 screen sc-screen2
lookup load X1
return

procedure mainpaint
menu clear 3 9
menu print 3 5 14 9 1.  Enter data
menu print 5 5 14 9 2.  Update data
menu print 7 5 14 9 3.  Print data
menu print 9 5 14 9 4.  Add new items
menu print 11 5 14 9 5. Delete records in file
menu print 13 5 14 9 6. Quit
menu input 15 24 14 9 1  $select
return

procedure delfile
goto file SC2 screen sc-screen2
goto record rec-number 1
$recno = 1
while $recno <= records
     delete
     goto record next
     $recno = $recno + 1
endwhile
unload file SC2
utilities purge SC2
load SC2 screen sc-screen2
return

procedure printd
input-screen load INPCONTR
split horizontal 11 2
goto window 1
goto file SUBITM2 screen standard
```

```
goto record rec-number 1
$rc = 1
while $rc <= records
     [Contract Name] = Text1
     goto record next
     $rc = $rc + 1
endwhile
key update
order key [Item number]
goto window 2
goto file SC2 screen sc-screen2
order key [trade]
goto record rec-number 1
$rcnt=1
while $rcnt <=records
     let $strade = [trade]
     while [trade] - $strade
          goto record next
          $rcnt = $rcnt + 1
          let %1 = $rcnt
          if $rcnt > records then jump floop
     endwhile
     goto record previous
     let $strade = [trade]
     key update
     order key [trade]
     goto window 1
     goto file SUBITM2 screen standard
     query predefined trad-en index trad-enx
     order index trad-enx
     link 2 field [Item number]
     report print CONTR printer
     goto window 2
     goto record rec-number %1
endwhile
label floop
goto window 1
goto file SUBITM2 screen standard
query predefined trad-en index trad-enx
order index trad-enx
link 2 field [Item number]
report print CONTR printer
return

procedure additms
goto file SUBITM2 screen subitm-screen
enter
key update
return
```

Project Processing File SUB-ENQ

Introduction

This program uses database file SUB-ENQ which contains the records of names, addresses and trades of sub-contractors. A menu is displayed for the user to select one of the following options (i) Enter new records in file, (ii) Update records in file, (iii) Print out enquiries on pre-printed enquiry letter, (iv) Print out sub-contractor address labels and (v) Exit the program. If the user selects option (iv) a query must be defined to select the sub-contractors to which letters are to be sent. The format of the enquiry letter must then be defined before the letter can be printed. If the user selects option (v), the query defined in option (iv) is used to select the sub-contractors whose addresses are to be printed.

Description

1 The database file SUB-ENQ with screen sub-enq-screen1 is loaded.

2 The menu is displayed to allow the user to select a menu item which is stored in variable $selection.

3 If $selection = 1 then control of the program is transferred to label enter. Go to step 8.

4 If $selection = 2 then control of the program is transferred to label update. Go to step 10.

5 If $selection = 3 then control of the program is transferred to label enq. Go to step 12.

6 If $selection = 4 then control of the program is transferred to label lab. Go to step 13.

7 If $selection = 5 then control of the program is transferred to label end. Go to step 14.

8 The ENTER command is executed to allow the user to enter new records. When data entry is complete the file SUB-ENQ is ordered by the key field [no] which is sub-contractors reference number.

9 The KEY UPDATE command is executed to merge all newly added records into the existing key fields. A return is then made to the menu. Go to step 2.

10 The UPDATE command is executed to allow the user to update

existing records in the file SUB-ENQ. When the update is complete the file is ordered by the key field [no].

11 The KEY UPDATE command is executed to merge all newly added records into the existing key fields. A return is then made to the menu. Go to step 2.

12 The QUERY command selects records from the file SUB-ENQ based on selection criteria. The QUERY DEFINE command allows the user to specify which records are to be selected by typing in the reference numbers of the required records. The QUERY PREDEFINED command executes the defined query SUB-EN and the selected records are stored in an index SUB-EN. The file is then ordered using the index SUB-EN.

13 The REPORT command is used to define and print the form for the enquiry letter. The PAGE must first be defined. This specifies the file to be used in the report, whether it is a form, a table, or both and the page layout. FORM allows the user to design the layout of the information to be printed on the pre-printed enquiry letter. The REPORT PRINT command will print the information as specified by the user on the pre-printed enquiry letter. Only the records that were selected by the QUERY command will be used as the file has been ordered by the index SUB-EN containing these records. The file is then ordered by the key field [no] and a return is made to the menu. Go to step 2.

14 The QUERY PREDEFINED command executes the defined query SUB-EN. The query selects records from the file SUB-EN based on a predefined selection criteria and stores the records in an index SUB-EN. The file is then ordered using the index SUB-EN. The REPORT PRINT command is used to print the forms to be used as address labels as defined in SUB-ENQ. The file is then ordered by the key field [no] and a return is made to the menu. Go to step 2.

15 All the files are unloaded and the screen is cleared.

Project File SUB-ENQ

```
load SUB-ENQ screen sub-enq-screen1
label menu
menu clear 0 0
menu print 5 5 15 0 Options :-
menu print 9 5 15 0 1.  Enter new subcontract records
menu print 11 5 15 0 2.  Update existing subcontract records
menu print 13 5 15 0 3.  Print enquiries
menu print 15 5 15 0 4.  Print labels
menu print 17 5 15 0 5.  Finish
menu input 20 24 15 1 1 $Selection
if $selection = 1
     jump enter
elseif $selection = 2
     jump update
elseif $selection = 3
     jump enq
elseif $selection = 4
     jump lab
elseif $selection = 5
     jump end
endif
label enter
enter
order key [1]
key update
jump menu
label update
update
order key [1]
key update
jump menu
label enq
query define SUB-EN
query predefined SUB-EN index SUB-EN
order index SUB-EN
report define SUB-EN
report print SUB-EN printer
order key [1]
jump menu
label lab
query predefined SUB-EN index SUB-EN
order index SUB-EN
report print SUB-ENQ printer
order key [1]
jump menu
label end
unload all
clear
end
```

Database File SUB_ENQ

Field No	Field Title	Type	Length	Key	Total	Status
1	no	A	5	Y		N
2	name	A	26	N		N
3	add1	A	26	N		N
4	add2	A	26	N		N
5	add3	A	26	N		N
6	add4	A	26	N		N
7	add5	A	26	N		N
8	work	A	26	N		N
9	phone	A	18	N		N

Project Processing File SUB

Introduction

This project processing file is used in the calculation of subcontract payments to different subcontractors for a particular contract. The program uses two database files sub400 and sub300 which are both accessed from floppy disks. One disk containing these files is used per contract. File sub400 is a temporary store for details of the last payment made to a particular contractor. File sub300 contains the current payment certificate.

For each new payment certificate the user enters the code number of the subcontractor. The program then uses lookups to search for this code number in file sub400. If a match is found then data from selected fields in the file ie name, address and details of previous payment are moved to the file sub300. The user must then enter all the remaining details as required and the total subcontract payment will be automatically calculated. The last record displayed on the screen is printed and the menu is displayed to allow the user to choose whether to exit the program, continue entering data or to update existing payment certificates.

Variables Used

Name	Type	Description
$choose	character	users menu choice

Description

1 The database file sub400 is loaded from a floppy disk and ordered by key field [CODE NO].

2 The screen is split horizontally at coordinates 11,2.

3 The database file sub300 with screen sub300-screen1 is loaded into window 2.

4 The lookup definition PAY is loaded. When in enter mode the lookup will search for data in the field [CODE NO] in the file sub400 to match the data in the field [CODE NO] in the file sub400 to match the data in the field [CODE NO] in the file sub300. If a match is found, data from particular fields in file sub400 are transferred to file sub300 ie details of the previous payment certificates to the subcontractor in file sub400 are transferred to file sub300.

5 The predefined transaction PAID is executed in order to transfer the previous payment certificate from file sub300 to file sub400.

A transaction transfers data between files based on matching link fields.

Fields in the source file sub300 are moved to specified fields in the destination file sub400 if a match is found for the data in the defined link fields. The link fields are [CODE NO] in file sub400 and [CODE NO] in file sub300. The file sub300 (driver file) has the link field in each record searched for in the file sub400. The searched file sub400 is the driven file. The driver file can be either the source or destination of the action. The link field [CODE NO] for file sub400 must be a key field and the file must be in key order at the time of the transaction.

the data is transferred between fields as follows:

<u>**sub300**</u>		<u>**sub400**</u>
Contract No	============>	Contract No
Subcontractor	============>	Subcontractor
Address 1	============>	Address 1
Address 2	============>	Address 2
Address 3	============>	Address 3
Address 4	============>	Address 4
Type of work	============>	Type of work
Contract	============>	Contract
Payment No	============>	Payment No
Nom/own	============>	Nom/own
Vat No	============>	Vat No
Total 1	============>	Total 1
Discount	============>	Discount
Disc Total	============>	Disc Total
Total2	============>	Total2
Ret Total	============>	Ret Total
Total 3	============>	Total 3
VAT	============>	VAT
Tax	============>	Tax

7 The ENTER command is executed to enter new payment certificates in file sub300. The payment certificate is displayed for the user to enter the appropriate information.

8 The PRINT command is used to print the last record displayed on the screen.

9 The screen is cleared and the menu is displayed which offers the options of continuing with more sheets, updating previous sheets or finishing the session. The users reply is stored in variable $choose.

10 If $choose = "c" then control of the program is transferred to label cont. Go to step 13.

11 If $choose = "u" then control of the program is transferred to label update. Go to step 15.

12 If $choose = "f" then control of the program is transferred to label exit. Go to step 17.

13 The ENTER command is executed to enter new payment certificates into file sub300. The PRINT command is used to print the last record displayed on the screen on the printer.

14 Control of the program is transferred to label men. Go to step 9.

15 The lookup definition PAY is unloaded. The UPDATE command is executed to allow the user to update the data in file sub300. The PRINT command is executed to print the last record displayed on the screen on the printer. The lookup definition PAY is loaded.

16 Control of the program is transferred to label men. Go to step 10.

17 All files are unloaded. The CLOSE command is executed to close the two windows.

<u>Database File SUB400 (Field Information)</u>

Field No	Field Title	Type	Length	Key	Total	Status
1	Code No	NO	5	Y	N	N
2	Contract No	NO	5	N	N	N
3	Subcontractor	A	35	N		N
4	Address 1	A	35	N		N
5	Address 2	A	35	N		N
6	Address 3	A	35	N		N
7	Address 4	A	35	N		N
8	Type of work	A	25	N		N
9	Contract	A	20	N		N
10	Payment No	NO	3	N	N	N
11	Nom/Own	A	1	N		N
12	VAT No	A	15	N		N
13	Total 1	N2	9	N	N	N
14	Discount	N2	5	N	N	N
15	Disc Total	N2	9	N	N	N
16	Total 2	N2	9	N	N	N
17	Retention	N2	5	N	N	N
18	Ret Total	N2	9	N	N	N
19	Total 3	N2	9	N	N	N
20	VAT	NO	5	N	N	N
21	Tax	NO	5	N	N	N

Database File SUB300 (Field Information)

Field No	Field Title	Type	Length	Key	Total	Status
1	Code No	NO	5	Y	N	N
2	Contract No	NO	5	N	N	N
3	Subcontractor	A	35	N		N
4	Address 1	A	35	N		N
5	Address 2	A	35	N		N
6	Address 3	A	35	N		N
7	Address 4	A	35	N		N
8	Type of work	A	25	N		N
9	Contract	A	20	N		N
10	Payment No	NO	3	N	N	N
11	Date	D	8	N		N
12	Nom/Own	A	1	N		N
13	Work Upto	D	8	N		N
14	Paid by	D	8	N		N
15	V No	A	15	N		N
16	D1)	A	32	N		N
17	V1)	N2	9	N	N	N
18	D2	A	32	N		N
19	V2	N2	9	N	N	N
20	D3	A	32	N		N
21	V3	N2	9	N	N	N
22	D4	A	32	N		N
23	V4	N2	9	N	N	N
24	D5	A	32	N		N
25	V5	N2	9	N	N	N
26	D6	A	32	N		N
27	V6	N2	9	N	N	N
28	D7	A	32	N		N
29	V7	N2	9	N	N	N
30	D8	A	32	N		N
31	V8	N2	9	N	N	N
32	D9	A	32	N		N
33	V9	N2	9	N	N	N
34	D10	A	32	N		N
35	V10	N2	9	N	N	N
36	D11	A	32	N		N
37	V11	N2	9	N	N	N
38	D12	A	32	N		N
39	V12	N2	9	N	N	N
40	D13	A	32	N		N
41	V13	N2	9	N	N	N
42	D14	A	32	N		N
43	V14	N2	9	N	N	N
44	Total 1	N2C	9	N	N	N
45	Prev 1	N2	9	N	N	N
46	Payment 1	N2C	9	N	N	N
47	Discount	N2	5	N	N	N
48	Discount Total	N2	9	N	N	N
49	Disc Total	N2C	9	N	N	N
50	Disc Prev	N2	9	N	N	N

Field No	Field Title	Type	Length	Key	Total	Status
51	Disc Payment	N2C	9	N	N	N
52	Total 2	N2C	9	N	N	N
53	Prev 2	N2	9	N	N	N
54	Payment 2	N2C	9	N	N	N
55	Retention1	N2	5	N	N	N
56	Retention T 1	N2	9	N	N	N
57	Retention2	N2	5	N	N	N
58	Retention T 2	N2	9	N	N	N
59	Ret Total	N2C	9	N	N	N
60	Ret Prev	N2	9	N	N	N
61	Ret Payment	N2C	9	N	N	N
62	Total 3	N2C	9	N	N	N
63	Prev 3	N2	9	N	N	N
64	Payment 3	N2C	9	N	N	N
65	VAT	NO	5	N	N	N
66	VAT Payment	N2C	9	N	N	N
67	Charges	N2	9	N	N	N
68	Tax	NO	5	N	N	N
69	Tax Amount	N2	9	N	N	N
70	Tax Payment	N2C	9	N	N	N
71	Net Payment	N2C	9	N	N	N

<u>Database File SUB400</u>

Code No 1
Contract No
Subcontractor
Address 1
Address 2
Address 3
Address 4
Type of Work
Contract
Payment No
Nom/Own
VAT No
Total 1
Discount
Disc Total
Total 2
Retention
Ret Total
Total 3
VAT
Tax

7 If $selection = 5 then procedure browse is called.

8 If $selection = 6 then control of the program is transferred to label end. Go to step 10.

9 Control of the program is transferred to label mmen ie the start of the main program, so that the menu is displayed again. Go to step 2.

10 All database files are unloaded and the screen is cleared.

Procedure men

Variables Used

Name	Type	Description
$selection	character	Users menu choice

1 This procedure is used to display the menu and allow the user to select a menu item. The users response is stored in variable $selection, a return is then made to the main program.

Procedure enter

Introduction

This procedure is used to enter new records into the database file ADDLAB2.

Description

1 The ENTER command is executed to allow the user to enter new records.

2 The KEY UPDATE command is executed to merge all newly added records into the existing key fields. The file ADDLAB2 is ordered by the key field [ADDR3] to place the addresses in alphabetical order. Procedure refno is then called which assigns each address with a reference number. A return is made to the main program.

Procedure update

Introduction

This procedure is used to update the database file ADDLAB2.

Key Field Information For Database File SUB400

	Field Number	Title	Asc/Descending	Key	Length
major	1	Code	A		5

Calculated Field Equations For Database File SUB300

Field 44 [Total 1] =
[V1]+[V2]+[V3]+[V4]+[V5]+[V6]+[V7]+[V8]+[V9]+[V10]+[V11]+[V12]
+[V13]+V14]

Field 46 [Payment 1] =
[Total 1]-[Prev 1]

Field 49 [Disc Total] =
[Discount Total]*[Discount]/100

Field 51 [Disc Payment] =
[Disc Total]-[Disc Prev]

Field 52 [Total 2] =
[Total 1]-[Disc Total]

Field 54 [Payment 2] =
[Total 2]-[Prev 2]
Field 59 [Ret Total] =
([Retention1]/100*[Retention T 1])+(Retention2]/100*[Retention T 2])

Field 61 [Ret Payment] =
[Ret Total]-[Ret Prev]

Field 62 [Total 3] =
[Total 2]-[Ret Total]

Field 64 [Payment 3] =
[Total 3]-[Prev 3]

Field 66 [VAT Payment] =
[Payment 3]*[VAT]/100

Field 70 [Tax Payment] =
[Tax Amount]*[Tax]/100

Field 71
[Payment 3]+[VAT Payment]-[Tax Payment]-[Charges]

Key Field Information For Database File SUB300

	Field Number	Title	Asc/Descending	Key Length
major	1	Code No	A	5

Project File SUB

```
load A:sub400 screen standard
order key [1]
split horizontal 11 2
goto window 2
load A:SUB300 screen sub300-screen1
lookup load PAY
goto window 1
transactions predefined PAID no-audit
goto window 2
enter
print record screen all
label men
clear
menu clear 15 0
menu print 5 5 15 0 Do you want to :
menu print 8 10 15 0 Continue with more sheets  (C)
menu print 10 10 15 0 Finish this session        (F)
menu print 12 10 15 0 Update previous sheets     (U)
menu input 16 10 15 0 1 $choose
if $choose == "c"
     jump cont
elseif $choose == "f"
     jump exit
elseif $choose == "u"
     jump update
endif
label cont
enter
print record screen all
jump men
label update
lookup remove PAY
update
print record screen all
lookup load PAY
jump men
label exit
unload all
goto window 1
close
```

Project Processing File ADDLAB

Introduction

This program uses the database file ADDLAB2 which contains the records of names and addresses of all current Weaver sites. A menu is displayed for the user to select one of the following options (i) Enter new addresses, (ii) Update existing records, (iii) Print address labels, (iv) Delete labels from file, (v) Browse and (vi) Exit the program. If the user selects option (iii) a sub menu is displayed asking the user if one of each label is to be printed, a specified number of each label is to be printed or the labels to be printed are to be selected. If the user chooses to print a specified number of all labels an input screen is displayed which asks the user how many of each label are required. If the user chooses to select the labels to be printed a query must be defined to do this.

Main Program

Introduction

The main program loads the required database file and calls procedure men which displays the menu. The user selects a menu item and the appropriate procedure will be called according to the users response. When the user decides to exit the program, the database file ADDLAB2 is unloaded and the screen is cleared.

Variables Used

Name	Type	Description
$selection	character	Users menu choice

Description

1 The database file ADDLAB2 with screen ADDLAB-CRN2 is loaded.

2 Procedure men is called to display the menu and allow the user to select a menu item which is stored in variable $selection.

3 If $selection = 1 then procedure enter is called.

4 If $selection = 2 then procedure update is called.

5 If $selection = 3 then procedure plab is called.

6 If $selection = 4 then procedure dellab is called.

Description

1 The UPDATE command is executed to allow the user to update existing records in the file ADDLAB2.

2 The KEY UPDATE command is executed to merge all newly added records into the existing key fields.

3 The file is ordered by key field [ADDR3]. A return is then made to the menu.

Procedure refno

Introduction

This procedure is used to assign reference numbers to all address labels whenever new labels are either entered into the file or deleted from the file.

Description

1 Control of the program is transferred to the first record in the file which has previously been ordered.

2 The counter $rcnt and parameter variable %6 are initialised.

3 A loop is constructed so that each record in the file is assigned a reference number.

Procedure plab

Introduction

This procedure is used to display the sub menu which allows the user either to specify how many of each label is to be printed or select certain labels for printing.

Variables Used

Name	Type	Description
$selection1	character	Users menu choice

Description

1 Procedure men1 is called which displays the sub menu and allows the user to make a choice which is stored in variable $selection1.

2 If $selection = 1 the user wishes to print one of each label in the file. The file is ordered by key field [REF NO]. The REPORT PRINT command will print the labels on the printer as specified in the report definition ADDLAB.

3 If $selection1 = 2 the user wishes to print a specified number of each label. Procedure printno is called.

4 If $selection1 = 3 the user wishes to select the records to be printed. The file is ordered by key field [REF NO]. The QUERY command selects records from the file ADDLAB2 based on selection criteria. The QUERY DEFINE command allows the user to specify which records are to be selected by typing in the reference numbers of the required records. The QUERY PREDEFINED command executes the defined query ADD-LAB and the selected records are stored in an index ADDS. The file is then ordered using the index ADDS.

5 Procedure printno is called to allow the user to specify the number of times each label is required to be printed.

6 The GOTO FILE command returns the unordered file to the screen. A return is then made to the main program.

Procedure printno

Introduction

This procedure allows the user to print the specified number of each label.

Description

1 The input-screen ADD-LAB is displayed which asks the user to input the number of times each label is to be printed. The users response is stored in parameter variable %2.

2 A counter $count which stores the number of times the labels have been printed is initialised and a loop is constructed so that each label is printed %2 number of times. The REPORT PRINT command is used to print the labels as defined in the report definition ADDLAB. A return is then made to the menu.

Procedure men1

Introduction

This procedure is used to display the sub menu and allow the user to select an option.

Variables Used

Name	Type	Description
$selection1	character	Users menu choice

Description

1 The screen is cleared and the menu is displayed. The users response is stored in $selection1.

Procedure dellab

Introduction

This procedure is used to delete any addresses that become redundant from the file.

Description

1 The file ADDLAB2 is ordered by key field [REF NO].

2 The QUERY command selects records from the file ADDLAB2 based on selection criteria. The QUERY DEFINE command allows the user to specify which records are to be selected by typing in the reference numbers of the records required to be removed from the file. The QUERY PREDEFINED command executes the defined query ADD-LAB and the selected records are stored in an index ADDS. The file is then ordered using the index ADDS.

3 Control of the program is transferred to the first record in the program and a variable used as a counter $recsc is initialised. A loop is constructed so that the program will DELETE every record in the ordered file. The DELETE command will remove a record from file operations such as REPORT, but retain the record the record in the file. To remove a deleted record from the file the UTILITIES PURGE command must be used. This command cannot be used with an active file, therefore the file must first be unloaded and then purged. When this has been completed the file is loaded back into memory. The KEY UPDATE command is executed to rearrange within the key file the names of the existing

records in proper key order. Procedure refno is then called to re-reference the existing records.

4 A return is then made to the main program.

Procedure browss

Introduction

This procedure is used to allow the user to browse through the records in the file.

Description

1 The file is ordered by key field [REF NO].

2 The input-screen BROS1 is displayed to instruct the user to press the F8 key when finished browsing.

3 The BROWSE vommand is executed in order to scan mltiple records on the screen at the same time.

4 The SUSPEND command is executed which causes project execution to pause and return program control to the user whilst browsing through the records. The F8 key must be pressed to re-start execution of the project.

5 A return is then made to the main program.

The file is then ordered by the key field [no] and a return is made to the menu.

Project File ADDLAB

```
load ADDLAB2 screen ADDLAB-CRN2
label mmen
call men
if $selection = 1
     call enter
elseif $selection = 2
     call update
elseif $selection = 3
     call plab
elseif $selection = 4
     call dellab
elseif $selection = 5
     call browss
elseif $selection = 6
     jump end
endif
jump mmen
```

```
label end
unload all
clear
end

procedure men
menu clear 0 0
menu print 5 5 15 0 Options :-
menu print 9 5 15 0 1.  Enter new labels.
menu print 11 5 15 0 2.  Update existing labels.
menu print 13 5 15 0 3.  Print labels.
menu print 15 5 15 0 4.  Delete labels from file.
menu print 17 5 15 0 5.  Browse.
menu print 19 5 15 0 6.  Finish.
menu input 20 24 15 1 1 $selection.
return

procedure enter
enter
key update
order key [4]
call refno
return

procedure update
update
key update
order key [4]
return

procedure refno
goto record rec-number 1
$rcnt = 1
%6 = 1
while $rcnt <= records
     [REF NO] = %6
     goto record next
     %6 = %6 + 1
     $rcnt + 1
endwhile
return

procedure plab
call men1
if $selection1 = 1
     order key [1]
     report print ADDLAB printer
elseif $selection1 = 2
     call printno
elseif $selection1 = 3
     order key [1]
     query define ADD-LAB
     query predefined ADD-LAB index ADDS
     order index ADDS
     call printno
     goto file ADDLAB2 screen ADDLAB-CRN2
endif
return
```

```
procedure printno
input-screen load ADD-LAB
$count = 1
while $count <= %2
     report print ADDLAB printer
     $count = $count + 1
endwhile
return

procedure men1
menu clear 0 0
menu print 5 5 15 0 Options :-
menu print 9 5 15 0 1.  Print one of each label.
menu print 11 5 15 0 2.  Print a specified number of each label.
menu print 13 5 15 0 3.  Select labels to be printed.
menu input 14 24 15 1 1 $selection1
return

procedure dellab
order key [1]
query define ADD-LAB
query predefined ADD-LAB index ADDS
order index ADDS
goto record rec-number 1
$recsc = 1
while $recsc <= records
     delete
     goto record next
     $recsc = $recsc +1
endwhile
unload file ADDLAB2
utilities purge ADDLAB2
load ADDLAB2 screen ADDLAB-CRN2
key update
call refno
return

procedure browss
order key [1]
input-screen load BROWS1
browse all
suspend
return
```

Data Entry Screen

Address Labels

Ref No : 1 [Ref No]

Address	:	Weaver Construction Limited	[ADDR1]
		Site Office	[ADDR2]
		67 Pye Nest Gardens	[ADDR3]
		Sowerby Bridge	[ADDR4]
		Halifax	[ADDR5]
			[ADDR6]
			[ADDR7]

Database File ADDLAB

Field No	Field Title	Type	Length	Key	Total	Status
1	Ref No	NO	3	Y	N	N
2	ADDR1	A	34	N		
3	ADDR2	A	34	N		
4	ADDR3	A	34	Y		N
5	ADDR4	A	34	N		N
6	ADDR5	A	34	N		N
7	ADDR6	A	34	N		N
8	ADDR7	A	34	N		N

Appendix 4

Costing Exercise for Stand-alone Applications and Integrated Database Design

COMPARATIVE COSTING EXERCISE

OPTION ONE - Standalone Departmental Computers

Upgrading of existing Workstations

4 No Database Software	£1600
4 Hardware Maintenance	£1000
4 Software Maintenance (2hrs/wk)	£4000
Total	£6600

Cost of Additional Workstation

1 No PC with 20Mb Hard Disk	£1100
1 No Dot matrix printer	£300
Database software	£400
Hardware Maintenance	£250
Software Maintenance (2hrs/wk)	£1000
Total Cost/workstation	£3050

Total Costs For 4 Extra Workstations - £18,800

OPTION TWO - Computer Network (using existing Apricot)

Central Fileserver

Existing Apricot 386 +

300 Mb hard disk	£3700
Network Software	£1500
3 Extra Network Cards	£750
Database Software (For N/Ws)	£1500
Hardware Maintenance	£1000
Computer Maintenence (2 hrs/wk)	£1000
Network Administration (3hrs/wk)	£1500
Installation Costs	£2000
Total Upgrade cost	£12950

Cost of Additional Workstation

Single floppy PC	£650
Network card	£250
Total Cost/workstation	£900

TOTAL COST FOR 4 EXTRA WORKSTATIONS - £16550

OPTION THREE - Computer Network (New Fileserver)

386 PC with 300Mb hard disk	£4000
Network Software	£3000
4 Extra network cards	£1000
Database software (For N/Ws)	£1500
Hardware Maintenance	£1000
Computer Maintenance (2hrs/wk)	£1000
Network Administration (3hrs/wk)	£1500
Installation Costs	£2000
Total Costs	15000

Additional Workstations

Single floppy PC	£650
Network card	£250
Total Cost/workstation	£900

TOTAL COSTS FOR 4 EXTRA WORKSTATIONS - £17,700

(N.B. File server acts as workstation)

BENEFITS OF COMPUTER NETWORK

Intangible Benefits

* Consistent data

Same values of data being used throughout the company

* Greater potential for additional reports

Because all data is stored centrally it is easier to generate reports that have not yet been identified.

Tangible Benefits

* Time savings in data collection

Data has only to be entered ONCE into the system.
(say 10hrs per week) £5000 pa

* Time savings in data transfer

Data is SHARED. Therefore there is no need for departments from one department to another.
(say 15hrs per week) £7500 pa

* Faster and easier access to data.

Similarly, EVERYONE has access to ALL data. Therefore they can obtain it and use it much more quickly and easily.
(say 15 hrs per week) £7500 pa

* Less hardware & software maintenance

Already covered in comparative costs.

* Less training requirements

All staff do not require training on routine housekeeping duties. Similarly, because of the consistency of the applications there is less training as applications are modified or added.
(say 5 hrs per person) £100 pa

* Quicker and cheaper updating of software applications

Because of the common database, additional applications will be quicker and easier to add or update.
(say 20 programmer hrs) £400 pa

* Quicker and cheaper expansion

Already covered in comparartive costs.

TOTAL BENEFITS COULD RESULT IN SAVINGS OF £20,500 PA

Appendix 5

Post Implementation Interview Results

PROSPECTIVE USERS STRUCTURED INTERVIEW MEX1/PC
1:USE OF COMPUTERS

i What will be the function of the computer in your job?

Did not know, had never used a computer.	17%
Named specific applications in own area of work.	83%

The planners interviewed felt the computer would be useful in the areas of pre-contract planning, material scheduling and for drafting and altering programmes of work.
The surveyors felt the computer would be of use for subcontract payments and also to access cost data held by the accounts department. One surveyor expressed the view "I think there's little use for a computer in surveying, each job is different and it would be difficult to have a system which would be able to incorporate all the different variables. I think too much time would be spent inputting data."

ii Have you used a computer elsewhere?

Yes 83%

60% had used computers either at school or college
40% had used computers in their previous workplace to schedule manpower, produce B.O.Q.s valuations and progress reports.

No 17%

The interviewees who had used computers in their previous workplace had a general idea how the computer could be applied to their work. Only one person had never used a computer before and could not perceive any use for one in their job.

2:IMPLEMENTATION AND TRAINING

i Has there been any consultation regarding the installation of new systems?

All the respondents felt there had been little consultation, particularly concerning implementation of systems in other departments. 100%

The staff were unaware of the overall systems implementation plan for the company and could not envisage how the systems to be implemented in their departments related to other developments. All the respondents felt it would have been useful to have a briefing detailing an I.T. implementation plan, describing development work and planned installation dates.

ii What computer training have you had?

None	17%
Basic training at school/college, word processing and BASIC	66%

Computer appreciation on a management course	17%

The majority of interviewees had had a previous basic computer training at school/college but could recall very little of what they had learnt as they had not had the opportunity to put their knowledge into practice.

iii What training would you like?

Training in the applications that are to be implemented and any other training the company requires.	100%

The staff did not have any specific training needs. They requested to have sufficient training to enable them to efficiently perform their job functions

3:ADVANTAGES OF COMPUTER

i Will the system make your job easier or harder?

Harder initially whilst learning the system, easier in the long term.	33%
Did not know, had never used a computer	17%
Easier, providing the system meets user requirements and operates correctly.	50%

The planners interviewed felt the computer would make drafting and amending programmes much easier and also save time. However the programme would still have to be designed manually as the majority of planning packages used critical path analysis for programme production and this method was not used in the department. It was also said that the computer could create more work in order to provide data in a suitable form for input.
All but one respondent felt the computer would make their jobs easier in the long term after the initial learning period. Respondents who had used computers in their previous workplace and aware of possible changes were concerned that computerisation would be accompanied by an increase in workload in converting data into a suitable input format.

ii How do you think your job will change by introducing the computer?

No change to job, the same job will be done on a computer instead on manually	83%
More office based as information can be retrieved from the computer rather than having to liaise with people.	17%

The general feeling was that computerisation would not bring about a job redesign and it was evident that such a change would not be welcome. One respondent felt that changes would only occur if computer links were established with other departments and feedback systems were introduced into the company. "There are no feedback systems in operation, which is a problem as we never know what has arrived on site and whether materials have been over or under ordered." Another surveyor felt it would not be practical to have a computer on site and felt that much of his work involved "deals with people which can't be done on a computer".

iii Do you want to use a computer in your job?
Why?

Unsure until computers are in operation in company	17%
Yes to keep abreast with technology. "We must keep the pace with our competitors, the industry as whole should also be exploiting I.T."	32%
Yes to facilitate data retrieval. Also to remove the tedious parts of ones job, leaving more time to do the more interesting aspects.	17%
No, mistrusted computers. A surveyor expressed the view "I don't think it will be much quicker than doing the job manually. I want to have control of what I'm doing and write it on paper. It's easier to make mistakes on computer, and input incorrect data. A single mistake would be magnified several times without realising."	17%
Indifferent, if it is a company requirement then will use.	17%

The prospective computer systems were perceived as tools for speeding up tasks that were performed manually or something that should be acquired to follow the trend of competitors in the industry. One surveyor said " I'd use it for subcontract payments but I can't see any other use for a computer in surveying. Each job has different problems and variables. I don't think there's a package to deal with all the variables. I wouldn't want a computer on site. It's difficult to alter things on computer if mistakes are made on site and I want to hide costs. "

iv In view of the current downturn in the Construction industry, do you seethe computer systems as increasing the competitiveness of your company ?

Yes, increased productivity and therefore increased turnover and less overheads are required. People be made redundant. One respondent stressed that data must be kept up to date and the users must be competent, otherwise more mistakes could be made than if the job were done manually. The importance of training before the implementation of computers was also highlighted.	66%
Certain departments can increase competitiveness, such as estimating.	17%
No, the job can only be done quicker by labour on site.	17%

The majority of staff felt that competitiveness of the company would be increased in terms of speeding up operations and being able to reduce staff

4.FUTURE

In five years time do you see
(a) Each department being computerised and linked in the company?
(b) Staff ceasing to use the systems and returning to manual methods?
(c) No further developments. Only a few computers in certain departments.

All respondents gave (c) as their answer. No-one envisaged that all departments would be linked via a network, perhaps estimating, buying, planning and accounts could be linked but not marketing. It was felt that computerisation of departments would take place on a very slow basis, the developments being dependent on the departmental director.

The feeling expressed was that computers would not play a major part in company growth and development. The staff felt they did not have much influence over future plans. The departmental director had control over developments and would be a catalyst for further and more complex systems.

PROSPECTIVE USERS STRUCTURED INTERVIEW MAN1/PC

1:USE OF COMPUTERS

i What will be the function of the computer in your job?

Unsure	11%
Named specific applications in own area of work, such as bonus calculations, subcontract enquiries, planning programmes, resource scheduling, COSHH system and a feedback system to compare bill prices and value of work done on site which would assist in controlling costs.	78%
44% of these respondents felt that a system networked with head office would allow them to gain easy access to accounts information and the extraction of cost data. It was also suggested that a payroll system could be implemented rather than having to rely on the Mexborough office.	
Cannot be used for estimating. "We price many different types of jobs. It would take too long to input the information on prices and update it".	11%

ii Have you used a computer elsewhere?

YES 56% of these respondents had used a computer at their previous workplace. The remainder had used computers either at home for games purposes or on a college course.	89%
NO	11%

The majority of staff were aware of how the computer could be used in their jobs. Those who had previously used computers suggested applications with which they were familiar. The surveyors felt the most beneficial use would be to be networked to head office which would allow access to cost data held by the accounts office. This was only available on a monthly basis whereby the materials ledger books were brought to the office for a few days after which they were returned to head office. A networked system would increase their autonomy and independence.

2:IMPLEMENTATION AND TRAINING

i Has there been any consultation regarding the installation of new systems?

All respondents replied no, only informal discussions had taken place amongst themselves.	100%

No formal meetings had taken place whereby staff were informed of proposed computer developments. However it appeared that staff had informally discussed in detail, applications that would be useful and current I.T. developments in the construction industry.

ii What computer training have you had?

None	78%
Training at night school/college	22%

iii What training would you like?

Appropriate training to use the applications installed. 11% of these respondents also requested training on troubleshooting and problem solving. "At my previous firm, the computer systems were installed with no staff training. We had to learn by trial and error. The system had many bugs and because we new very little about the system we had to rely on other staff to solve our problems." 11% of the respondents requested training to use a word processing package. Several people also felt it would be useful to have a keyboard skills course to gain familiarity with the location of the keys and increase the speed of input.	78%
Training that allows one to retrieve relevant information to compare costs and provide feedback.	11%
Basic training that assumes no previous knowledge.	11%

The majority of staff wanted adequate training to use the systems installed and enable them to effectively perform their job functions. The office manager said he would like a system with a user friendly interface which would allow him to interrogate and retrieve any data he required from the system. Another respondent who had experienced many problems with a system at a previous workplace and had little post implementation support felt it was important to understand how the system worked in order to be able solve and overcome any problems.

3:ADVANTAGES OF COMPUTER

i Will the system make your job easier or harder?

Easier, it would reduce paperwork, allow easier and quicker access to information. 11% of respondents felt it would make their job easier once they were accustomed to the system and indicated they would double check calculations at first.	45%
Unsure	22%
Easier providing accounts information was accessible	22%
Much harder	12%

The majority of respondents felt the computer would enhance and make their jobs easier because it would improve the information flow, particularly if systems in different departments were networked.

ii How do you think your job will change by introducing the computer?

No change to job, but it will remove the mundane tasks, make repetitive tasks less laborious, reduce paperwork increase productivity and provide more information and feedback.	67%
Increase professionalism	11%
More office based as information would be available via computer	11%
Control would be removed from the job "I'd be pricing a job using numbers previously entered into the computer and loose control"	11%

Only one member of staff perceived his job would change and that control would be removed and transferred to the computer. The other members of staff did not perceive any change. The surveyors felt much of their job involved valuations whereby they were liaising with people on site which a computer could not do. One respondent envisaged that perhaps their job would change after the system was installed and the capabilities were fully understood thus allowing further developments to take place.

iii Do you want to use a computer in your job?
Why?

Yes to keep abreast with technology	22%
Yes to access cost information from accounts in head office and be more autonomous. "Many functions are performed in head office which could be done here if we had a computer."	33%
On respondent replied "No, it would be of no benefit to the way I do my job. I've seen other companies using computers in estimating and no	11%

computer can price a job as quick as I can.

Yes to investigate and learn something new	11%
Yes it would provide increased accuracy, efficiency and feedback from other departments	22%

All but one respondent wanted to use computers in their jobs. The staff could see the benefits and value of being able to share information.

iv In view of the current downturn in the Construction industry, do you see the computer systems as increasing the competitiveness of your company ?

Yes, more accurate information, increased efficiency, time savings and feedback. The office manager felt computer systems would improve the flow of information enabling better and quicker decision making.	55%
No, it provides information after the event, they cannot alter that way buildings are constructed on site.	45%

Opinions were very mixed, several people were of the view that computers could not increase productivity on site.

4:FUTURE

In five years time do you see
(a) Each department being computerised and linked in the company?
(b) Staff using manual methods?
(c) Only certain departments using computers others using manual methods.

(a) The respondents would like to see each department linked in the company and also have a link to head office in order to exchange information.	66%
(c) One respondent felt computers would only be useful in the accounts department. He also had the opinion that computers wasted too much paper and were sold on saving staff. "I am too old to change the way I do things. Everything is stored in my head, it's easier to do my job this way." The general manager sympathised with this view and felt estimating would still be done manually and jobs would have to be standardised before they could be priced accurately on computer.	44%

The majority of respondents were of the opinion that computers should be a part of company growth and development. Many felt computers had not been exploited to date and saw great potential for computer developments in the company. Few people envisaged computers on site.

CURRENT USERS STRUCTURED INTERVIEW

1.USE OF COMPUTERS

i What is the function of the computer in your job?

The estimating department were using computers for comping bills, producing the monthly tender analysis and budget figures, sending out subcontract and material enquiries and producing telephone lists.	60%
The surveying department were using computers for producing bonus sheets and subcontract payment certificates.	40%

b) How long have you been using the computer at work?

1 - 2 years	100%

c) How many hours/week do you use the computer?

The Estimating department were using the computer 10 - 20 hrs/wk on average depending on the number of jobs that required pricing.	60%
In surveying the computer was used 3 - 7 hrs/wk	40%

ii Have you used a computer elsewhere?

Yes, at school/college. Computers had been used for word processing, producing spreadsheets and retrieving data from databases.	80%
No	20%

Although most interviewees had previously used computers at school/college they could remember little of what they had learnt. Only one respondent had regularly used computers as part of a part time course and found the experience gained had helped her to easily adapt and learn the systems implemented at work.

2. IMPLEMENTATION AND TRAINING

i If you are using a computer in your job : do you feel you had adequate input into the development of the system prior to its installation ?

Yes, in estimating discussions had taken place with the departmental director and the systems implementor both before and during the implementation.
The surveyors felt they had made sufficient contributions, particularly in refining the system to meet user requirements.
The systems had undergone many changes to satisfy requirements from other departments.

All interviewees were satisfied that they had sufficiently contributed to systems development. One respondent who had never used computers felt that their input had been minimal because of a lack of computer knowledge and suggested a computer appreciation would have been useful before any development work had

proceeded.
The systems in surveying had all undergone post implementation changes suggesting that the end users receiving computer output had not been adequately consulted.

ii What training have you had before the systems were installed ?

a) before the system was installed

In house training on how to operate the system, input data and produce reports.	100%

b) after the system was installed

User support was provided to deal with any problems. Training courses were also conducted at the polytechnic which were specifically designed for the company. These covered databases, spreadsheets and the operating system MS-DOS.	100%

iii) Do you feel you have had adequate training in the use of

a) the system you are using in your job

Yes. One interviewee requested further training on troubleshooting and solving system problems.	100%

Another respondent said it would be interesting to learn about other packages being used in different departments which would perhaps generate ideas for further applications that might be useful.

b) the operating system MS-DOS

Yes. However some respondents said that because systems were menu driven, they rarely needed to use MS-DOS commands to access their programs and couldn't remember them when required without referring to the manuals which they had acquired on their training courses.	100%

c) Floppy disks, keyboard, printers.

Yes	100%

iv) What training would you like ?

Adequate training has been given to perform job function.	20%
Would like to know more about other systems and packages available in company.	40%
Would like training on troubleshooting and problem solving.	40%

The opinion expressed was that training had been adequate in using the systems in ones own department, but it would be beneficial to have an awareness of what developments were taking place in other departments.

v) What would you do if you had a problem with

a) the system you are using in your job ?

Would attempt to find the root of the problem by checking the input data and re-running the program. If this failed the systems manager would be contacted. 40% of the respondents had kept their own records of previous problems and how these had been solved.	80%
Systems manager would be requested to solve the problem.	20%

b) the operating system MS-DOS

The MS-DOS manual would first be consulted and then the systems manager.	60%
The systems manager or departmental supervisor in estimating would be consulted	40%

c) the floppy disks

Consult departmental supervisor who normally backs up data and performs file management functions.	40%
Consult systems manager.	40%
Would perform a check disk and attempt to reformat disk.	20%

d) the keyboard and printer

Check connections and keys and then notify the systems manager.	80%
Notify systems manager.	20%

The majority of users felt confident enough to tackle problems and attempt to solve them by themselves.

3:ADVANTAGES OF COMPUTERS

i Do you like using the computers? Why?

Yes, it was felt that the computer produced a more professional output, added variety and interest and was much quicker than doing the job manually. However one interviewee found that prolonged use of the computer caused eye strain but would still rather be using the computer than a typewriter.	80%

One interviewee who was using the bonus system felt the computer saved time providing all the targets were stored on computer as he didn't have to search through a book to find them. However the portable computer on which the system was implemented did not have a floppy disk drive which meant data had to be down loaded by connecting the portable to the departmental computer and using the communications module. This was a time consuming process which could occupy the computer for several hours. The surveyor had also been requested to provide more information than had been required previously with the manual system in order to facilitate integration at a later stage. He did not particularly welcome this change, but felt that once the systems were integrated the benefits would be more apparent. However he still enjoyed using the computer because he was learning something new and it added variety to his job.

Indifferent. "I have lots of problems with the system and sometimes it can take the same amount of time to input data into the computer as it would to process subcontract certificates manually."	20%

ii Do you understand how the system operates that you are using?

Yes, the interviewees understood the processes involved and felt they could clearly explain them to someone else.	80%
Vague idea.	20%

iii Has the system made your job easier or harder?

Easier because it was quicker.	80%
Easier provided the system is functioning correctly and no problems are encountered.	20%

All the respondents felt the computer made the job easier. One interviewee expressed the opinion that it was easier, for sending out enquiries and also for comping bills providing there's someone to check what has been input. Another advantage of comping the bill on computer was in situations where the priced bill is called for. The bills have already been calculated and show all the extensions for labour, subcontract and materials on each printout. This is not necessary for the initial tender, as only the page totals are required.
However if the job had been totalled on a calculator all the extensions would be accumulated to show only the page totals. If a priced bill is later requested all extensions and totals would have to be recalculated.
The surveyor using the subcontract enquiry system found that he did not always have sufficient time to process all the required subcontract payments as he spent little of his time at head office. On occasions the other surveyors had processed their own sheets and accidentally corrupted data files as they had not had sufficient training on operating the system. It was then a time consuming task to restore files and correct mistakes.

iv How has your job changed since introducing the computer?

No, the job is the same but easier and quicker to perform.	100%

v Would you prefer to do your job as before without the computer? Why?

No. The opinions expressed were that the computer was much quicker, more accurate and increased job satisfaction. An interviewee from the estimating department stated " We couldn't the same amount of work we do now when we are busy without a computer. "	80%
Indifferent.	20%

vi What improvements would you like to make to your system?

None.	60%
Requested better reporting facilities which would provide feedback on site progress.	20%
Would like the computer to perform more validity checks on input data and provide error messages.	20%

vii What does it do that you don't like?

Nothing.	100%

viii Is there any data from other departments you would find useful?

Probably, but being unaware of what the systems implementation plan is for the company and therefore of what data would be stored on computer. Hence it is difficult to specify what would be useful.	60%
Nothing	20%
Would be useful to have feedback from surveying on the subcontractors they use on their jobs. Enquiries are often send out by estimating to subcontractors who the surveyors never use. They have their own contacts who they often appoint for to carry out subcontract work. At present finding this data involves a time consuming search through the surveyor's files.	20%

ix In view of the current downturn in the construction industry, do you see the computer systems increasing the competitiveness of your company ?

Yes, the estimating department felt they could tender for more work due to the increase in productivity. Also other competitors	100%

were introducing I.T. and it was important for the company to exploit computers to remain competitive.
One interviewee felt the computer systems could enhance decision making if particularly if integrated as more feedback would be available.

4:FUTURE

i In 5 years time do you see

a) Each department being computerised in the company ?

b) The staff ceasing to use the computer systems and returning to manual methods?

c) No further systems being installed into the company?

a) One interviewee felt this was the best way forward. 40%

c) One interviewee felt that the recession had hampered systems development, however envisaged that every department would eventually acquire a computer system but would not be integrated. 60%
Another interviewee felt there was no-one in the company who would act as a catalyst to encourage further systems development and integration. However it was envisaged that progress would be made in the estimating department because the departmental director was aware of the benefits and potential of computerisation.

ii Do you feel that by being able to use computers you have increased your job prospects?

Yes 100%

All the interviewees felt their computer skills would be an asset in finding future employment, because computers were now used in most offices.