

THE RELATION BETWEEN FRONT-END
PLANNING AND SUCCESSFUL
COMPUTERISATION OF PROJECT
MANAGEMENT SYSTEMS
IN CONSTRUCTION

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A project report submitted to the Faculty of Engineering, University
of the Witwatersrand, Johannesburg, in partial fulfilment of the
requirements for the degree of Master of Science in Engineering.

Johannesburg, 1988.

DECLARATION

I declare that this project report is my own unaided work. It is being submitted for the degree of Master of Science in Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Suzanne Khan
(Signature of candidate)

01 day of MARCH 1988

ABSTRACT

Research has shown that front-end planning is the single most important factor contributing to success, when computerising a construction orientated project management system. Allied to this front-end planning the next most significant factors were shown to be top management and end-user involvement and participation in all phases of the system development. Lesser factors contributing to the successful computerisation include structured design formats, sound strategic thinking, strong leadership for the development, clear cost analysis and an evaluation of alternatives.

In Memory of my Father

JOHN ALLEN (1922 - 1983)

who, I believe, would like to have read this.

ACKNOWLEDGEMENTS

Without the direction and encouragement I received from Hamid Bastani, from the University of the Witwatersrand, this project report would never have been completed. Carol van Zyl offered much initial support playing an important role in refining the questionnaire.

The field research involved many time-consuming interviews. I would like to thank the following people who helped me analyse the development of the project management system in their organisations.

Ivor Evans	B S Bergman & Partners Inc.
John Colley	Engineering Management Services, Ltd
Kaay Koch	Engineering Management Services, Ltd
Bruce Rodrigues	DMD Projects Inc.
Danielle Dayel	DMD Projects Inc.
Jost Wiederhold	S W Goldstein & Co (Pty) Ltd
Dave Albarr	Combrink Construction (SA) (Pty) Ltd
Rob Brites	JJ Schneid & Associates
Andrew Chodelski	George Kendall (Pty) Ltd
Edward Wilson	JJ Schneid & Associates

The following people assisted with distributing the questionnaire to as many areas of project management as possible.

Ronald Schloss	S A Institute of Building
Colin Spence	S A Association of Consulting Engineers
Robin Pee	Institute of S A Architects
Brian Phillips	S A Federation of Civil Engineering Contractors
Kaay Koch	Project Management Institute

Ross Leighton, offered encouragement and advice in setting up the in-depth interview guide questionnaire. Matthew Carr searched for grammar and logic errors.

To all these people I offer thanks and hope they will be interested in reading the result.

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CHAPTER ONE

INTRODUCTION

- 1.1 The Aim of the Investigation
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CHAPTER ONE

INTRODUCTION

1.1 The Aim of the Investigation

Construction projects are becoming increasingly complex and multidisciplinary, with durations being reduced as far as possible to minimise the cost of finance, inflation and escalation. These factors necessitate a management system that provides increased detail for analysis; speed and accuracy of reports; and construction planning and co-ordination in greater depth. Almost all construction companies in South Africa today have been forced to computerise to some extent (Thamhain, 1986). In some large and progressive companies all functions have been computerised and integrated, while in other smaller companies only one aspect, such as time control has been computerised.

The development of completely integrated computerised systems is complicated by the fact that most companies have not embarked on such a design before and there is no standard or accepted methodology to follow.

Whether the system is completely integrated or individual modules are used, computation has, in general, markedly increased the efficiency of most projects. This degree of efficiency, however, can be further optimised with careful front-end planning during the system design. The aim of this project, therefore, is to determine the extent to which front-end planning increases the success of the computerisation of project management systems in construction. In turn the term front-end planning has to be defined and the aspects of front-end planning prioritised.

1.2 Justification for the Investigation

Project management has almost become a fixed methodology varying, in application, according to the size and type of the project and the philosophy of the company. Various methods, such as critical path method (CPM) for time control, have been established and, to an extent, standardised. The advantages of computerising these methods of project management are well documented and accepted, however, there is no clear cut methodology to follow when computerising a project management system (O'Brian, 1965).

Project management software, has been designed and developed to varying degrees by engineers, architects, quantity surveyors, project managers and software houses to cover various aspects of project management. However, a method of developing a total project management system, incorporating all aspects, computerised or manual, has not yet been clearly devised.

Measuring the success of development projects is difficult as there are many unknown factors before and during the design which complicate time and cost estimates (Gensert, 1986). Project managers have often made use of systems for construction management planning and control and are therefore completely familiar with their workings; yet they lack insight to plan the working phases of these systems. On the other hand, MIS professionals are familiar with the planning phases for systems development but lack knowledge of the specific construction applications, namely construction management, planning and control. Consequently the logical step is to combine the expertise of project management personnel with that of the MIS personnel. The idea of linking project management and information systems has emerged only recently and has proved to be of strategic importance in a fast-developing area (McFarlan lecture, 1985).

Pre-designed packages are available and can be bought "off-the-shelf" but these are only useful to a company if the package meets the exact needs of that company. The present state of software and hardware technology has not yet advanced to the point

where all construction project managers can have their requirements met by simply acquiring a package. The result being that some project managers are forced to design or develop their own system so that they can meet their own requirements. Developing a system does not necessarily mean designing in-house, it can incorporate the analysis of available software. The decision process results in a number of possible paths:

- o If an available system is satisfactory it can be bought and used in the manner for which it was designed;
- o A purchased system may be modified to suit the company needs exactly;
- o A system may be developed to meet the company requirements. This is usually done by buying some modules, designing others and designing the linkage to integrate them; and.
- o A computer bureau could be considered to perform the project management function.

At present, theories of systems development for project management have not been tested as most companies are developing a total system for the first time. The process of designing and computerizing project management systems often occurs within areas that cannot be clearly defined such as non-technical areas, which are usually outside a project manager's training and experience. These areas include:

- o conceptual analysis;
- o corporate culture;
- o strategic planning;
- o definition of needs;
- o personnel participation;
- o motivation and training;
- o implementation of the computerized management system;
- o personnel's resistance to change;
- o evaluation; and
- o feedback monitoring of the systems after implementation.

The problems, identified above, of undefined methodology, inadequate packaged software, many alternative development routes and lack of experience highlight the need to define an early thinking process (front-end) plan which should precede any development.

1.3 Structure of the Investigational Project

This investigational report is divided into six chapters which are described below.

CHAPTER ONE outlines the aim of the research, the justification for the investigation and describes the structure of the report. It highlights the requirements for designing a project management system and the fact that little research has been done in the area of designing this type of system. This lack of documentation is the main motivation for the research.

CHAPTER TWO summarises the relevant principles of project management that were gathered during a literature survey. This survey established the extent of the existing writing in the field of project management and layed the ground for the field research.

CHAPTER THREE describes the practical field research that was necessary due to the lack of research and documentation of the computerisation of project management systems in construction. This research entailed investigating selected companies in the F.W. area by means of in-depth interviews. The comments from the interviews were used to construct questionnaires the answers to which were statistically analysed. The comments, ideas and answers are used in the text to support various arguments and theories.

CHAPTER FOUR discusses the initial considerations for computerisation of project management systems and the planning phases necessary for their successful development. The analysis and decision phases, plus the elements necessary for each possible decision, are covered. At this stage the text deals with general philosophies and theories. This high level of design is necessary to establish the direction the company wishes to take with its systems design. Ideas from the literature survey and the field research are combined in this chapter.

CHAPTER FIVE deals with the actual design of project management systems. Incorporated here is material information gathered from practical research, during which the common ground between project management (PM) and management information systems (MIS) was explored. This stage of the design is called the front-end plan and is in more detail than the conceptual stage but precedes the detailed design and programming phase. It is essential to create a definite plan for the detailed design and cover all aspects of cost and requirements planning.

CHAPTER SIX covers the literature survey and the interviews by summarising the theories of project management. It then discusses the aspects which are most important for success when designing a computerised project management system for construction. There is a detailed discussion on top management involvement and user participation which are the most important factors. Other issues which emerged are also discussed.

The research project endeavoured to:

- a) Establish project management principles by conducting a literature survey; and

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The research project endeavoured to:

- a) Establish project management principles by conducting a literature survey; and

- b) To prioritise the factors that can lead to successful systems design.

The results and conclusions are intended to give project managers a guideline so as to avoid the most usual pitfalls and to anticipate problems that others have encountered.

CHAPTER TWO

THE RELEVANT PRINCIPLES OF PROJECT MANAGEMENT - A LITERATURE SURVEY

- 2.1 Introduction
- 2.2 Project Management
- 2.3 The Project Manager
- 2.4 Planning
- 2.5 Monitoring
- 2.6 Lack of Basic Project Management Training
- 2.7 The Benefits of Planning
- 2.8 Developments within the Project Management and the Construction Industry
- 2.9 Effective Project Management Systems
- 2.10 Conclusion

CHAPTER TWO

INTRODUCTION

2.1 Introduction

Project Management is a multi-faceted discipline covering all aspects of management imperative to the successful execution of a project. It requires a project manager to lead a team of professionals, all of whom are dedicated to seeing the project through to completion. Figure 2.1 itemizes a project manager's services which cover the management feasibility, design, procurement, construction and operation. Other functions, such as those associated with funding, law and real estate also constitute an important part of project management. One of the largest, most time-consuming functions in the project management cycle is the construction management which includes contract administration, planning and control, quality control and assurance, information gathering and dissemination and risk administration (Taylor, 1982).

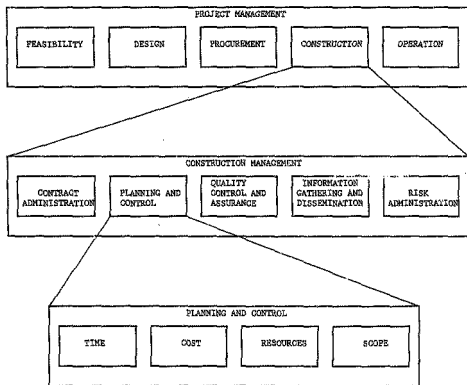
Planning and control, in turn, consist of management of time, cost, resources and scope, as shown on figure 2.1.

2.2 Project Management

A project can be defined as a once-off undertaking which always has discrete time, financial and technical goals and is usually multi-disciplinary (Harrison, 1983). A project manager's client has the primary objectives of building a facility which is technically sound; is economical to operate and maintain; which produces the required return on investment and is built in the shortest possible schedule and at least cost (Ritchie, 1982). It is the aim of project management to help the client achieve these objectives.

FIGURE 2.1

THE RELATION BETWEEN
PROJECT MANAGEMENT, CONSTRUCTION MANAGEMENT, PLANNING AND CONTROL



The multi-disciplinary aspect of the project determines the need for communication control and conflict resolution. The legal environment and scope changes require contract administration and record keeping.

In large multi-disciplinary projects there are usually many different companies and departments involved, requiring communication between people from different professions, trades and backgrounds. Their necessary interdependency entails complexity at best, confusion at worst. For the duration of a project, emphasis moves from one department or company to another, so that no "division" manager can assume the leading role over the whole project simply because his department or company plays a larger part for a certain period. Rather, the project manager has to be chosen for his management abilities. These abilities are not restricted to the construction field as usually projects involve large capital expenditures and high finance costs. Both construction and financial management and control are thus extremely important for minimising the overall costs.

To avoid difficulties, each functional role and level of responsibility has to be clearly defined. There should be one person, the project manager, co-ordinating contributions from all other parties involved. Emphasis should be placed on establishing the correct organisational structure when appointing the project management team.

External pressures, such as energy and material shortages, inflation, high interest rates, environmental and consumer group concerns, together with a range of government and union regulations, add to the complication of large projects and often result in cost overruns (Andrews, 1982).

Often the reason for using a professional project manager is that, if fully effective, he can overcome many of the difficulties of personnel management, financial management, external pressures, planning and control, where many firms are involved, with long time spans, large uncertainties and very large sums of money.

In project management it is necessary to integrate, analyse and summarise large volumes of data from varying sources. This provides information for assessing alternatives, predicting cost and performance and exercising tighter control. In this way data once transformed into useful information enables the project manager to co-ordinate a multi-disciplinary project with definite restraints on time and cost (O'Brien, 1982).

If project management is executed by one of the professionals on the project team, it is too easy for his usual professional role, whether it be architecture, design or quantity survey, to take preference over the role of management. This over emphasis of one field may easily detract from management, leading to reduced control and eventually increased costs. This, however understandable, is not acceptable and will usually lead to reduced management emphasis. If, however, the full management function is placed with a professional project manager, it is less likely to be neglected as a secondary function. This project manager will probably have a basic training in one of the associated professions but may have further training and experience along the lines of human behaviour, law, administration, finance and management (see figure 2.2 in Section 2.6).

In many multi-disciplinary contracts it is difficult to give one discipline overall control, as occurs in traditional construction where the main contractor supervises all the subcontractors. The supervisory role is, therefore, removed from any one contractor and given to a specialist project manager who can concentrate on the complex aspect of co-ordination. This shifts many of the interaction problems away from contractors (who are then free to concentrate on their individual responsibilities) to a project manager whose sole responsibility is co-ordination. Centering the project management responsibility is essential but only one step in being successful (Morris, 1986).

2.3 The Project Manager

Appointing a project manager for a certain project may have been correct but it is still quite possible to choose the wrong project manager. That person should be a leader, an organiser and have the ability to make decisions quickly, sometimes without having comprehensive data. That person should have sufficient technical expertise and be able to understand technical discussions and resulting problems well enough to win credibility from all parties involved. His emphasis, however, should be on an overall view, not technical details. That person should be able to work well and easily with people from different organisational levels representing different disciplines (see figure 2.2). This type of person is difficult to find but the success of the project lies largely in his hands. So, "don't skip on the Project Manager's qualifications or payment" (Avote, 1969).

2.4 Planning

The main function of planning is to create a schedule which represents the total project broken down into smaller, more manageable sections. Durations, resources and costs can be allocated and the work can be organised to meet project objectives. Without a comprehensive plan the actual durations and costs of the activities on the site have nothing to be monitored against (McCoy, 1986). This means that delays and cost overruns will not be noticed in time for remedial action.

Project Planning involves:

- o Developing a work breakdown structure (WBS). The total project is divided into smaller packages which define, in greater detail, all activities to be completed. There could be a high level breakdown into disciplines such as civil, electrical and mechanical engineering, architecture and quantity surveying. Within each, the level of detail depends

on who is using the information. This WBS defines how information can be grouped or sorted. It is, therefore, important to work out carefully all the possible types of reports and levels of reporting needed (Bon, 1986).

- o Defining responsibilities. Each person on the project has to have a clearly-defined responsibility and position in the hierarchy. This way there can be no confusion over each individual's contribution. Furthermore, the job definition will include any information processing necessary to produce reports which document progress over a specified period (Kerzner, 1984).
- o Detailing the information flow. Information flow details the origin and destination of dates, durations, frequencies of reports. Any processing and calculations to be done to incoming information to produce the new report will be detailed (Gibbreath, 1983).
- o Allocating a time scale. Using the WBS, activities are defined, each with a duration, predecessors, overlap with other activities and fixed starting or completion dates where applicable. By using established methods such as PERT (programming evaluation and review technique) or CMP (critical path method) a network or schedule can be planned. This network also determines the final completion date for the entire project. The network, too, should be hierarchical. The detail should increase for parts of the network being used or analysed by specialists or section foremen and be at a summary level for higher managers (Albarn, 1985).
- o Allocating cost and resources. Most activities have labour, plant, material and/or subcontractors associated with them. These resources each have a cost and affect the activity duration. For example, if the activity of excavation has extra labour or an excavator, the duration will be shortened

at an increased cost. Costs and resources, together with the network schedule, produce cost curves and resource histograms (Kerzner, 1983).

- o Developing a procurement schedule. All material or plant required on the project has a date on which it is needed and an ordering lead time. From this information a schedule can be developed to ensure timely order of required materials (Rodrigues, 1985).
- o Developing a drawing register. Initially all required drawings should be planned. This will define what the drawing will show and in what detail, how long the drafting will take and when it is required on site. This can be used to create a drawing schedule to monitor all drawings (Rodrigues, 1985).
- o Developing an action list. This is used for planning required action and defining the person responsible for it. Each action can be coded relating it to a person responsible, construction activity, discipline or any other related aspect. Careful coding can enable sorting of actions relating either to a particular person or activity. This facilitates monitoring and expediting actions and can track any progress or lack of it in a particular area (Rodrigues, 1985).

These project planning methods may or may not be computerised but each element is imperative for effective planning. The level of development and computerisation of each element will depend on the size of the project management company or the complexity of the project. The creation of these systems and the initial gathering of ideas is largely an exercise in human relations; demanding and encouraging communication and contribution from everybody. These initial plans (the master plan) must be flexible enough to change in response to a dynamic project. They should be reviewed and updated regularly.

2.5 Monitoring

The planned performance is contained in the original programme, cost schedule, resource histograms and procurement schedule. Actual performance should be compared to planned performance and deviations in time and cost should be scheduled into future parts of the original master programme so as to bring the project back on track (Diegerich, 1984).

Monitoring involves:

- o Recording actual time and costs. This involves measuring actual start and finish dates of activities, actual labour, manpower, plant and subcontractor costs.
- o Comparing actual to planned. This involves calculating the difference between the actual time and cost of activities and that which was planned;
- o Forecasting the impact of deviations on the final completion of the project in terms of time, cost, resource and other obligations;
- o Taking corrective action. If the actual performance, cost or time, deviates negatively, costs, planning and resources could be affected. Remedial action could be taken by increasing resources or rescheduling activities in order to shorten durations and bring the plan back on schedule; and
- o Client reporting. Any changes to the original plan as a result of delays, for example, should be discussed with the client. The effects and costs should be settled immediately.

A delay in any activity can be remedied, but of an increase in cost. Despite the fact that at this stage it may not be known who will be responsible, the events should be recorded. At all times the client should be informed of the progress of his project.

If monitoring is successful, delays will be recorded very soon after they occur and remedial action can be effective with both minimum cost and time changes. Effective monitoring and reporting keeps the project manager and the client in touch with the real situation and prevents unexpected results towards the end of the project.

The manual development of construction activity networks and their associated costs and resources is very time-consuming. To be effective they have to be changed and updated frequently. For this reason computerisation is desirable and, in fact, it is this area where planning methods are almost standardised and where computerisation is most highly used.

While planning, information must be captured and manipulated until the resulting plan meets all pre-defined milestones, completion dates, constraints of resources and costs. Many alternatives should be analysed to attain the most advantageous plan. Analysis of alternatives requires the recalculation of duration and dates which is almost impossible without the speed of a computer. Similarly, monitoring requires continued changes to produce new schedules reflecting the actual work done.

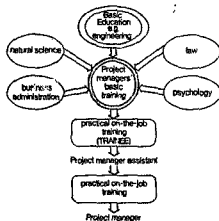
Network scheduling is the area which has been most successfully computerised. The different system modules, however, do not operate independently. For example, if the duration of one activity is extended, its cost increases, so that starting, completing and ordering dates for subsequent activities also change.

Integration between modules can prevent multiple data entry for all changes resulting from one duration change. This type of integrated system is complex and expensive and would have to be justified by the size of the company and/or the complication of the projects. The degree of integration required differs greatly depending on company philosophy, size and objectives.

2.6 Lack of Basic Project Management Training

Finding the correct person as project manager may overcome many of the problems associated with running a particular project successfully (See 3.4). Finding that person, however, may, in itself, be a serious problem. He has to have interpersonal ability as well as management abilities and a knowledge of planning and monitoring. The requirements for an effective project manager exceed the boundaries of individual disciplines such as engineering, architecture etc. (Stroope, 1984). For example, it has been contended that a civil engineer is suited to project management. He may, however, be specialised in analytical training at the expense of an ability to handle human relations or finance. In addition to a basic training, project managers need a knowledge of business administration, law and psychology (Gutsch, 1982) (see figure 2.2).

FIGURE 2.2 DEMAND ON A PROJECT MANAGER'S BACKGROUND
(Duffy, 1980)



A serious problem with operating project management systems, as opposed to other systems, is that there is no formal education programme to train construction project managers (Adams, 1984).

Many project managers are, therefore, engineers and builders first, and managers second.

Available training sessions are usually too general and not specifically adapted to the needs of project management in a specific organisation. This encourages many companies to resort to in-house methods of training (Phoenix, 1986).

The Project Management Institute (PMI), recognising the fact that there is no formal undergraduate degree in project management, has introduced an examination which gives the title of Project Management Professional (PMP). Once a person has enough related education and experience he can take this examination which is split into six fields of project management: namely management of time, cost, quality, human resources, scope and communications (Koch, 1985).

This lack of formal project management training necessitates increased project definition and early discussion, i.e. front-end planning to clarify exact requirements and to overcome different methods of thinking and project execution.

2.7 The Benefits of Planning

Someone once said, "... if you don't think about the future, you won't have one!"

There are certain objectives in completing a project professionally such as quality, service, support, innovativeness, profitability, competence and reliability. These can be achieved by effective planning which is aided by the computer systems. If, as McFarlan (1971) maintains, effectiveness is proportional to planning, then the better the planning, the more effectively the objectives may be met (McFarlan, 1971).

Without a plan, whether manual or computerised, actual progress has nothing to be compared to. Monitoring will then be done by "gut feel" which is not accurate and cannot be expected to yield good results. Activities then follow each other spasmodically, materials and resources may not be ready when required and generally the project duration increases.

Correct planning ensures that activities take place in an orderly way. Important problems can be anticipated and changes can be made to ensure that the outcome is as expected. This is increasingly important as the capital expenditure of a project increases when effective project management can reduce the overall exposure to risk. Project management, therefore, should be detailed enough to allow decisions to be made reliably. Mistakes are expensive and even small percentages of the total project costs constitute large sums of money.

Before one looks at a specific systems plan, however, the industry in which the system is to operate has to be analysed.

2.8 Developments within the Project Management and the Construction Industry

One of the major changes in the construction industry is that the role of managing projects no longer only covers planning and control but has been extended to other spheres ranging from marketing and finance to law. This wider role is covered by project management.

The following trends have been identified (Rodrigues, 1985):

Industry trends:

- o Projects are able to be larger and more complex because of such factors as the industrialisation of construction and multi-disciplinary involvement;

- o Project durations are shortened as much as possible to reduce high finance costs. This can be achieved by use of fast-tracking; and
- o Project planning has been brought closer to the construction site and position of activity to increase the effectiveness of the control.

Management trends:

- o An increased emphasis on financial control to forecast realistic figures of final costs involved. Cost control methods have also been computerised but the methods are not as standardised as the networking (Jones, 1984);
- o Involvement in aspects other than construction due to the multi-disciplinary nature of the projects;
- o A move away from manual calculations to work done on computers to increase speed and accuracy; and
- o A demand for immediate results and systems which are simple to implement; less complicated programmes for in-location use (Campbell, 1982). This aids quick decisions in a fast-moving, unpredictable environment, such as construction.

These trends together with the specific project management needs lead to computerisation as a method of accommodating the requirements.

2.9 Effective Project Management Systems

A systems definition and a development plan is the final product of extensive investigation of project management concepts together with the analysis of the industry and the particular organisation's methods and systems requirements. This plan is devised during the

early stages of designing the project management system when a separate development method for each module has to be defined and the degree of integration decided upon. These decisions may result in some manual systems or varying degrees of computerisation. Most small companies start with manual systems which are developed as the company grows. Manual systems are obviously not integrated, so there will be double data entry. For example, if a change in the schedule changes the costs, these changes have to be made in both the time and the cost module.

The trend of reducing manual work has led to the computerisation of such systems. A system can range from complete integration of each module to varying degrees of integration between modules. Independent modules necessitate double data entry but decrease complexity. The degree of integration will depend on the size of the company and its investment in computer hardware and software.

Computerisation does not necessarily improve project management but if the system is successfully used it has the potential to improve the project management function.

The following are five major factors governing the effective use of project management systems:

- o An effective project team. Without the support, involvement, commitment and motivation of its members, the project team, even with the best system, will be ineffective. A good user-friendly system is likely to gain more support than a system which is remote and unyielding. Involvement of the team members in the design and implementation of the project management system can ensure that their requirements will be met. With adequate training the users should understand the system better and resist it less. This leads to greater willingness to use the system as they do not see it as a threat to their jobs;

- o Base and speed of implementation. Implementation is a very important final step to systems design. Training the users, on-site assistance, fast delivery and installation and the use of software packages can aid effective implementation;
- o Learning to operate the system easily. Fourth generation languages enable the systems to be user friendly, aiding training and usage. In some systems the user is able to omit the user friendly steps to save time and frustration, however, for easy use the system must be consistent: facilities, commands and techniques learnt in one situation must be applicable to another;
- o Successful communication. For information to be truly valuable to the company as a whole, it must be successfully communicated to all potential users. Reports, therefore, should be clear and easy to interpret, while the format should be flexible enough to satisfy various needs. Reports with high visibility, such as graphs, have become a popular method for improved communication; and
- o Forward thinking. Project management is a fast-developing discipline with continuous changes in the tools and techniques used, qualification of project management personnel and the types of future projects (Baker, 1982).

System analysts and developers have to be aware of potential company growth and the latest trends in methodology to gain the best opportunities for staying ahead of their competitors or gain a leading edge.

2.10 Conclusion

Projects have taken on a new complexity because of the trend towards multi-disciplinary projects which often require more experienced professionals. Costs are, therefore, automatically

increased and the only way to reduce them is to ensure shorter 'on-the-job' durations. To achieve this, construction planning and control has been expanded into construction management. The general thinking amongst project managers is that the need for effective co-ordination and monitoring will be met in the face of time limits and complexity.

The management function, however, does not end with the construction phase. It covers all phases beginning with marketing, real estate and funding aspects; moving through all design, documentation and tender award phases before reaching construction. These management aspects can be performed by a specialist project manager whose function it is to lead a team comprising all the professionals involved in the project.

In all of these phases, computerised and manual systems aid the project manager and his team. In some areas computerised systems are better developed than others, however, the degree of computerisation will generally depend on the size of the project and the company undertaking the project management.

Computerisation of the system does not, in itself, produce better project management since a computerised system could never replace the project manager. On the other hand, without any computerised systems at all, even a good project manager will have difficulty in controlling all aspects of the project successfully. Effective project management, therefore, is put into effect by a good project management team which makes optimum use of systems comprising a combination of computerised modules as well as manual methods.

This literature research has highlighted the need for practical field research into methods and results of different types of project management systems development. The resultant research is described in chapter three.

CHAPTER THREE

RESEARCH

- 3.1 Justification and Aim of the Research
- 3.2 Qualitative Research - In-Depth Interviews
- 3.3 Factors Relating to the Success of a Computerized System
- 3.4 Quantitative Research - The Questionnaire
- 3.5 The Statistical Analysis
- 3.6 Recommendations

CHAPTER THREE

RESEARCH

3.1 Justification and Aim of the Research

The literature survey summarised in chapter two clarifies the theories of project management and management information systems. However, the dearth of research and documentation in the area of developing computerised project management systems in the construction field, necessitated field research. This chapter describes the practical field research that was undertaken in order to gather first-hand knowledge from people who have designed, investigated, installed or used computerised project management systems.

The aims of the field research were:

- o To discuss issues in the areas of planning, finance, corporate culture, the system and the user;
- o To investigate the methods of design, development and implementation of computerised project management systems;
- o To determine whether front-end planning had any bearing on the ultimate success of the system and satisfaction of the users; and
- o To identify and prioritise the subsections comprising front-end planning.

The review of relevant literature provided a background and framework for the field research which was in two forms:

- o Qualitative: In-depth interviews; and
- o Quantitative: Statistically analysed questionnaires.

3.2 Qualitative Research - In-Depth Interviews

The in-depth interviews were aimed at analysing companies in the FVV area who had been involved in computerised project management systems development.

A structured guide to the interview (see Appendix A) ensured that each interviewee discussed the same issues relating to the development and operation of the system used by their company. The areas covered by the interview were:

- o What are the problems associated with development and operation of a computerised project management system?
- o What are the reasons for and/or causes of these problems?
- o How and when could they have been prevented?
- o Which factors make the construction industry different from any other which may complicate the design and operation of the system?
- o Why do managers (in general) and engineers (in particular), who need a computerised system, not put greater emphasis on planning it?

These questions were intended to establish whether increased front-end planning (including conceptual analysis, definition of needs, people motivation and training) can reduce the development and operating problems and increase the overall success of the system? Peculiarities of the construction industry which may affect the systems design were also investigated.

Ten in-depth interviews were conducted with the following companies involved in construction project management.

B S Bergman & Partners Inc.	Ivor Evans	Consultant
Combrink Construction (Pty) Ltd	Dave Albarn	Contractor
DMD Project Inc.	Bruce Rodrigues	Project Manager
DMD Project Inc.	Danielle Davel	Systems Operator
Engineering Management Services, Ltd	John Colley	Project Manager
Engineering Management Services, Ltd	Kaay Koch	Project Manager
George Kendall (Pty) Ltd	Andrew Chodelski	Software Specialist
J J Schneid & Associates	Rob Brites	Quantity Surveyor
J J Schneid & Associates	Edward Wilson	Quantity Surveyor
S M Goldstein & Co (Pty) Ltd	Jost Wiederhold	Contractor

The aim of the investigation and specifically the interviews, was communicated verbally and in writing to prepare each interviewee in advance. The interviewee, however, was not restrained from commenting about anything relevant and was encouraged to express any strong feelings or ideas relating to his experience.

All the interviews were recorded and transcribed verbatim. Many of the comments and ideas were extracted from the transcripts and are included in chapter four and five as examples to illustrate some of the theories.

3.3 Factors Relating to the Success of a Computerised System

The interview transcripts were studied and used to highlight areas that required further investigation after asking the question "What makes a Computerised Project Management System Successful?"

Five areas determining the success of a system covered factors relating to planning, finance, the company, the system and the user. These five areas have a number of questions associated with them which are summarised in Table 3.1. This table was used to construct a questionnaire which was sent to people involved in project management (see section 3.4). Questions relating to these five areas are now discussed.

TABLE 3.1
AREAS TO BE ANALYZED WITH THE QUESTIONNAIRE
WHAT MAKES A SYSTEM SUCCESSFUL?

a	PLANNING RELATED FACTORS		b	c	d				e		
	FINANCIAL RELATED FACTORS		COMPANY RELATED FACTORS		SYSTEM RELATED FACTORS						
	USER RELATED FACTORS										
	- Top Management - Project Management - Site Management - Support Staff										
a	Short Term To satisfy immediate needs	Long Term To satisfy potential needs	Constraints, Budget limits imposed by top mgt; influenced by their strategic planning	Culture, planned envi- ronment for system design team & P.M. supporting team	Integration within functions	Software Analysis of alternatives	Hardware Analysis of alternatives	Development	Training	Systemization/ acceptance of the people	Input characteristics during design & development
House Committee Strong leader D.P. Dept.	Communication - Interdisciplinary - every role - understanding of other disciplines - needs & constraints - Availability of channels to communicate	Growth - Planned or - Evolved	Planning - Time - Cost - Staff/Exper- ience - Consultants	Planning aligned - strategies: Where does system fit into the company, how can using the P.M. system help the company achieve - All Levels Top Middle Operations	P.M. - Integration between modules - integration between projects	Capabilities: - modules contained for control of - cost - time - resources - information - "what if?" analysis	What type - capacity - compatibility	Changes: - On going growth - Philosophy - Objectives	Users - P.M. - Operators	Computer - Constraints - Literacy	Recognition of requirements - Definition of needs
consultants	Study - Existing system in the company - Definition of needs & requirements - Available alternatives	Strategic In light of Top mgt's - support - appreciation - understanding of system potential	Systems - Hardware - Software - Experience - Training	Communication of corporate objectives & action functions. - Interdisciplinary/ horizontal - Through hierarchical levels; Vertical	Corporate - Project info used to compile corporate reports	Integration - Between modules - Data base and word sheets	Development on existing H/W or new H/W	Design: To cover the defined needs	Involved Users - Top Management - Other departments	Proj. Mgt. - methods - experience	Participation in initial design - Input from potential users
	Decision - Improve new system. Buy Develop Bureau - Expand & upgrade existing system		Operation - Running costs	Top Management - Involvement - Levels of mgt between SP and top mgt. - Top-down policies - Realization of potential & needs	Operational - Project info used to compile corporate reports - Output availability when req. - Accuracy	Case of use - Input - Output - Responsiveness - Reliability - Interoperability - Support - Availability when req. - Accuracy	Organization - Centralized - Decentralized - Networked	Implementation - Reviewing - Monitoring	Implementation - Introducing - Adapting to users	Feedback - For ongoing change - Monitoring - Criticism after use of the system. - Feedback participation	

a) Planning Related Factors

- o Who was involved in the initial design? Was the design done in-house or by consultants? Was there a committee set up and who led the design? Was it led by the data processing (DP) department and how strong was the leader? Were consultants used to aid the development process?
- o Short term planning to satisfy immediate needs. Was there inter-disciplinary communication and the available channels for it to be achieved? Did designers gain an understanding of the constraints and needs of other disciplines.

Was there a study of the existing system and future requirements as well as an investigation of available alternatives.

- o Long-term planning to satisfy any future needs. Was the system planned to accommodate expected growth or did the system evolve and grow as the demands increased? Were top management involved to ensure the system planning reflected the strategic planning for the company?

b) Financial Related Factors

- o Constraints imposed by budget limitations. What was the attitude of top management to computerisation and the importance of planning? How did top management influence the budget? How did this budget, in turn, affect the amount of planning that could be done and the allocation of time, staff, expertise and/or consultants. Did the budget constrain the system hardware, software, training and operating costs.

c) Company Related Factors

- o How did the organisational structure and culture dictate the environment in which the project management system operates? Did the company culture determine whether the management is orientated to planning or not, as well as whether company objectives are communicated through the organisation? How did top management's involvement and the DP department's position within the company affect the development (Elmes, 1986).

d) System Related Factors

- o To what degree was integration of various modules within the system required? For example, were modules of the system integrated for one project only or was all the data from all projects integrated; was the project data required to integrate with the corporate data on other company systems; and what were the operational integration requirements (stand-alone, centralised or decentralised).
- o What functional capabilities were required from the software, for example, how were calculations to be performed; how was data to be captured, stored and accessed and what were the reporting requirements?
- o What type of hardware was needed to perform the required functions. Should the hardware be entirely new or should the existing hardware be expanded? How should the hardware fit into the organisation structure?
- o Did the development include defining the company's requirements and incorporating them with any anticipated changes into the system design? Was there review and monitoring to confirm that the objectives were being met?

- o Was there training of direct and indirect users to ensure correct systems functioning for maximum benefit. How did training take place in the implementation phase?

e) User Related Factors

- o How did the sophistication of the users, depending on their knowledge and experience of project management, computer systems and their computer literacy, affect their contribution to the design?
- o Was there input during design and development from the users in defining the needs of the system and in the initial design? Was there a method for feedback after implementation of the system?

3.4 Quantitative Research - The Questionnaire

The aim of the questionnaire (which is contained in Appendix B) was to test the following questions and issues that had emerged from the literature survey and the interviews.

- o Does a greater emphasis on front-end planning lead to greater systems success?
- o If the financial constraints are high, will the planning and development process be less successful?
- o Does top management play a vital role in whether the systems development will be successful or not?
- o Is the success of the system affected by the method of development, analysis of alternatives, training and implementation?

- o How important is the role of the end users in the systems definition, design, development and success?

The questionnaire was designed to identify:

- o Type of work;
- o Size of company;
- o Type of computerised system used for project management;
- o Method of systems evaluation, planning, development and training;
- o Degree of the user's satisfaction with the system;
- o Capabilities which were perceived as more important than others; and
- o Degree of support for front-end planning.

The questionnaire was sent to approximately 1270 organisations in construction related industries. Various institutes and associations were contacted as follows:

		Number of Questionnaires sent to members
SAACE:	Members of the South African Association of Consulting Engineers	180
SAPCEC:	Members of the South African Federation of Civil Engineering Contractors	140
SAIB:	Members of the South African Institute of Building	510
ISAA:	Members of the Institute of South African Architects	340
PMI:	Members of the Project Management Institute	100
		<u>1270</u>

The response from a mailed questionnaire is generally 10-15% when it is sent to people who are all potentially able to answer. As people who were not involved in construction project management could not be identified from the membership lists, questionnaires were sent to all members even though the "true" population may have been somewhat

smaller. There were 87 usable responses, which may appear to be a low response rate (6,9%), however, it was accepted that there would be many people who would not reply, such as, consultants and architects who were involved only in design, contractors and builders who were too small to use extensive project management systems and project managers in fields other than construction.

3.5 The Statistical Analysis

A statistical analysis, using SAS (statistical analysis system), was performed on the returned questionnaires in order to establish correlations and trends. Some interesting comments attached to the questionnaire have been used in the text and as examples.

The correlation analysis was done using the following variables:

- o Front-end planning;
- o System success;
- o Communications;
- o Training;
- o Influence of top management;
- o Analysis of alternatives;
- o Use of consultants;
- o Manual back-up;
- o Systems development leader;
- o Influence of workload.

The following points are a summary of the correlation analysis:

The success of the system is strongly increased by:

- o Following a well defined, long term development strategy;
- o The systems leader having a good computer background;
- o Front-end planning of the systems development;
- o Effective communication and training;
- o Top management involvement in setting the strategy; and
- o User involvement in the design.

Communication and training is improved by:

- o Top management creating channels for feedback;
- o The systems leader having a good computer background and understanding of the requirements; and
- o Channels for contribution of ideas from systems users.

The creation of the development plan is influenced by:

- o Top management involvement as time and expenses have to be approved;
- o Top management's understanding of the system requirements and therefore the need for a plan;
- o Top management being goal orientated which can decrease planning in favour of quick results and actions;
- o Workloads which can prevent planning taking place due to lack of time;
- o Lack of communication vertically between top management and project managers or horizontally between departments. This prevents understanding each other's requirements and, therefore, planning; and
- o User participation in the system design.

3.6 Recommendations

The research indicated that while front-end planning does increase the overall success of project management systems development there are other important factors that can influence the effectiveness of this planning. Of these factors the two that emerged as significant are top management involvement and user participation.

Top management sets the strategic thinking of the development and monitors its progress by setting up and being involved with a Steering Committee. It is top management that establishes the channels for communication that aid the collection of ideas and feedback. Increased understanding through involvement will improve the chances of approval of time and cost budgets and resources for planning, development and training.

User participation increases the success of the systems development as it is through this participation that good and practical ideas can be collected. If the user is involved in the planning the development is more likely to be kept on schedule by preventing the design going off-track. *Partial ownership* of the system attained during planning reduces the resistance and training at the implementation stage.

Other factors for increased system success are strong leadership, a structured design approach, careful cost analysis and control, evaluation of alternatives, a phased development approach and extensive training.

Organisations embarking upon a computerised project management system development would do well to ensure these factors are taken into account as early as possible.

CHAPTER FOUR

INITIAL CONSIDERATIONS FOR PLANNING PROJECT MANAGEMENT SYSTEMS

- 4.1 Introduction
- 4.2 Front-End Planning to Establish Constraints
- 4.3 Reasons for Computerising a Project Management System
- 4.4 Development Considerations
- 4.5 Top Management Involvement and Systems Planning Teams
- 4.6 Designing Project Management Systems for the First Time
- 4.7 Planning and Designing the Project Management System
- 4.8 Advantages of Centralised Planning of the System
- 4.9 User Participation
- 4.10 Varying Size and Type of Construction Project and User Companies
- 4.11 Conclusion

CHAPTER FOUR

INITIAL CONSIDERATIONS FOR PLANNING PROJECT MANAGEMENT SYSTEMS

4.1. Introduction

This chapter discusses the initial steps to be taken after a decision to computerise the project management system has been reached. These steps should be analysed in order to decide whether to buy a pre-designed package or whether to develop a personalised system.

A project management system does not have to be computerised, in fact, most start off as manual control systems. A company can easily gauge when a project requires a computerised, as opposed to a manual system. Initially a computer helps by increasing the speed and accuracy of mechanical calculations, for example, calculating the dates on a critical path schedule and updating after an activity change, completing bills of quantities, calculating payment certificates and determining actual construction costs.

More often than not, individual aspects are computerised step-by-step. For example, time management is computerised first with the possibility of the resources being included later. Companies have to look at which modules they want to computerise and whether those should be integrated and, if so, to what degree (Ghodelski, 1985). Some possible modules are:

- o Time (Activities covering scope and the schedule);
- o Cost (Budget and Actual); and
- o Resources (Materials, Equipment and Personnel).

The advantages of integrating the modules are that integration reduces double data entry and ensures that different modules are updated to the same degree at any time. Monitoring can be performed reliably without having to rely so heavily on "gut-feel" or memory.

An issue that complicates integration, however, is the need for different levels of detail within each module. For example, the installation of an expensive piece of equipment could have a high cost implication and a low time duration; curing a concrete slab has low costs but effects the time scheduling greatly. This means that the degree of integration has to be carefully investigated (Benjamin, 1984).

Since companies tend to differ in the type of work they perform, their philosophy and perhaps style of management, a different management system is often required for each company. In-depth planning for the design and choice of a system is vital to ensure that the system finally developed performs the function required by the company.

There is not always sufficient pre-written, packaged software on the market to allow a company to buy a system which performs the required project management function exactly (Evans, 1985). Hence a company is very seldom in a position to be able to decide exactly what it wants of a system and then buy that complete system. This applies particularly when a company has its own specific methods or techniques. Rather, it has to define its exact requirements, analyse the available software and match the two as best it can. If this is not possible it may choose the systems development path for a tailored system.

4.2 Front-End Planning to Establish Constraints

The process of planning can never be overlooked despite the fact that there are different development paths which can be followed, namely: package, in-house design, consultants or a bureau (see section 1.2). The company still has to perform the planning steps of deciding what is wanted; what functions the system must perform; how it fits into the company; who will use it; and how each user will benefit. The development path chosen will change the nature of each phase of planning. However all phases should still be considered.

The decision of which path to follow is constrained by:

- o The investment that the company is prepared to make, and how much each alternative costs relative to the budget;
- o Whether the company already has hardware that the new system can run on or if not, the fact that hardware costs have to be added to the development cost;
- o Whether the required manpower is available and whether the cost of this manpower will be approved for planning phases. (Evaluating alternatives is time-consuming and therefore expensive even before reaching the specific systems planning stage); and
- o The time and finance available for training and installation. (These are the final steps of the development and easily forgotten).

4.3 Reasons for Computerising a Project Management System

Computerising a project management system, can greatly assist in reducing manual input, increasing the level of detail for improved control and, one of the main functions, "managing the client's money". Using a computerised system for project management has certain advantages which assist the managers and should enable a project management company to gain a competitive edge by making time available for concentrating on management aspects rather than mechanical, administrative aspects.

The advantages of a computerised system are listed below (Ropeanu, 1984):

- o Increased speed of processing and response time;
- o Integrated modules allowing data to be entered only once (i.e. reduction of data redundancy);

- o A system which is likely to be more up-to-date and contain more detail;
- o Reduction of clerical work and human error;
- o Increased accuracy, reliability and standardisation;
- o Greater ability to reorganise or summarise data into valuable information for decision-making. The sorting facilities increase flexibility of report formatting; and
- o Ability to perform repetitive calculations for evaluation of alternatives and sensitivity analysis.

Some disadvantages follow:

- o Increased cost;
- o Negative reaction to a new method of performing similar work;
- o Bad results due to poor training; and
- o Useless reports because of too much detail or because they are late.

4.4 Development Considerations

Before deciding upon a development path for a system, whether buying or designing it, there are many issues that should be considered. The following questions should be asked:

- o What are the project management functions that the company wishes the system to perform?
- o What is the size and type of projects that the company manages?

- o A system which is likely to be more up-to-date and contain more detail;
- o Reduction of clerical work and human error;
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4.4 Development Considerations

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- o What are the project management functions that the company wishes the system to perform?
- o What is the size and type of projects that the company manages?

- What is the system development budget?
- How long and how much training do users need in order to use the system successfully?
- How easily can the user access the system?
- How flexible is the format of the reports? Do they have the ability to change format for different clients? and
- How successfully can the system satisfy the specific needs of the project staff and the client? How well, for example, will the system help the project manager with his cost control or how well will the reports keep the client informed about his construction?

The decision to computerise is an early step in a long-term plan which involves company culture, strategy and large finance. It must therefore be preceded by the correct motivation and benefit study. Benefits can be actual or perceived, tangible or intangible, and all of them should be assessed and recorded. Reports, for example, can be a great benefit while reams of calculations and print-outs are utterly useless if they are provided before the management control requirements have been assessed or the project managers are trained to read them (Brites, 1983).

A company, for instance, may acquire a system with great potential benefits but which is so intricate that it is forced to put personnel on a course to learn how to use the system. Even then, the system is so complex that it requires a specialist, or a systems department, to use it. While a specialist may be assigned to the project to operate all aspects of the system, this could be too expensive unless the project is very large. Furthermore it is strategically dangerous for a company to be entirely dependent on one person. A department with each member operating one aspect of the system for many projects removes these problems but may be too removed from the construction site. This criticism may be defended

by a very large company that has a department operating its complicated system, however, if the data capture and operation of the system is so complicated that it needs a trained operator, the cost of operating the system may be increased too much to be justified by a small company. If the information on the reports cannot be analysed easily by the person who needs the information, it will not be used or an expensive analyst may have to be employed.

Another company may use a far less integrated system and introduce the modules to its project managers one at a time. The advantage of this decentralised operation is that operating time is reduced and the operator can be the project manager who is completely dedicated to and involved in the project (see 4.8). He would usually have an assistant but would be able to operate the system himself if necessary. The ease and speed with which raw data is captured and converted into valuable, easy-to-analyse information is a measure of the value of the computer system. Examples of raw data are durations, dates or required resources on site, while valuable information is in the form of bar-charts, histograms or progress reports.

4.5 Top Management Involvement and Systems Planning Teams

When designing a computerised project management system, it is recommended that steering and operational committees be appointed to give direction to the system development, provide a forum for discussion and make decisions.

4.5.1 Steering Committees

A steering committee is a group of people comprising representatives from all departments that will be affected by the system being designed. The function of this committee is to monitor the direction and progress of the systems development. The members are not necessarily included at an operational level but meet to discuss and resolve issues.

The steering committee should consist of representatives from top management, construction management and systems development areas. This provides input regarding strategy, functionality and technology from all spheres each of which has a different definition of success (Tunan, 1986). The size of the steering committee will vary depending on the size of the company. In smaller companies the same person may represent more than one area or function to be included in the system. Regardless of the company size, a steering committee having equal representation from all areas and providing guidance for the development should be considered.

4.5.2 Operational Committees

Below this steering committee is an operational committee incorporating end-users and functional managers. This operational committee is a working group and could be the design team. They do the research, investigation and reporting to the steering committee. There should be a good balance of expertise within this operational committee and the chairman should be a strong leader so as to encourage maximum contribution from each member (Kline, 1986). Each person has to be able to express his needs and recognise the constraints of the others. Each module leader has to have his design, coding methods and level of detail compatible with the other modules. This forces interaction and liaison between module leaders at the planning stage.

An imbalance in the operational committee, for example, could mean that the emphasis might be on costing, while time planning or overall flexibility is lacking. High calibre planning, costing, technical and management people must make up the team (Rodrigues, 1985).

The position of these steering and operational committees within the company hierarchy is of crucial importance. If the operational committee works closely with the top management, it will be more

effective by incorporating relevant, top level information into any plans. If, for example, the systems development team reports to the financial manager, there is a chance that the system may have an emphasis on costing rather than time control and may neglect taking full advantage of strategic and marketing aspects.

The findings of Dean (1968) and McFarlan (1971) indicate that if there are two or more layers of management between the computer system department and the executive manager, there will be lower effectiveness and planning ability. As a result, the operational committee should be closely associated with the top management in the steering committee. In communicating and reporting upwards, the planning of the computerised project management system is likely to have a better format and be more regularly reviewed.

These teams should exist even if the system is being designed by consultants (Wiederhold, 1985). The systems development guidelines can come from the consultants but company input and involvement is still vital.

4.5.2 Top Management Involvement

The plans that the systems planning teams are to follow should be precise, formal, communicated to all the people involved and have the support and participation of top management. Unfamiliarity with computers or not being involved in the systems development can cause management to expect unreasonable results or progress. Formulating a detailed plan is a slow process, and there is little output to justify the time, and therefore cost, spent in planning. The advantages are intangible until much later and are difficult to quantify. If top management backs the planning stage, the costs are more likely to be approved. In order to get their backing, their understanding and involvement are imperative (Kanter, 1972).

The advantages of top management involvement, therefore are:

- o They offer planning input at a strategic level which contributes to the position of the system within the company and how the system can improve the company in the industry;
- o Through understanding the planning process budgets will be approved more easily; and
- o By creating and participating on a steering committee they will review the development and keep it "on course".

4.6 Designing Project Management Systems for the First Time

Companies who embark on the design of a computerised project management system for the first time often face problems with top management unfamiliarity with systems requirements and other problems arising from inexperience in designing systems.

4.6.1 Top Management's Unfamiliarity with Project Management Systems

Company financial systems follow a certain set of accounting rules which stipulate methods of drawing up accounts and ways of dealing with most situations. Such systems can be obtained in packaged form to satisfy most company requirements. Project management, on the other hand, follows no set methods and is still a developing field. Systems for project management therefore, are not as fully developed and are not as standardised as those associated with the accounting field. Top management are often familiar with these corporate systems, whereas they cannot easily understand the needs of the project management systems user and their company's client. This unfamiliarity with project management systems can cause a communication breakdown between different levels of management within a company.

In order to prevent problems arising from this possible communication breakdown much discussion and "throwing around of ideas" has to precede any plans. This can also help to establish what expectations different people have and clarify the goals of the system. What aspect of the project management, planning and control do the project managers themselves want the system to perform, and how (Colley, 1983)?

4.6.2 Problems Due to Lack of Experience in Systems Design

Computer packages that adequately perform individual project management functions, such as budget control or activity scheduling, can usually be bought off the shelf. These separate systems, however, would not integrate into a complete system. Until recently the demand for integration was not great enough for project managers to acquire computer design skills. Now, however, integration is mostly automatically required. Project managers without design experience and designers without project management experience both lack the necessary combination of skills to design the integration from either of these two backgrounds. The following is a list of difficulties typical of those encountered by people designing project management systems for the first time.

- o Construction management has previously been performed by getting involved on site, making "on the spot" decisions and crisis fighting. Contractors, therefore, may not be experienced at using a system and possibly are not exactly sure how it can assist them. These first time designers should ensure they spend enough time on front-end planning to determine their needs precisely (Rodrigues, 1985).

There could be a benefit in buying a relatively general and not too complex project management system in order to be used as an initial learning tool. In this way project managers can learn systems abilities while reinforcing

their project management knowledge. When using this system good points and inadequacies emerge and can be incorporated in the subsequent more detailed and personalised development. These deeper levels of understanding can only emerge effectively with personal experience (Chodelski, 1985).

- o Initially some users even have difficulty in appreciating the basic distinctions of computer systems: packages and multi-function systems. This is dangerous because these people, who are making large financial decisions, are doing so from a weak base.
- o The new project management system does not necessarily assist each department or discipline within the company equally. Such unequal benefit could cause problems when departments, who use the system less often, are reluctant to contribute important data to the central data base to be used by all departments.
- o Top management commitment can often be insufficient in companies that have not introduced systems before. This could be due to not realising the potential benefits the system can provide. One quantity surveyor said he needed systems to help with bills of quantities, certificates and costing but other managers did not understand his need.

He spent much unrewarded time trying to develop systems on his own for himself (Wilson, 1985). Developers should take this into account and ensure that the benefits are understood by the top management so as to elicit their commitment.

- o Individuals required to use a system for the first time may resist using it for apparently illogical reasons (see 5.11). A project manager not previously exposed to a system may not understand how a system can help him.

He may fear losing his job. Without certain knowledge he will not understand that the system gives him more time to manage and while it may cut down on administrative staff it will not replace him.

- o It is very easy to overlook the ramifications of introducing a new computerised system into a company. Areas such as detailed planning are often under-emphasised. Even if front-end planning is done, plans for implementation and training may be forgotten. These phases are essential and, if unplanned, can reduce the effectiveness of the computerised system and cause budget overruns (Rodriguez, 1983).
- o Developing a computerised project management system for the first time means that there should be a greater emphasis on planning the process of gathering ideas, analysing alternatives and detailing requirements as they are all new concepts. The company is temporarily moving into a new area of systems design when its expertise is in construction management.
- o Development of the system and the applications that it performs have to be carefully controlled so as not to duplicate effort as might happen. When project managers spontaneously develop their own applications. The advantage (see 4.11) of these developments is that the managers get exactly what they require but the disadvantage (see 4.12) is that this knowledge is isolated and lost to the company as a whole. If, for example, a cashflow module is too complicated to keep updated easily the project manager may devise a spreadsheet cashflow matrix that takes less time to operate. This spreadsheet, is highly efficient in a selfish way to the person himself, however establishes no permanent system that can easily be made use of by other project managers. It is, therefore inefficient to the company.

4.7 Planning and Designing the Project Management System

4.7.1 Initial Planning

The new computerised project management system should derive the full benefit of computerisation not merely increase the speed and accuracy of an old system. For example, scheduling for time control is a slow process when effected manually and can be completed more quickly and accurately by computer. If this increased speed and accuracy is all that the computer is used for there will have been an enormous financial investment without maximising benefits by including such capabilities as simulation or graphics. For example, simulation can achieve end results so quickly that many alternative construction methods can be analysed and the best chosen. "What if" functions could propose a cost-saving alternative or avoid continuing on an expensive course. Graphics can save costs by increasing the level of communication on site during the management project and by improving presentation, even win a tender (Chowits, 1984). If the company plans strategically it will incorporate these new functions that the manual system did not perform. This should provide a competitive edge.

While the fullest advantage should be taken of computerisation it is also possible to over-computerise. For example, a change effected in the time module could, through integration, automatically cause a chain of changes to other modules, such as cost and resources. One contractor proposes a manual interface which would reduce the automatic integration but would ensure that changes to other modules would be highlighted (Wiederhold, 1985).

Positive motivation (Glealand, 1983) is a vital pre-requisite for spontaneous and free flow of ideas from everyone within the organisation. It must be established from above; from managers and the organisational culture they develop. Project managers, engineers and contractors are all highly trained

with technical backgrounds and useful ideas. To gain the greatest benefit from ideas generated from within the company there has to be a standard procedure for gathering and categorising them for easy reference and inclusion into later phases of the systems planning.

4.7.2 Phases of the Planning Process

The planning process may be divided into several phases through which the development moves:

- o Defining the company in systems terms. How is the system going to help with the business of controlling costs, resources, time, people and scope?
- o Defining the needs and goals for each division. The company knows its need is for project management, however, the details at a lower level of methods and integration have to be defined. Should the emphasis be on cost or time, for example?
- o Collecting information and ideas from the project people themselves. Who may be able to contribute towards the requirements and ideas?
- o Making assumptions and forecasting construction industry trends and the economy. Construction being a volatile environment makes this difficult.
- o Establishing specific objectives - for example the type of project the company may specialise in.
- o Evaluating alternatives for the systems development - packages, development in-house or by consultants, what best satisfies the company methods.
- o Deciding upon the best methods to meet objectives.

- o Formalising a long term plans for systems development. spreadsheets for cashflow or bar-charts for control could be an interim short term plan whilst the integrated time and cost modules would take longer to implement.

4.7.3 Factors Affecting the Planning Process

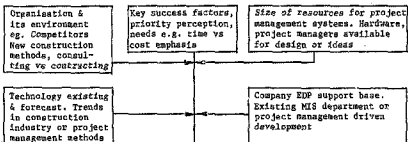
The process of planning a computerised project management system has many factors which affect, and therefore have to be consolidated into the planning process (see Figure 4.1). The top management steering committee and users should be aware of the following basic points to give the development the correct direction and emphasis (Lucas, 1981).

- o A manager may request information that, in fact, will not provide him with what he wants. For example, he may want to know percentage completion of an activity. He may believe that a report of time spent as a percentage of planned duration will provide this and request this to be incorporated. However, only by looking at time estimated to completion can the correct percentage be obtained (Gibson, 1987). In designing a system both needs and methods have to be analysed carefully.
- o Some managers do not necessarily fail from a lack of relevant information but from their own inability to deal with what they have. If the manager has more information, a better decision will not necessarily be taken. Adequate training can ensure each person knows and understands the potential of the system. If the users do not know exactly how to read a report or analyse its contents the reports they receive will be misunderstood or not used.
- o Better communication between different levels of managers and all users usually, but not always, improves the

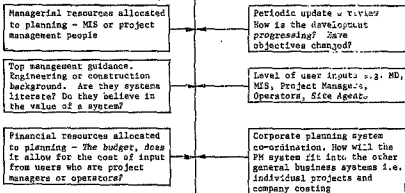
FIGURE 4.1

THE PROCESS OF PLANNING A PROJECT MANAGEMENT SYSTEM
(McFarlan, 1971)

FACTORS TO BE CONSOLIDATED
CREATIVELY IN
THE PLANNING PROCESS



FACTORS INFLUENCING
THE PLANNING PROCESS



OUTCOME

PLAN & STRATEGY
For system development
as well as company growth
while using the system

design and, therefore, performance. All the users, managers or operators, have certain project management or specific construction knowledge which should be used. Only effective communication can assimilate it all and produce an effective system.

- o A manager should understand how the information system works, not only how to use it. Davel (1985) saw the biggest problem as an operator was that she knew the capabilities of the system but needed assistance in the area of project management as that was not her training. The project manager was not providing adequate contribution as he did not understand the operations of the system.
- o Managers should at all times be alert to new areas that may be computerised so as to use the system for competitive advantage over other companies.
- o Interim assessments should be made of all or part of the system to identify any stagnating developments. Such sections of the system can be put aside or rejected so as not to continue wasting money on a failed area.
- o Organisation and control should be emphasised. The system development project should be managed as the construction projects are managed by using budgets, progress reporting and evaluation.

4.7.4 Structuring the System before the Detailed Design

The initial systems plan must incorporate an analysis of the system structure or architecture which will best produce what is needed. For example, should the system have highly integrated modules, standard report formats, a central data base or spreadsheet ability to manipulate data? Where the system will fit into the company structure also has to be

decided; will it be centrally controlled, completely decentralised or decentralised operation with a central control or data base?

One contractor involved in project management systems design has defined his working base in terms of generic products. These are data base, spreadsheets, word processing, graphics, scheduling and comms (communication networks). None of these are specific to construction but his plan is to follow the path of general training with these products for all employees. The project management system will be introduced in phases with parallel training (Wiederhold, 1985). This kind of strategic decision has to be taken early as it significantly determines the method and path of the systems development.

Another contractor believes that complete integration is what makes the system effective and powerful. He believes that it should be possible to trace any item from the bill of quantities, to the drawings, to the ordering, delivery, payment and to the final physical position on site. Any changes will change all modules. This strategy has to follow a different development path from that of the first contractor (Colley, 1985).

A consultant who was very aware of the importance of early planning said that despite the fact that they planned the requirements of the system, they did not realise that planning involved more than a detailed system description. They neglected to extend the plan fully to incorporate training and implementation (Rodrigues, 1985). Another aspect which can influence the effectiveness is that during the development people become more educated in project management as the development proceeds. Systems understanding and exposure to benefits change their demands and requirements. However, the development plan cannot change at every new idea whenever it comes. A development has to find a balance between a rigid

inflexible plan and no plan at all. After a certain amount of planning and "brain storming" a plan has to be fixed until a certain review point (Wiederhold, 1983).

Everyone needs to be aware that, generally speaking, engineers or contractors tend to be goal-orientated and want to see results. This has a negative effect on careful, cost effective analysis of the pros and cons of all alternatives and full expansion of the planning phase (Rodrigues, 1983).

4.7.5 Design of the Project Management System

The systems developer should provide a practical, thorough (but not rigid) definition of the system to be computerised and a method of design. This definition and method of design forms a blueprint plan which facilitates regular evaluation. Although the plan should be definite it must allow for flexibility and adaptation when certain changes are identified (see 4.7.4).

In order to understand what a project manager may expect of a system it is almost essential that the system's developer should have a sound construction management background. Without this background specifications may be confusing or misunderstood and ideas lost.

All systems design should be well structured and documented so that a systems developer going back to a previous design is easily reminded of the original logic. Anyone modifying the original systems design can do so with greater speed and accuracy. Further clarity and ease of change is provided by "egoless programming" (Lucas, 1981); no person is solely responsible for design of any section of the system, as a group is formed for the design and implementation of the system as a whole. Finding errors takes more than one person so that members of the design group assist each other in that task. Programmers view each other's work and so encourage

checking, clarity and awareness of the entire system. These aspects strengthen back-up in an environment in which errors have to be found.

The structural design of the proposed system breaks down the system into its functions which deal with specific data requirements. Very simply, each sub-structure can be identified by defining the end product, such as the report, the data input and the method of transforming the raw data to useful information. The objective is to have each module in the structure concise, explicit and complete, in that all situations are covered, while there should be no redundancy (Davison, 1982).

4.7.6 Systems Development using Consultants

Some companies decide that they do not have the in-house capacity to design the systems themselves. They may choose to use a consultant to aid them but the planning process should still include similar phases as the in-house development. Using consultants, however, presents other problems such as the following listed below:

- o The consultant knows the business of systems design but is not as knowledgeable in the physical business of project management;
- o External design does not mean that the company's project managers, users and top management are less involved. The consultant should only provide the DP, MIS and programme coding input; and
- o Copyright, ownership and support of the system becomes a new issue which has to be discussed as modifications are inevitable. The details should, therefore, be settled in advance (Rodrigues, 1985).

The advantage of using consultants is that they should be able to provide an objective viewpoint and a "fresh look" at the company methods and existing systems, manual or computerised. They should be able to guide the development effectively and prevent pitfalls. As systems leaders they should stimulate and encourage user and company contribution for the details of the business. The consultant's cost, obviously, has to be assessed versus the in-house cost and ability to lead the development.

4.8 Advantages of Centralised Planning of the System

Although decentralisation is more advantageous for operation of the system (as discussed in 4.4), as it brings the system nearer to the construction site, it is not so for planning. Decentralisation planning may lead to weak co-ordination as isolated users tend to regard their needs as unique or their methods of meeting them as superior; they lose the benefit of constructive ideas from other users, develop applications of the system for themselves alone or develop applications that already exist (see 4.9.2).

Lack of co-ordinated design reduces standardisation which can result in a breakdown in communication and, therefore, reduced effectiveness and productivity. On the other hand, a centralised design department may act as a co-ordinating body, pooling all design proposals and thereby allowing all participants to contribute ideas and share in the benefits.

A separate department for developing systems may be removed from the actual construction sites. The physical separation may well cause a mental separation so that the systems developments may lose touch with the day to day thinking of the project managers. This separation can be overcome by formalising channels for communication, such as regular meetings at which project managers can be exposed to the development or systems developers can visit the sites.

One contracting project management company has established a centralised design department with strong technical expertise. This management information system (MIS) department is headed by a data processing (DP) expert who has worked in a construction environment. He communicates closely with top management and the construction managers. Instead of being remote, this department's role is one of support, packaging, distributing and training. The development is completely centralised but emphasises maximum input from the final users and feedback from the work face. Rather than imposing a redesigned system, the MIS department co-ordinates the original gathering of ideas and intuitive needs of the project managers. From there, the ideas that are congruent with the company philosophy are identified and incorporated into any design. Once designed, a module is packaged and distributed to the project managers after they have had certain basic training. Feedback in the form of recommended changes, complaints and suggestions are once again gathered and used to modify the module. This modular, step-by-step approach also overcomes installation or training for the whole system at once (see 5.12) (Wiederhold, 1985).

Centralised systems development prevents all the problems involved with end user designed systems (see 4.9.2). However, care has to be taken not to block out the initiative and contribution from the end users.

4.9 User Participation

The contribution of the users of a computerised project management system are very important to its design as they will ultimately determine whether the system will work successfully or not. Users need to be included in the planning and design phases so that their requirements can be incorporated and when they use the system it meets their expectations (Erlandsen, 1986).

4.9.1 The User within the Project Management Company and how he Participates in the Systems Development

The socio-economic systems (SES) approach divides systems development into two aspects, each with its own objective; the technical aspect and the social aspect. These should run in parallel during the design. The objective of the technical aspect is to optimise productivity while the objective of the social aspect is to recognise the users' requirements, by involving him in the planning of his working environment (Hirschheim, 1984).

Mumford (1981) offers four principle arguments in favour of user participation:

- o Individuals have a certain right to be included in the planning of any technology or system which may affect them. One of South Africa's largest contractors who bought a pre-designed package says that all project managers and MIS people were involved in the planning. This involvement ensured the decision makers knew what the users wanted (Colley, 1985);
- o Project managers trained in the 1960's, for instance, did not have extensive computer education. Although some have kept up-to-date with computer development others, who have not, resist computerised systems because of their own ignorance of such systems. Colley (1985) says that despite the fact that the users were sceptical at first, they were soon convinced that the system could aid them. He puts this change in attitude down to the system satisfying the needs which they had identified. Effectiveness of the system was increased by initial involvement which in turn reduced the resistance (see 5.11);
- o The computerised system and its operator can become a threat because of their ability to highlight the project manager's lack of knowledge in the systems area. This lack of knowledge means that the project manager is

unable to use the system to its full advantage. Because the benefits of the system are not maximised such a project manager remains sceptical of computerisation as a whole. As a result a highly expensive computerised system is under utilised and wrongfully branded as a white elephant; and

- o If a project manager is not prepared to accept that he needs the services of the systems operator, he can jeopardise the project as a whole. By not taking advantage of an up-to-date system he may lose a competitive edge for his company. Both the systems operator and the project manager, therefore, should acknowledge their need for each other.

Lucas (1981) divides user participation during design and the user's influence in effective operation into three major components:

- o User involvement. User controlled design is such that the user is in charge of the design process, with the analyst or consultant as a catalyst for ideas and to explain options. Many companies say that their systems development was "driven" by the project managers themselves - the people who were going to use the system;
- o User interface. The user friendliness of a system is largely gauged by the ease of using the screens and reading the reports;

Often people on a construction site do not have much systems education and may not even have used computers before. A difficult interface may cause them to feel inadequate and reject the system. To overcome this difficulty there must be maximum user friendliness; and

- o User evaluation. User ability criteria have to be used for systems evaluation. For instance, data personnel may regard speed and reduced cost of operation as chief priorities: these should not, however, be placed before the priorities of effective project management.

Lucas' belief in involving the user has increased the probability of satisfying the user and reducing problems in implementation. On the negative side, however, it may extend the system design time.

4.9.2 Advantages and Dangers of a System Developed by an Individual End-User

A system developed completely by the end-user has certain definite advantages which can be summarised from Davis paper (1984) as follows:

- o New ideas thought of on site can be put into operation immediately without time-consuming reference to a systems development department. This reduces the workload and demand on development personnel;
- o Having a project manager develop his own application on site and implement it directly eliminates the need for an MIS person to determine the requirements of the project manager in the first place; and
- o Engineers and/or contractors have a technical background and usually have no difficulty developing a system or programming it themselves. This does not mean it operates at maximum efficiency but it does produce the required report or results.

Developing a system requires certain varied expertise that is rarely found in one person. If an individual designs a system there are some risks and disadvantages which follow:

- o It is difficult to find one user who has the expertise to enable him to identify completely the requirements for all applications and company needs. The individual will only draw from his own, possibly narrow, experience;
- o The user and the analyst have different perspectives of the system. The user tends to look narrowly at particular functions whereas the analyst's concern covers every possible situation. A user designed system possibly neglects the overall systems viewpoint usually taken by an analyst. This individual application may solve, for example, a cash flow calculation but neglect overall productivity on site;
- o There may be a lack of quality assurance through neglect of testing validation and control processes, often overlooked by an individual not reporting to a co-ordinating body;
- o Systems can be unstable from lack of documentation and standardisation between different users. This prevents future integration because of lack of compatibility. In the volatile construction environment, with unpredictable labour and weather problems, essential paper work and documentation are often neglected;
- o Duplication due to each user "re-inventing the wheel";
- o Encouragement of private use, not transferable to another user. Knowledge belongs to the user as opposed to the company or the system. This also prevents gathering useful ideas which can be developed; and
- o Undesirable systems behaviour such as storing useless information or information used for misrepresentation is permitted.

In conclusion, it seems that user participation is vital for successful implementation of systems and correct reporting that will satisfy the users. It is also clear, however, that users should not be left to develop the system alone. The analyst must be available to control the development, advise and review. Training, documentation and procedures must be formalised and standardisation must be emphasized. User-development should be encouraged but a system of investigating present software, analysis of requirements, review, testing and documentation should also be enforced.

4.10 Varying Size and Type of Construction Project and User Companies

Project Management systems designed for a single large project are not always effective for smaller projects. This is an important problem, as any one company usually expects to cope with the management of projects of different sizes and types. There is therefore a need for a flexible system which can be adapted to the project's needs (Colley, 1985). Again, combined experience is required in the design phase. An individual may have experience only on a particular type or size of project and may overlook aspects needed by another manager or project.

The type of project management company has to be assessed before a system can be designed. All systems need cost, time, people, scope and resource control. However, a contracting company needs to cover wages and the project at a detailed activity level, for example, while a project management company does not require these facilities. This means that one system will not satisfy all companies (Wiederhold, 1985).

Another consideration is how educated and experienced the users are. A contractor using his system on site is likely to have less experienced operators than a specialist consultant project manager. How user friendly a system has to be is determined by how experienced the user is and how often he uses the system.

Certain aspects of the design should take the type of company and user into account by investigating the following:

- o How experienced is the user; with project management and with the use of computers?
- o How often will the user access the system? This will determine how user friendly the screens have to be; whether there have to be self explanatory menus and how the requirements for moving from one module to another without going via menus;
- o What is the level of detail that the system has to track? Is it necessary to track sub-contractors and how small will activities be;
- o What are the size and type of the projects? This will determine how many activities the system has to handle and whether there needs to be multiple calendars, for example, as with a process plant shut down; and
- o What factors do management want to track for progress and monitoring; and in what format do they want the reports?

4.11 Conclusion

Front-end planning is vital in deciding which path the systems development is going to follow. This planning even precedes the system design plan and covers a wide variety of areas.

- o The motivation for computerisation has to be analysed. How will the company benefit from the investment? What do management wish to achieve, on a functional and strategic level? What size and type of project is the project management system to manage? Who are the people that will have to access the system?
- o The people involved have to be carefully chosen for a balanced contribution of computer technology, project management functionality, top management direction and user requirements.
- o The company has to be aware of restraints created by being first-time systems designers or developers, or being unfamiliar with project management systems.
- o There has to be careful control of development by both the MIS department (the developer) and the project manager, (the end user). This will decide whether the system will be designed centrally or in a decentralised manner.
- o General structure and architecture of the system must be decided upon: whether it is to be a large central system, networked, a data base with decentralised operation or a "self standing" decentralised system. Will it compromise integrated modules and database and spreadsheets?

The design planning for the programming and internal structure of the system can only begin effectively after all these questions have been answered; a direction and strategy determined and maximum input from users and developers gathered.

CHAPTER FIVE

DESIGN AND DEVELOPMENT OF THE CONSTRUCTION PROJECT MANAGEMENT SYSTEM

- 5.1 Introduction
- 5.2 A Computer System's Life Cycle and Life Cycle Costs
- 5.3 The Degree of Integration
- 5.4 Analysis and Review Capabilities
- 5.5 Interface with the Client's System
- 5.6 Report Flexibility
- 5.7 Systems Resilience and Manual Systems Back-up
- 5.8 Evaluating Purchase of Hardware and Software
- 5.9 Documentation
- 5.10 Development and Training of Personnel
- 5.11 Implementation of the Project Management System
- 5.12 Strategy for Design and Implementation
- 5.13 Conclusion

CHAPTER FIVE

5.1 Introduction

Chapter four dealt with the initial systems planning and covered general aspects of the reasons for computerising; who should be in the design team; top management involvement; and user participation. Chapter five discusses details of the system's life cycle covering aspects of integration, report flexibility, evaluation of alternatives and finally implementation. These phases are very important as they define the system in greater detail to complete the specification for the system's design and to establish an implementation methodology. This methodology should cover all aspects of the detailed design (including hardware and software technical architecture), conversion, training and documentation.

5.2 A Computer System's Life Cycle and Life Cycle Costs

A computer system's developer proposing a new project management system will usually be asked for the cost and a cost benefit analysis because top management usually understands the cost criterion for justifying a system. The cost of designing a system is very difficult to establish but it can be broken up into categories for further investigation and cost allocation such as:

- the actual cost of the hardware and software;
- the cost of resources, e.g. people or machines;
- the cost of upgrading the system;
- the cost of training; and
- on going operating costs.

There are, however, other criteria that can justify a systems development. Even though a competitor may put in a higher bid for a particular project management job, he may win the tender by meeting the client's demand for tighter control. This control is being

gained by a higher system cost which might not be justified in a cost benefit analysis alone but may be more than justified by the strategic advantage.

The costs and benefits have to be compared to decide whether the development is feasible. Initially, the only resource involved is people who investigate needs, gather ideas, evaluate and compare software packages and hardware. Costs are therefore related to salaries (or fees if consultants are used). Later in the development cycle, hardware may already have been bought or software developed and some initial training done. Changes at this stage could mean discarding some of the hardware and software and wasting the training. This is far more expensive than just changing ideas and plans on paper (see Figure 5.1).

One consulting company that recently installed a project management system said they initially wrote programmes to operate on the hardware they were using for design and analysis. These in-house developed modules were effective temporarily but eventually they realised they needed something far more integrated and complex than that which they could design themselves. After software evaluation, they bought a project management package which is "giving the client the reports he wants and the project is being effectively managed". Front-end planning could have highlighted their needs and saved them the expense of pursuing a "dead-end" (Evans, 1985).

Front-end planning, therefore, is cost-beneficial in the systems development. In addition, it is easier to make changes while people are open-mindedly looking for alternatives rather than later after they have accepted the system they are designing or installing. The benefits of front-end planning relate to speed, accuracy, improved service to the client, a greater level of detail and tighter control. Added benefits are: a possible saving by analysing alternatives, and a possible gain by winning tenders on improved service and presentations.

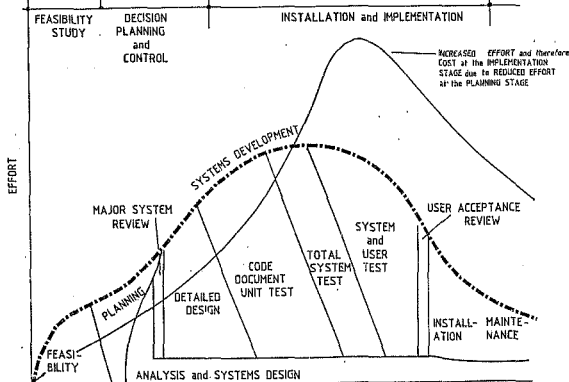
SYSTEMS LIFE CYCLE and LIFE CYCLE COSTS
(Adapted from Dreyer, 1962)



FIGURE 5.2

EFFORT REQUIRED AT DIFFERENT PHASES OF PROJECT MANAGEMENT SYSTEMS DEVELOPMENT

(from DUFFY 1981)



5.2.1 Life-Cycle and Life-Cycle Costs

Front-end planning gained established validity on the basis of the theses of Dreyer (1982) and Duffy (1985). In Figure 5.1 Dreyer shows that at the system-planning stage, the cost of changes is still relatively low. At the earlier stages most of the expense is in time and ideas, and still on paper. At the implementation stage, the cost of making changes is much higher especially if training or running a prototype has taken place. He implies that changes should be kept to the early stage and, with sufficient planning, this is where they will be. Duffy indicated, in Figure 5.2, that if effort is reduced at the planning stage, increased effort, and therefore cost, is required of the implementation stage.

Despite these findings of Dreyer and Duffy, companies still resist, to their own detriment, careful and precise front-end planning. They often resist this planning because, if done properly, it is expensive and initially its benefits are intangible but as described in section 5.2 a lack of planning caused double expense. For example, a certain construction company went through all the planning phases and could not reach a decision. This meant two packages had to be run in parallel until one proved to be better (Wiederhold, 1985). Although this company's planning did not lead to an immediate decision, they eventually had exactly what they needed, whereas the first company had to start again after reaching a "dead-end", because of insufficient front-end planning and forward thinking.

5.2.2 Iterative Development

A problematic aspect of systems design is that it is an iterative process; once some of the design has been completed, evaluation and review can point out inefficiencies and shortcomings so that the systems developers may have to back-track and repeat certain phases. If evaluations are not frequent enough the development can proceed to a point where

back-tracking is very expensive as it entails abandoning large portions of work. On the other hand, designers should be careful of too many changes which may cause the users to lose faith in the design (Rodrigues, 1985).

5.3 The Degree of Integration

Without integration it is difficult for the system to have the same data in all its modules at one time. One project management company regards this as an important philosophy (Colley, 1985). The in-house designed system that they use is integrated down to the last detail.

Another project manager said that his development team had originally thought along similar lines. However, while they realized that integration is important they found it difficult to implement. For example, items in the cost module and those in the time modules "are so different at a low level that you cannot integrate them" (Rodrigues, 1985). In the time module there may be an important milestone date which is vital in the time module but has zero cost. Therefore, it is irrelevant in the cost module. Deciding just how much detail is necessary is a problem since items required in one module may be irrelevant elsewhere, hence cluttering other modules.

A single central data base with carefully coded data could solve this problem. There is only one location for the data which facilitates maintaining data integrity and avoiding redundancy and double data capture. Each module can draw upon the data base using coding defining what level of detail is required. All data can be "rolled up" or summarised at a higher level of detail.

Wiederhold (1985) proposes an interface whereby changes in one module highlight any resulting changes in another. This way a project manager can be aware of any "ripple-effect or damage a change may cause and act accordingly".

From the above it can be seen that there does not seem to be a universal approach to integration. Certainly, there is a process of trial and error which may modify the original beliefs and ensure nothing is omitted or included unnecessarily (Ruth, 1963). However, the solution is very much dependent on the environment; there are no definite trends as they change depending on size of the company, the projects, the investment and company philosophy.

5.4 Analysis and Review Capabilities

The capability of analysing alternatives is essential as it allows the project manager to investigate possible alternatives before actual decisions for expenditure are made. Review capabilities allow him to compare actual progress to that which was planned so that deviations can be noted and rectified in time. Both these functions improve the quality of decision making and avoid expensive wrong decisions.

5.4.1 Analysis of Alternatives and Sensitivity Analysis.

- o This can be used to decide whether to tender for a project and how to structure the rates depending on risk, expected profit, cost and complexity. Different combinations can produce results which can be analysed before making a decision.
- o On site for example, this can be used for assessing certain methods by analysing the time and cost results.

5.4.2 Time Schedule Review and Control

- o To control a project it is imperative that an up-to-date schedule be used to supervise events. This is the only way to ensure that the project is proceeding in accordance with the master control network.

- o At predetermined stages progress is reviewed and compared to the target schedule. Regular meetings to discuss the progress should be held to ensure that negative influences are counteracted and that the given target dates are discussed, agreed upon, and met.
- o The detailed networks and the master control network are adjusted after the actual situation has been analysed and the control is agreed upon. The results of the progress measured against the schedule, form the basis for the continuation of the work (Lompe, 1982). The method of summarizing the results for management information must be discussed during the systems planning.
- o Reviews and updating play an important role and the system should have these comparative capabilities. However, lack of extra data and over-confident estimates should not be overlooked.

5.4.3 Impact Analysis

Bernhard (1982) indicates that the project management system should be able to produce results of the impact caused by a change. The following are examples of changes to the company or the project which may alter the project cost, end date or activity durations:

- o A new project which will require resource sharing;
- o The loss of a resource or insufficient resources for a particular activity;
- o A change in a milestone date;
- o A change in costs or duration because previous estimates were incorrect;

- o A difference between actual cash flow and the plan because the work on site is slower than expected. (Can the project management company cope with lower income for that period? He may, for example, be paid for percentage work completed); and
- o A moving forward of the completion date. Are there enough resources to shorten the durations? What is the cost involved?

5.5 Interface with the Client's System

Clients often have completely different views as to how the project should be run. Therefore the systems must be able to accommodate a range of business principles. Often clients will procure equipment or materials themselves, and issue them to the contractors for use or installation. The purpose of this arrangement is to shorten the overall time scale of the project, while placing greater emphasis on central control. This has a considerable impact on the control and procurement of materials. In this case, management does not commence at subcontractor level but at the lower level of material and equipment control. All items of material and equipment have to be monitored from the design stage through to the 'as built' location in the construction (Langan, 1982).

It is advisable for the project manager and the client to decide on the method of reporting in advance. Often reports from a construction project form the raw data for the client's corporate system. Compatibility is therefore imperative if confusion is to be avoided. To illustrate: the client may report cost figures which contain costs for scope changes, whereas it may be preferable to show costs of scope changes separately since they will be compared to the original budget.

The project manager has to be careful that he does not set up a project reporting method to suit the client at the expense of

control. For example, the client may want the individual costs for the various areas within the project. That is, he may want to track the cost of the warehouse or the office block. However, control is more effective if the project breakdown is done by contractor and not according to area. If the project manager allows the client to persuade him to set up a cost coding system according to area, the result may be a loss in control (Rodrigues, 1985).

If this is the case then the cost coding should be set up by the contractor such that the project manager has control on a detailed level. Since the project management reports are used for control, the control breakdown should take priority. The client reporting can be done later by grouping the costs for each area.

This type of dual reporting should be discussed during the systems development. If not, the required client report may have to be produced by hand or on a separate spreadsheet as the system may not be able to produce what is required (Davel 1985).

5.6 Report Flexibility

The project management system is used to help the project manager control the construction and to keep the client informed about his project. It is important therefore for the system to satisfy both the needs of the project manager and the client (see 5.5). Often this can be achieved only by producing reports with similar information arranged in different formats.

Most clients demand similar information about their projects but each one requires it in a different format. This is as a result of different internal reporting methods, levels of detail required or emphasis in method control (Rodrigues, 1985). It is unlikely, therefore, for one system to satisfy all clients.

It has been suggested that standard reporting principles be used for internal control and a flexible report generator for producing

client reports. This enables the system to produce the required in-house reports and interface with the corporate systems of a range of clients (Langan, 1982).

During project management different reports are needed at different times. Details may become significant only for "exception reporting" that is: when the project manager wants certain data in a specific format to handle a crisis.

A project management system should have a "user friendly" facility for extracting data and reporting it in the required format. Andrews (1982) suggests an accessible, on-line system where calculations can be performed and reports can be generated easily.

5.7 Systems Resilience and Manual Systems Back-up

An aspect which will not be covered in great detail, but is nevertheless important, is the manual alternative of operating a computerised system. This aspect could easily be overlooked as it is hoped that it will only seldom, if ever, be used.

If a project management system is to be used on a construction site it should have built-in resilience as operating conditions are usually severe. Terminals on a construction site often have to operate in a hot, dusty environment. These conditions require foolproof back-up and contingency arrangements since the computer may be vital for the project to run smoothly. The contingency plans should include the option of falling back to a manual system or using another computer system (Andrews, 1982).

With construction project management it is important to have well-developed, up-to-date manual systems as they may be needed in cases other than disaster back-up situations. Conditions on a particular site may demand manual as opposed to computer systems if there are no telephone lines or electricity. A contract may be too small to warrant a terminal on site, but nevertheless, a management system will have to be used (Colley, 1985).

5.8 Evaluating Purchase of Hardware and Software

The points raised so far are more applicable to the most complex development option, namely, in-house custom designed systems, however, it must be emphasized that while the importance of certain phases may change if the developments takes another route no one phase must be discarded before adequate investigation (Jones, 1984).

If a company decides to follow the development route of buying software and hardware front-end planning is still important. This will ensure the systems requirements are correctly defined and therefore satisfied. While there may be a reduction of emphasis in some phases, such as design, all steps should still be performed.

Analysis of suitable software packages becomes the most important phases. Wiederhold (1985) suggests reducing the alternatives to a shortlist of three packages. Finally, it may be necessary to run two in parallel to establish which is ideal.

Other issues suggested by Ralph (1986) to be investigated during the analysis of alternatives, which do not warrant close discussions are:

- n Vendor analysis of the hardware and software: does the vendor offer updates, maintenance, training, source code modification, etc?
- o Full cost analysis: including initial capital outlay and installation, together with cost of modifications, updates, training and operation costs.
- o Modification effort: How much does the package have to be changed to customise it? Will it be done by the vendor or in-house?
- o Documentation and support: Is the systems documentation good or will the vendor have to be relied on for training? How much support does the vendor offer or at what cost?

- o Ease of use: data entry, access to the system, user friendliness, ease of interpreting the reports, etc.
- o Hardware evaluation: What support and maintenance is offered by the vendor? Are other clients satisfied?

5.9 Documentation

Documentation covers instructions, programmes, in fact anything written about the construction project management system. During design, documentation is an evolving product developed by the design team and users. After implementation, the documentation is the basis for making changes to the system. The quality of the documentation determines, to some extent, how much flexibility the computer department has in being responsive to user requests and it enables users to understand the system more easily (Lucas, 1981). Good documentation means adequate reference is available allowing users to solve problems for themselves and even teach themselves.

For documentation to be effective it has to be well-written, clear, concise, easy to follow and with examples so the reader can solve his own problems or teach himself. This is time-consuming and for it to be comprehensive, it is usually long, discouraging users from reading it. This poses the thorny problem of whether to have documentation at all. Not having it is a point against the system and to have good lengthy documentation may be wasteful (Rodrigues, 1983).

The manual containing such documentation could be computerised allowing personnel to make additions or corrections more easily so keeping it up-to-date.

5.10 Development and Training of Personnel

Choosing and training personnel is complicated by the nature of construction projects. Duration of construction projects are kept as short as possible, reducing time for personnel development. High standards in performance regarding time, cost and resources create large stress effects which reduce time available for training. Multi-disciplinary work requires complex qualifications, and multi-nationality on project teams leads to culture and language problems (Dworatschek, 1982).

The effectiveness of a project management system depends not only on how good the system is but also on how successfully the system is operated. Good operation requires commitment and know-how from the operators. As already discussed, participation in the design and marketing of the system gains user commitment, while know how can be improved with training.

The system user has to be defined during system planning as the design has to be aimed at his level of education, training and needs. In different companies the users will differ. Different modules may only be used by various people. If the user of a certain module has a high degree of technical training the user interface should differ from one where the user has no technical education at all. In other words, the use of the module must be geared towards the specific user. This aspect of user interface is vital for successful use; the definition of the user must be outlined in the design specification.

Users involved in the system's initial design and development will already be familiar with the relevant parts and be well prepared for training. Lucas (1981) suggests that the user group should train themselves by learning from each other as they solve problems together, with guidance from the computer department and design team.

Because training is time-consuming it needs to be included in the planning before implementation takes place. This shortens the

learning curve and reduces frustration and teaching problems, thus enabling users to be self-sufficient as soon as the system is operational.

Users should have a general knowledge of the computerised system which includes a clear understanding of the benefits of using the project management system. The new methods will provide increased available information and the ability to analyse alternatives and save time.

5.11 Implementation of the Project Management System

Implementation is the stage that completes the system's development. It integrates the hardware and the software and converts the individual modules into an operating system. Implementation is the last phase and should not be forgotten because it can make or break a system, no matter how well it has been designed.

Implementation should not only begin at systems conversion but should take place during the development in the form of user participation, training and staged introduction of modules.

During final implementation systems standards, security and training are established (Prisco, 1986). Designers also need to find a method of encouraging people to use the system without forcing them. Enforcement may cause users to resist the system and build up negative attitudes which may be made worse by initial operating problems.

An individual may have any number of reasons for not wanting the system to work. These could include any of the following: fear of inadequacy to meet technical demands; not seeing a need to change; determination to prove the old system is just as good; dislike for the computer-based person; believing that typing is a low level occupation; not having, or wanting to find time to learn about the

new system; or being too impatient to try and resolve "teaching problems". Resistance due to any of these reasons may introduce counter implementation strategies which could hinder the design, smooth implementation or successful operation of the project management system. The systems developer must be aware of the reasons causing resistance and be able to identify them. This resistance may prevent a user operating the system successfully.

As discussed before, research indicates that user participation is an important element for successful implementation (Miracheim, 1984). Systems developed by a technical team without user expertise tend to generate resistance which can cause the system to fail due to incorrect use, or no use at all (Duffy, 1980). People are fearful of change, not knowing how their jobs will be affected by it. Direct participation enables users to understand the system, its operation and advantages. This in turn will result in decreased resistance when the time for implementation and operation is reached.

5.12 Strategy for Design and Implementation

Implementation is most effective when done step-by-step. The time module, for instance, could be introduced first. Once users were familiar with it the cost module and others could follow. By the time the user was required to take over the whole integrated system he would already be entirely familiar with each individual component, wasting no time or money in wrestling with the whole unknown system too soon.

Of all project management modules, the time control area seems to be so particularly vital in construction because of such elements of fast-tracking and escalating costs. It follows, therefore, that the time control module should be designed and implemented first.

There may be certain overlaps, but effectively one package will be in operation before another is designed. This step-by-step technique means that if the complete system has to be abandoned

individual operating packages are not lost. In parallel system-development all packages are developed simultaneously and a single stop in development along the way causes all packages to be partially developed and useless.

5.13 Conclusion

The system in all its aspects, has to be designed before any single part is actually developed. The systems designers, together with the project managers, should decide whether the modules are to be completely integrated, have a manual interface or a central data base. This decision forces them to analyse exactly their needs and the most suitable structure. Such close analysis, in turn, ensures the minimum of expensive changes at implementation. This holds true for later decisions concerning which analysis and review methods to adopt. Because flexible report formats cannot later be included at implementation they have, of necessity, to be included in the planning phase. Implementation, if not planned for, can be rushed, have no budget and fail. This is the most important stage, and if incorrectly handled, can ruin even the best system. Other aspects that should be thought of ahead of time are documentation and training so that they can be scheduled and budgeted. These aspects confirm that front-end planning produces a better system, is time-saving and cost-effective.

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 Summary

6.2 The Necessity for Front-end Planning

6.3 Top Management Involvement

6.4 User Participation

6.5 Other Factors that Ensure Successful Computerisation

6.6 Conclusion

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 Summary

Construction projects are becoming increasingly complex and multidisciplinary and project managers are coming under increasing pressure to reduce the project duration as far as possible to minimise the cost of finance, inflation and escalation. These factors necessitate a management system to provide more detailed analysis, increased speed and accuracy of reports and in-depth construction planning and co-ordination. Almost all construction companies in South Africa today have been forced to computerise to some extent (Thamhain, 1986) and in some large and progressive companies all functions have been computerised and integrated while in other smaller companies only one aspect, such as time control, has been computerised.

The development of completely integrated computerised systems is complicated by the fact that most companies have not embarked on such a design before and there is no standard or accepted methodology to follow.

There is a lack of formal research and documentation by those recently involved in the development of project management systems. To overcome this information shortage basic field research was required to determine the factors contribution to the successful design of a project management system. This field research was in two forms:

- o Twelve in-depth interviews with systems developers and end-users; and

- o Questionnaires sent to people involved in project management in the PWV area. The answers were statistically analysed to establish the success factors and their importance in the successful design and implementation of a project management computer system.

In the field of information management the advantages of computerised systems have been proven and accepted. They are used in many aspects of business, such as general finance, creditors, debtors, inventory control and other record keeping. Similarly in project management there are established methodologies, some of which have been successfully computerised. An example of one of these methodologies is CPM (Critical Path Method) which is a generally accepted method of time control.

Project management software, has been designed and developed to varying degrees by engineers, architects, quantity surveyors, project managers and software houses to cover various aspects of project management. However, a method of developing a total project management system, incorporating all aspects, computerised or manual, has not yet been clearly devised. Measuring the success of these development projects is difficult as there are many unknown factors which complicate time and cost estimates of the conception and design phases (Genest, 1986).

Project managers have often made use of a system for construction management and are therefore familiar with its workings, and yet they seem to lack insight into planning the working stages of that system. On the other hand, those using MIS (Management Information Systems) are familiar with the planning phases for systems development but lack knowledge of the specific construction applications, namely construction management, planning and control. The idea of linking project management and information systems expertise has emerged only recently and has proved to be of strategic importance in the fast-developing area of project management.

The planning phase covers the way in which a system fits into the company and how it can stimulate company growth and increase the company's competitiveness. It is this level of strategic thinking which will allow the system to be used as a competitive weapon by improving the company's effectiveness (McFarlan lecture, 1985).

Pre-designed packages are available and can be bought "off-the-shelf" but these can be useful to a company only if the package meets the exact needs of that company. The present state of software and hardware technology has not yet advanced to the point where all construction project managers can have their requirements met by simply acquiring a package. The result is some managers are forced to design or develop their own system so that they can meet their own requirements. Developing a system, however, does not necessarily mean designing in-house. The resultant decision process can open up a number of possible paths:

- o the project managers can analyse available software choose a package that suits the company's needs, and purchase it;
- o they can buy extra packages or modules to supplement those already designed in-house;
- o they can use consultants to help design the system; and
- o they can investigate the benefits of bureau services, decide whether to use a computer bureau for the project management.

At present, theories of systems development for project management have not been tested. Most companies who are developing a total system are doing so for the first time and the process of designing and computerising project management systems often occurs within areas that cannot be clearly defined. Even technical areas which are apparently distinct grow unclear as a result of their interdependency in project management.

Furthermore there are other non-technical areas, usually outside a project manager's training and experience, which have to be

considered. These include conceptual analysis, company culture and strategic planning, business and legal administration, definition of needs, personnel participation, motivation and training, implementation of the computerised management system, personnel's resistance to change, evaluation, feedback and monitoring of the system after implementation.

The perceived breakdown in understanding between project management and MIS teams leads to the investigation of how to develop a successful computerised project management system. This paper has discussed front-end planning, and the degree to which it can improve the success of the system. Other considerations, such as top management involvement and user participation, which emerge as having a significant impact on the system's success are also investigated.

It must be noted, however, that computerisation of the system does not, in itself, produce better project management since a computerised system could never replace the project manager. On the other hand, without any computerised systems at all, even a good project manager will have difficulty in controlling all aspects of the project successfully. Effective project management, therefore, is put into effect by a good project management team which makes optimum use of systems comprising a combination of computerised modules as well as manual methods.

6.2 The Necessity for Front-end Planning

Thus, the project management function does not end with the construction phase. It covers all phases beginning with marketing, real estate and funding aspects, moving through all design, documentation and tender award phases, before reaching implementation. These management aspects can be performed by a specialist project manager whose function it is to lead a team comprising all the professionals involved in the project. In all of these phases, computerised and manual systems aid the project manager and his team.

Project management, because it incorporates many functions, is a complex task and the development of a system to perform these functions is, therefore, equally complex. The following points illustrate the advantage of careful front-end planning.

- o The writer's field research and interviews with end-users show that there is a definite correlation between front-end planning, long term strategic planning and successful systems development.
- o Front-end planning ensures that the system is efficiently tailored to incorporate all requirements and eliminate any redundant modules (Langan, 1982). The resulting structured design enables more changes to be made at the beginning of the project which keeps the costs at a minimum. Figure 3.1 shows that costs are lowest at the initial stages of a project and this is when changes should be made to keep the negative effects at a minimum (Dreyer, 1982). Figure 3.2 shows that increased effort at the planning stages reduces effort, and therefore cost, at implementation (Duffy, 1985).
- o Front-end planning should even precede the detailed system design plan and cover a wide variety of areas. This planning is vital in deciding which path the systems development is going to follow; how the company is going to benefit from the investment; and the size and type of project the project management system is likely to manage.
- o The people involved in the system development have to be carefully chosen for a balanced contribution of computer technology, project management functionality and top management direction. There has to be a careful control of development by both the MIS department (the developer) and the project manager (the end user). The company has to be aware of restraints created by the involvement of first-time systems designers or developers, or those unfamiliar with project management systems.

- o The general structure and architecture of the system must be decided upon: whether it is to be a large central system, networked, a data base with decentralised operation or a "self standing" decentralised system.
- o Good front-end planning usually results in a short and long term strategy preventing systems design from following a non-optimum or dead-end path. The development of the system was found to be most successful when it was designed to incorporate company growth and all strategic opportunities rather than just computerising manual functions. Front-end planning can help achieve this and uncover any strategically advantageous areas.

6.3 Top Management Involvement

Top management involvement is expensive, however it is vital to ensure that the front-end planning has the support it requires to be successful.

- o Top management is the only level at which strategic planning for an entire project can be established (McFarlan, 1971). It is essential, therefore, to have a two-way communication between the planning team and management.
- o A Steering Committee should be formed comprising top management people and representatives from each department involved. These will include DP, construction, design, procurement, operations and finance. This committee allows each person the opportunity to explain his priorities and problems and ensures close involvement of top management increasing their understanding of problems and complications of designing a computerised project management system. This understanding enables the planning committee to justify its work and existence in general, it also enables top management to be directly and effectively responsible for any direction decision making and budget approval.

- o Without top management involvement the project can be severely hampered by budget restrictions, lack of support and reduced strategic input to the design.

6.4 User Participation

User participation is another important element for successful front-end planning.

- o System requirements are more likely to be clarified and defined. Clear definition of requirements pools as many ideas as possible and prevents later misunderstanding through poor communication.
- o User participation keeps the system design on-track during the development. This continual involvement enables any deviations from the original plan to be detected early and corrected with minimum expense.
- o The resistance to using the new system is reduced, for two reasons:
 - The user feels that the system is partially his own as he had a constructive part in its design (Hirschheim, 1984); and
 - His involvement also allows him to understand the working details and reduces the extent and cost of training programs at the end of the design project (Davis, 1984).

6.5 Other Factors that Ensure Successful Computerisation

Despite the research indicating that front-end planning increases the success of computerisation there are factors that can hamper the

development. The following are additional factors which need to be kept in mind before and during the design so as to ensure that the front-end planning is successful, time-saving and cost-effective:

- o System's developers should analyse exactly their needs and the most suitable structure so as to ensure a minimum of changes (which can be expensive) at implementation. For example the cost of adding flexible report formats during the implementation phase will be higher than if they were included during the planning phase; and implementation, if not planned for, can be rushed, have no budget and often fail. Other aspects that should be thought of ahead of time are documentation and training so that they can be scheduled and budgeted. It is imperative to have consistent budget support from top management and to ensure that the costs of all phases have been budgeted for and approved;
- o The leader of the development, whether in-house or a consultant, should carefully analyse the development budget and systems cost benefit analysis (Duffy 1985). The final phases of documentation training, implementation, feedback and review are often overlooked, and should be planned for and included in the budget (Rodrigues, 1985);
- o A strong systems development leader is required to co-ordinate the efforts of the design and the analysis shows that a person with a good computer and DP (data processing) background who has management abilities often makes a successful leader (Avots, 1969). If the individual workloads of the project managers are too great, consultants are often used. Consultants provide objectivity and an established proven systems development methodology which is more difficult with in-house designers;
- o A holistic view of the development should be taken at the conceptual design phase in order to incorporate company growth and strategic direction. This overall viewpoint, however, should be maintained during the entire development to ensure

that the correct strategy is followed and that the correct emphasis between operating modules is maintained (McFarlan, 1985);

- o High level aspects of the design require early discussion as opinions and systems requirements may differ from one user to the next. It was found, for instance, that the degree of integration increased if the systems designer believed in complete integration of all activities within all modules. The method of integration differs if it is believed that integration should be at a higher level with detail available only if specifically requested. A manual interface between modules, again demands a different method of design (Wiederhold, 1985); and
- o Software and hardware should be extensively analysed prior to any decisions. A restrictive budget can be detrimental in that it may not allow for sufficient screening of software or cause non-optimum existing hardware to be retained. There is strong evidence that if the software design is constrained to having to operate on existing hardware the success of the system will be threatened. Rather, the software should be designed and the most suitable hardware then chosen.

6.6 Conclusion

The research indicates that there is a correlation between front-end planning and the increased success of computerisation of project management systems in construction. The important aspects of front-end planning are:

- o Top management and user participation in defining requirements;
- o Strategic and conceptual planning for competitive advantage;
- o Analysis of all development alternatives;
- o Detailed budget analysis and cost control;
- o Detailed planning to include all development phases; and

- o Ensuring a strong development leader and Steering Committee for control, monitoring and feedback.

The phases of front-end planning have been itemised with the importance and advantages of each discussed in detail. The recommendation is, therefore, that companies developing new project management systems or requiring extensions to existing systems would do well to use front-end planning which may increase the cost effectiveness and efficiency of their development.

APPENDICES

- A. In-Depth Interview Guide
- B. Questionnaire
- C. Glossary

APPENDIX A 1

IN-DEPTH INTERVIEW GUIDE

Fill In Sheet: Company Details:

Company Date

Address Name

Position

Type of Work
.....

Major Contracts: Past

.....

Present

.....

Size: Turnover

Employees

APPENDIX A 11

1. WHAT SYSTEMS DID YOUR COMPANY HAVE, PREVIOUS TO THE SYSTEM IN OPERATION AT PRESENT?

PROBE

What are your manual systems?
Are they used now?

2. WHAT IS YOUR PRESENT SYSTEM?

PROBE

What kind of hardware do you have?
Make Model Type
Who designed the software?
Package: bought or modified?
In-house design?
Areas & functions covered
To what extent are they integrated?
What type of reports are produced?
Of the functions covered by the system, can you list them in order of importance? Which functions are essential, important and which are superfluous?

3. WHAT MOTIVATED YOUR COMPANY TO COMPUTERISE?

PROBE

Was you previous system inadequate?
What were the problems?
Did you look at improving the previous system?
Why did you choose a computer and not a different manual system?

4. WHAT FEASIBILITY STUDY, IF ANY, DID YOU UNDERTAKE BEFORE COMPUTERISING?

PROBE

How did you establish the needs of the new system?
Who participated in the design?
Who established the requirements?
What system needs are peculiar to Project Management?
Was there a steering committee formed?
What alternatives, if any, were investigated?
How were the alternative hardware and software assessed?
What method of evaluation was used?
Who did the evaluation?
What were the criteria for decisions?
Was there a cost-benefit study?
Who made the final decision?

5. STRUCTURE OF THE ORGANISATION AND COMPUTER SYSTEM

PROBE

What is the hierarchical structure of your company?
 Where does the computer system fit into the structure?
 What is the physical position of
 MIS/DP Department
 Processing/Printing
 Terminals
 Who does MIS Department report to?
 What is the background of the MIS/DP Manager?
 Who is your end user?
 Who is your operator?

6. HOW SATISFIED ARE THE USERS AND OPERATORS WITH THE PRESENT SYSTEM?

PROBE

Are you satisfied with the reports received?
 If yes, what is good about them?
 If no, why not?
 Is the format adequate for your requirements?
 If not, what would you change?
 What is the standard reporting: Timorous? Accurate? Reliable?
 Who do you report to?
 How do you have to manipulate or reconstruct information before
 reporting upwards?
 Volume of reports received
 Which don't you use?
 Which extras would you like?
 Is there any flexibility in the system as regards input and records?
 Why do you need flexibility in reporting?
 Does the system do what was promised?
 Does it fulfil your needs?
 How much training for using the system was there for operators and
 users in interpreting reports, capabilities and advantages of the
 system?
 Was there any form of marketing of the system?
 Internally to the user?
 Externally to potential clients?

APPENDIX A iv

7. PROBLEMS EXPERIENCED

PROSE

What problems were encountered during:

Design?
Installation?
Conversion?
Operation?
At Present?

Why do you think these problems arose?

How could they have been avoided?

What makes the construction industry different from any other which complicates the design and operation of the system?

Why didn't the methods for avoiding problems take place?

Was there any resistance to using the system experienced?

From whom?
Why?

8. IN HINDSIGHT

PROSE

Objectively review your:

Method of investigation
Choice of system
Method of implementation
Success of operation
Meeting of objectives

If you installed another system what would be the success factors and points to remember?

APPENDIX C 1

GLOSSARY

1. Constuction Project
2. Fast-Tracking
3. Front-End
4. In-house Design
5. Planning and Control
6. Project Management
7. Management System
9. Modules
9. Success
10. System Development Project

GLOSSARY

- Construction project:** This paper is specific to the construction industry in that examples are drawn from the construction environment. Construction projects, nowadays, are more multi-disciplinary and include areas of mechanical, electrical and process engineering. The project management system is used during the projects to co-ordinate, plan and control the activities.
- Fast-tracking:** The method of overlapping or interphasing design and construction activities in order to reduce the overall duration of the project. An example is, the excavation and foundation starts on site, before the super-structure design is completed. Fast-track projects require an emphasis on initial planning and co-ordinating of design and construction activities and intense monitoring and control. Any deviation from the master plan in a fast-track project has greater negative consequences than in traditional construction. To avoid any programme deviations, while using the fast-tracking method of construction, the co-ordination side of project management may be used to greater advantage.
- Front-End Planning:** The early planning of the method and the order in which activities will be executed. It involves analysing alternatives and contingency planning.
- In-house Design:** Any systems design that is done by the company's employees. It may only involve part of the overall system, such as, interfaces or special modules.
- Planning and Control:** The development of the original construction time-schedule, or fast-track programme, is covered in the planning phase. Comparing actual performance to this plan, and taking action to rectify any deviations, is monitoring and control.
- Project Management:** An all-embracing term that cover many aspects of site co-ordination, construction management, planning, monitoring and control (See Figure 2).

APPENDIX C iii

GLOSSARY (contd)

Management System:	A method of management which may be manual or computerised or both. This paper covers phases and considerations of designing a computerised project management system for construction.
Modules:	A computerised system is made up of individual packages or modules which may be integrated or stand-alone.
Success:	A measure of how well the system meets its objectives. Depending on who does the rating criteria may be cost, technical efficiency, report layout, speed, accuracy or level of intergration.
Systems Development Project:	The task of analysing all alternatives involved in either buying, designing in-house or a combination of both.

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Name of thesis The Relation Between Front-end Planning And Successful Computerisation Of Project Management Systems In Construction. 1988

PUBLISHER:

University of the Witwatersrand, Johannesburg

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