A COMPARISON OF A PREFERRED AND ACTUAL METHOD OF SELECTING AND IMPLEMENTING COMPUTERISED CONTROL SYSTEMS IN A MANUFACTURING ENVIRONMENT

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Thesis Summary

The failure rate for the selection and implementation of computerised control systems in manufacturing companies continues to be unacceptably high. This document researches the reasons for this problem and then continues by highlighting new important issues and providing an implementation methodology, which gives a practical guide to an implementor. The document concludes by presenting a series of brief case studies of situations where the new methodology has been applied. The research is based upon the practical experiences of a teaching company scheme.

Key Phrases

Manufacturing control systems
Methodology for selecting and implementing computer control systems
Practical implementation methodology
Implementation issues

DEDICATION

I would like to dedicate this thesis to my parents, Irene and Stewart Robinson.

ACKNOWLEDGEMENTS

I would like to acknowledge the contribution of Mr. Howard Halliday during the software selection and implementation work at Tuberex.

I would like to thank Miss Carol Turner for her help and support with compiling this document.

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CHAPTER 1

INTRODUCTION

1.1 Background

There is a lot of literature around, concerning the selection and implementation of computer aided production management (CAPM) systems. There are also many consultants and software suppliers selling their services and products in a fairly well established marketplace. However, despite the seemingly saturated nature of the subject, it was found during the research work that although there is a great quantity of knowledge, the picture is not complete and the presentation of the information may not be sufficiently clear, especially for a company with little or no experience in these matters.

1.2 The Need for a New Approach

The main indicator to the fact that the subject still deserves serious attention is the apparently high proportion of projects not fulfilling their potential or failing completely. A study of the available literature reveals several issues. Firstly, that it tends to focus on problem identification rather than problem solving. Secondly, there is disagreement between writers on many issues. Thirdly, literature generally fails to provide a practical implementation method, and finally, from the case study work many issues not covered in the literature were raised.

There is a need for a clear repeatable implementation structure and method, in which the well-known and the new ideas are combined in order to provide a more complete picture. There is also a need to not only raise problems but also suggest solutions.

Any new approach needs to have been verified by successful application on a wide variety of sites.

1.3 Objectives

This thesis aims to fulfil these needs. It contains a practical structure and methodology for the planning, selecting and implementing of CAPM systems, or any other computerisation project. It uses research findings to identify new issues and to clarify more well-known issues. These findings are then supported by examples of practical applications. It also aims to provide advice and guidance in order to overcome many common problems.

1.4 Benefits

The benefits of the approach have already been seen within Lucas, where the methodology has been used on several occasions. By using a structured approach of this kind it has been found that not only are the chances of success higher, but also the duration of the project tends to be shorter.

CHAPTER 2

CURRENT METHODS FOR SOFTWARE SELECTION AND IMPLEMENTATION

2.1 Background

It has been felt for some time that the success rate for CAPM systems has not been as high as it should be. *Aggarwal (1985)* estimated that 90% of all implementations were "disappointments" and *Shaw & Regentz (1980)* estimated that 50% were "failures". In an attempt to accurately measure the perceived success of CAPM implementations *Cerveny & Scott (1989)*, targeted questionnaires at 2892 American companies. The results showed that around 67% of companies perceived their systems to be successful in the period for 1980-85. The degree of success however varied greatly with the type of manufacturing control software that was being implemented. An APICS report (*Anderson, Schroeder, Tupy & White (1981)*), indicated that only 9.5% of companies undertaking an MRP2 implementation have succeeded in utilising its full potential and *Thomson & Graefe (1989)* only put the figure at around 20%. Although the situation seems to have been improving during the 1980's, there is clearly still a problem involved with implementing CAPM systems, the scale of which seems to be dependent on the complexity of the control software.

The difficulty of the problem of successful implementation is widely acknowledged, not least by the large amount of literature written on the subject. *Blackstone & Cox (1985)*, suggest several reasons for this; firstly the dynamic nature of the systems means that there is often a "knock-on" effect of changes around the system; the need for highly accurate data; detailed knowledge of the manufacturing operations, the application software and the associated methodologies; top management commitment and involvement. *Blasingame & Weeks (1981)* and *Kochhar (1986)* endorse this view in that even after many years of experimentation, installation of more complex systems i.e. MRP, seems to be an elusive undertaking. *Kneppelt (1981)* comments that techniques and principles continue to advance, with the effect of making implementation issues more complex. The only thing that has not changed in the last 10 years is the basic difficulty in organising for a successful implementation.

Perhaps our continued failure stems from the lack of documentation of practical experiences, particularly in those cases of failure. *Kochhar (1986)* comments on this point, and suggests that failures need to be more widely discussed. However, it is quite clear that most companies would not want their short-comings publicly analysed.

Most of the surveys considering the rate of success or failure tend to measure "perceived success". An attempt has been made recently to approach the problem more objectively. *Udoka & Nazemetz (1990)*, have established a general method of evaluating implementation performance so that comparisons can be made between companies and across industry types. This kind of approach may lead to a more accurate understanding of the scale of success or failure in the future. However, even allowing for the difficulty in measuring the problem, the failure rate for CAPM systems implementation is unacceptably high, especially considering the vast amounts of literature and the many years of practical experience.

2.2 Conflicting and Inadequately Considered Issues

2.2.1 Introduction

A literature survey of software selection and implementation issues and methods was made in order to assess its usefulness in providing a complete and practical guide for a company embarking upon an implementation project. The results of this survey showed a number of issues where conflicting opinions were given and a number of issues which were inadequately covered, although shown in the light of the case study (see chapter three) to be of importance. A table of these points is included below, followed by a discussion of why they are considered to be of importance.

The importance of companies understanding the marketplace is not stressed
The importance of getting independent advice is not stressed
Literature tends to be very prescriptive when advising on computer systems selection
There is a need to develop a business and manufacturing strategy
Gap analysis between the strategy and world's best practice is needed
Literature does not stress that control problems should be simplified before computerisation
The time to use computers and when to stay with manual systems is not clearly defined
Not enough is said about software demonstrations and what to look out for
Literature does not outline a structured approach to software selection
Software modifications are generally looked upon as being an acceptable option
Literature recommends a project-based approach but does not explain how this is achieved
Literature is unclear on how to make the transition from old systems to new
Literature does not adequately explain the working practices of suppliers and consultants and how to use them

2.1 - Table of Conflicting or Inadequately Considered Issues

2.2.2 Discussion of the Issues

Many writers have stressed the need to match CAPM requirements to CAPM solutions (*Maull, Hughes, Childe et al (1991)*), and the need to select a software package that requires the minimum of modification (*Beddick (1983)*). However, both of these assertions by their nature imply a knowledge of the current software solutions available. Other observers tell the reader about how difficult the task of finding the correct software package is. *Shore (1984)* comments that although software may be hard to find, it is important to find the correct package. *Kneppelt (1981)* goes further by stating that a basic understanding of manufacturing systems control is required before embarking on a project of this nature. This seems to be reasonable. The problem can be thought of as being three-sided. Understanding of your own system requirements, understanding of different manufacturing methodologies and understanding of the software marketplace and what it has to offer in supplying a solution. The first two issues are well documented (*Hartley (1983)*), although the second may not be practised to a great enough extent. The missing link is the third. Perhaps this explains the trend identified by *Primrose, Harrison and Leonard (1987)*, that companies tend to follow the 'fashion' in the manufacturing marketplace, because they do not investigate the whole marketplace. They go on to say that this can lead to systems being selected that do not make economic sense. My argument is supported by *Burton Swanson (1974)*, in a management science paper, where in a discussion on the broader subject of information systems, he comments that implementation failure can be attributed in part to managers merely understanding the type of system that is required and not whether the market place can supply it. Clearly an understanding of the market place is desirable and much under emphasised. Poor understanding will almost certainly lead to wasted time and effort during the selection process and may result in an unsuitable system being selected.

The picture of how an external consultant should be used in the implementation, is presented in a very unclear manner by the literature. Generally there is not agreement on where a consultant should and should not be employed. *Blackstone & Cox (1985)*, state that most implementations fail because of organisational issues, but fail to make any mention of getting outside help in this matter, and *Harvey (1967)* expresses the same views. However, *Alavi and Khumawala (1982)*, state that one of the benefits of a consultant's input is that they have seen organisational mistakes made in the past and provide the correct advice to prevent these problems occurring. *Kinnie & Staughton (1991)*, claim that companies limit their chances of success, because they adopt a reactive attitude to problem solving. They claim that the solution is a broader knowledge of issues that need to be addressed in the preparation and planning stages. *Monniot, Rhodes et al. (1992)*, also support this view, but go on to add that this area is one that is best addressed by the input of a qualified consultant. *Fisher (1981)* recommends that consultants are used in the software selection process. *Hartley (1983)* suggests a consultant should be used for objective business analysis, education, advice on project planning and to act as a 'catalyst'. *Kneppelt (1981)* states that a consultant is useful for assistance on production and inventory control concepts and giving education to inventory control personnel, but not to expect them to bear the burden of implementation. *Cerveny & Scott (1989)* on the other hand see outside help being useful as providing the impetus for change. The issue of how to use independent advice is certainly considered to be important by many observers. *Frizelle(1991)*, in his derivation of an implementation method, shows it was ranked at position twenty out of twenty key success issues. Unfortunately, the way in which these issues are prioritised, leads the observer to underestimate its importance. A major survey by *Monniot, Rhodes et al. (1992)*, showed that one third of companies failed in their implementation efforts through a shortage of experienced skills, mostly in the area of strategy and design. It also showed that consultants were normally not hired because they lacked detailed company knowledge or were perceived to be too expensive. Clearly there needs to be some clarification in this area, and the areas where consultants can be used beneficially, clearly defined.

The majority of the software packages available for manufacturing companies are based upon the Manufacturing Resource Planning (MRP2) methodology. Unfortunately, most of the literature was also focused towards the implementation of MRP2 (*Kneppelt (1981)*, *Blasingame & Weeks (1981)*, *Hartley (1983)* and *Fisher (1981)*, etc.). Only more recently have more generalised implementation papers been more available (*Maull, Hughes et al. (1990)* and *Frizelle (1991)*). This concentration of effort towards MRP2 will certainly not have helped resolve two major problems linked with implementation failure. Firstly, *Monniot, Rhodes, et al. (1992)* report that small companies in particular, expect prescriptive solutions from suppliers and consultants, which can lead to over sized and over complex solutions being applied to quite simple manufacturing environments. Secondly, *Udoka & Nazemetz (1990)*, report that companies are being forced to align themselves with corporate wide solutions that may not be appropriate for their particular site. Certainly, literature in the past has supported this prescriptive kind of strategy. *Ross (1989)* suggests that this has led to inept implementations and disastrous utilisation. My view is that even the more recent literature does not take a high enough view of the problem, in stressing the importance of strategy setting and design, before launching into software selection and implementation. This would help to eradicate the prescriptive approach.

The need for the implementation of a computer system to be supported by a higher level strategy is an idea that is only recently beginning to appear in the literature (*Maull, Hughes et al. (1991)*). Although, several authors (*Platts & Gregory(1990)*, *Abernathy, Clarke & Kantow (1981)* and *Hill (1985)*) have indicated the benefits of developing a manufacturing strategy based on a business strategy, the same has not been proposed for a computer strategy, although this seems to be a logical deduction. Many writers have divorced the two subjects of computerisation and company strategy. *Kneppelt (1981)* and *Blasingame & Weeks (1981)*, in describing their implementation considerations, make no mention of strategic planning. *Kochhar (1982)*, does however say that an effective and successful system can only be achieved by combining computer hardware and software with appropriate techniques and a high level of commitment from management and users. Other writers hint at the need for a synchronisation of the computer implementation with a high level strategy, but fail to make the point clearly. *Muscatello & Greene (1990)* detail the failure of a company that attempted to implement a new computerised manufacturing system without changing its manufacturing methodology and *Thomson & Graefe (1989)* state that there is a need for a new manufacturing model before a computer solution is applied. *Udoka & Nazemetz (1987)* suggest that significant gains can be made by changing to a new way of working, not just computerising. Clearly the way to achieve commitment from the whole company towards the new computer system, is to make this part of a company-wide strategy. This is a point that needs to be stressed more strongly.

One of the major failings of current implementation methodology is that there is no technique describing clearly the steps required to move from the current state to a new state as described in the business strategy. Many writers stress the importance of reviewing the current systems and designing new systems but do not describe how to do so. *Fisher (1981)*, states the project team should look at what we are doing now and what we want to be doing. *Beddick (1983)*, defines some milestones in the implementation to be situation analysis followed by requirement's definition, with no mention of how to get from one to the other.

Some observers fail to recommend a review of current procedures altogether (*Blackstone & Cox (1985)* and *Landnater (1981)*). While others suggest that the new requirement's definition can be drawn up purely on local requirements, without a knowledge of world's best practice *(Metzger (1984)*). *Hartley (1983)*, agrees that steps for change should be identified and form the basis of an implementation project plan, but offers no means by which this can be achieved. *Maull, Hughes et al. (1991)* state that the new design should be based upon the criteria for competitiveness, but they give no method for discovering these. This thesis recognises the need for a clear technique to be used in defining the steps for change and designing the new systems. This method should be based upon the recommendations of the business strategy and world's best practice.

In a survey of implementation success by *Cerveny & Scott (1989)*, the results indicate clearly that the rate of success was linked to the complexity of the control systems that the company were trying to implement. *Monniot, Rhodes et al. (1992)* also say that simple aims and activities are easier to control, and hence the chances of implementation success are greater. It would therefore seem logical to expect the literature to promote the idea of simplifying the control systems as far as possible before applying computer systems to them, however some literature on implementation does not *(Kneppelt (1981)*, *Blackstone & Cox (1985)* and *Muscatello & Greene (1990)*. Other writers however, do agree that computerisation should be preceded by simplification. *Blasingame & Weeks (1981)*, state that the more complex the innovation, the more difficult it is to implement. *De Toni, Caputo & Vinelli (1988)* correctly identify one of the aims of implementation as simplification. Once again there is disagreement between observers on this issue.

Computerisation in itself is a complication, in that a computer solution is probably more difficult to implement, than a manual one, in that more training may be needed with a whole new set of skills that may need to be learnt. It is noted that most observers do not even consider the idea of taking a manual approach to implementing a new methodology (*Hartley (1983)*, *Fisher (1981)*, *Alavi & Khumawala (1982*), *Metzger (1984)*, *Beddick (1983)*, *Ginzberg (1978)* and *Kochhar (1986)*). In a survey by *Monniot & Rhodes et al. (1992)*, it states that many companies had not thought clearly about the means by which an integrated organisation would be achieved, some had tried to integrate simply by applying an integrated computer system. They go on to say that companies that relied on computer technology, as a means of integration were the least successful implementors. *Thomson & Graefe (1989)*, endorse the dangers of applying computer technology to a problem blindly. They say that expectations of solving shortcomings in productivity with hardware and software alone have failed. There is clearly a case for considering alternatives to computerisation, which is either not mentioned in the literature or not clearly presented.

Generally the process of software selection seems to be very poorly described by most people. *Monniot, Rhodes et al. (1992)*, identify the need for research into how companies can find the most suitable software package for their needs. Many companies select their systems on the basis that is has many successful users already. However, *Kochhar (1986)* suggests that the fact that a particular software package has been used successfully elsewhere is no guarantee of success. *Martignago (1984)*, outlines a mathematical method for software selection based upon degree of fit, vendor assessment and technical assessment, however there are no practical guidelines on how to handle a software demonstration. *Shore (1984)* suggests that most companies resort to the least objective way of selecting software, which is to rely on the salesperson's assurances that their package is the most appropriate. This is a obervation as the personality of the salesperson will certainly have an influence in the decision-making process.

No structured method for a software selection exercise has been discovered, indeed most writers make no mention of the subject *(Beddick (1983), Blackstone & Cox (1985), Maull, Hughes et al. (1991), Udoka & Natzmetz (1990)* and *Metzger (1984)*). Others explain the problems associated with software selection, without giving any answers (*Martignago (1984), Muscatello & Greene (1990)*). Frizelle *(1991)* however, stresses the importance of selecting the correct software package. There is certainly scope here for a structured methodology that can be used in the evaluation and selection of software packages.

Many writers prescribe software modification an as acceptable part of the software selection process. *Fisher (1981)*, states that the software specifications must be detailed and then the software can be tailored appropriately. *Hartley (1983)*, suggests that most companies cannot afford to have a perfect system developed for them, therefore they should concentrate on getting eighty per cent of their needs as standard and tailoring the other twenty per cent. *Maull, Hughes et al. (1991)* write that a set of features of the major CAPM packages should be compared with the company requirements and then the most appropriate package selected, the 'fit' being improved by tailoring. Other observers take the opinion that tailoring the software is not acceptable. *Shore (1984)* argues that rather than change the company to fit a standard package, the temptation is always to have the package modified. He goes on to say that software experts routinely underestimate the cost of modification , with hidden development costs often neglected including those costs those borne by the company staff, while the modifications are being made. *Beddick (1983)*, cites a case in which the software was modified to the extent where it could not be upgraded. Other observers point out why it is easier to change the software than change the company to fit the software. *Monniot, Rhodes et al. (1992)* state that most companies are unwilling to change their working practices to fit software, unless undergoing a fundamental change to the whole organisation. *Kneppelt (1981)* maintains that companies will conduct a major software selection exercise with the intention of computerising their inefficiencies. The weight of the evidence is beginning to change peoples ideas about modifications, in a recent survey *Monniot, Rhodes et al. (1992)*, identified that in companies where software modifications were made, they were only successfully implemented in cases where they involved only very minor change. The appropriate course of action is still far from clear from a broad survey of the literature.

There is little doubt from the literature survey that the question of a project-based approach is strongly endorsed. *Kneppelt (1981)*, recommends a formal project structure as a key success factor. *Hartley (1983)* states that the overall management of the project is a major factor influencing the chances of success. *Udoka & Natzmetz (1987)* identify one major reason for failure to be over enthusiasm to implement the systems and get the benefits straight away. The implementation must be project-based and conducted at a sensible pace. *Maull, Hughes et al. (1991)*, conclude from their field work that a major reason for computer systems failure is that although the correct system was selected, a badly managed implementation caused the project to fail. *Blackstone & Cox (1985)* however make an interesting point in that they recognise that failures directly attributable to poor planning and implementation are higher in smaller companies. This point may be explained in part by *Monniot, Rhodes et al. (1992)* who recognise that smaller companies tend to expect suppliers and consultants to do everything for them. However, it should be add that they are also less likely to have people with the correct project management skills. Although project management is clearly a vital issue, literature gives no advice on how to overcome the problem of project management skills not being available, which seems to be particularly acute in smaller companies. *Harvey (1967)*, writes that research has shown that in successful implementations a recurrent success factor is the recognition by management of the difficulties to be expected in implementing the solution, including the skills and disciplines required. In terms of project management skills this issue is not being addressed.

Fisher (1981) identifies three methods for the transition from old systems to new. These are a pilot program, total systems implementation or parallel running. More recent papers identify a fourth method, which is a modular approach (implementing one functional area at a time), this has become more popular with the modular design of more recent software packages. All four methods have their advocates and opponents. *Kochhar (1986)*, suggests that parallel running can be prolonged, leading to projects getting more and more behind schedule. *Kochhar (1986)*, also describes how a pilot approach failed because it demanded too much staff time. However, *Beddick (1983)* advocates a special test case using simulated but consistent data as a vehicle for generating and confirming the operational procedures used in entering transactions into the system. *Metzger (1984)*, suggests the modular approach to be the best, where a complete module is implemented at once. *Frizelle (1991)* also recognises the benefits of a modular approach. *Udoka & Natzmetz (1987)*, suggest that the complex myriad of technologies that worked well in isolated pilot projects are not easily co-ordinated in the real world. *Fisher (1981)*, however recommends a pilot approach stating that the total systems method is the most extensive and unsettling and that most companies are not prepared to risk bringing the whole factory to a standstill. On the other hand a parallel running approach is the most costly and requires tremendous amounts of personnel time, although it seems to be the option most readily accepted by companies. Others suggest that there is advantage to be gained from making the transition as quick as possible. *Udoka & Natzmetz (1990)* suggest that the pace of the changeover is a major success factor. *Hartley (1983)* suggests the probability of success is inversely proportional to the length of the project. The issue is certainly one that needs clarification. *Kneppelt (1981)* observes that the transition of moving from the old systems to the new is one area of project planning that receives the least amount of attention.

There is a lack of information in the literature relating to software suppliers and consultants, both on what to look out for and when and where to use them to best advantage. Some writers fail to mention either (*Metzger (1984)* and *Alavi & Khumawala (1982)*). Some writers express doubts as to the genuine priorities of software suppliers. *Monniot, Rhodes et al. (1992)* suggest that software suppliers have a more optimistic view of the ultimate capabilities of CAPM than users, the reason being that the they assume that the necessary resources and correct timely data will be available and that adequate planning will take place. *Maull, Hughes et al. (1991)* claim that CAPM vendors have traditionally concentrated on the supply of hardware and software, rather than policies and procedures. *Kochhar (1982)* suggests that vendors may make a standard claim that the implementation of a computer aided production control system will lead to a fifteen to twenty-five per cent reduction in inventory and work in progress levels. *Kochhar (1986)* maintains that software suppliers tend to highlight successful implementations and that failures are rarely documented and published, except for a few exceptional cases. Against this background it becomes very important to have a clear idea of when to take the advice of vendors or consultants, and when not to. *Udoka & Natzmetz (1987)* highlight the dangers of purchasing an over specified system, in that the effectiveness of the new system will be dependent on having the right amount of technology and initiating simple new procedures required to prepare the company for new operation. *Hartley (1983)* recommends that consultants are used but does not state where, *Fisher (1981)* recommends consultants are used for software selection and *Kneppelt (1981)* recognises that consultants can be useful.

2.3 The Presentation and Structure of Current Literature

Having reviewed many papers and books on the subject of implementation, some issues require further discussion.

The hub of most of the literature centred on identifying problems that are likely to occur. Very rarely was there any practical advice on how to resolve these problems. *Blackstone & Cox (1985)* under the title of implementation, typify this approach by writing several subsections merely identifying potential problems (management, technical, human, etc.). Also where literature does give advice on what action to take, it rarely describes how to do it. *Fisher (1981)* in his paper 'How to implement MRP - Successfully', gives general indicators on what action to take, but goes no further. The effect of all of this is that there is a shortage of good practical guides to software selection and implementation.

Another common practice seems to be to provide the reader with a list of issues that need to be tackled, but no feel for the order in which they should be undertaken. *Monniot, Rhodes et al. (1992), Kochhar (1986), Alavi & Khumawala (1982).* This kind of information is obviously vital when formulating a project plan.

Finally, much of the recent research effort seems to have been targeted at establishing a priority sequence for implementation issues, in order of importance (*Frizelle (1991), Monniot, Rhodes et al. (1992)*). Surely, the fact that one issue may be marginally more important to the success of a project is of limited use. My belief is that all the issues should be treated as being of equal importance, and all should be tackled as part of a good implementation methodology.

CHAPTER 3

A SELECTION AND IMPLEMENTATION CASE STUDY

3.1 Introduction

Chapter two of this thesis has identified many issues that are handled poorly, or omitted completely, in current implementation literature. Also, the distinct lack of a repeatable implementation methodology is highlighted along with the presentation of much of the research, in terms of attempting to assign priority to implementation issues, which may be inapproriate when the reader requires practical advise on how to proceed.

This chapter is a study of a software selection and implementation project at Tuberex Ltd. The work is particularly useful as it demonstrates many pitfalls that a company new to computerisation may encounter.

3.2 The Case Study at Tuberex Ltd

3.2.1 Introduction

The research project was undertaken as part of a teaching company scheme between Aston University and Tuberex Ltd. The aim of this type of project is for the associates to gain practical experience and at the same time give the company well-educated resources with which to undertake an important project central to their strategic development.

Tuberex Ltd is a small manufacturing company producing automobile exhaust systems, they employ approximately one hundred people and have an annual turnover of around four million pounds. They are the United Kingdom's largest independent exhaust manufacturer. At the start of the project in 1986, the company was in its fourth year of trading, however much of the management, including the managing director, had previous experience in the business.

Tuberex's initial market had been 'make to order' exhausts for large aftermarket distributors. Scheduled orders were used, giving a lot of visibility and the ability to run large batches of parts through the factory. However, at the end of 1985, Tuberex had decided to enter the much more competitive market of supplying direct to aftermarket outlets. This meant that orders were now dealt with through a telesales office and competitiveness depended on stock availability and price, in addition to maintaining a reduced level of scheduled orders. Furthermore the product range now needed to be far wider than before. This changeover was not easy for the company, as it had to expand its warehousing facilities, develop a distribution network, and most importantly become far more flexible and responsive, especially in manufacturing.

Tuberex was not coping with the changes very well. The manufacturing facility was not flexible, lead times did not shorten and batch sizes did not reduce with the effect that stock levels rose rapidly, whilst stock availability remained poor. Also the increase in paperwork meant that the office staff were heavily overloaded and as a result, some of the manual systems, including stock recording, started to be neglected. The result was that the management did not have the necessary information around them with which to run the business.

These were the main drivers for the teaching company project. Mr. Howard Halliday was employed to look at the manufacturing systems and my responsibility was to look into computerised control systems to reduce the workload.

3.2.2 Objectives

The objectives of the project were to improve data flow and give better management control by having better up-to-date information available to them. It was also perceived that this improvement in control would lead to an ability to maintain current staffing levels as the company expanded.

Looking at these objectives they were aimed simply at applying computerisation to solve the work load problem, there was no remit to study why the problem existed, and tackle some of the more fundamental issues. The company had a business strategy to move from 'make to order' to 'make for stock', but did not understand how world's best practice could be applied to assist this.

The senior management had rather prescriptively suggested that a manufacturing resource planning (MRP2) system should be implemented. They had heard that this kind of system could provide the kind of benefits that they were looking for;

- accurate sales forecasting using analysis based on historical seasonal demand,
- reduced overhead costs,
- reduced manpower levels,
- reduced indirect labour costs,
- increased stock availability,
- improved financial reporting and controls,
- improved image of the company with its customers.

The computer systems would embrace all areas of the company;

- sales order processing,
- purchasing,
- costing,
- accounts,
- stock control,
- production planning,
- payroll.

These areas were to be integrated to enable up-to-date information flows between each department.

3.2.3 The Selection and Implementation Procedures

A computer steering committee was formed. This involved the teaching company associates and three or four junior managers from Tuberex. None of the board members attended on a regular basis.

The first task undertaken was to make an assessment of the current manual systems at Tuberex. This was to enable the important features of any software systems we were considering, to be identified. This process took several months to complete, as conflicting descriptions of how the systems worked were common. Finally the current systems were flow-charted, and described to the satisfaction of most people. There was no concept at this time of redesigning the systems to meet the future business strategy.

The next stage was to select a software package to fit the design. Neither the company nor ourselves had any knowledge of the software marketplace, and so a very wide sweep of manufacturing systems was made. The systems had to fulfil the functional objectives laid down by the management, and also fulfil the design specification that had been drawn up. Suppliers were invited to view the factory at Tuberex and software demonstrations were arranged. There was no budget set for the hardware and software purchase and therefore the cost and size of the systems considered varied greatly. Reports were compiled on each system and these were presented at the computer steering committee meetings. It was felt at the time, that because the format and scope of the demonstrations was largely dictated by the supplier, it was very difficult to make an objective comparison between the systems.

However, from originally considering twenty systems a shortlist was drawn up, of systems which best satisfied the original design specification. At this stage it was felt that the design requirements should be more formally described and distributed to each of the five suppliers. To this end, the invitation to tender was written. The idea behind this was to gather the responses of the suppliers to specific questions and therefore gauge their suitability to supply, and narrow the choice down further.

It was found that invitation to tender was very much a waste of time as far as using it to select software. Most suppliers answered in the affirmative to all the questions, claiming that the software could be modified to satisfy any requirement not covered by the standard system. A short list of two was compiled based on those which claimed the fewest modifications.

In order to separate the final two candidates a 'benchmark test' was devised. This was designed to simulate the way in which the different systems would cope with the real life situations encountered at Tuberex. Both suppliers were asked to load a standard set of data onto their systems and run through a sequence of scenarios. Basically the tests were very successful, however in hindsight less data could have been used. The results of this test along with other considerations of talking to current user sites, supplier stability and support and systems expandability, were used to make the final decision.

At this stage having selected a 'suitable' system the company broke the news, that due to a poor quarter's trading there were no funds available for the purchase of the computer system selected. It was also made clear that the price of the suggested system was beyond the means of the company. Therefore, in order to save the project, it was decided to concentrate the effort on computerising the sales and accounting areas and exclude manufacturing. It was decided that the cheapest multi-user system, with the required functionality should be selected, and that a PC network should be used.

A quick search of the PC software marketplace was made and it was found that there were no standard systems within Tuberex's budget that met the required functionality. The decision was therefore made to purchase a system that gave basic functionality but could be modified to suit exact requirements (TAS accounts). The modifications would be made by the teaching company associates. Due to the very short timescales involved, several fundamental errors were made during the modification process;

- sufficient time was not given to software testing,
- changes were made without fully understanding the workings of the code,
- major changes were needed in some areas where the standard system was a bad fit,
- many unnecessary changes were made through poor understanding and communication,
- changes were not properly documented for users or within the software.

As a result the initial software proved almost impossible to implement. Much effort was involved in fixing the database and making continual changes to the software in an attempt to cure the problems. Although the system gave a small amount of benefit in some areas and also gave users experience of using computer systems, it eventually failed because it had lost all credibility. The final deciding factor was a problem with the multi-user handling on the network. Tuberex had been the first company to use a new version of the software package and hence the first company to discover this serious fault.

During the three month period in which the computer system had been operating, company profitablity had been improving due to improved sales, and funds were now made available to purchase a more suitable software package. Another software selection exercise was embarked upon but this was more focused by the need to use the existing hardware. Also a more far-sighted view was taken, in that it should be expandable to meet future needs and to incorporate manufacturing if required. Eventually Omicron was selected and the network upgraded.

3.2.4 Important Issues Raised

The major problem involved with the selection and implementation process, was that Tuberex completely overlooked the organisation implications of what they were doing, and the impact that it would have on the company as a whole. Senior management had little or no understanding of how to use computerisation to assist them. They were unaware of the current best practice for what they were trying to achieve and saw computerisation as a means by which they could solve problems. Unfortunately there were more fundamental issues surrounding the operation of their manufacturing facility which were totally overlooked. What was required at an early stage was some independent advice coupled with senior management education. As a result of this many other issues were overlooked;

- the scale of the task was underestimated,
- there was poor project management,
- the new systems design did not move the company forward,
- there was no understanding of the critical issues to be tackled,
- there was no attempt to simplify before computerisation,
- there was no understanding of the importance of education,
- there was no understanding of the importance of data accuracy,
- there was no clear communication of the implications of changes on the staff.

Most importantly there was no commitment to the project throughout the company.

As a result of the project some very important issues were exposed.

It was felt that the company had formed a business strategy without understanding the issues that needed to be tackled to make that strategy successful. The company had problems around them brought on by their move to supply their product from stock through a telesales operation. The company needed independent advice, it needed to understand world's best practice and it needed to be able to understand the steps that were essential for improvement. This would then have enabled the management to initiate a series of projects based on the overall business strategy to bring about the necessary changes. Computerisation may have been one of these, but it probably would not have been the first.

Assuming the computerisation was a suitable option the new systems should have been designed with a knowledge of the software market place, in order to limit the number of systems considered. This process would be assisted greatly by an attempt to simplify the new systems design and computerise only those areas where manual systems could not cope. Application of a simpler benchmark test at an earlier stage in the software selection process would have brought us more quickly to the most suitable system.

There was a need to better organise the project management issues. None of the Tuberex staff had any knowledge of how to properly manage a project of this sort. The project was led mainly by the financial controller who had a very limited view of company wide activities, especially manufacturing.

The way in which the transition from old to new systems was handled was very poor for both implementations. In both cases the company tried to run both systems in parallel, with the effect that staff had to work twice as hard to keep both systems operational. The effect was that the new systems tended to be neglected and therefore the implementation process was unnecessarily delayed. The problems associated with software modification were clearly illustrated between the TAS system and the Omicron system where the standard package was used from day one. Both systems in their standard configuration were almost identical, however, Tuberex gradually changed its working practices to suit Omicron and eventually no modification was needed.

Finally, the disruptive members of staff at Tuberex were not dealt with effectively by Tuberex management and this served to prolong the implementation period further.

3.2.5 Results

The computer systems at Tuberex are operational and giving benefit. This is largely due to the efforts of the users who were fortunately able to see the advantages it would give to them, in reducing their workload, from a very early stage. The experience of the first (TAS) system, helped to make the second implementation more successful. Lessons were learnt from the mistakes.

Although the implementation looks largely successful on the surface, the software selection and implementation procedures could have been shortened considerably and still the fundamental issues of manufacturing methodology and a general simplification of procedures have not yet been tackled. Tuberex could potentially be much more competitive and successful than it is. In the light of these changes the computer systems that were selected may be totally inappropriate.

CHAPTER 4

A NEW IMPLEMENTATION METHOD

4.1 A New Implementation Structure

4.1.1 Introduction

A comprehensive survey of approaches relating to software selection and implementation issues and methodology was conducted. From this, many common issues were widely supported by most observers, however, from the Tuberex project there were many situations where issues were not covered in the literature or where observers gave an unclear or conflicting opinion (these issues are highlighted in chapter two). The issues identified, both well understood and new, are listed here. They have been categorised into subsections relating to the area of the implementation they are concerned with.

People & Organisation
Top Management commitment and active support for the venture
Develop strong programs for education and training tailored to the recipients
Whole company support for the venture
Commitment to the idea of change (a felt need for change)
A willingness to sacrifice short-term operational results for long-term gains
Be prepared to take on the organisational changes as well as the technical ones
Management and user involvement through the selection and implementation phases
Ensure ownership of, and responsibility for the system, data and procedures
Understand that computerisation to reduce manpower rarely happens
Do not underestimate the scale of the task
A dogged resolution to succeed
A policy of continuous improvement should be adopted, especially after the implementation is complete
Always strive to maintain the credibility of the computer system, especially in the early days
Data
Demand absolute integrity and accuracy of data
Ensure ownership of and responsibility of the system, data and procedures
Project Management
Proper project managed implementation
Communicate the project status
Willingness to commit key personnel to the project full-time
A cross-departmental project team
Appointment of the right project leader
Strategy & Design
A thorough understanding of the new system design requirements
Promote the computer strategy as one of the highest priorities in the company
Implement a flexible solution which enables future change with the marketplace
A review of current procedures to act as a yardstick for future improvements
Formulation of the design and objects of the new system before beginning software selection
Software & Hardware
Do not overkill on functionality, only provide the minimum
Software, don't be the first
Ensure software/hardware compatibly
Ensure software/hardware upgradability and modularity
Select the software first and then the hardware
Costs & Benefits
A good understanding of the costs involved and the potential benefits
A recognition that some of the benefits may be intangible
Suppliers
Detail the specification of the new systems well, especially if it is the basis of a contractual agreement with suppliers
Get professional advice when drawing up contracts
Ensure vendor stability, support, experience

4.1 - Table of Well Established Implementation Ideas

People & Organisation
Document and procedurise all interactions with the computer system
Do not parallel run the old and new systems, use a modular approach
Deal with disruptive influences
Project Management
Train the project team in project management techniques
Select a project leader from manufacturing
Strategy & Design
Company decision makers must have an understanding of world's best practice
Use gap analysis to identify the tasks for improvement and set a priority for work
Company decision makers must have an understanding of the software marketplace
Apply world's best practice and a knowledge of the software market place
An independent consultant will invariably be needed by the company at some stage of the design and implementation
Simplify the current systems as far as possible before considering computerisation
Computerise only if manual systems are inadequate due to volumes or complexity
Change the company as far as possible to suit the standard software package
Software & Hardware
Use a structured approach, i.e. benchmark test when reviewing software
Always run with the standard software package from day 1, don't modify before delivery
Modify only where absolutely necessary after an extensive trial period
Always use an integrated package wherever possible
Software selection is not always necessary
Costs & Benefits
A budget for computerisation must be set before any software selection procedure starts

4.2 - Table of New or Little Exposed Implementation Ideas

4.1.2 The Need for a New Implementation Methodology

Having identified many implementation issues, the literature was then referenced again for a practical implementation structure. It was discovered that most literature on the subject of implementation merely provided a list of issues (as illustrated in chapter two), of the kind shown above. Where research work had been conducted some of it was directed at trying to prioritise this list rather than acknowledging that all the issues are equally important, and trying to formulate practical implementation guidelines and solutions to common pitfalls and problems. The way in which the issues have been sub-divided in the above list is of use in terms of categorisation, however it is of little benefit as a practical guide.

The implementation structure presented here has been drawn up in the light of the implementation issues (new and existing) listed above, to give a practical implementation and software selection guide which can be generally applied across a wide range of business types. This method has now been adopted by Lucas Engineering & Systems Ltd, and is used by engineers on software selection and implementation projects. Some of the work conducted using elements of the new menthodology is reviewed in chapter five. The initial results have been very encouraging.

4.1.3 The New Implementation Structure

The new implementation structure draws together well documented and new ideas to provide a practical solution

The structure (see 4.3) details 11 steps for the total design, selection and implementation process. At each step the important implementation considerations have been fitted in. There are 35 issues that are considered to be well established and generally understood and another 18 that are considered to be either not clearly presented in the literature or new ideas (these are shown in bold type), as listed above.

The way in which the structure holds together is explained, followed by a discussion on each of the implementation issues and how they should be approached.

Step	Issues
Step 11: Continuous Improvement	A policy of continuous improvement should be adopted
Step 10: SUCCESS	
Step 9: Implementation (Technical & Organisational)	Develop strong education and training programs Ownership and responsibility for systems, data and procedures **Document and procedurise all interactions with the computer system** Be prepared to tackle organisational issues as well as technical ones Demand absolute data accuracy and integrity **Do not parallel run the old and new systems** **Always run the standard software system from day 1** **Modify software only where absolutely necessary** Maintain the credibility of the system especially in the early days **Always use an integrated package wherever possible** A dogged resolution to succeed
Step 8: Software Selection	**Software selection is not always necessary** Ensure hardware/software compatibility Ensure hardware/software expandability and upgradeability Do not be a software pioneer Select the software first not the hardware Do not overkill on functionality, use only the minimum requirement Detail the specification of the new systems well Get professional advice when drawing up contracts Ensure vendor stability, support and experience **Use a structured methodology for software demonstrations**
Step 7: COMMITMENT	
Step 6: Get the whole company to buy into the New Design	Whole company support for the venture Communicate the project status **Deal with disruptive influences**
Step 5: The Detailed Design of the New World	**Apply World's Best Practice and knowledge of the software marketplace** Ensure management and user involvement from the design stage onwards Have a thorough understanding of the new systems requirements Design a flexible solution that enables future change with the company Formulation of the detailed design is necessary before software selection **Change the company as far as possible to suit a standard software package**
Step 4: Establish an Understanding of the Relevant Methodologies	Develop strong on-going education tailored to the recipients **Train the project team in project management techniques** **Company decision makers must have a knowledge of the software marketplace** **Set a budget for computerisation before the project starts** Top management commitment and active support for the venture A willingness to sacrifice short-term results for longer term gains A properly project managed implementation Appointment of the right project manager **Select a project manager from manufacturing** A cross-departmental project team Willingness to commit people to the project team full-time Understand that computerisation to reduce manpower is rarely realistic A recognition that many of the benefits may be intangible **Better understanding of how an independent consultant can be used**
Step 3: Develop a 'felt' need for change	Establish a 'felt' need for change Promote the computer system as one of the highest priorities in the company Have a good understanding of the costs involved and potential benefits **Simplify the current systems as far as possible before computerisation** **Computerise only if manual systems are inadequate due to volume and/or complexity**
Step 2: Gap Analyse the Business Strategy with the current systems using World's Best Practice	**Use gap analysis to identify the tasks for improvement and set a priority** **Company decision makers must have an understanding of World's Best Practice** Review current systems as a yardstick by which to measure future improvements Do not underestimate the scale of the task
Step 1: Formulate a Business Strategy for the future	Formulate a business strategy before beginning the computerisation process
STARTING POINT	

4.3 - The Implementation Structure

4.1.3.1 The Implementation Structure Explained

As explained before, a survey of the literature relating to computer systems implementation revealed a number of frequently mentioned issues and a number of gaps in the implementation theory. Many of the issues are highlighted and discussed, but only very rarely is practical advice given on how to carry out a project of this kind.

After further study, it was noticed that many of the issues highlighted are interlinked and must be fitted together like the pieces of a jigsaw. If a task is overlooked then the likelihood of success will be affected in varying degrees.

In order to show clearly the methodology for successful implementation the important elements have been combined into the structure. As a result it was found that most of the gaps in the list of well-understood implementation issues were filled by the new issues.

The structure is designed to show the necessary steps and the order in which they must be taken. If a step is missed or inadequately covered then this will damage the chances of success or could mean complete failure. The model concentrates on the objective of attaining whole company commitment to both the vision of the future company and the computer systems that will support this. No priority or particular importance is given to any one aspect, all are equally important, and none should be overlooked, as with the pieces of a jigsaw.

Step 1. Formulate a Business Strategy for the future

Senior company management should have the responsibility to plan the future of the company. Within a business strategy issues such as, whether it will expand, explore new markets, develop new product lines etc., should be covered. These company goals should be agreed along with suitable time scales, and documented. Using these global goals it follows that management can now generate supporting strategies for each of the areas of the company, e.g. manufacturing, purchasing and sales. The goals for each of these areas should be matched to those which are desirable for the business as a whole. For instance, if shorter lead times are necessary to compete and increase market share, then the manufacturing strategy must be shaped using this 'driver'. There may be several 'drivers' of this kind impacting directly on one or more areas within the business. Once the strategies have been identified the best methods for achieving them can be investigated.

More recently literature seems to recognise the fact that computerisation should be one element of an overall business strategy. *Levy (1992)* writes that companies need to explore all possible business strategies in order to achieve a competitive edge, and that lower level strategies for each of the business functions should be mutually supportive, computerisation being one important element of this. It follows from this that the objective of computerisation must be to support the achievement of the overall business strategy. In a recent survey to formulate an implementation methodology *Frizelle (1991)* identifies that more other writers support this view (*Hofer & Schendel (1978)*, *Platts & Gregory (1990)*, *Hill (1985)* and *Hayes, Clark & Wheelwright (1986)*). This use of a business strategy as a framework for a whole business improvement, of which computerisation may be one important element, is the starting point for the implementation structure. Tuberex, like other companies observed subsequently, began their implementation project at step 8, with little understanding of the objectives, strategy or need for commitment.

Step 2. Gap Analyse the Business Strategy with the Current Situation using World's Best Practice.

Having formed the business strategy and the lower level supporting strategies, it would seem important to understand the tasks that must be undergone in order to achieve these aims in the best way. To do so an understanding of 'world's best practice' is essential. The term 'world's best practice' is used to represent the methodologies or way of working practised by the best performing company in the same marketplace, where perfromance may be measured on such issues as, delivery performance, stock turns, quality, customer satisfaction and profit. It would be desirable to target this knowledge of good practice towards the issues that have been identified as company 'drivers'. A logical way of doing this is to gap analyse the current state of the company with the 'world's best practice', for the strategy that has been defined. The exercise of gap analysis should be understood to mean the process of comparing current ways of working with a perferred method (outlined by 'world's best practise'), in order to identify areas of deficiency which then provides a focus for improvement. This process is obviously dependent upon a review of the current systems. From this work an idea of what needs to be done should begin to form, as well as an understanding of why it is necessary and a feel for the scale of the task.

Any gap analysis must involve a knowledge of world's best practice. *Monniot, Rhodes, Towill & Waterlow (1992)* commented in a survey of computer aided production management in the UK, that small companies and first-time users tended to be very prescriptive when it came to implementing new methodologies for computer systems, and they expected suppliers and consultants to provide prescriptive solutions. This experience was mirrored at Tuberex who had the same desire to select an MRP type system without looking at any other type of control system. It is believed that one of the reasons for this narrow view was that Tuberex had no knowledge of world's best practice. This point is supported by *Maull, Hughes et al (1991)*, when they state that computer aided production management (CAPM) requirements must be matched to the best CAPM solutions. This surely assumes a knowledge of best practice. The dangers of not selecting the best methodology for the company are explained by *Primrose, Harrison & Leonard (1987)*, who say that companies who tend to follow the latest 'fashion', rather than looking at the whole picture, sometimes end up selecting systems that do not make economic sense.

Particularly for the small to medium sized company, it is unrealistic for the decision-makers to have a good working knowledge of the latest methodologies, therefore it would make sense to enlist the help of an independent consultant to audit the current and future needs of the company and suggest the appropriate methodologies to support this, from his/her knowledge of world's best practice. *Fisher (1981)* explains that there are many consultants available with a good knowledge of the current best practise in manufacturing. An audit of this kind could take anything from a couple of days to a week depending upon the size of the company (from subsequent experience in doing this job). Larger companies may have their own experts. Care should be taken when using software suppliers for this task , as they will obviously be biased towards their own products. A good consultant should be able to provide sound evidence to support his case and this should avoid a prescriptive route being followed. It is essential that the consultant convinces the company decision makers of his reasons for reaching his conclusions, so that they buy into the methodologies prescibed.

Knowledge of the best methodology for the company e.g., MRP, JIT, Kanban, OPT, cellular manufacture etc., or any combination, is then an input into the gap analysis process.

The other prerequisite for gap analysis is to have a detailed view of the current situation and most observers seem to believe that a review of the current procedures is an important requirement for a project of this kind. *Kneppelt (1981)* sees the importance of this activity as being to establish an understanding of current management strategy and policy. *Shore (1984)* advocates the need for a review of manual systems, but states the need as being in order to computerise them. This view has to be wrong as it takes no account of whether what they are doing currently is the best approach to the problem. *Beddick (1983)* states that a current review is necessary in order to establish the magnitude of possible future benefits from the new systems. We can conclude that this step is an important one, primarily because it establishes a baseline from which to begin and from which possible benefits and actual improvements can be measured, but also from a project planning point of view, since it allows the project plan to be drawn up. The current procedures were thoroughly reviewed and documented at Tuberex, but the lead time was too long due to the lack of previous systems analysis experience and difficulties involving staff availability. The issue is also a vital ingredient in the gap analysis process.

The aim of gap analysis is to look at the business strategy for the future and using the acknowledged world's best practice to achieve this strategy, identify the issues that must be tackled to move the company from its current position to that outlined in the business strategy. This process assumes knowledge of three things;

- the current position of the company,
- the business strategy for the future,
- and the world's best practice available to best support that strategy.

The objective is to identify the tasks required for improvement together with some priority on how they should be tackled. This output will form the basis of the project plan to be carried out in step 9, the implementation. It will identify what to do, but as yet not how to do it. This is an essential element in establishing a 'felt need for change'.

Most writers ignore this issue completely, and it is only recently that recognition of the technique has been made (*McGarrie & Kochhar (1989)*), although it is a process which consultants may go through subconsciously when assessing implementation issues. The belief here, is that the process should be formalised and be recognised as an essential element in the implementation methodology.

The process should logically be a collaboration between the company decision makers and the independent consultant involved in the input on world's best practice described above. This is because the company decision makers should have knowledge of the current situation and the future business strategy (from step 1) and the consultant should have assessed the appropriate supporting methodology, from his/her previous input.

The process of gap analysis should provide a good understanding of the scale of the implementation project. *Blackstone & Cox (1985)* highlight the fact that most CAPM failures can be related to management failing to recognise the commitment, in terms of education and data preparation, necessary to make the system work. Such underestimation of the task usually means that the project is doomed to failure. My belief is that many writers compound this problem by not giving a clear structure to the implementation process. Some start their discussions at the formation of a project team (*Hartley (1983)*) and some with education (*Fisher (1981)*). Some of the later writers are now starting to recommend a business strategy as a sound basis for an implementation methodology (*Maull, Hughes et al. (1991)*). The belief is that in order to see the full size of the picture you need to start from far enough away, i.e. the business strategy.

Tuberex confirmed this point in that the costing of the project was based solely on the software and hardware with a small allowance for hands-on computer training. No budget was set for any other implementation expense. Also staff and management were not prepared to put in the effort to make the new system work.

Step 3. Develop a 'felt' Need for Change having identified what must be done

A 'felt' need for change would surely be an asset in terms of establishing commitment to the project. Having conducted the gap analysis there should be an understanding of what must be done and why the changes are necessary. Other issues may start to fall into place at this point.

A company needs to 'feel' that change, in terms of the computerisation, is necessary. This can only come if computerisation is a necessary part of an overall business strategy. Many companies embark on computerisation for the wrong reasons and sometimes where there are better alternatives. *Blasingame & Weeks (1981)* support this idea, and in their research identify that success is more probable where the reasons for change are clearly understood. *Beddick (1983)* observes that management must perceive that change will bring economic advantage based on the ability to meet specific goals not yet achieved. This factor was regarded by some as the most positive determinant for success (*Herold, Yoon & Parson (1988)*).

The decision for computerisation at Tuberex was not made as part of the requirement to fulfil a business strategy. The feeling of the need for change came from the desire to have a computer system because their competitors were using them and that the Teaching Company Scheme was a good way of achieving this. Thus the effort and the application of the company to the project were not as strong as they should have been.

Without a felt need for change it is impossible for management or staff to feel any commitment to the project.

This need for change should help top management see the possible benefits and promote the project within the company. *Caruth (1974)* stated in his study of organisational psychology that the best way to make something happen is for organisation members to see that their senior management are actively promoting it. The computer strategy should be directly tied into the overall business strategy, together with other projects perhaps, although because of its cross-departmental nature and because it can be a restricting factor for other changes, the computer strategy should be given the highest of priorities. *Ross (1989)* sees this as being an important success factor. Tuberex was not untypical in its approach to computerisation, and subsequent observation showed that the day to day 'fire fighting' activities always took priority over implementation tasks. It should be the responsibility of top management and the project team especially, to see that this situation is not allowed to develop.

The gap analysis process may have identified areas where simplification is required or where computerisation is not necessary.

It follows from first principles that simple aims and activities are easier to control than multiple aims and complex activities. This leads to a more predictable environment (*Monniot, Rhodes et al. (1992)*), which has to be a good quality in a manufacturing company. Therefore it makes sense to simplify the company as far as possible before designing the new computer systems around it, rather than computerising complexity (*Kneppelt (1981)*). *Maull, Hughes et al. (1991)* suggest that the product portfolio may need rationalising by distinguishing those which are profitable and those which are not. Alternatively, the shop floor may need to be redesigned into a group technology layout. These issues should form part of the business strategy and be an aspect of the 'felt' need for change. *Thomson, Vince & Graefe (1989)* say that expectations of solving shortcomings with hardware and software alone are false. In the past the emphasis has been placed on modelling the software to cope with inefficiencies in a company's operation (*Blackstone & Cox (1985), Hartley (1983)*).

More recently this idea of simplification has been pushed by the Lucas group, with particular emphasis on reorganising the shop floor into a cellular layout (*Dale & Johnson (1986)*). It is believed that this idea should be applied across all areas of the business not just manufacturing, because at Tuberex many simplifications could have been made to the commercial and financial systems as well, in order to make the computer systems easier to run. It would have also meant that there was a greater likelihood of a standard software package being available without extensive modification. Most of the modifications made for Tuberex were because of their particular complexities.

Monniot, Rhodes et al. (1992) make the point that simplification should not be confused with integration of different parts of the business. Integration may be necessary as well, but companies that rely on computerisation to achieve integration are the least successful implementors.

It seems likely that simplification may well follow naturally from the application of world's best practice, as many of the best methodologies are designed to achieve this.

Computerisation was seen as the panacea at Tuberex. They tried to 'computerise' away all of the inefficiencies and complexities of the manual systems. This experience supported the view that the computer is only a support tool, not a solution to the problem.

Following on from the conclusion that simplification must be a good activity in a manufacturing environment, computerisation must be viewed as a complexity as demonstrated by the limited successes in the past (*Aggarwal (1985)*).

Hartley (1983) suggests that the project team must resist the temptation to include unnecessary luxuries in order to allow the system to provide all things to all people. A logical extension of this is to computerise only where necessary because computerisation equates to complexity. This has been demonstrated on occasions where complex shop floor data capture systems have been applied where only occasional work in progress data is needed, and where complex scheduling systems are operated in a potential Kanban environment.

Having studied the results of the gap analysis and given consideration to any other implications, an idea of costs and benefits should begin to form. Many writers stress the importance of establishing costs and benefits. Research by *Frizelle (1991)* indicates the importance of this information, as it is required for proper project justification, which he views as an important success criterion. Other observers recognise that costs are more easily measured than benefits (*Kneppelt (1981)*), with the recognition that many of the benefits of the system may be intangible. *Brown (1986)* even comments that computer implementations of this kind are quite often an act of faith, however an idea of the scale of expenditure is still very important. Tuberex had little understanding of the total costs or benefits and it was felt that if the true cost of doing the project properly had been known at the beginning it may never have been started. This is therefore a vital planning issue.

Step 4. Establish an Understanding of the Relevant Methodologies

By now the first three steps of the implementation should have established what changes need to be implemented and why they are of such great importance. The aim is now to allow as many people as possible, especially top management and the project team to see how this 'felt' need for change can be converted into reality. This establishment of understanding might include targeted education sessions, seminars, site visits or training sessions on the computer systems themselves. Although these processes have been identified under step 4 of the implementation structure, this is meant to indicate a starting point for this activity and it may be that it is necessary to continue educational sessions throughout the lifetime of the project and beyond.

Education and training are important for a number of reasons, as highlighted by many writers. *Ross (1989)* explains that because of the relational nature of data, a thorough curriculum of training and education is needed for all levels of users to establish formal procedures, information flows and data maintenance. *Fisher (1981)* writes in detail about several phases of education, 'first-cut' for key people including top managers in the organisation on the new methodology to be implemented, in order to help establish the vision, 'detailed' education for the project team members on the finer points of the chosen methodology and lower level education and training both on how the methodology applies directly to the company and on how to operate the software. This 'targeted' training is essential to breed understanding of, and commitment to, the new systems. *Kneppelt (1981)* stresses that education should not be a one time event, it must be a continuous process throughout the life of the system. *Blackstone & Cox (1985)* give some of the reasons for this continuous education process as growth of the workforce, promotions, job changes and people leaving.

The Tuberex project suffered greatly from a lack of education of staff. Education was seen as being too expensive. The company embarked on computerisation for the wrong reasons, namely as a result of reading about some of the successes of other companies similar to themselves, but they did not fully understand the implications or whether what they were trying to do was the best solution for their company. This kind of education vacuum tends to have a knock-on effect on the ability of staff to contribute in the decision-making processes of the project and on the commitment of people to the new systems as a whole.

Users received basic systems training only. No data maintenance procedures were written, nor was there any understanding of how their part of the system affected other people. As a result data accuracy suffered.

There are other areas where this thesis considers education and understanding to be important. There is plenty of evidence to suggest that good project management in an implementation is essential to success (*Harvey* (1967) and *Kneppelt (1981)*). Some writers give more specific reasons for this, these being mainly the setting of objectives and responsibilities, the proper management of people and tasks and realistic time phasing of the process (avoiding the temptation to do too many things too fast) (*Udoka & Nazemetz (1987)*, *Blackstone & Cox (1985)*, *Hartley (1983)*, *Lawless (1978)* and *Ginzberg (1978)*). In a more quantitative analysis of the issue *Frizelle (1991)* writes that *Waterlow & Monniot (1986)* recognise project planning and justification as being the third most important issue for success and that *Barrer, Lockett & Tanner (1986)* suggest that it is the number one issue in their survey of what implementors would do differently second time around.

It is suggested by some writers that the project management issues are being handled badly by many companies at present. *Maull, Hughes et al. (1992)* state this to be the case and *Thomson & Graefe (1989)* suggest that a reason for this may be that project management is still considered to be an art, rather than a science, which may explain why project results vary greatly in quality and format. The problem is made worse by the fact that many writers do not put sufficient emphasis on the problem and take the skills involved to be assumed knowledge (*Fisher (1981)*, *Metzger (1984)* and *Kochhar (1986)*).

As discussed earlier, many writers put great emphasis on the need for education and training especially in any new methodologies to be employed or new systems. However, it is believed that a similar emphasis should be placed on the necessity to train the people who are running the project in project management. This has been shown to be a major issue and an area where many companies are deficient. Tuberex did not have the correct skills, nor did the teaching company associates. As a result the project ran over time and there was no master plan to which everyone was working. The approach was very informal.

Having selected the appropriate methodology and gap analysed this against the current situation, a number of issues for action will have been raised. It is necessary to know how the software tools available on the market can support the resolution of these issues, which obviously assumes a good knowledge of the marketplace. Most writers consider the problems associated with software selection without looking at possible solutions. *Beddick (1983)*, *Shore (1984)*, *Hartley (1983)* and *Fisher (1981)* all state that the appropriate software package may be hard to find and that it should require the minimum of modification. Surely, a good knowledge of the software market place would help ensure that the new design of the systems is realistic and that the timescales associated with software selection can be significantly reduced as a result. There is no point in designing a new system for which there is no available software product on the market to support it, assuming the complexities of the design or the volumes of data warrant computerisation, and the costs of custom software writing are prohibitively high. Certainly at Tuberex several months were wasted looking at packages that were not appropriate because the specification produced as a basis for software selection was unrealistically complex. The temptation was to simply computerise the manual systems with all their built in complexity. It is believed that this is an area again where it is prudent to use an independent consultant to help, particularly for a small to medium sized company where experienced resources of this kind are not available. If the same consultant used in the original audit and gap analysis process is used, timescales will be reduced, since he/she will have a working knowledge of the company. The terms of reference for the consultant will be to ensure that the new systems design is a realistic document with which to start the software selection. The case of Tuberex proves that the cost would have been justified because it would have greatly reduced the timescales for the software selection and the project as a whole.

Following on from an understanding of the software marketplace, it should be possible to set a suitable budget for the project. During the implementation at Tuberex, several months of effort were wasted in software selection because no budget for the implementation was set at the start of the project. Many hardware and software systems were considered which were outside the price range of Tuberex. This is an issue that follows on naturally from the cost vs. benefit analysis and must be addressed before any serious education is undertaken and the project team is drawn up. It is a vital project management issue, and many references can be found endorsing the importance of cost analysis (*Monniot, Rhodes, et al. (1992), Hartley (1983)*), but none that specifically recommend the use of this information in setting a realistic budget for the project as a whole, and the software and hardware in particular. This was surprising as it is a logical conclusion and was an important issue in the implementation at Tuberex.

A number of other very important issues should follow on from good on-going education and training.

The point of top management commitment is one of the most popular amongst observers and obviously very important. *Beddick (1983)* writes that top management does not necessarily have to know how the system will work, but what it will accomplish and that the 'new way of doing business' will improve the competitiveness of the organisation. This can be achieved by the correct educational program. *Udoka & Nazemetz (1987)* stress that top management must commit to the new strategy and commit the necessary money and resources. *Blackstone & Cox (1985)* and *Beddick (1983)* highlight the requirement for top management to communicate the message and lead from the front, especially in projects where the computer system cuts across departmental boundaries. *Alavi & Khumawala (1982)* suggest that top management commitment is best secured by involving them in the project from start to finish. In *Frizelle's (1991)* methodology for implementing CAPM systems, he consulted many eminent consultants in the field and top management drive for the project was identified as being one of the top success factors. Many other authors including *Kochhar (1982)*, *Hartley (1983)* and *Fisher (1981)*, support these ideas.

The effects of not getting the top management drive for the project were seen at Tuberex, in that the changes required to the organisation were impossible to implement. Middle management especially tended to be very set in their ways and change was made very difficult. Another effect was poor communication of the purpose of the project around the company, since top management were unable to see how the new systems being developed would tie in with business strategies for the future.

When making changes to an organisation on the scale of that which computerisation may mean, disruptions to the normal operational effectiveness may obviously result. However, in order to make the 'step-change' improvement, this short-term sacrifice must be accepted. *Udoka & Nazemetz (1990)* say that during the transition period problems may arise, but that the company must be sufficiently committed to risk short-term operational results for the sake of longer term improvements

Tuberex were not prepared to let the implementation of a computer system disrupt their production. This was shown in a reluctance to change their manual procedures in order to tighten up control of data and people necessary for the computer system. It was always stressed that sales came first, even during the transition period. Also, regarding education, committing people to training was seen as reducing the factory output, and therefore education was limited.

It is a test of commitment that short term sacrifices must be made to reap longer-term benefits.

As a result of providing good project management training, there will be a whole host of project management issues which are detailed below.

It is widely recognised that with a project of the magnitude of computer selection and implementation, it is vital to apply proper project management controls, to set timescales and milestones, to assign responsibility and to monitor progress. *Alavi & Khumawala (1982)* recognise the role of the project as a way of generating a feeling of commitment. They advocate management and user participation as a way of achieving this. *Fisher (1981)* agrees that the project team must have a broad knowledge of the company and the methodologies to be considered. He goes on to suggest that with any large project of this kind it should be divided into sub-projects with responsibilities for progress and reporting assigned to these. The activities of the project must not be divorced from top management. *Kneppelt (1981)* identifies a proper project structure with project management tools as being a common success criterion, a view which is supported in a recent survey (*Frizelle (1991)*). *Hartley (1983)* writes in detail about the importance of project planning in CAPM systems implementation, concluding that by properly organising the project using project management techniques, the process will be smoother and the chances of success higher.

The benefits of proper project management are quite clear;

- a mechanism for generating involvement and commitment,
- a means of communicating progress,
- a demonstration of commitment from top management in assigning the best people to the project,
- a proven method for planning and measuring progress, costs and resources,
- and a way of officially assigning responsibilities.

The project plan at Tuberex was drawn up long before the commencement of the teaching company scheme and was therefore based on unrealistic expectations and little knowledge of the task in hand. As a result estimates and timescales were largely inaccurate. However, these were used to measure progress and the predictable slippage that resulted led to management becoming impatient with the project. The project plan should have been drawn up to fit in with an overall business strategy for the company, after the key people had gap analysed the current situation with world's best practice and had been educated in the main principles of what they were embarking upon. Only then could realistic goals and timescales have been set.

Another element vital to a well project-managed implementation is the project leader, and the credentials for this person need to be well understood. There has been much written on the qualities of the correct person to lead a project of this sort (e.g. *Frizelle (1991), Kinnie & Staughton (1991)* and *Hartley (1983)*). There seems to be a common theme, in that the person should be an organiser, a motivator, a communicator, a diplomat, an educator, persistent, know the company and know the methodology. *Hartley (1983)* makes the recommendation that this person should have some project management education to review current methods and practices. Above all, the project manager is usually the vital link between the project, the company and top management, and as such he has responsibility to communicate the project status, allocate resources, approve budgets and ensure that the new system meets all the criteria of the new design proposed in step 5.

At Tuberex the wrong people were 'appointed' as project leaders. These duties were left up to the teaching company associates. This supports the view that the project must be led by a member of the company staff with the necessary attributes given above, since as an external party, we did not possess the necessary detailed company knowledge, and also did not have the necessary respect from within the company.

From the experience at Tuberex this thesis takes the issue a little further and recommends that the project leader has a manufacturing background.

At Tuberex the original project was to look at a company-wide computer system including manufacturing. However, there was no manufacturing input on the steering committee and as a result of the financial constraints, the project was targeted at sales and finance, mainly because this is where the problem of workload was most acute. In hindsight, if there had of been a voice representing the views of manufacturing, then the situation may have been different, with a better focus on the real problems which were in manufacturing.

The project leader needs to be someone with the widest possible knowledge of the company (*Hartley (1983)*). Manufacturing will impact on all other areas of the business, with direct connections to sales, purchasing, planning, finance etc., in a one team member need understand the underlying methodology of the new systems, since this was the case at Tuberex and although the steering committee was cross departmental, the quality of debate was severely limited by team members being unable to fully contribute through a lack of understanding about the new methodology.

Education will lead to a better understanding of the kind of benefits to be expected.

Certainly the computerisation process at Tuberex was embarked upon on the basis that it would reduce staff numbers. This misapprehension was also confirmed by *Kochhar (1986)*, who writes that historically computers have been oversold on the basis that they will provide a reduction in manpower levels, when in reality, few companies have been able to reduce, in absolute terms, the number of people required to carry out all the activities involved. The situation at Tuberex was that staffing levels were not reduced, however the workload of staff was greatly reduced, and since the implementation, as the company has grown, more staff have been taken on.

This problem stems from a lack of understanding of the implementation methodology. Education of top management should make clear the benefits that can be expected from the project and remove these misapprehensions. The purpose of computerisation should be to assist the fulfilment of the company business strategy defined in step 1.

It has been recognised for some time that the majority of benefits of computerisation, are intangible. *Primrose (1988)* maintains however, that in the past computerisation has been justified as a means of cutting jobs and that in reality this normally does not happen. In another paper, *Primrose & Leonard (1987)* maintain that through their work they have identified extensive lists of intangible benefits from computerisation, and that most of these make a company more competitive and jobs more secure. They go even further in suggesting that all intangible benefits can be restated in terms of tangible ones. The point being made by this research is that even though computerisation may not look viable on the basis of direct cost savings, when the intangibles are evaluated this may change the whole complexion of the situation. *Swann (1988)* maintains that capital investments have been made solely on the grounds of payback periods or discounted cash flow calculations, and that this kind of investment in technology way that no other department has. Therefore it was believed that manufacturing people generally should have the widest possible knowledge of what makes a company work, making them ideal candidates for the project manager role. Far too often as at Tuberex, the main company representative on the steering committee is from finance, or even worse, the computer department (*Shore (1984)*), which is usually even more remote from the daily operation of the company. It was found that there was no research to support or dispute this issue, but from the experience at Tuberex and logical deduction, it is a sound conclusion.

Udoka and Nazemetz (1990) write about the importance of committing key management and staff to the project. *Fisher (1981)* describes these key people as being top managers from manufacturing and support functions, which should ensure and demonstrate top level commitment, but also there should also be lower level managers who are in touch with day to day operations. Generally there is agreement from observers (e.g. *Hartley (1983), Blackstone & Cox (1985)*) that project members should ideally be assigned full-time to the computerisation project, however, in smaller companies a part time role may be necessary. The qualities of good project team member should be a positive attitude, good conceptual abilities, good communication skills, dependability, a good education in the new methodologies and a good company knowledge. Obviously the way in which the particular people mix and interact with each other is also very important.

The Tuberex project was run by a steering committee which met on a monthly basis. The make-up of the committee was not properly balanced, with no representation from lower levels in the company. The sessions were not really constructive as many people were unable to contribute through a lack of understanding on what the new system had to offer and what was required to make the implementation happen. The company were not prepared to commit people to the project full-time, a failing on their part which had a negative effect on commitment and the project as a whole.

Beddick (1983) states that he believes a successful implementation requires effective interfacing with functional areas affected by the new systems. He goes on to say that this is best accomplished with dedicated project team members from these key areas, these people then becoming the best 'salespeople' for the system. It is quite obvious that representatives from all affected areas should contribute to the project planning process. Disagreement was felt with his assertion that only should not be evaluated in the same way, because of the intangible element. It should be part of a strategic decision. The decision to computerise was not properly evaluated at Tuberex, and the decision was made in the belief that it would reduce labour costs.

Finally, there will be a better understanding of how an independent consultant should be used as part of the whole process of setting a strategy, gap analysing, designing, selecting and implementing. The issue of whether to use an external consultant, train up an internal member of staff, or not do either, is a decision that is likely to make or break a new system (*Cerveny & Scott (1989)*). However, there is still some debate over the issue. The main reasons for people not using consultants were investigated by *Monniot, Rhodes et al. (1992)*. They discovered that 16 out of 33 companies surveyed did not use consultants to help in their implementation, mainly because they had no company knowledge and they were considered to be too expensive. Also in a survey of academics and industrialists by *Frizelle (1991)*, although the importance of using a consultant was highlighted, it was prioritised as issue 20 out of 20. The philosophy however of this implementation methodology is to move away from this idea of prioritisation with all issues being of equal importance.

Many writers give good reasons for using consultants. The survey by *Monniot, Rhodes et al. (1992)* also suggested that skills shortage was a reason for implementation failure as was a lack of strategy, both of which are areas where consultants could be used. *Fisher (1981)* agrees that consultants are necessary for their software market knowledge and *Hartley (1983)*, *Kneppelt (1981)* and *Alavi & Khumawala (1982)* approve of their use for education and professional advice to avoid possible pitfalls. *Keen (1981)* and *White (1980)* suggest that some form of external assistance or 'change agent' is necessary.

This thesis stresses the importance of not trying to undertake a project of this kind alone. The timescales and overall success of the project were certainly affected at Tuberex because of this. Independent consultancy is vital for a knowledge of world's best practice and identification of the major issues that need to be addressed to meet strategies for the future. It can also show how the new design might be influence by the limitations of the software marketplace. Other important tasks might include education and another issue raised by *Hartley (1983)* that senior management tends to listen if advice is paid for and comes from an outside source.

Maull, Hughes et al. (1991) however warn against using consultants for quick fixes and prescriptive solutions, without fully understanding the reasoning behind the proposed changes. This can result in a company becoming increasingly dependent on the consultant.

Step 5. The Detailed Design of the New World

Having analysed world's best practice and the software arena against the future business strategy of the company, through steps 2, 3 and 4, this knowledge can now be applied to the detailed design of the new company. However, this is also the stage to combine this knowledge with user input, which should now be more enlightened after education.

This issue is really a consolidation of the chosen methodology and software marketplace knowledge into the detailed design of the new system. The situation at Tuberex was that a computerised version of the original manual systems was implemented, along with its evolved inefficiencies and complexities. The opportunity to redesign using a business strategy for the future was not taken. At Tuberex this led to poor maintenance and data integrity procedures because these were characteristics of the old systems. A knowledge of world's best practice would have meant the new systems design could have used the latest methodologies to achieve the company's goals and a knowledge of the software marketplace would have enlightened Tuberex as to the maintenance and data integrity procedures required in most packages. *Maull, Hughes et al. (1991)* from their research, state that in situations where the new design simply mirrors the old manual systems, the result will be a decay into partial failure, leading eventually to outright failure. This was identified as a major cause of implementation failure. They went on to say that the rate of decay was very much dependent upon the stability and quality of the original systems. Several writers (*Slack (1988)*, *Hill (1985)*, *Skinner (1985)*, *Meredith (1988)*, *Hayes & Wheelwright (1984)* and *Fine & Hax (1984)*) have highlighted the importance of the policies, procedures and practices (infrastructures), which govern the software use and enhance or restrict its ability to achieve the business strategy. It follows that these infrastructures can only be properly developed using world's best practice, as defined earlier in this thesis, and latest knowledge of software.

Management and user input, once enlightened by education, is also a vital aspect of the new design. A requirement for success is for all levels of the organisation to understand the system and actively participate in its design and implementation (*Blackstone & Cox (1985)*). In order for people to be committed to and support an idea, it is important to involve them in the formulation of the idea and consult them throughout its implementation. *Shore (1984)*, highlights the consequences of not getting users involved, in that resistance to change can easily sabotage an otherwise appropriate software system. Therefore the users should be involved from early on in the design phase.

The lack of involvement of the users and middle management at Tuberex, bred uncertainty for what the future would bring. This had a negative effect on the project as people were less compliant when implementing the changes later on in the project.

A thorough definition of the new systems design is crucial for several reasons.

It follows from first principles that in order to select the correct software package to fit the company's new design for the future, the new systems design must be properly understood and documented in sufficient detail. This is also essential when promoting and communicating the ideas across the company. *Ross (1989)* supports this thinking and adds that not only should the new design of each functional area be understood but also how the static, relational and dynamic information between them interacts. The new systems design should have company-wide involvement and from this through good communication, promotion and education, it should be possible to build up a good understanding and from that, commitment.

At Tuberex the new systems design was essentially the property of the teaching company associates. Although a data flow block diagram was produced and displayed, it was not understood by many people and so there was no clear vision of the future across the company and as a result, little commitment. The design was based upon the desire of management to move to an MRP type system, even though few people understood the concept of MRP.

Many writers make the point that software must be flexible to cope with future changes in requirements (*Hartley (1983)*, *Kneppelt (1981)* and *Fisher (1981)*), however it is never quite clear what they mean by this. Some implementors may understand this to mean that it is important to ensure the software is highly modifiable (in terms of tailoring the source code to suit exact requirements) and that the hardware is upgradable. This is of course an issue, but a far more important point to make, is that the new business design and strategy must allow future change and perhaps expansion. If the correct methodology and strategy for the company are selected then the company will be able to become more responsive and flexible to the demands of the marketplace (*Ross (1989)*). This indicates the importance of considering world's best practice when formulating the strategy and not simply computerising what you already have. Tuberex were attracted by the 'fashionable' solution of MRP2, without considering any other options.

Step 6. Get the Whole Company to Buy into the New Design

If steps 1 to 5 have been followed then most of the company should feel involved with the project at this stage and understand why it is necessary. There may be some staff that are still obstructive to a project of this kind, and a decision on their future will need to be made if they are not to become a disruptive influence.

Top management support is of particular importance, but this drive needs to be transmitted across the whole company, particularly in areas directly affected by the changes. *Blackstone & Cox (1985)* highlight the fact that a requirement for success is for all levels of the organisation to be committed to the system and to actively participate in its design and implementation. They add that the top management must allow and encourage this to happen. *Alavi & Khumawala (1982)* point out that it is the duty of management and the implementation project team to develop commitment, in order to enhance the project's chances of success. All staff should be willing to accommodate change in behaviour, procedures and roles. The resultant effectiveness of the system is seen by *Kochhar (1986)* to be directly related to company-wide commitment.

The situation at Tuberex was that the system users could see that the new systems would be beneficial and made every effort to work with them, however, their position was made difficult by the less committed approach of management.

A vital element in gaining commitment is to effectively communicate the progress and status of the project. One of the benefits of project management is the ability to regularly report the progress and status of the various elements of the project.

Activities will be going on in parallel and different people will probably be involved with these. It is however, the duty of the project team to communicate the progress of the project to the company as a whole. *Hartley (1983)* sees this responsibility as being divested amongst the project team members, which should represent all areas of the business. He concludes that each should act as a 'missionary', communicating the news back to his department. The project leader would be tasked with communicating with the senior management. This is certainly a good mechanism, however, a more co-ordinated approach may be preferable. Minutes of the meetings might be circulated to key people with an edited version of these, in the form of a short report, circulated company-wide. *Blackstone & Cox (1985)* highlight communication as being a major requirement for success. *Caruth (1974)* adds that people tend to accept change when support is communicated through top management, they understand what is to happen, and understand how the changes will be implemented.

Tuberex had very poor communications between departments, and the computer selection project suffered because of this.

One of the issues that tends to be glossed over in most of the literature relating to implementation is the question of key people who refuse to accept the changes that are required in moving to a new system. This problem was certainly encountered at Tuberex, with the general manager being particularly obstructive to changes that needed to be implemented in order to maintain data integrity and get the full benefits from the system. This issue was not tackled directly by the managing director, and as a result the implementation was impeded, until the general manager finally left the company. This experience certainly illustrated a potentially dangerous issue.

Blasingame & Weeks (1981) explain this resistance to change through a perceived loss of power or status. This is because decision making processes tend to become more structured whereas in the past decisions were made on a best estimate of the conditions. They outline the normal reaction from these people to the system as being to blame the systems for mistakes and not devote the time and effort required in order to make them work. The problems are highlighted but no solutions offered.

From the other studies within this thesis, the likelihood of this problem occurring can be minimised, by getting commitment to the new ideas through management and user involvement and education, as part of a total business strategy. However, as at Tuberex there may be staff who will stubbornly resist the move towards change, even though the logical argument has been presented on many occasions. It is believed in situations of this kind, senior management must be prepared to demonstrate the importance of the project to the company (*Ross (1989)* and *Caruth (1974)*), and be prepared to take tough decisions over the future of these people with the company, ultimately leading to them being moved to a less influentual position or being dismissed.

Step 7. Commitment

If all the previous steps have been followed then the whole company should now be committed to the implementation of the new system. The company can now embark on implementing its plan for organisational and technical changes. It is essential to reach this state of commitment before proceeding with the actual implementation itself. If company wide commitment and understanding are attained then the actual selection and implementation process should follow on smoothly, if not, then what follows will be an up-hill struggle, probably with increased cost and timescales. Tuberex were a very good demonstration of this effect.

Step 8. Software Selection

Having developed a detailed design of the new systems in step 5, which has the involvement and commitment of the whole company, software may need to be selected to make this design practicable.

Before embarking on a software selection process it is worth considering whether it is entirely necessary. Research has shown that the likelihood of the project succeeding is inversely proportional to the length of the project (*Hartley (1983)*, *Udoka & Nazemetz (1990)* and *Muscatello & Greene (1990)*). Therefore it follows that any process that can be safely removed from the implementation procedure will increase the chances of success as well as reducing cost. Having embarked on a major software selection exercise at Tuberex, it is believed that the differences between CAPM systems are not great enough to warrant lengthy software selection exercises. Systems were differentiated by fringe functionality, the hardware they run on and the quality of supplier. It was found that for the case of Tuberex most of the fringe functionality was unnecessary and merely served to increase complexity and we have shown earlier that most research points to hardware considerations being of secondary importance. Therefore, the most important issue after the software fit is the performance of the supplier.

It is believed that if the new system has been designed with a knowledge of the software market then it should be a reasonably straight forward task to find a stable supplier that supplies an appropriate system at the right price. Therefore the wide trawl of software packages examined at Tuberex was completely unnecessary.

If a software selection exercise is undertaken then there are many issues to consider.

It is certainly tempting during the software selection phase, to choose a computer system based purely on its functionality. *Ross (1989)* warns against this temptation. Functionality usually implies complexity and also a degree of redundancy. He warns that the computer systems should provide the simplest possible operation with the minimum of functionality to satisfy the design specification. This will increase the chances of understanding and therefore commitment and success. Also increased functionality usually means increased cost, so why pay for something you probably will not use? This issue is now becoming less of a factor as software prices fall. *Ackoff (1967)* explains peoples desire for functionality as it is seen as a mechanism for providing managers with more information for decision-making. He warns that the information presented to managers should be the minimum that is required, presented in the most appropriate form, and that there is a danger of an abundance of irrelevant information. At Tuberex the software selection exercise was cost constrained and functionality overkill was not a real issue, however in the early stages when no budget was set for the project, a lot of time was wasted in considering much too complex and expensive systems.

The point to remember here is to select the system that fulfils the specification with the minimum of excess functionality, providing there is sufficient scope for expansion at a later date.

The business of software implementation can be a very difficult process for any company, as demonstrated by the high failure rate discussed earlier. Any issue that introduces an element of further risk into the process should be avoided. As with any new product there is always an increased risk of problems occurring with a newly released software package. This was an issue with TAS accounts when it was introduced at Tuberex. Errors occurred in the multi-user capabilities of the software and the result of this repeated failure was that confidence was lost in the system and it was eventually necessary to replace it completely. *Shore (1984)*, insists that user lists should be made available to the company and visits should be arranged without the attendance of the vendor. *Beddick (1983)* and *Fisher (1981)* also confirm the view that software should not be purchased without seeing it in operation elsewhere. *Kochhar (1986)* however warns that the fact that software has been used successfully elsewhere is no guarantee of success, the software must still fit the company's own needs. The situation with the software marketplace at present is such that there is no need to take unnecessary risks of this sort, there are so many packages available that a company is more than likely to find one that fits their specification and has a reliable track record.

It is essential, as highlighted above, that there are no problems concerning the operation of the software or hardware, especially in the early stages, when the systems are under close scrutiny and need to prove their reliability and performance. Any problems of this kind are bound to undermine confidence in the new system. The point on making sure that the hardware and software are seen running together in the configuration to be used (*Fisher (1981)*, *Beddick (1983)* and *Shore (1984)*) are essential with this issue. At Tuberex the hardware and software configuration were demonstrated working satisfactorily together and no problems of this sort were encountered. It is important however in a networked environment to make sure that the cabling is properly installed. At Tuberex this was a constant source of problems.

Having made the point that software functionality should be kept to a minimum, it is important to balance this with the issue raised in step 5, that a flexible solution must be implemented. To this end *Blackstone & Cox (1985)* warn that software and hardware is usually a long term investment and should therefore have the capability of growing as the business grows, and that many features deemed unnecessary now might be vital in a few years time. The insight into what might be required in the future must come through the vision of the future described in the business strategy, and therefore it would seem sensible to base the decision on the level of functionality needed upon this. *Metzger (1984)* introduces the concept of modularity into the discussion of upgrades when he suggests that the current trend to produce modular software based upon areas of functionality (e.g. sales, purchasing etc.) might be used as a mechanism by which a system can grow or be upgraded and improved. Certainly the common view is that whichever hardware and software are selected, an upgrade path should be available on the hardware and the software should be sufficiently expandable to cope with company growth or functionality growth (modularity providing a good solution). Upgradability was somewhat overlooked at Tuberex because of cost restrictions and it was found that there was usually a cost premium attached to buying a system that allowed a degree of expandability, particularly when considering the hardware.

Steps 1 to 7 of the implementation structure have been aimed specifically at establishing an understanding and commitment to a new vision of the company in the future. The primary aim therefore must be in finding a software package to support this new system. By following this line of reasoning the selection of the hardware is irrelevant so long as it does not interfere with the effectiveness of the software in fulfilling the new vision now or in the future. Having said this, companies are still seen, especially larger ones, with corporate policies for buying hardware, even though this inflexibility greatly restricts their choice of software and may conceivably prevent them from selecting an appropriate package. This view is confirmed in the studies of software selection by *Fisher (1981)*, *Beddick (1983)* and *Shore (1984)*. At Tuberex there was no policy of hardware selection and therefore software functionality was rightly considered as the number one priority.

There will be other issues to consider regarding suppliers and contractual agreements.

Shore (1984) describes what he believes to be a common occurrence when specifying a computer system design or modifications to it. He states that after one and a half years of customisation to a standard package, the system was used for only three days, because it did not meet the specification that the company had expected. Arguments between company and supplier followed. As explained later it is believed that modification of this sort should be avoided as far as possible, and that if a great deal is required then the wrong software system has probably been selected. *Shore (1984)* concludes that the design of any changes to the standard software, should be the water tight and the sole responsibility of the company, and not in anyway left to the discretion of the supplier. *Fisher (1981)* restates the dangers and adds that a specification of this sort usually forms the basis of a contractual agreement for which specialised professional help is invaluable. In the recommended implementation plan presented here, a design of sufficient detail should have been drawn up during step 5. It should then be very easy to outline where the specification of the standard software deviates from this design, and this can be used if modifications are needed at a later date. Tuberex did not request any modifications by the software suppliers.

The importance of getting professional advice when drawing up contracts is described by *Fisher (1981)* who states that evaluating supplier proposals and writing contracts to protect yourself is a complex task, and will usually justify obtaining professional advice from consultants or lawyers. He says that a few pounds invested here can save much time and money further 'down the line'. It follows from first principles that any measures that can be taken to minimise the risk element in a transaction of this magnitude and importance must be a good idea. Tuberex enlisted the help of the company accountant to handle the negotiation process with the suppliers.

Computerisation normally involves a major purchase from one or more suppliers, and it is therefore in the interests of the company to ensure that the suppliers will be able to provide an on-going service if problems occur, a view which is supported by many writers (*Beddick (1983)*, *Shore (1984)* and *Fisher (1981)*). It therefore follows that it is worth investing time and effort into looking at the financial situation of the supplier if possible, and also talking to their customers to get an impression of their support capability. At Tuberex the supplier's past performance was examined by talking to as many current users of their products as possible.

An issue that this thesis considers to be vital when minimising the time period for software selection is the use of a structured method in software demonstrations.

The software selection process at Tuberex took 6 months, mainly because the investigation and demonstration of systems was undertaken in a very unstructured manner. The first requirement is a very good understanding of the new systems design by all the people evaluating the packages, through good education and good documentation. This was available at Tuberex. The second requirement is the budget limitation for the systems, to save time considering packages not available within the budget. In addition to these, we felt that more constructive use of the demonstrations themselves could be achieved, so that packages could be discarded more easily and for well understood reasons.

Many writers explain that it is important to select the correct package for the company (*Monniot, Rhodes et al. (1992)*), and some outline the problems associated with making the decision (*Martignago (1984)* and *Shore (1984)*), however, none give a practical way of overcoming the problems and selecting an appropriate package.

During the software selection process at Tuberex many systems were viewed. It was noticed that the data used to run demonstrations varied considerably in type and volume, and that neither ever matched the conditions at Tuberex. Most suppliers overcame this problem by saying that their system could be seen working in a similar environment to ours by visiting a user's site. It is debatable whether this is a good solution, *Kochhar (1986)* suggests that the fact that a particular software package has been successful elsewhere is no guarantee of success.

In response to this problem the idea of a benchmark test to get a good feel for the suitability of a package in the shortest possible time was developed.

The idea for a benchmark test came from reading about similar tests made on computer hardware to assess relative performance. However, it would be unrealistic to devise a quantitative test as used for assessing hardware performance. Instead, a qualitative test to show the software system running actual company data in simulated situations could be devised. One of the problems with demonstrations given by software suppliers is that the data used bares no resemblance to the kind of data used by the company. As
a result it is difficult to simulate some of the problems that might arise during operation and also, it can be difficult for non computer acquainted staff to visualise how the system will work in their environment. Therefore by using data familiar to them it should prompt a better response during the demonstration and highlight more clearly the strengths and weaknesses of the system.

A small sample of data should be selected, otherwise reluctance from the supplier to enter the data may be encountered, and a series of scenarios should then be devised. The supplier should follow these guidelines as closely as possible. The test should represent the problem areas that may be encountered once the system is installed and running. Staff from the company should be present at the test to answer/ask questions and to hear how the supplier intends to cope with any problems that may arise.

The concept could ultimately be taken a step further. This would be for an independent body to devise a standard dataset and tests for manufacturing packages, similar to those in operation for computer aided design software. This would then, hopefully, ensure a minimum standard for all manufacturing packages on the market. With this sort of test it would be possible to introduce a quantitative element, e.g. the time taken for a regenerative material requirements planning run, using standard data over a standard time period.

The benchmark test was a unique idea when applied to this subject, therefore this was probably the first application of the idea to simulate more accurately the working environment of the company within a supplier's software demonstration.

Important lessons were learnt during this first trial of this technique. Firstly, if supplier co-operation is to be obtained and the length of the test is not to be excessive, the amount of sample data used for the test must be restricted. Information on six part numbers was used for the initial benchmark tests and only one of the final short-listed suppliers was prepared to enter all of the data, the other two only entered part of it. Because the questions asked in the test related to all of the part numbers was vital that all of the original data was present. Therefore, two of the tests were not very conclusive. The other test was, although it took a considerable time to complete the exercise.

With the benefit of this experience the test should have been restricted to include data on not more than a couple of customers and suppliers, and two or three part numbers. The willingness of the supplier to participate in the test will obviously depend on the size of the potential income from the implementation project, coupled with the amount of preparation required for the test.

In conclusion, this kind of test should be used more widely as a tool for comparison and appraisal. The technique would become even more effective if a standard test could be developed by the British Standards Institute or some other authoritative body.

Step 9. Implementation

Having selected the appropriate hardware and software to comply as closely as possible to the specification there are some organisational and technical issues linked with the implementation process to resolve.

Organisational Issues

At this stage the on-going education issues discussed in step 4, should start to encompass the actual hands-on training with the system. This should be given at the company site on the actual system in a test environment by the software supplier. This education in association with the more conceptual education that has gone before, and the company-wide commitment should help to develop responsibility and ownership for the system, data and procedures.

It is important in any organisation to make people accountable for what they do. A well-defined set of guidelines relating to responsibilities and performance assessment will make life easier for both employer and employee. *Fisher (1981)* comments that if a manager knows his paycheque and bonus depend on a successful implementation, you can be sure he/she will devote the necessary time and effort towards achieving it. *Beddick (1983)* stresses that the users of the computer system must look upon it as 'their' system. It follows from first principles that if an individual is given ownership and made responsible for some data, or procedure, and this identity is clearly defined, that the procedure is more likely to be adhered to and the data is more likely to be accurate and up-to date.

Ownership of the system at Tuberex was left in the hands of the teaching company associates, as no full time involvement of company staff was allowed. Therefore staff felt no commitment to the computer system and as a result data became difficult to maintain and informal procedures were difficult to control. Only very late on in the project did staff become more actively involved. A full time system administrator was appointed and staff roles were more clearly defined, however, a lot of time and effort were wasted unnecessarily.

This issue has been included in step 9 of the implementation plan, although in order to achieve this goal there must have been widespread input into the new systems design and good education on the new methodology. At this step the exact responsibilities and measures of performance are clearly documented and assigned.

After an extensive literature survey, no direct reference to the importance of documentation and procedurisation of the interfaces with the computer system was found, and many authors writing on the subject of implementation methods had failed to mention it. However, the dangers of not formalising these processes were amplified and are well understood; data inaccuracy, reverting to informal practises and incorrect operation of the new system. These dangers were well demonstrated at Tuberex, where no procedures were written.

The need for procedures is obvious due to the fact that the advent of the new systems will more than likely have organisational implications in terms of job changes and new working practices (*Maull, Hughes et al. (1991)*, *Udoka & Nazemetz (1990)*, *Kinnie & Staughton (1991)* and *Kochhar (1986)*), and this new structure needs to be captured and recorded, to ensure that it becomes the normal operating mode for the company, now and in the future, despite possible changes of personnel. The new procedures for operating the system should be drawn up as a result of the training on the new systems and knowledge of how the new systems design should operate and it may be necessary to involve the unions in this process. The procedures however should not be 'cast in stone', as they may need to be revised as part of a continual improvement policy.

If the new working practices had been documented at Tuberex it is believed that there would have been a better understanding of the duties and responsibilities of the staff for running the computer system, that fewer mistakes affecting data integrity would have been made, that less support would have been necessary and that people would have had a clearer picture of what the computer could do for the company and how they could contribute.

These organisational issues are sometimes overlooked, as at Tuberex. In a study of UK manufacturing companies by *Monniot, Rhodes, Towill & Waterlow (1992)*, it was identified that barriers to the use of CAPM are organisational rather than technical, for example, lack of skills, past investment, requirements not defined and fixed organisational structure. *Kinnie & Staughton (1991)* in a paper on the human resource aspects of implementation argue from their research that failure to deal with the organisational issues is likely to undermine the success of the change.

Other writers, *Blackstone & Cox (1985)*, *Blasingame & Weeks (1981)* and *Kochhar (1986)* amongst others, back this theory.

Tuberex failed to make the necessary organisational changes for many reasons. Mainly a lack of commitment and education, leading to a reluctance to make the changes, perhaps because they were unable to see the reasons why they needed to.

Many organisational changes may be necessary within a CAPM project, which could be in working procedures, job descriptions, retraining staff for new skills etc.. Management must understand the importance of, and be prepared to make, these changes.

A direct benefit of encouraging ownership and responsibility, documenting procedures and generally tackling the organisational issues, should be good data integrity and accuracy. It is widely understood that any computer system is only as good as the data that is input into it. *Ross (1989)* categorises data into static (Bill of materials, routings, customer files etc.) and dynamic (works orders, stock levels etc.). He states that in order for a computer system to be successful, both types of data must be correctly maintained. He writes that very often it is the static data that gets neglected because proper maintenance procedures have not been implemented. Clearly, failure to update bill of material records in an MRP system could lead to shortages or excessively high stock levels. *Fisher (1981)* talks about the importance of achieving accurate stock figures in an MRP implementation. In a recent survey (*Monniot, Rhodes et al. (1992)*), data accuracy was seen to be the most important issue in CAPM system implementation. The writers considered so far have concentrated on the importance of data accuracy from the point of view of the operation of the system and the fact that the system will give the wrong answers if inaccurate or out of date data is used. There is of course a 'knock on' effect from this, and that is that confidence and commitment towards the computer system will be damaged. Some writers (e.g. *Kneppelt (1981)* and *Blackstone & Cox (1985)*) do not make this point clear. *Blackstone & Cox (1985)*, but state that in order to maintain a high degree of data accuracy, disciplines and procedures must be put in place wherever there are transactions with the computer system. This issue supports the point discussed earlier that there must be ownership and responsibility for all the data in the system.

The experience at Tuberex was, because maintenance of accurate data had not been critical for the manual systems, that there was a reluctance to accept the fact that an increased effort was necessary for the computer system. The computer was perceived as a tool to reduce workload, and not to impose new disciplines. There was a fundamental misconception of what a computer required in order to give benefit and what procedures needed to be put in place. It was clear that a good program of education early on in the project would have avoided some of this problem. It would have been important for the education to have come from an external organisation. On many occasions the importance of data accuracy was made clear, but as teaching company associates our opinion did not carry the necessary weight to change the long-held beliefs of the senior managers.

Beddick (1983) states that many problems will confront the project team, particularly during the implementation phase, and that a dogged determination is required to identify and overcome any and all problems encountered. This point is clearly an issue with any large scale project of this kind, and although the impact of the problem is seen in the implementation stage, the ground work for building up this resilience must be established through a company-wide commitment to making the new system work (steps 1-7).

This dogged resolution was shown by some of the users and the teaching company associates at Tuberex, who believed that the new systems they were recommending would bring benefit to the company. Eventually this is probably what saved the project and allowed the company to realise some of this benefit.

Technical Issues

The question of whether to parallel run systems during a software implementation is one area in which it is believed the practice in industry and the recommendations of experts are completely opposed. Tuberex, and indeed most companies that have been clients recently, are adamant that they must maintain the manual systems for a period before trusting the new systems. Normally the timescale for this is extended; a couple of months at Tuberex. The reason for this safety net is because the company was not fully committed to the new systems design and did not fully understand what effect it would have on the day to day operation. They were not convinced that the system would operate as it should and not throw the company into turmoil, with the effect of losing business.

Many writers have voiced the downside of parallel running. *Kochhar (1986)* describes a case in which a company parallel ran their old and new systems, and the staff became so overloaded with having to maintain both, that the company performance suffered as a direct result. He also gives an example of an implementation that failed because of lack of staff time in a similar situation, the tendency was to maintain the manual systems first and the computer systems if there was time. It seems that the new system usually takes lowest priority, whereas it should take the highest.

Other writers raise concerns over the way in which new systems are being introduced. *Kneppelt (1981)* says that it is the one area of project planning that receives the least amount of effort. *Udoka & Natzmetz (1990)* suggest that the length of the changeover period is a critical success factor. *Hartley (1983)* confirms this in that the probability of success, he claims, is inversely proportional to the length of this period. In another paper, *Udoka & Natzmetz (1990)* report that management must be prepared for disruption at this stage and also for short term losses in performance.

This thesis subscribes to the view that a modular approach is the best solution to the changeover problem. This approach advocates that one area of functionality is implemented completely before proceeding to the next. It is recognised that in some situations more than one module may need to be implemented at once due to an overlap of functionality. Most software packages of any size now come in a modular form, which facilitates this approach. In this way there is no parallel running, so the changeover period is minimised and the new system has not got to compete with the old, for staff time (a particular problem at Tuberex). This approach of course must be preceded by thorough testing of the module with real company data running in a test area on site. There are several advocates for this approach amongst the literature (*Metzger (1984)* and *Frizelle (1991)*).

The sequence in which the modules are introduced can also be critical to success. Indeed *Muscatello & Greene (1990)* give examples of where, as a result of modules being implemented in an inappropriate order, special temporary programs had to be developed to keep other parts of the business operational. *Petty (1989)* at UMIST has developed a general sequence in which module should be introduced in a CAPM environment, but he still believes that it is very much influenced by the attributes of the particular company. Another approach that may be equally valid, and good for commitment, is to tackle those areas that give the greatest payback for the minimum disruption first (*Thomson & Graefe (1989)*).

There are questions to be answered surrounding the modification of the chosen software package. The points about designing new systems with a knowledge of the software marketplace and simplifying the design as far as possible before computerisation, have already been made. However, it is still quite likely that the new company's design will not be matched exactly by any standard software package. This raises the question of modifications.

The views put forward by this thesis are at odds with many writers on this subject. *Hartley (1983)* specifically advocates the action of modifying the software, usually through the supplier, to fit the company. *Maull, Hughes et al. (1991)* suggest that it is acceptable to improve the fit of a package through tailoring. *Martignago (1984)* reports that in many cases no attempt is made to improve the fit by changing the way a company operates. *Monniot, Rhodes et al. (1992)* explain Martinago's observation, because companies are naturally reluctant to change the way in which they work. *Ackoff (1967)* highlights another reason in that a manager who does not fully understand a system or methodology will 'play safe' and want the system to provide as much information as possible, which may involve modification to give him the same information as he had with the old system.

Research by *Monniot, Rhodes et al. (1992)* across companies implementing similar types of systems (roughly the same complexity), shows that they are more likely to be successful where a standard system is used with only very minor modification (8 out of 33). The rest either had bespoke systems written (9 out of 33) or embarked upon major modifications. The success rate amongst these categories was much lower. The experiences of Tuberex demonstrate why this is likely to be the case. The first attempt at computerisation was made with a 'modifiable' system, either by the supplier or in-house. The decision was taken to modify many of the programs quite extensively, before it had even been implemented or used, because it did not match exactly how the old manual system had worked. This work was undertaken in-house and the results were disastrous. The start date for the system was put back by several weeks, due to underestimation of the time it would take for the modifications. When the system did go live, bugs in the software were discovered (because of the rushed development), and it was a full time job to maintain data integrity and make fixes to the software. The result was that confidence in the new system quickly disappeared and the old manual system started to reappear. When the 'Omicron' software was implemented later as a replacement, the standard product was used, and although there were areas where it did not match the way in which the company was used to working, after time, staff changed their working practices and in many cases, found the new way to be better. Also none of the problems of the modifiable approach were encountered. These experiences have been echoed by other writers. *Maull, Hughes et al. (1991)* state that modifications can tie a company into a set way of working, negate support and make future modifications more difficult. *Shore (1984)* talks about the strong temptation to modify and the dangers, including the tendency for software experts to routinely underestimate the costs of projects they undertake with hidden development costs often overlooked, including costs incurred by the user whilst the vendor is modifying, debugging and implementing. *Beddick (1983)* reports of one company that modified their software so much that they were unable to upgrade to new and improved versions.

This thesis maintains that a balanced approach should be taken. If the preceding steps of the implementation structure have been followed the company should have purchased a software package that is a reasonably close fit the new systems design. The company should also be committed to the idea that they must change the way in which they currently work, an attitude which should allow the standard system to be operated from day one, even if there are slight mismatches against the new design. Every attempt should then be made to operate the new system in this way, and only after several weeks' operation should minor modifications be considered, and then only if the systems are affecting the effectiveness of the new systems design. In this way you have given the company the chance to mould itself to the way in which the software operates, rather than jumping into costly modifications, with all the associated risks, without giving the standard system a chance. An added benefit of this approach is highlighted by *Beddick (1983)*, in that the software will normally be a forcing function for state-of-the-art development and operation.

The cornerstone of the implementation methodology is the attainment of commitment towards the new computer system, and any factor that will adversely effect this must have a negative influence. The credibility of the computer system can be affected in several ways, through data inaccuracy, through performance inadequacies or through faults in either the hardware, the software or both. *Kochhar (1986)* writes that a high level of credibility for the computer-based system must be maintained. It would follow that any degradation of its performance will have an adverse effect.

Lack of confidence in the TAS system at Tuberex led to its replacement, even though at the time it was replaced all the problems had been resolved. Its credibility had been affected due to heavy modification in an effort to make its functionality fit that of Tuberex's manual systems, and the fact that the modification introduced bugs into the software. This is certainly an issue when considering software modification. Secondly, the TAS system was new to the market and there were some inherent problems that were discovered when it was operated in a networked environment. There is an issue about being a 'software pioneer' when selecting software. This experience proves that as much uncertainty as possible should be removed to ensure system credibility and in order to encourage confidence.

The benefits of deriving an information technology strategy from a business strategy have been well explored earlier, however, there are other issues which result from a company-wide strategy for computerisation. At Tuberex and at other companies, there is prehaps a temptation to target computerisation at one specific problem area, and then proceed with apparently less problematic areas at a later date, but there are several logical reasons for taking an integrated approach. Firstly, there need only be one systems design and selection exercise. A lot of extra work will probably be created due to the new interactions required between the existing areas and the new computerised area. Improvements in the newly computerised area may be restricted by the old systems operating around it, or if benefits are seen, then inefficiencies in other areas may be exposed. When other areas are computerised there may be many integration issues to consider, especially if the systems run on different hardware and are supplied by different vendors.

At Tuberex the computerisation was targeted at sales and finance due to the heavy workload in those areas. This was very much a containment exercise, although they should have been considering improving their manufacturing systems as well, in order to improve their responsiveness and lower their stock holding costs and so exploit a very lucrative market. At a later date when they wish to expand the computerisation into this area there will undoubtedly be integration problems of the kind mentioned above, and the best option, as a result, may be to remove the existing systems and start again.

Step 10. Success

By following the guidelines detailed here, and particularly by ensuring that the system is being purchased to fulfil part of a total business strategy and that the whole company is involved and committed before launching into the software selection and implementation tasks, the chances of success for any company should be greatly increased.

Step 11. Continuous Improvement

Once the implementation has been completed the real work of running the system begins. The ease in which this can be achieved should logically depend firstly on how well the system was implemented initially and also on continuous improvement. Continuous improvement can be considered at two levels, firstly as a continuous revisiting of the organisational issues that were used in step 9, and secondly as a higher level business strategy realignment, on perhaps a yearly basis. Changes at this level should then be implemented in the same way as the original implementation, although they would probably only involve tailoring the existing systems and procedures, rather than purchasing new software.

The point at which the real work begins is after the implementation is completed as recognised by *Kochhar (1986)* when he states that once an effective system has been put in place, considerable work is required to maintain its effectiveness. *Maull & Hughes et al. (1991)* view this stage as the 'performance ratchet', making incremental improvements to the performance of the company. It should be remembered that the whole point of the implementation is to provide a system that will help fulfil the business strategy of the company, but this will not be achieved on day one of operation and the business strategy may not be the same in a year's time. This point about continual improvement has indeed been missed by some of the earlier writers(*Kneppelt (1981), Hartley (1983)*) and could lead an observer to believe that the implementation ends on day one of operation. The strategy presented here is that continuous improvement can be considered at two levels, firstly as the refinement of procedures towards achieving a more finely tuned system and therefore improved performance, achieved by a continual revisiting of step 9 to ensure that the system is still fulfilling or exceeding its original requirements. Secondly, a change in business strategy may impact upon the computer systems, in which case steps 1 to 10 must be revisited and the existing systems modified or, in extreme cases, replaced.

At Tuberex no program of continuous improvement was planned and the problems were merely tackled as and when they arose. There was no monitoring of the effectiveness of the systems against the original targets.

CHAPTER 5

SUCCESSFUL APPLICATIONS OF THE NEW IMPLEMENTATION METHOD

5.1 Introduction

Following the formulation of the new implementation structure and new issues as described in chapter 2, these have now been adopted by Lucas Engineering & Systems Ltd, as part of the manufacturing systems implementation product. The method has now been used on several occasions and been proven to be successful.

This chapter contains a series of case studies, outlining the objectives of the work, how the method was used and the benefits that were achieved. There is also a summary of the important implementation issues. The nature of the type of project work undertaken by Lucas, means that each project will only cover part of the total implementation method, the reason being that acting in the role of external consultants, we can only act in an advisory capacity and will not necessarily be involved over the whole life of the selection and implementation project. The names of the companies involved have not been disclosed.

5.2 Case 1 - A Strategy Review and Software Selection at a Control Systems Company

A northern based manufacturer of electrical control units for power tools and ventilation equipment needed help in selecting a suitable manufacturing control system.

Due to an increase in demand for the company's products, weaknesses had been exposed in the way the organisation operated. This was particularly noticeable in the purchasing department where there was a great increase in the workload. Tight cost constraints had prevented the company from increasing staff levels. This all resulted in the company failing to meet its business targets.

The company had been using a network of PC's in the accounts department for some time, and so were keen to protect this hardware investment. The main interest therefore was in selecting a PC based package. The company had fortunately secured a government grant to cover the majority of the software purchase cost.

Lucas was called in to help select a software package, but it was very quickly realised that there was no clear manufacturing strategy to help in this process. The company were making the same mistake as at Tuberex, in that they were trying to start at step 8 of the implementation structure, without laying the foundations for success.

Using the implementation method, Lucas studied the current systems and using their knowledge of world's best practice were able to use a gap analysis approach to identify a suitable methodology and the areas in which improvement was required in order to achieve the business targets. It was suggested that an MRP1 system with integrated sales and financial functions should be purchased, which was completely different from the finite scheduling systems the company had been considering, which would not have helped to ease the workload in the purchasing department.

From the results of the gap analysis, training courses were arranged and the company was able to draw up a new design for their systems.

In this case a lengthy software selection exercise was not necessary due to the constraints imposed, with regard to budget, hardware and methodology. There were only one or two systems that satisfied the requirements and Lucas was able to suggest the one that would most closely fit from previous experience.

When the project started, the company was on the verge of buying a system that was totally inappropriate for them, solely on the advice of the software suppliers. There would have been very little commitment for this system, as it did not satisfy their main requirements and the methodologies it used would not have been understood. Fortunately the company has now developed an appropriate manufacturing and computer strategy and has every chance of succeeding in the future.

Summary of Important Issues

An understanding of world's best practice
Review of the current systems
Formulation of a strategy for computerisation
Gap analysis to identify problem areas and important issues for further work
A knowledge of the software marketplace
Realisation that a detailed software selection exercise is not always necessary

5.3 Case 2 - Cell Control Software Implementation at an Aerospace Factory

An aerospace company based in the West Midlands was in the process of redesigning its shop floor into a cellular layout, in line with an overall business strategy. It had chosen the most appropriate methodology to use for its cell level control systems, however the volumes and complexities involved meant that there needed to be some kind of computer support system in each cell. The software selection process was made very easy by the fact that there was only one package that would operate the required methodology on the market. However, the procedures surrounding the new systems needed to be designed and implemented, as well as the software.

The methods for implementation described in steps 9 to 11 were used. The situation was made very much easier by the fact that the people at cell level were very much committed to the new methodologies and had been well trained and were supported by the senior managers.

The first task was to design and procedurise all the interfaces between the cell based system and the outside world. This included manual systems and an existing centralised planning and shop floor data capture system. The procedures for using the documentation from the system were also discussed and documented.

The cell staff were then trained how to use the software and how to operate the procedures to ensure that the system ran properly and that data integrity was maintained. Problems with the software were resolved immediately in order to maintain confidence levels. It was not possible to impose an immediate changeover from the old systems to the new, but the period of parallel running was kept to the absolute minimum.

Finally procedures to enable continuous improvement were put in place, in terms of reducing lead times and stock levels, which involved educating people to accept new measures of performance and putting in feedback loops from the cell level up to higher levels.

The result has been an extremely successful implementation in two cells so far, with many more to follow. In the cells where the system is operating both lead times and stock levels have fallen dramatically.

Summary of Important Issues

Document and procedurise all interfaces to the new computer system
Education and training in the new working methods and new systems
Minimisation of the period of parallel running
Ownership and responsibility for data and procedures
Maintaining the credibility of the new system
Encouraging a policy of continuous improvement

5.4 Case 3 - A Strategy Review at a Parts Distributor

A company in the West Midlands dealing with the storage and distribution of automotive parts on a very large scale, needed its business and computer processes redesigned in the light of the fact that it was now taking on additional work from other sites that were closing down. The implications of this being that each of these sites had their own goods inwards procedures and systems, which had all been transferred to the central location, with the result that the employees were having to operate eight different goods inwards procedures depending upon the type and source of goods.

The project was to redesign the goods inwards procedures to give a single procedure for all goods, controlled by one computer system. Before commencing the project, it was necessary to study much of the literature on world's best practice in goods receiving and distribution.

Several weeks were spent at the site analysing all of the current goods receiving systems and recording transaction volumes and lead times. From the output of this analysis and the operational study, a new design for the goods inwards process was drawn up. The design used knowledge of the world's best practice and was shaped to fit within the functionality of the existing mainframe computer system. It was arrived at only after lengthy consultation with the management at the site and the operators who would have to work the system. A benefit of carrying out the detailed study of the existing practices, was that it highlighted all the areas where the current systems were deficient, and answered a lot of previously unsolved questions in the minds of the senior management.

Before the project had started the idea of replacing the entire computer system had been discussed. However, by using the implementation method and in particular attempting to simplify the processes and only computerise where benefit was to be gained, the company was able to keep its existing hardware and software.

The new system design was presented to the company and they are now in the process of implementation.

Summary of Important Issues

An understanding of world's best practice
A thorough review of the current systems
Simplification of the new systems design as far as possible before computerisation
Computerisation only of the areas in which it will bring benefit
Application of world's best practice to the new design
Changing the company as far as possible to comply with the current computer systems

5.5 Case 4 - A Strategy Review and Design for a Fuel Injector Manufacturer

A fuel injector manufacturer in Gloucestershire was in the process of designing a manufacturing strategy in order to greatly improve its manufacturing performance. Their attentions had been mainly concentrated on looking at rationalising the product mix and redesigning the factory layout. The job was to review their current computerised planning and control systems and suggest an improved design.

The first task was to look at the new manufacturing strategy and study the current operation of the business and the systems that would support it. Because the company had a very old and unsupported stock recording and order processing system, it was obvious that these would need to be replaced. The company was also operating an optimised production technology (OPT) system although very poorly, for many reasons. The system had been badly implemented in that only a small group of managers understood the concepts behind the methodology, whilst the cell managers and operators saw no logic to the schedules they were asked to work to and therefore reverted to expediting, which they understood. Also the measures of performance placed upon cell and module managers were not commensurate with the OPT philosophy. Other problem areas were the fact that there were no procedures in place to ensure that OPT received the feedback of accurate shop floor data which it required, and also the archaic hardware which was being used gave unacceptably long response times. Even if OPT was the correct methodology to use, it had little future in this company, as the workforce had no confidence left in the approach. In addition, there was no integration between the sales, manufacturing and purchasing systems, which meant a lot of manual intervention and terribly out of date and inaccurate data. One of the priorities therefore was for a fully integrated system.

Using the gap analysis technique, the major issues to be tackled were identified in order to achieve the manufacturing strategy, which formed the basis for future project work. The best control systems for the environment were also identified. These were an MRP1 overall control package, driving a mixture of Kanban and period flow control cells, depending upon the volumes and mix of the cell. The cells themselves would also require redefinition due to the low levels of autonomy currently within them.

The new system was designed along these lines and presented to the senior management. It was greeted with a favourable reaction and the conclusions were given more weight by the ability to identify the areas of most concern and give reasons why. This was the first stage of getting the senior management to buy into the ideas.

The company has subsequently adopted the ideas and has started to educate its staff, and is currently involved in the software selection process.

Summary of Important Issues

Formulation of business strategy before beginning the computerisation process
Understanding of world's best practice
A detailed review of the current systems
Gap analysis to identify areas of improvement for future projects
Establishing a 'felt' need for change
Applying knowledge of world's best practice to the design
Ensuring management and user involvement in the design
Attaining company-wide commitment to the new design

5.6 Case 5 - A Strategy Review at a Switch and Solenoid Manufacturer

The company was a switch and solenoid manufacturer in Yorkshire. They had a computerised production management system that had evolved piecemeal over a ten year period. It was felt that the system was an unacceptably high overhead due to its poor integration and the lack of procedures to control it properly.

The project was to look at the current operation of the factory and computer control systems and suggest a manufacturing methodology that might be more suited together with 'quick hits' which could bring immediate improvement to the current systems in the meantime.

The strategic review had to cover both areas of the business, which were completely different in terms of mix, volume and complexity. The review therefore resulted in two different manufacturing and computer strategies being recommended, one for the solenoid business and one for the switch business. However, there were some areas of common ground, particularly in the sales and purchasing areas. The world's best practice and gap analysis had to take this complexity and commonalty into account, in order to present a series of 'quick hit' issues and more long term issues with which to move the whole company towards the suggested methodologies for the future. The recommendations involved a mixture of MRP1 and Kanban systems, but in the short term many issues were identified to improve the integration and performance of the current MRP2 computer system.

Additionally, as part of this project it was necessary to start to associate some costs and benefits involved with implementing the recommendations, so as to help management to develop enthusiasm for the changes and become committed.

The issues that were identified have now formed the basis of projects currently in progress and planned for the future.

Summary of Important Issues

Formulation of a strategy incorporating both sides of the business
Review of the current procedures
Application of world's best practice to give a solution for the whole business
Assessing the implications in terms of costs and benefits

Gap analysis techniques to identify a methodology and problem areas for consideration
Establish a 'felt' need for change

5.7 Case 6. A Detailed Systems Design for a Control Systems Manufacturer

The company was a manufacturer of a very wide range of control systems products with many variants. They had defined a business and manufacturing strategy and been through the initial processes of a review of the current systems, education and identification of the areas to be addressed. They were however in the unusual position of requiring a planning system that was not supplied by the manufacturing software market, although the methodologies that were required were sound. The type of system which was required was a combined order entry and simple planning system, without any higher level MRP type calculations. A project was initiated to produce a detailed design for the new system, which would later be written. The fairly small scale of the project and the simplicity of the design made the timescales involved with the development and testing acceptable.

The important considerations in this project were to ensure that the design combined world's best practice, with management and user inputs. This was crucial if the system was to be accepted and adopted. The new design also had to be sufficiently flexible to cope with any requirements that may arise in the future, as well as satisfying the needs of the manufacturing strategy. In order to achieve this, time was spent getting a thorough understanding of the current operations and how the new systems were required to operate.

After several weeks a new design was generated in close consultation with the company and especially with those people who would be using it.

The design has now been converted into a suite of programs, which are now operating to the satisfaction of all parties.

Summary of Important Issues

Apply a knowledge of world's best practice to the design
Ensure management and user involvement in the design
Have a thorough understanding of the new systems requirements
Design a flexible system to cope with future requirements
Get whole company support for the design

5.8 Summary

The case studies above show that all aspects of the new implementation methodology have been used at least once since the Tuberex project, and are continuing to be used now. Most of the important issues described concentrate on the initial setting of the strategy and the use of gap analysis and world's best practice. This is mainly because these issues, as shown on the implementation structure, must be the starting point for any project of this kind. However, the steps involving design, software selection and implementation, have also been tested.

CHAPTER 6

FUTURE POTENTIAL AND CONCLUSIONS

6.1 Introduction

This thesis has identified the areas in which current literature is deficient or conflicting and also the lack of a practical guide to implementation, which is applicable over a wide range of industry types.

The previous three chapters have firstly drawn on the experiences of Tuberex Ltd in order to rearrange old and new implementation issues into a meaningful implementation structure, and resolve the deficiency in the current literature. The method has then been shown to be sound through its use in a range of different companies and situations.

This final summary examines the future potential of both the specific implementation issues that were raised and the implementation methodology as a whole.

6.2 Future Potential

A lot of new or unclear implementation issues have been identified in this thesis, however there are one or two with scope for further development.

It is believed that a lot of time is wasted on software selection (as was the case at Tuberex). The thesis provides two approaches to reducing this problem. Firstly by eliminating the process altogether, where there is a good, well-supported package that fulfils most of the design requirements, and/or secondly by providing a structured approach to the software demonstration by use of a benchmark test. The test was shown to be of great benefit in the decision making process at Tuberex.

There is a great deal of scope to take this kind of test even further, using a standard set of test data. In this way it would be possible for an independent organisation to compare similar types of software (e.g. MRP), on a more quantitative basis. The results of this might then be published to provide potential buyers with a first pass, which could be used to reduce the number of possible suppliers, in a similar way to the current testing of spreadsheets and databases.

Hopefully some of the issues raised have highlighted the importance of getting expert independent advice, particularly in the design stages. A consultant has been shown to be vital in providing input on world's best practice, assessing a company's needs in terms of the appropriate methodologies, helping with gap analysis and providing a knowledge of the software marketplace, as well as in the more documented role of being the educator. Many companies we see the present view a consultant as an unnecessary luxury to a project of this kind, and attempt the project by themselves. The figures shown earlier confirm that this is a false economy.

The implementation method has been designed specifically as a 'top-down' approach. This is in line with the thinking of most of the literature, which advocates senior management commitment and leadership. However, the most important technique omitted by most observers is the use of gap analysis, whereby problem areas and important issues are identified in the process of moving towards the new design.

In recognition of the importance of this task, Lucas Engineering & Systems Ltd and Bradford University have developed a computer-based knowledge base to assist the consultant. The software asks a series of questions about the current situation in the company, and having already been programmed with a knowledge of world's best practice in the chosen area of interest it can help to identify the important issues. This tool is now being used to support the implementation method.

6.3 Conclusions

The objectives set out at the beginning of this thesis were:

- To provide a practical implementation structure and method
- To identify solutions to problems, and not just identify them
- To clarify and draw together current knowledge and identify new issues

Firstly, the high failure rate for CAPM systems has been researched and confirmed. Also, many areas where current literature conflicts or is somewhat lacking in clarity have been identified. Then a new method to overcome these anomalies and fulfil the objectives has been presented.

A practical implementation methodology has been designed in order to cover the entire process of planning, designing, selecting and implementing the computer system. It is felt that the chances of success for a project of this nature will be increased by following all of these steps. The experiences of Tuberex are likely to be typical of many other companies in the position of launching into computerisation for the first time, in that they tend to overlook the planning and design stages and launch straight into the software selection. The new implementation methodology can guide companies through all these necessary stages and, more importantly, show them the benefits of doing so.

Some important issues were raised, especially in the early steps of the implementation method. These included the idea of formulating a relevant manufacturing and business strategy and then looking at how computers could assist this, not the other way round. The concept of gap analysis to identify the issues that need to be addressed to make the manufacturing strategy a reality and then the appropriate levels of education to understand how to do it. This education should ideally include some exposure to project management techniques. All of this activity is aimed at producing an atmosphere within which the company feels the need for change. The idea being that when a detailed design of the new company is drawn up and approved, people are far more likely to support it and be committed to their part of it.

Having achieved commitment the company can now move forward with the software selection and implementation stages. Firstly, it may be wise to consider whether a detailed software selection exercise is really necessary, especially if the new systems design fits a known, well-tried package very closely, an area where advice from an independent consultancy can save a lot of time. If however a more detailed analysis is required, then the idea of a benchmark test was raised in order to shorten the selection process and more accurately compare products.

The implementation raised a few new issues, firstly, in the area of procedurising and documenting all interfaces with the computer system. Although the importance of data accuracy is stressed by most writers, they do not all stress the importance of procedures in order to achieve this accuracy. It was also suggested that many companies still try to introduce new systems by parallel running them while trying to maintain their old systems. It was recognised that company management may consider a changeover for all parts of the system at once too risky, therefore a compromise solution was suggested whereby modules of software are implemented and introduced one at a time, to cause the minimum of disruption and still avoid duplicating effort during the initial stages. The order in which to implement each module should become clear from the gap analysis work, in that it should highlight the areas where effort is most urgently required.

The main difference between this document and some others on the subject, is that it attempts to provide the structure of a comprehensive method for a CAPM system implementation. The reader should gain sufficient knowledge to steer the project towards a successful conclusion, although there may be other more localised issues overlaid on this methodology. Another characteristic of the work, is that it attempts to give the reader solutions to problems and not simply list them. In some cases this might include seeking outside assistance. Finally an attempt has been made to combine some new issues identified during the work at Tuberex Ltd with some of the more popular theories presented by other writers, where these were observed first hand.

It is felt that the document fulfils its objectives and is therefore perhaps a more useful document than many others in this area. This point has been supported by the subsequent successes that have been achieved at companies where it has been applied, as outlined in the case studies.

Overall, the implementation method and recognition of the new implementation issues have helped a number of projects to be completed successfully, and should continue to do so in the future. The future potential of this work is great, because it will allow others to overcome the problems that have dogged implementation efforts in the past and led to the unacceptably high levels of partial success or even failure.

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