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Ph.D. DISSERTATION

SYSTEMS DISCIPLINE

MANAGERIAL PROBLEM-SOLVING METHODS AND
OUTLINE SPECIFICATION FOR A COMPUTER-BASED
MANAGERIAL JOB-MANAGEMENT SYSTEM

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ABSTRACT

This thesis examines problem-solving theory and practice by managers and proposes a structure for computer-based job and problem management.

Two principal models are advanced. The Problem-centred model reflects existing perceptions of the problem-solver analysing a specific issue but with further definition given of the main model components. The Role-centred model broadens the perspective to reflect the manager dealing with the totality of his current work units (tasks) amongst which problems form a sub-set. Whilst a work unit may not be 'problematic' it is linked with other issues both in terms of competition for resources and the causal relationships engendered by any resulting actions.

The thesis describes a number of designed methods that have emerged in the last few decades including rational sequential approaches as well as self-contained methods which focus on a particular facet. Whilst the varied nature of most managerial problems precludes the adoption of a rigid phased approach, the individual phase components of the former and the specific foci of the latter may be relevant to some amongst the population of problems. Some of the failures in acceptance of the methods by practitioners can be attributed to an assumption that these are comprehensive rather than selectively relevant. Fieldwork provides additional insights into processes adopted in real-world problem-solving, main findings being fragmentation of a problem into sub-problems, the distinction between processes to solve problems and processes to administer the problem-solving process and the network of relationships between different problems.

The desk-top PC is identified as currently the main tool for managers offering the most significant potential in terms of medium for methods design and delivery. The recently-emerging PIMs systems can provide the basis for job management but the functionality requires substantial expansion to include the problem-centred activities resulting in broad categories termed Search, Input, Output, Holding, Data and Relating. Executive Information Systems and Expert Systems provide increasingly relevant support within this overall framework, along with other tools and techniques.

The main implication of the role-centred model is the requirement that problem-solving methods be embedded within a wider, holistic structure which reflects the manager addressing the totality of his current activities which are prioritised but also inter-related. Within this structure many existing methods, tools and techniques can be assimilated on a non-prescriptive basis as they can be viewed as selectively relevant to types of problem or individual activities within problem-solving processes.

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CHAPTER 1

INTRODUCTION; METHODS, PROBLEMS AND DECISIONS

CHAPTER CONTENTS

INTRODUCTION

TO USE OR NOT TO USE METHOD

METHODS APPLICATIONS POST 1950

THE NATURE OF DECISION

THE PROBLEM-SOLVING CONTEXT

REVIEW

INTRODUCTION

The following extract is from the May 1993 edition of the Professional Manager (Professional Manager 1993a).

"Consider a day in the life of Sandy Jones, a manager, in terms of the succession of problems encountered. As you read the problems confronting Sandy consider what your reaction might be.

*Sandy learns from the news that the train services are delayed which will create a problem in getting to work for an 8.30 meeting.

*On arriving at work Sandy has to cover for the absence of a senior colleague who has been taken ill.

*Sandy receives a letter from an aggrieved customer complaining about poor service.

*Sandy's boss discovers all the managers wish to take holidays in August and asks Sandy to come up with some ideas in response to this.

*The telephone bills run up by Sandy's section are twice as high as the same time last year. The Finance manager calls Sandy about it.

Some of Sandy's problems might require an immediate solution. Others might be satisfactorily resolved with investigation. Some may not have any obvious solution. Some, on reflection and investigation, may not be problems at all".

The article contrasts jumping to solutions with a 'reluctance to rush to judgement associated with the desire to acquire more (and more) information' and this is 'associated with a more reflective or

theoretical learning style'. This thesis is concerned with the degree to which method can be used to help managerial problem-solving and how computers can provide the medium by which such methods can be assimilated within a broader system which attempts to capture more of the manager's job.

Having provided a general introduction to the issues arising from the published literature of the last few decades, Chapters 2 and 3 examine the methods in greater detail whilst Chapter 4 considers the potential for using computers as a management decision aid. A basic theoretical framework is proposed in Chapter 5 which is compared in Chapter 6 with the conclusions arising from field-work case studies. The principal strands are brought together in Chapter 7 with the outline of a computer-based system which aims to incorporate current developments with the primary needs emerging from this survey. The final chapter briefly reviews the developments in the light of the possible future trends in the way managers operate.

In some ways the timing of this research is propitious. Whilst the introduction of computers has not been without problems, the 1980s decade, continuing apace into the 1990s, has seen the desk-top computer emerge as the principal tool of the manager. More managers have them than ever before and a greater variety of software is being used. It would be unusual to travel on a train without finding some managers or professionals using lap-top computers to carry out office work.

However, there is no similar steady trend towards the increasing use of method. Whilst there are still numerous references to the use of tools and techniques in both academic and popular managerial literature there is no discernible widespread adoption of rational methods and one might conclude subjectively that the popularity of books such as *In Search of Excellence* (Peters and Waterman 1982) and *The One-Minute Manager* (Blanchard and Johnson 1983) indicates a preference for instant solutions. Harris (1993) refers to the 70's and 80's as 'management by panacea'. He adds:

"Such package programmes seem to proceed through phases of high enthusiasm and much activity followed by a period of disillusionment to be replaced by the next stage panacea."

There is no guarantee that the incorporation of a wide range of methods into a computer-based framework will reverse any such trend but the convenience, flexibility and power of the desk-top computer does make it feasible by addressing the identified shortcomings in earlier use of methods. The massive investment by Industry in Executive Information Systems and Expert Systems (see Chapter 4) suggests that, at least in those areas, we are likely to see widespread exploitation in the coming years.

If we take Sandy's problems as typical we can note a number of features. Firstly, the problems are not what one considers to be major, strategic problems that are often the subject of methods designers' attentions. Yet they may turn out to be complex or fraught and will no doubt keep Sandy preoccupied for some time. Secondly, there are a number of problems and doubtless other ones will surface as the day progresses. Sandy will have to consider how he manages the totality, how he decides which to deal with and in what order and how to keep track of any actions that may emerge from his conclusions. Two broad complementary perspectives can be adopted. In the first the focus is on the manager whose job requires him to deal with a range of problems and issues. In the second, the emphasis is on the individual problem and its associated lifecycle.

Thirdly, there is the possibility that some of the problems may be linked either tenuously or directly. Action to resolve any of them could impact on other problems, thus there is a need to avoid dealing with each problem in isolation. Fourthly, the article throws up key words which will be encountered regularly in the forthcoming chapters, such as 'priorities', 'schedules', 'information', 'group discussion'. Finally, it will be seen that the system outlined in Chapter 7 could constructively contribute to Sandy's ability to investigate, analyse and decide on a range of issues raised by these problems and it is hoped that this becomes clearer as the thesis unfolds.

Were Sandy to turn to the published literature for assistance in resolving his problems he could be faced with a variety of choices. One approach would be to start by considering why he should use method rather than simply rely on experience or intuition.

TO USE OR NOT TO USE METHOD

Experience can clearly play a critical role in problem-solving, providing exposure to previous decisions and their outcomes and knowledge about the functioning of the organisation. Brown (1981) considers that experience is adequate to solve 90% of problems but that in the other 10% it can limit or constrain thinking. Dale (1969) noted that lack of previous exposure to problems can directly contribute to failures:

'Both indecision and mistaken decisions are likely to occur less because of lack of knowledge of the process itself than because of unfamiliarity with the subject matter ...'

Ackoff (1978) comments:

"There may be more technology in an old hand than a new mind"

and Vickers (1965) stresses that each decision is conditioned not only by the concrete situation in which it is taken but also by the sequence of past decisions, the setting of precedents as well as the direct effect on events. Whilst experience is not the only mechanism for identifying this information, direct apprehension clearly has advantages.

Intuition, which might be regarded as antithetical to rational problem-solving, is often linked with experience as Eastman (1970) suggests:

"Intuitive design processes are the procedures that designers have implicitly derived from their own design experience through case studies in school or from professional experience - the antithesis of design methodology".

Kaplan (1973) defines intuition as any logic-in-use which is both pre-conscious and outside any inference schema for which we have readily available instructions. Whether intuition is regarded as a variant on experience or a totally distinct item, both would appear to account for a proportion of problem-solving. Whilst the primary focus of the system design here is to provide access to method, it does not preclude the retention or transmission of experience which can be done via checklists or Expert Systems (Chapter 4) or communication with experts.

Whilst there is no unified view on which problems would benefit from the application of method we can consider the arguments which may be advanced in its favour. Slovic, Fischhoff and Lichtenstein (Howard 1980) suggest that in the final analysis a strong case is made that judgemental biases affect important decisions in the real world and claim several examples to support this view. Dreyfus and Dreyfus (Howard 1980) report that experienced human beings perform better under controlled conditions using their experience than beginners using a formal approach but this is refuted by others, for example Eddy (Howard 1980).

Hogarth (1980) relates the need for rational problem-solving to the limitations of human information-processing capacities and the way in which humans process information. He cites four main consequences:

1. Perception of information is selective rather than comprehensive.

2. The norm of sequential processing of information can create difficulties in adjusting to unstable environments.
3. People do not have 'intuitive calculators' to enable them to make optimal decisions and so rely on heuristics or rules of thumb.
4. People have limited memory capacity.

In the context of information-processing Zmud (1982) summarises the main shortcomings as being:

1. Severe capacity and attention-span limitations.
2. Slow, inconsistent, unreliable and risk-averse processing.
3. Under or over-emphasis on particular information elements.
4. Strategic misrepresentation of issues.

And with specific reference to the CPS method Van Gundy (1988) advances the following potential advantages from using techniques:

1. Reduction in problem uncertainty
2. Increase in the number of available solution alternatives
3. Increase in competitive advantage
4. Decrease in the number of solution revisions
5. More efficient utilisation of individual abilities

The question of the need for method can be extended to encompass whether problem-solving and decision-making represent processes of art or science with the implication that the greater the scientific component, the more scope there is for adopting method. Those like Ackoff (1978) who incline towards the creative requirement in problem-solving raise doubts about the value of a disciplined approach. He comments:

"The more philosophy and science I try to bring to bear on problem-solving the more I come to realise that even together they can assure us of no more than adequate solutions to problems. They cannot provide exciting solutions, ones that we call 'beautiful'".

Kaplan's (1973) pragmatic approach considers that insights from many disciplines can be brought to bear on problem-solving:

"The domain of truth has no fixed boundaries within it. In the one world of ideas there are no barriers to trade or travel. Each discipline may take from others techniques, concepts, laws, data, models and theories - in short whatever it finds useful in its own inquiries".

Whilst Ackoff tends to emphasise the creative dimension to problem-solving Waddington (1977) stresses a more mundane dimension:

"The scientific method, for all the philosophical sophistication you like to put into it, involves about as much sheer bloody footslogging as sculpture with a chisel against marble".

Logcher (1970) sees only limited scope for creativity stating:

"Design consists of a series of decisions, usually a choice between alternatives, each restricted by the circumstances of the problem. The designer is creative only in the sense that he has a choice at each of these decision points, that he can exercise some ingenuity within the constraints and that to this extent, the final product reflects his individual preferences and imagination".

Those arguing for a rigorous and constrained approach often emphasise quantification and measurement. Stake (1972a), for example, suggests that measurements are ...

"... vital to this world, not because they tell us what is truth but because they keep the other sides of truth alive".

Furthermore he sees measurement as helping to counter the onrush of 'the Great Simplification' with only observations standing in the way. Thus measurements can become 'new seeds of doubt'. The importance of measurement as perceived by managers receives support from the priority given to the development of Management Information Systems and Executive Information Systems discussed in

detail in Chapter 4. However Stake (1972b) is equally conscious of the practical shortcomings of measurements, noting that they are 'praised often by my colleagues, seldom by my clients'. He adds:

"I do not see people becoming more rational even when their measurements are better. I do not see people increasingly in control of their destinies. Just the opposite. I see them more isolated from control".

Thus there are logical reasons why the use of method might sensibly be considered for at least some problems, essentially those where experience is insufficient or less relevant but we can also note a divergence between theory and practice that often emerges as a significant factor when assessing the performance of methods. We can consider how successful the application of methods in general has been in the managerial environment by briefly reviewing developments in the post-war period.

METHODS APPLICATIONS POST 1950

During the 1950s and 1960s many commentators saw scientific and rational methods and processes, coupled with increasing quantification and measurement, as having the potential to make a great and direct impact on many aspects of business operations. Kaufman (1968) suggested that...

"... the businessman will be obliged to acquire the basic principles of a new science which has been created for him - 'Praxeology'. They will learn how to construct praxeograms or mathematical models of action ... then perhaps this disturbing world will be more easily controlled".

Even the otherwise pragmatic and experience-based Drucker (1955) overestimated the potential role of new methods of quantification:

"It is not too fanciful to expect that within ten or twenty years these new tools of logical and mathematical analysis will have superseded the traditional financial accounting methods with which we are so familiar today".

Gore and Silander, writing in 1959, are quoted by Hodgkinson (1978):

"One has the impression that there are those who look toward the time when numerical values, representing estimated outcomes, may be substituted for verbal symbols in a formula representing organizational goals, which would then be solved for a decision".

Typical of the line of reasoning which can lead to similar conclusions is that advanced by Hodgkinson (1978). Firstly he proposes that 'decision-making is a process whereby one arrives at a choice'. At the point of choice there are at least two alternatives - taken further, "... finally there must be not more than two alternatives. This must be so because it is logically impossible to choose between more than two things". "Complex decision situations can thus be analysed in terms of an iterative binary comparison procedure which progressively narrows the field of choice".

Nevertheless Hodgkinson concludes that "... the special body of knowledge dealing with decision-making reveals that the process itself cannot be rigorously scientific".

Others have warned of the dangers of over-simplifying the issue from John Stuart Mill (Kaplan 1973) who stated:

"Invention, though it can be cultivated, cannot be reduced to rule"

to Fleisher (1970) who announced:

"The attempt at a general problem-solver is an exercise in Utopian optimism".

The experience of these earlier attempts to make problem-solving more rational and measurable led to mixed reactions but with the balance being unfavourable. Broadening the issue, John Cox (1983) wrote:

"After years of talking, theorising and posturing since Hawthorne, behaviourists have brought forth little of sufficient practical value to be regarded as worthy of general use".

Referring to the use of tools and techniques, Argenti (1976) alluded to the publication in 1966 of the 'Three Star Guide to Management Techniques'. It proved to be so popular that 25,000 reprints were requested. Contrasting this with the position in 1976, Argenti states:

"And now? Boredom, cynicism, scepticism - contempt even. There is little enthusiasm for any techniques today, not even the three stars ... The souffle has slumped".

A number of reasons can be identified as potential causes for the relative failure of the early designed methods, often grouped under the generic heading of Decision Theory. The following comments,

however, represent a variety of causes attributed to a variety of methods, not a single set of causes that apply to all methods.

Pounds (1969) identified a number of reasons why the newer methods have experienced such difficulties in ousting traditional intuitive approaches. First he notes that many managers find the language of the new techniques foreign. Second he suggests that the new techniques often involve a greater degree of generalisation and there remain honest questions of model validity. Finally, the current processes of problem-solving keep managers too busy to find out about and experiment with new methods.

Kaplan (1973) quoted R.A.Fisher:

"Any brilliant achievement on which attention is temporarily focussed, may give a prestige to the method employed, or to some part of it, even in applications to which it has no special appropriateness".

Kaplan then introduces his own Law of the Instrument:

"Give a small boy a hammer and he will find that everything he encounters needs pounding".

Argenti (1976) offered the view that managers were quite right not to use some of the techniques which were 'disgracefully oversold' and also identifies a prime cause as being relevance. Fenwick and Doyle (1976) in discussing the applications of Decision Theory to Marketing, suggest that 'textbook applications' have concentrated on a restricted problem set which is not representative of Marketing problems taken as a whole.

Brown (1970) drew some conclusions on the theme of 'Do managers find Decision Theory useful?' A variety of responses and conclusions are offered much of which has to do with the method of implementation and commitment. Decision Theory Analysis with its emphasis on quantification of values suggests some of the difficulties attendant on any system which depends on putting numbers on what may hitherto have been subjective assessments. Referring to the use of probability factors he quotes Dr. Meal of the consultants Arthur D. Little:

"Very few executives think of themselves as gamblers ... They want to think of themselves as individuals whose greater grasp of the available information and whose greater insight remove the uncertainty from the situation".

Decision Theory may be seen as costly, as leading to potential delay in decision-making and as usually unpopular because it requires executives to change from their traditional methods of thinking. Those in favour saw it as helping to communicate decision-making rationales.

Kaye (1975) also noted shortcomings in the application of Decision Theory with specific reference to the Planning, Programming and Budgeting System (PPBS). This, Kaye suggested, implicitly assumed a system in which the objectives of all parties are consistent and the review process becomes a sequential filtering of the original proposal. The author then quotes a 'US authority':

"This model may actually describe some governments but it does not describe the relations between the agencies and review authorities in the US Federal Government".

Kaye sees Decision Theory as assuming a monolithic decision-maker or at least a decision-making machinery with well-defined connections. In practice the machinery holds many surprises even for those supposedly familiar with it. The conclusion is that the goal of decision-theory should not be to provide all-embracing and irrefutable conclusions to all-powerful decision-makers but should provide a more or less standard model within which impending decisions can be considered in a consistent manner at whatever level they are being considered.

As shortcomings in the application of rational methods became evident analysts proposed new models which sought to explain managerial behaviour more satisfactorily. Simon (1969) identified the limited access decision-makers have to relevant data and the fact that they tend to consider a small number of options with the process terminating when a 'satisficing' solution has been obtained. The limitation was described as 'bounded rationality' and optimisation was replaced by acceptability. However, Gahmberg (1982) considered Simon's rejection of non-measurable variables such as the ethical and value elements as limiting and indicated that Simon was concerned only with the administrative element of routine, structured decisions. Lindblom (1959) had earlier referred to the decision-making process as 'muddling through' and one which is characterised by an extended sequence of small steps. In an extreme case Cohen (Heller, Drenth and Koopman 1982) proposed his 'garbage can' model where the elements of problem, process, participant and opportunities "are mixed together more or less arbitrarily in the garbage can, giving rise to utterly unpredictable combinations. There is no a priori time sequence. Solutions can come before problems, or problems and solutions can wait for a suitable opportunity for a decision".

Yet, the complexity of many problem-solving situations should not imply a chaotic process. Gabor (1976) comments:

"Indeed far from being irrational, the administrative decision-maker actually may be more rational than the classical one because he includes (explicitly or implicitly) a wider range of factors principally social and psychological ones, which the classical model ignores".

Hogarth (1980) identified three shortcomings in the application of decision-making aids. First, it is impossible to eliminate the need for judgement, for any problem-solver still requires 'decisions concerning design, choice of variables, mode of use etc.' Second, most methods have proved incapable of encapsulating the 'essence' of the problem. Finally the systems have great difficulty in accommodating the 'contextual' considerations associated with situations where people are involved.

Schon (1983) has described the reaction that set in after the euphoria in the professions in the sixties. Whilst the professions are not defined, one can take these to be engineers, architects, planners etc. Ackoff (1979) also identifies them as culprits, suggesting that the decline in Operational Research was largely caused by the obsession in professional societies with techniques combined with an unawareness of or indifference to the changing demands being made of managers. The practitioners did not take problematic situations as they came but sought, selected and distorted them so that favoured techniques could be applied. Ackoff contrasts the analytical mode of thought which prevailed up to the post-war era with the systemic thinking which emerged subsequently where the principal elements are:

The object is conceptualised as part of a larger whole.

One needs to understand the larger containing system

The system to be understood is explained in terms of 'role' or 'function' within the containing system.

Thus the initial promotion of decision-making methods with its emphasis on quantification and modelling left practitioners cold or actively hostile and this may not have helped subsequent attempts to introduce new methods. Yet it would be quite untrue to suggest that methods, techniques and tools, are not currently in evidence and three principal strands can be identified which contribute to this. Amongst the methods reviewed in Chapter 2 are those which identified shortcomings in the early quantified methods and which consequently adopted a more flexible and less rigorous approach. The

development from hard to soft systems (see Checkland method) and COPE are both examples of such progress. Secondly, the training of practitioners with associated documentation, driven from within organisations, has continued to recommend the use of method whether on a large scale like Work Study or Project Management or within the looser framework of quasi-cultural programmes such as TQM. These are covered in both Chapters 2 and 3. Finally, in Chapter 4, we can see the emergence of tools and techniques within the computing environment and specifically associated with Executive Information Systems and Expert Systems. Both from within and outside industry there is a readiness to consider rational methods, tools and techniques, as valid ways of improving managerial effectiveness.

From this has emerged a more sober but arguably more realistic assessment of the potential role of method. Despite his over-enthusiasm for the scope for quantification Drucker (1955) sees a role for methods to help deal with aspects of problem-solution but not the totality. In particular he considered that they can help problem analysis and the development of alternatives through the identification of underlying patterns. In contrast they cannot define the problem, identify the appropriate questions to ask, set objectives, aid the decision process or make the decision making effective, "yet these are the most important phases in decision-making".

Kaplan (1973) suggests that asking for a systematic procedure which "guarantees the making of discoveries is surely expecting too much". He concludes that the role of the methodologist should not be the baseball commissioner writing the rules, not the umpire disciplining the player:

"He is at best only a coach and the merit of his recommendations rests entirely on what the play of the game shows to be effective".

THE NATURE OF DECISION

Having identified the considerable difficulties encountered by methods designers in gaining acceptance for their products it would seem appropriate to take a closer look at what people mean when they refer to problem-solving and decision-making.

An initial problem is how to identify how managers make decisions. A number of commentators suggest that the lens through which the researcher attempts to view practical decision-making is opaque. Dill (1964) comments:

"Most executive decisions produce no direct evidence of themselves and ... knowledge of them can only be derived from the cumulation of indirect evidence".

However, Dill considers that managers do carry away with them clear impressions of what has been decided and can work within the organisations to carry out the decisions. Porter, Loyd and Fleisher (1970) report similar difficulties in trying to identify thinking processes within the design cycle:

"It is usually difficult to find examples of the design process. What usually surfaces are the bits and pieces that remain of the problem after it has been reduced to a size that can be grasped by a person or manipulated on a drafting table. Order, when it is made, almost always comes ad or post hoc".

Hodgkinson (1978) quotes J.F.Kennedy:

"The essence of ultimate decision remains impenetrable to the observer ... often indeed to the decider himself ... There will always be the dark and tangled stretches of the decision-making process - mysterious even to those most closely involved".

Possibly linked with these difficulties are the criticisms advanced by some commentators on the quality of analysis of managerial activity. For example Campbell, Dunnette, Lawler and Weick (1970) observed:

"Much of the business and psychological literature on the topic of managerial effectiveness is based on little more than personal experiences or opinions about 'traits' possessed by good managers, what they must do to be effective, or what the products of their effective behaviour may be ... Most are being undertaken without benefit of research-based evidence defining the nature ... of managerial effectiveness".

Even recently, Fondas and Stewart (1990) noted the 'atheoretical' nature of research on managerial jobs. Confusion can be caused by the varied references to the two terms 'problem-solving' and 'decision-making'. Lang, Dittrick and White (1978) categorise writers on these topics into three groupings. In the first case it is problem-solving which is seen as the broad process with decision-making as a distinct phase within it. In the second group problem-solving is seen as an element in the overall decision-process. The final group take problem-solving and decision-making as being synonymous.

If we initially consider problem-solving, a significant concern is what makes issues 'problematic'. Archer (1970) suggests that when action appropriate to the correction of a particular unsatisfactory

condition is not apparent, a problem exists. Brown (1981) sees difficulty in getting to a goal as the critical factor whereas De Bono (1980) suggests:

"A problem is something you want to do but cannot".

Other candidates for 'problem' constituents are:

Size (big v small problems)

Consequences (especially of failure)

'People' involvement (cf. Richman 1987)

Complexity

Some distinguish 'puzzles' and 'problems', for example Revans (1982) sees puzzles as within the field of experts who can be given algorithms to solve them. The 'problem' he views as within the domain of leadership and unlike the puzzle it is charged with unanswerable questions as well as unformulated ones. Ackoff (1979) also notes a difference between the more complex and the more straightforward issues but, for him, managers deal with complex groups of problems. They are not confronted with problems that are independent of each other but with dynamic situations that consist of complex systems of changing problems that interact with each which he calls 'messes'. Ackoff defines problems as "abstractions extracted from messes by analysis."

Turning to the expression 'decision-making' Churchman (1971) comments that it was a 'phenomenon far more mysterious than the phenomena of matter, or of life, or of space' and Dale (1969) sees the psychology of decision-making as encompassing the whole philosophical problem of free-will versus determinism. Young (1968) reports that decision-making is complex and multi-dimensional, with little consensus among the various disciplines. Each discipline approaches decision-making differently in its purpose, processes, nature and analysis. Hogarth (1980) takes the broader perspective referring to judgement and choice as being 'pervasive activities ... an inevitable aspect of living'.

An historical perspective is advanced by Stainton (1982) who quotes Shackle as saying that a decision is 'a cut between past and future, an introduction of an essentially new strand into the emerging pattern of history'. More pragmatically, Rosenhead (1989) considers a decision to be 'a commitment of resources which transforms some aspect of the decision-maker's environment'. Howard (1980) succinctly suggests that decision-making is what you do 'when you don't know what to do' but Elbing (1970) sees selection amongst alternatives as the key concept in the term decision-making which coincides with Taylor (Elbing 1970) who states:

"Decision-making is that thinking which results in the choice among alternative courses of action".

Ofstad (Elbing 1970) also reflects this emphasis when commenting that to make a decision is to make a judgement regarding what one ought to do in a certain situation after having deliberated on some alternative courses of action. However Simon (Elbing 1970) expands the definition (see Lang, Dittrick and White 1978. comment above):

"In treating decision-making as synonymous with managing I shall be referring not merely to the final act of choice among alternatives but rather to the whole process of decisions".

Ackoff (1978) attempts to clarify the distinction when he suggests that not every choice situation is a problem situation but every problem involves a choice. A problem arises when the decision-maker has some doubt about the relative effectiveness of the alternative courses of action and the solution process is directed at dispelling doubt. He develops the theme later in the same paper:

"Solving a problem consists of finding a set of values of the controlled variables that, under the environmental conditions defined by the values of the uncontrolled variables and the relative constraints, produce a satisfactory level of performance".

Analysts may also echo the important distinction between conceptual and practical decision-making. Vickers (1965) contrasts the theoretical and practical approaches when observing that:

"Academic minds argue to a conclusion, business minds to a decision".

Patterson (undated) defines a problem as 'a question proposed for solution' and a decision as a 'final judgement'. This reflects Lang, Dittrick and White's (1978) first category and is the view represented in this thesis whereby problem-solving refers to the process of finding the solution to the proposed question. Decision becomes the exercise of choice - a determination to take a specific action or inaction. This can be more fully explored in Chapter 3 where 'decision-making' is presented in many staged methods as a step in the sequence of problem-solving activities.

THE PROBLEM-SOLVING CONTEXT

Arguably, one of the most critical features in practical problem-solving and decision-making is the existence of 'context'. With Sandy's set of problems at the beginning of the chapter the context is largely invisible yet Sandy will be aware of many of the factors which will have a bearing on how his

organisation conditions or constrains decisions. Some may be documented in plans and procedures whilst others are assimilated experientially.

Vickers (1965) stresses the need to accommodate contextual issues:

"The individual decider can no more be studied in isolation than the individual decision. The mental activity and the social process are indissoluble".

Thus when researchers consider what appears to be happening in practical decision-making a highly complex picture emerges reflecting this myriad of contextual issues which in turn presents great difficulties in reconciling them with the 'rational' methods referred to in the following chapters.

Schon (1971) quotes Tolstoy's War and Peace:

"The activity of a commander-in-chief does not at all resemble the activity we imagine to ourselves when we sit at ease in our study examining some campaign on the map ... At every moment of this continuous, uninterrupted shaping of events the commander-in-chief is in the midst of a most complex play of intrigues, worries, contingencies, authorities, projects, counsels, threats and deceptions, and is continually obliged to reply to innumerable questions addressed to him, which constantly conflict with one another".

McCall and Kaplan (1985) comment:

"Managerial decision-making is rarely a matter of picking up a single problem and disposing of it in an expeditious step-by-step fashion. With every problem comes a context, which includes its own history and the host of related and unrelated problems that co-exist with it".

Vickers (1965), in rejecting Simon's 'satisficing' thesis, emphasises the regulating role of policy-makers rather than as pursuers of objectives. In particular he stresses the importance of the underlying appreciative system in determining perceptions and values and he rejects 'weighing' (an energy concept) in favour of 'matching' (an information concept). Reciprocity is also critical with the setting of the appreciative system changed by every exercise of judgement. The uniqueness of decision-situations is emphasised and characterised by a vast array of facts:

"An appreciative system is necessarily selective, its distrust of experiment performed solely with hypotheses and hypothetical situations on the mind's machinery is well founded and its preference for

the less radical. rather than the more radical, is based on a true judgement of the cost of unlearning and relearning. however necessary".

Vickers' emphasis on the adaptive and dynamic elements of decision situations receives support from other field-work and case- studies. Pinfield (1986) noted:

"... organisational goals and ideology, participants in decisions and competing choice opportunities all changed over the evolution of the decision process studied".

The decision process can be speeded up or delayed partly by the participants and partly by external issues. Hickson et al (1986) in the extensive 'Bradford studies' noted:

"... numerous impediments crop up in the path of the decision- making processes, most often delays either due to problems which impel a re-examination of the situation or due to opposition".

Mintzberg (1991) also identified the non-linear path and states:

"... strategic decision-processes are stopped by interruptions, delayed and speeded up by timing factors and forced repeatedly to branch and cycle".

The Bradford studies constitute one of the very few extensive research programmes into practical decision-making and the conclusions are pertinent. In contrast to Lindblom's 'muddling through' and Cohen's quasi-anarchic view of management decision- making, Hickson et al. find that most decisions arise from 'deliberate management strategies' although they note that while most are positive, a minority are negative involving refraining from or undoing something. There were major differences in timescale with decisions taking from a month to four years. Following on from an assessment that all decision-making is incremental the writers discern three main types of movement; 'vortex sporadic' where problem complexity combines with a vortex of political interests, 'tractable fluid' decisions which are smoothly paced and formally channelled and 'familiar constricted' where familiarity brings an established process pattern into play.

Whilst the organisation can influence the framework of rules for decision-making Hickson et al. note that all three types of process occur in every kind of organisation studied and that all three can occur in any one organisation. Variation is common with 'decisions on different topics in any one organisation following different processes' but the opposite also applying with 'decisions on the same

sort of topic in different organisations' often following the same type of process. Nevertheless, anarchic models are firmly rejected:

"... whilst the image of rollicking in a dented dustbin is fun, the wide differences in decision-making belie it as a general model".

They conclude:

"The decision-making game is played by groups, or by individuals backed by groups, who act deliberately, even though what they do does not necessarily have the result they hoped for".

Pinfield (1986) observes that both structured and anarchic models are useful but limited and without attempting any reconciliation, he does suggest that such an attempt would be useful in future research:

"A synthesis of both perspectives could be used to link changes in participation and relevant external events to decision control routines that switch decision processes from one phase to another".

The existence and relevance of context also impinges on another of the central themes in problem-solving - whether to reduce and select the focus or whether to expand and adopt an holistic approach. The reductionist approach is typified by Davis and Kennedy (1970) who suggested that one should determine which parts of the problem have the most far-reaching implications within the problem structure and then concentrate on these. Rockart (1979) introduced the concept of Critical Success Factors (CSFs) defining them as:

"... the limited number of areas in which results, if they are satisfactory, will insure successful competitive performance for the organisation. They are the few areas where 'things must go right' for the business to flourish".

Leidecker and Bruno (1984) develop this concept and Executive Information Systems, discussed in Chapter 4, claim their theoretical lineage from this approach. A similar notion is advanced by Kepner and Tregoe (1980) who, in the context of strategic appraisal, argue for the existence of the Driving Force:

"... the primary determinant of an organisation's Product and Market scope. Identifying and determining the Driving Force is key to setting the organisation's strategy, and it is also key to strategically managing the major product and market choices that come before the organisation".

Yet the attempt to reduce complexity by 'focussing on essentials' is not without risk. Maver (1970) sees dangers in any process that selects certain elements from the totality:

"To simplify problems, to exclude certain variables or make limiting assumptions reduces and often impoverishes the range of solutions possible".

Ackoff (1979) reports a similar complication in that optimising model solution is not the same as problem optimisation unless the model represents the problem perfectly.

REVIEW

We commenced this chapter with a reference to Sandy and his potential problems. However uncomplicated they might at first appear any notion that the available literature would provide instant, succinct and relevant panaceas is soon dispelled. This literature is characterised by variety but lack of consensus underlying the enormous diversity that exists when one considers the broad headings of 'problem-solving' and 'decision-making'. Hart (1992) identifies three themes in management literature. The first is that of 'rationality' and Hart comments:

"Literature makes it clear that behavioural issues, e.g. bounded rationality, satisficing, political behaviour, will limit the achievable level of rationality".

The second is the symbolic role of top managers, the requirement to articulate and motivate, an area that has great relevance to decision-making and gaining acceptance but is considered beyond the scope of this thesis. Thirdly, analysis of implementation problems suggests that the extent and type of involvement of managers is critical. The implications of context have a close bearing on implementation and we return to the topic in Chapter 3.

Whilst the earlier rational and quantitative methods failed to achieve the penetration that was forecast by their designers, the arguments in support of the need for methods have not been rebutted and other methods have appeared of which a selection are reviewed in the next Chapter. Furthermore methods such as Work Study have continued in use within industry and commerce throughout this period and rational methods of the type discussed in Chapter 3 are still recommended in intra-company training schemes. Thus method should not be regarded as an imposed discipline from outside the world of business but as a feature which has its adherents in both camps.

The widely differing views as to what constitute problems and decisions must be in part attributable to individual perceptions. Just as managers adopt personal and individual views on problems which make achieving unanimity difficult, so also do analysts in terms of their focus. Eden (1979) quotes Epictetus:

"Men are disturbed not by things, but by the views they take of them".

The diversity of opinion is significant enough even when problems are taken in their simplest form. The process of real-world problem-solving as discussed earlier, the dynamic nature of development and the interplay of problems, decisions, causes and actions increases the level of complexity several-fold. If Sandy is to receive genuine assistance he will need a system with the flexibility and variety to cope with this complexity yet still add value to what Sandy could already achieve by employing experience and intuition. In the next two chapters we attempt to gain a deeper insight into what facilities are offered by modern methods and which individual activities appear to be pertinent to the process of problem-solving.

CHAPTER 2**SOME METHODS FOR PROBLEM-SOLVING**CHAPTER CONTENTSINTRODUCTIONKEPNER-TREGOECOPE/GCPRIORITY DECISION SYSTEMNIPPERCHECKLAND METHODVENTURE ANALYSISWORK MEASUREMENT AND ANALYSISTOTAL QUALITY MANAGEMENTREVIEWINTRODUCTION

The selection of methods reviewed in this chapter is not intended to be exhaustive but rather illustrative of the variety that exists. Some are widely recognised in the business community, others will be unknown to most managers. Some have general applicability whilst some have only been used within a single firm. Some are conceptually very broad and wide-ranging, others are specific in their applications focus.

Methods developed within or having primary relevance to specific professions are not included although these are extensive and often have greater relevance where the area is narrowly defined. Duffey and Torrey (1970) comment:

"Many interested in design methodology are happy to ignore the fact that typologies of solutions exist".

Thus architects, town planners and accountants will have available their own range of techniques and methods. In the field of design Logcher (1970) reports on the distinction between 'Black box', prescriptive methods and looser assemblages of tools whereas Moran (1970) offers a range of concepts which, although originated within the design environment, has potential applicability to a limited subset of managerial problems. Forecasting, and particularly Technological forecasting, has spawned a number of complex and sophisticated methods such as Delphi which although criticised by Sackman

(1975) has continued to be widely used, (see Young and Linstone, 1982; Garde and Patel, 1985 and Yong et al., 1989). For the development of product-line strategy Wind and Claycamp (1976) introduce a phased method. Hamilton (1977) suggests a five-step approach to curriculum design, Humphrey (1986) describes his TAM system for Business Planning, McPherson (undated) proposes five main and twenty-two subsidiary phases for Marketing innovation and Robertson (1987) identifies 16 phases in a Market Research survey.

There are in addition some more recent methods such as Hypergame Focus by Bennett, Cropper and Huxham (Rosenhead 1989). Rosenhead also describes Friend's Analysis of Interconnected Decision Areas (AIDA) used in conjunction with his Strategic Choice Approach, subsequently backed by a computer package and with one application reported by Hickling.

KEPNER-TREGOE

BACKGROUND

The Kepner-Tregoe problem-solving method arose primarily within an applications framework but without any apparent theoretical underpinning. However, the method goes beyond a simple statement of the recommended steps for rational problem-solving, incorporating in the book, the Rational Manager (Kepner & Tregoe 1965) a full description of the basis for the approach, how it should be applied and a number of examples of practical applications.

Methodologically, Kepner and Tregoe claim to have started out by researching the available literature before concluding that they had found "... bits and pieces but precious little" that they considered useful. Next they looked at the way organisations functioned but decided that business details did not help in finding a concept that could be used in solving problems. Finally, they took a business problem as the starting point and worked back through the process of solving it, an approach that is mirrored in this research as the Case studies in Chapter 6 indicate.

The main emphasis of the method they derived is on the identification of cause which clearly follows from the methodological route they took. They comment:

"A problem cannot be solved unless its cause is known. A problem is an unwanted effect, something to be corrected or removed. It was brought about by some specific event or combination of events".

and:

"Every problem has only one real cause".

In justifying the use of their method, which applies equally to the application of any method, Tregoe states (Carson 1971):

"In today's rapidly changing environment the executives can't fall back on experience because they don't have it".

Kepner and Tregoe also attempt to relate the use of rational method to those who advocate that creativity is pivotal in problem- solving:

"We are not trying to disregard the creative spark. The figures on the grid have simply recorded his judgement. It helps him keep track of all his judgements; it keeps all factors visible and prevents him losing sight of his objectives".

and:

"Sure there's a lot of art in decision-making. But a big proportion can be taught. Most executives don't know how to deal with and evaluate information on a rational basis. However I don't know anyone who found out how to teach the final 20% that is art".

DESCRIPTION

The problem-solving sequence of activities proposed by Kepner and Tregoe involves the following steps which are also shown diagrammatically in a wheel:

- Recognise problems
- Separate and set priority
- Specify deviation
- Develop causes
- Test for causes
- Cause determined
- Establish objectives
- Classify objectives
- Generate alternative actions
- Compare and choose
- Assess adverse consequences
- Decision made
- Anticipate potential problems
- Set priority
- Anticipate possible causes

Take preventive action
Set contingency actions
Set controls
Implement plan

These activities can be subsumed in four main phases:

Problem analysis
Decision making
Potential problem analysis
Direction and control

The authors comment:

"The sequence runs clockwise systematically around this 'wheel' ... but a manager may enter the sequence at any point ... If he clearly knows the cause of a problem he will start with decision-making steps, or if a decision has been made, he will concentrate on potential problem analysis and direction and control".

The sequence is also expressed in narrative form:

1. Objectives must be established first
2. Classify objectives according to importance
3. Develop alternative actions
4. Evaluate alternatives against established objectives
5. Tentative decision on the alternative best able to achieve all objectives
6. Tentative decision is explored for future possible adverse consequences
7. Effects of final decision are controlled by taking other actions to prevent possible adverse consequences from becoming problems

The method attempts to address implementation by itemising different action options which are available. These are:

1. Interim action. This buys the manager time to find the cause of the problem.
2. Adaptive action. This lets the manager live with the tolerable effects of a problem or with an ineradicable cause.
3. Corrective action. This gets rid of the known cause of a problem.
4. Preventive action. This removes the possible cause of a problem or reduces its probability.
5. Contingency action. This provides stand-by arrangements to offset or minimise the effects of a serious potential problem.

EVALUATION

The Kepner-Tregoe method must match Work Study and Total Quality Management (reviewed below) in terms of being widely recognised by managers and with Work Study has stood the test of time. Twenty years after its first appearance it was still ranked 20th on the league table of the most popular management books according to the Business Information Review (1986).

There is some evidence of applications experience although much is anecdotal. Carson (1971) quotes one practitioner who suggests that the method is used selectively:

"I don't use the formality of Kepner-Tregoe on every decision - I reserve it for the really big ones".

Also quoted is Jim McGregor of Honeywell:

"It's not a gimmick, nor does it make good decisions certain. It just takes you through formal steps and gives you the discipline of writing down all the factors, looking at alternatives and testing your decision. Yet it only works when the atmosphere is right".

However, not all are so enthusiastic, for example E. Williams, Managing Director of Atwood Auerbach Ltd:

"You can go overboard about rational decision-making. It's a trap that computer people fall into. The man who is going to move ahead of the pack in business is the man who can look far ahead, and

usually there is not much information available about the future to enable him to make fully rational decisions".

In one of the few research papers covering attempted applications of the method Von Zugback and Wilson (1989) describe the use of Kepner-Tregoe linked with selection criteria and weightings to help in the selection of IT systems. The conclusion was that the process failed because of the constant need to refer decisions back for authority with consequent delays. Deficiencies were identified on mathematical, organisational, political and procedural issues but an observation from the authors was that part of the problem was a perceived alienation of top management resulting from their exclusion from the process.

The Kepner-Tregoe method can be viewed as widely known in managerial circles and, by implication, influential. Unlike some other methods reviewed below it has survived for nearly three decades which suggests some resilience. It is thoroughly argued although there is little objective research to support the conclusions. Whilst close to the 'rational' methods surveyed in the next chapter, its primary relevance would appear to be when applied to problems where the key is to establish the cause of some known deviation. The cause is derived from the application of a rational series of analytical steps which contrast with COPE, which is reviewed next, where causal relationships are critical but where the emphasis is on the explication of differing views of a problem and the reflection on and modification to these perceptions. Thus differing viewpoints are acknowledged and incorporated. For Kepner and Tregoe there is one single truth with the rational process directed at identifying that truth, whence the decision automatically follows.

Ultimately, judgement on why Kepner-Tregoe has proved to be so durable has to be subjective but critical issues would appear to be that it is:

- Easy to comprehend**
- Clear and logical**
- Simply expressed and communicated**
- Explicitly set within a managerial context**
- Effectively 'marketed'**
- Faced with little effective competition from other methods**

COPE/GC

BACKGROUND

The SODA (Strategic options development and analysis) approach and the related COPE/GC software package emerged from work by Dr. Colin Eden, initially at Bath University and subsequently the Strathclyde Decision Support Unit (Eden, Sims and Jones 1979, Eden and Sims, 1984). In justifying the approach to decision-making in organisations Eden stresses the critical role of inter-subjectivity as the basis for social interaction, commenting:

"The heuristics we use as the basis for becoming wise are richer and reflect a more complex form of non-parametric correlation analysis than we are able to conduct when constrained by the explicit logic and axioms of mathematical statistics".

In the handling of complex issues Eden contrasts the 'information-gathering' route with the 'cognitive help' approach. The latter can be subdivided into 'techniques of thinking' within which Kepner-Tregoe is cited as an example and 'exploring own thinking' which represents Eden's approach. Attempts to represent organisations in rational-analytic or normative terms which are seen as the most common organisational types are rejected as being "essentially boring to anyone interested in organisational life".

"Often it does not seem to him that he is being offered a technique of thinking which is superior to that which he would have used naturally ... rather he feels he is being offered a structure which causes him to be rigid in his definition of the relevance or otherwise of elements of data".

Eden's approach follows the lead of Neisser (1976) but more particularly Kelly (1955) and the applications of Kelly's work by Bannister and Fransella (1971). Kelly's work has had an influence on a number of methods designers such as Boxer (see NIPPER below) and Reynolds and Darden (1974) trace the development of psychographics in Market Research back to him. An important consideration with Eden was that the system should be capable of capturing complexity. Other significant issues were the need to capture 'the peculiarities and idiosyncrasies of the client's world', the requirement to trade-off between generality and particularity and the ability to represent models in a comprehensible form. The role adopted is not that of an expert but rather a 'facilitator' to an individual's or group's realisation as to what they know with the consequential opportunity for exploitation of this knowledge. The aim is consensus rather than compromise and commitment rather than agreement. However, Eden is anxious to avoid the suggestion that decision-makers must use the system, rather:

"We are merely arguing that there are some decision-makers who will find it very helpful to undertake learning from the egoistic knowledge-base of theories-in-use and espoused theories rather than from the base of external theories".

Thus the SODA approach helps individuals to externalise their personal views of the world; to share these and then, following reflection on these shared perceptions, to assimilate any desired changes back into their cognitive maps. The maps reflect Kelly's ideas whereby understanding can be enhanced by using distinctions or 'bipolar constructs' and these can be both interconnected and ordered.

Initially, the maps tended to be networks of 'equivalent' constructs but more recently the emphasis has been on an hierarchial structure where 'tactical options' contribute to the achievement of 'strategic issues' which in turn help satisfy 'goals' (see Martin, 1992).

DESCRIPTION

Martin (1992) suggests four main phases in running a SODA project, as follows:

Phase 1. Preliminary negotiations

Phase 2. Information gathering (includes individual cognitive mapping)

Phase 3. Modelling (merging these into a collective strategic map)

Phase 4. Action selection, allocation and implementation.

The COPE software, as originally conceived, requires input of concepts and their appropriate linkages. A number of routines can then be used to facilitate ordering and analysis. These include LIST which can be used to list constructs or a specified sub-set based on numbering or containing specified text and CONSEQUENCE which facilitates exploration of the consequences of a concept. CONFLICT searches for potential conflict between different paths, alerting the user to inconsistencies and with GROUP related sections are automatically grouped by reference to key concepts specified by the user. The command LIST GROUP HIERARCHY lists the group hierarchial structure for a model, showing each group and the groups which are subordinate to it whereas the LOOP analysis reports the feed-back loops in a model. MAP represents the output in the form of a map and PATH ANALYSIS

addresses links rather than concepts. TRACE examines the way one concept is linked to all other concepts.

Steady development of the software has brought additional facilities and with Version 10.8 (Cope User November 1988) the model could handle up to 1,800 concepts and 4,000 links driven by in excess of 120 commands. A major enhancement came with the graphics version GC which promotes group working and commitment. Martin (1992) comments:

"It allows the screen to act as a viewing window that can be moved at will to inspect any part of a large map, and the mouse and menu-driven command system makes it very easy to edit the map".

Evidence can also be found of practical applications. For example, Eden and Sims (1984) describe the application of COPE to senior managers in a Local Authority housing department, introducing the concept of the 'conscious dream' when looking at the future and contrasting it with a Delphi-type approach. They argue that the use of mapping enables the structure of ideas to be modelled and that the use of a computer, whilst not essential, facilitates one person's ability to consider the ideas of another. The authors note:

"There was a furious rush of all the things they had been wanting to say and hear about the longer term future of housing for years. We had done nothing in particular to make such a conversation happen, nor even consciously to facilitate it happening".

A more recent example is given by Martin (1992) where the application of SODA in conjunction with COPE/GC to Reed Enterprise is described.

EVALUATION

SODA and the related COPE package display a theoretical pedigree backed by applications experience and while overall awareness in the managerial community may still be relatively limited it has already made a more significant impact than other packages like PDS and NIPPER (reviewed below).

Whether in its original form when mapping causation or in its redirected emphasis towards goals and action, COPE provides a capability that does not appear to be replicated elsewhere. Mapping of processes is an integral part of managerial practice and is used in Work Study (see below) and process flow-charting (see Chapter 4). However, mapping processes which are to a degree measurable and observable is very different from developing cognitive patterns of relationships. Buzan (1974) describes more loosely structured 'mind-maps', Sibbet (1981) combines text, diagrams and symbols in his Group Graphics approach and Schnelle (undated) refers to the Metaplan method which like SODA usually involves group participation and requires the use of a shared representation medium.

PRIORITY DECISION SYSTEM

BACKGROUND

The Priority Decision System (PDS) is a PC-based software package developed and marketed by Work Science Associates in conjunction with the Brunel Management Decision Programme. Designed by Jimmy Algie and William Foster, the package became commercially available and was supplemented by seminars and a user group. Version 3.12 was tested as part of this research. Whilst the basis of the programme is mathematical with the rating and comparison of options the central feature, the position taken by its proponents is that it is an aid to thinking rather than an optimising process. The Decision Analysis Unit subsequently transferred to the London School of Economics but current (1994) information is that the unit was disbanded and one must assume the software is no longer available.

DESCRIPTION

The available sources are limited but the PDS manual (1983) describes problem-solving and policy-making as comprising five steps with the PDS functions in brackets:

1. What? (Issues)
2. Which? (Options)
3. Who? (Decision-makers)
4. How important? (Priorities)
5. What to do? (Decisions)

The claim is that PDS has been effectively used for decision-making and policy-evaluation at all levels from Director to rank-and-file and in all functions from line management to personnel and accounting. Examples of applications areas are listed below:

Appraisal
 Bidding
 Career counselling
 Decision analysis
 Interdisciplinary problem-solving
 Lie detection
 Organisational analysis

Research and intelligence management
Scenario writing
Tactics

The PDS approach rests on the assumption that there are three decision-making processes:

Problem-solving
Policy-making
Policy-in-practice

Problem-solving is concerned with options and the framework for the decision-maker whereas policy-making addresses criteria and their weighting. Policy-in-practice combines problem-solving and policy-making and feeds through to individual and team decisions. The PDS manual summarises the main elements:

"Starting is simple. You just state the issue in plain English.

Compare the options for resolving the issue and put your views to PDS direct. With team decisions, others do the same once you have noted who is involved.

PDS then calculates your priorities. It reconciles divergent views in one team decision.

The built-in reliability checks tell you how far you are consistent, how far the team agrees and whether you need to revise your decisions. They illuminate or validate your thinking".

The procedure is for options to be entered and a choice can then be exercised as to whether to assign priority using intuition or judgement. If the latter, a succession of paired-comparisons is used not just in terms of which option is preferred but also how much more priority is appropriate using a 1-9 scale on which 1 is 'equal' and 9 is 'absolute'. Multiple decision-making can be catered for with a facility to ascribe voting power to different decision-makers. Consistency measures, which apply to both individuals and teams, can be reported at three levels; ranking, proportionate and weighting consistencies.

EVALUATION

An application described by Algie and Foster (1985) gives a brief rationale for the system. It claims that research had indicated that 'managerial decisions contradicted priorities, priorities contradict agreed policies, and agreed policies contradict what managers really believe'. The method of ranking was intended to facilitate reflection on the processed results with progress being iterative and with a planned reduction in dissonance. The case reported concerned the use of PDS by NUM officials and

senior management at the time of the miners' strike. Although the resulting solution was not endorsed by NCB and NUM officials, benefit was claimed in the way that PDS:

"... calculated the negotiating position of each party; the consistency of each negotiator; the degree of agreement within each party; the joint priorities of both parties taken together and the degree of agreement/disagreement between the parties".

A particular advantage of the computer-based system was suggested to be the avoidance of face-to-face confrontation and the haphazard exchanges that take place at negotiating tables. Equally, it is possible to become aware of other individuals' rankings and options although personal results remain confidential.

A more coherent paper was produced by Phillips (1982), also as part of the Decision Analysis Unit. Phillips refers to 'requisite decision modelling' which contrasts with the 'optimal' modelling characterised by earlier decision analysts (e.g. Raiffa and Schlaifer, 1961). For him, because perception of the model 'often changes the client's understanding of the problem', decision-making is seen to be labile. Furthermore, stakeholders adopt differing views of the problem and the earlier methods did not adequately cope with anything other than a single decision-maker. However:

"... most of the obstacles disappear if decision theory is seen as providing a framework for the iterative development of a coherent representation of the problem. In this sense, decision theory is conditionally prescriptive in that it polices coherence only within the 'small world' of the problem at hand rather than serving as a normative model for decision-making in general".

And again:

"... requisite decision modelling treats problem-solving as a dynamic process in which all relevant actors become clearer about the problem and develop a deeper understanding of it over time".

PDS can thus be seen to adopt a similar approach to COPE with the software package purporting to enhance reflection both by the user on his own judgements but also on those of others. However, whilst COPE focusses on networks of causality PDS emphasises options and choices, their values and priorities. As such they could be considered complementary, each addressing different facets of problem analysis. Finally, one can note that although it successfully reached the marketplace as a viable product, PDS would not appear to have survived, having had no discernable impact either academically or on management practice.

NIPPER

BACKGROUND

The NIPPER suite of computer programmes was developed as part of a project funded by the London Graduate School of Business Studies and as reported by Boxer (1978, 1979). His summary of the system describes it as:

"... a method of computer-assisted reflective learning capable of being used by managers. The method enables managers to explore the value of their past experience in relation to a particular problem context; to consider how their own experience relates to that of other managers; and finally to create design criteria for strategic options within a problem context capable of commanding a consensus between the managers ... The method represents a new departure in the use of computers for supporting strategic management."

Claiming Kelly's Personal Construct Theory as its heritage, it was described as helping to develop the intuitive, qualitative and judgemental aspects of decision-making. Boxer distinguishes between 'object-referenced' modes typical of the rational-analytic type of decision-making and 'subject-referenced' approaches which relate the problem area to an individual's past experience.

DESCRIPTION

Boxer proposes three phases entitled Reflective Analysis, Consensus Generation and Strategic Design and these, in turn, can be subdivided into six modules:

- Past Reflection
- Option Analysis
- Concept Analogies
- Role Network Analysis
- Exchanging Views
- Consensus grouping

Essentially a problem is perceived as comprising a series of options (Elements) which can be qualitatively rated in terms of a number of different value descriptions (Concepts). Both elements and concepts can be grouped and compared in terms of their relatedness. The process, summarised as 'enabling the individual to reflect on his core structure', concerns the manipulation of these two dimensions with or without the insertion of additional elements and concepts from other parties. Two

examples are quoted by Boxer, the one relating to a choice between cars in terms of their characteristics. the other to a choice of projects.

In the car example Boxer shows how five car types, e.g. Renault 12, are rated in terms of such experiences as 'comfortable' or 'robust'. The ratings appear on a scale from Low to High. Thus the Renault may be High for 'good value' but low for 'tinny'. A number of routines can then be run to check for validity and consistency which are more fully explained in the references.

The arguments suggest that the user makes explicit his value judgements particularly in relation to his own past experience. It enables him to reflect on his conclusions and amend the ratings in such a way as to minimise the gap between the computer-based model and his own intuitive view as to how he perceives the relative values. Exchanging Views and Consensus Grouping enables the user to compare and contrast his own values with those of other users and to incorporate any additional elements or concepts suggested by other viewpoint holders.

EVALUATION

NIPPER, much like PDS, operates on the basis of comparisons of options but offers an additional dimension by allowing these comparisons to reflect different attributes. No longer is 'X' just being compared with 'Y' in absolute terms but 'X' is compared in terms of attribute 'a' or 'b' or 'c'. In this respect it is better able to reflect the complexity of problem situations.

Whilst appearing as a computerised package, NIPPER was not commercially available. Hence there appears to be no documentation on applications and equally, no evidence that the development has survived or created any impact on the arena of methods design. As the approach would seem to offer a relevant facility which is not offered elsewhere, it is to be hoped that something similar might surface in the future although it would have to be 'user-friendly'.

CHECKLAND METHOD

BACKGROUND

The historical development of the Systems movement has been documented elsewhere, for example by Checkland (1981). Two initial strands are apparent. The first is Systems Engineering, typified by Hunt (1954) and Hall (1962), and the second, Systems Analysis, which is associated with the Rand Corporation and exemplified by Quade and Boucher (1968). More recently a distinction has emerged between 'hard' systems approaches which require a clear definition of objectives and the 'soft' systems method of Checkland which aims to cater for situations where objectives are 'fuzzy'. Additionally Checkland distinguishes between 'structured' problems which are amenable to solution by hard systems approaches and 'unstructured' problems where soft systems may provide a more relevant

means of analysis. Naughton (1984) identifies six key issues which distinguish the 'soft' systems approach.

1. Problems do not exist independently of the humans involved.
2. People 'appreciate' situations differently.
3. Solutions are also 'intellectual' constructs.
4. Analysts need to consider the 'whole' problem.
5. Analysts take an interactivist approach.
6. The analyst cannot be divorced from the analysis.

The Checkland approach is important to any analysis of managerial problem-solving methods having the advantages to the researcher of being more comprehensively argued and documented than most other methods and being based on the practice of 'real-world' problems. It is also claimed to be evolutionary, to have emerged over a period of time from a series of applications, implying modification in the light of practical experience. Checkland is at pains to distinguish between his approach which is a methodology - a set of principles of method - and a method or technique.

Although set within the systems tradition, the Checkland method emerged from the shortcomings perceived in the hard approach to the types of problem referred to above arising out of the practical consultancy carried out by ISCOL Ltd. which was owned by the University of Lancaster. Checkland identifies five different types of study with five different aims:

1. Systems design
2. Action to improve an ill-defined situation
3. Historical analysis
4. Survey of an area of concern
5. Clarification of concepts.

DESCRIPTION

The Checkland approach typically comprises 7 phases as follows.

1. The problem situation unstructured

2. The problem situation expressed
3. Root definitions of relevant systems
4. Conceptual models (the following also feed into this)
 - (a) Formal system concept
 - (b) Other systems thinking
5. Comparison of 4 with 2
6. Feasible desirable changes
7. Action to improve problem situation

It should be noted that there are variations in the versions advanced not only by Checkland but also by Wilson (1984). For example, 'Appraisal' may appear as an additional item at the end and stage 6 may be termed 'debate'. The first four steps encapsulate the differences in the systems and specifically soft systems approach and involve essentially a comparison between an analysis of the current situation and the conceptual model or models that follow on from the root definitions. Hence there is a stated emphasis on comprehending and improving problem situations rather than solving problems.

Checkland's analysis phase is described as being an attempt to "build up the richest possible picture ... of the situation in which there is perceived to be a problem". Checkland's stages 3 and 4 are concerned with an examination of one or more Desired States. First the Root Definition "captures a particular view" via selection amongst several possible root definitions evaluated on the basis of their potential usefulness. Next conceptualisation "is an account of the activities which the system must do in order to be the system named in the definition."

Whilst the Root Definition is not presented as an objective, the examples quoted often suggest similarities. Examples given by first Checkland (1981) and second Wilson (1984) are:

"An institution encouraging and helping community action aimed at development of the community's own resources".

"A Forest Group-owned system for the continuously effective and efficient conversion of raw materials into a range of paper products to meet customer demand while achieving the Group expectations for performance but within Group and environmental constraints".

However, the Root Definition identifies a system rather than an indicator and is an option to generate discussion in contrast to a set goal.

Stage 5, the comparison, is then carried out between the resulting Cognitive and Desired Systems or as Checkland suggests "... parts of the model situation ... are examined alongside the conceptual models". The purpose of this comparison is to 'generate debate' from which a selection emerges. Action then takes place which entails movement towards a conclusion. In addition an 'appraisal' phase may follow which entails a potential re-iteration of the cycle.

As a set of 'principles of method' the Checkland approach has little difficulty in assimilating specific techniques and tools and the case studies reveal just how extensive these are. The following examples are quoted by Wilson:

1. Work Study, (reviewed later in this chapter), is used in the Lastric case with Wilson describing how charting was used to help design a clerical control system.
2. Comparison of models with Root Definitions is performed inter alia by question generation techniques using a tabular display as with the Cookwell Chemical Company research.
3. With the Management Services branch of the CEGB an 'experience matrix' was utilised to create a greater appreciation of the extent of the branch's capability.
4. When considering the design of management control systems Wilson advocates a checklist approach covering five broad areas of concern.
5. Charting and mapping representations are taken a stage further than usual with the employment of grouping and overlay iterations, (see Wilson, 1984, p.177 et seq.)
6. A tabular/matrix approach is used to compare activity to activity information flows with previously identified communication processes.
7. The Maltese Cross, similar to Kanter's data matrix and Orsey's IBM Information cross, is devised for a data processing project but is found to have general relevance to primary task modelling.
8. Gane and Sarson-type diagrams are utilised to facilitate the transition from activity diagram to data-processing activities.

EVALUATION

The Checkland approach can be viewed as a variant on 'gap analysis', in this case between Rich Picture and Conceptual Model. This places it closer to the Kepner-Tregoe method which focusses on the need to identify deviations. However, this simplification does not reflect the arguably critical contribution of the Checkland method which is to the principles that can be used to derive 'useful' definitions of Cognitive or Desired States. Furthermore, particular emphasis is placed on the 'orchestration of debate' metaphor. In contrast, Kepner-Tregoe, with its emphasis on establishing causation, setting objectives and a lengthy process relating to the consideration of the consequences of proposed actions can be viewed as more practice-based with the Checkland approach designed to initiate a deeper re-appraisal of relevant fundamentals, such as the direction the organisation wishes to take.

Wilson echoes Pounds' (1969) emphasis on the importance of problem-structuring stating that:

"... a major output of the Action Research programme has been the change in emphasis towards the development of methodologies to structure problems and away from the development of techniques to 'solve' problems".

This he relates to the increasing uncertainty as to what the nature of the problem is as one moves from the hard to the soft end of the spectrum. Whilst there is nothing in the inherent structure of the methodology to prevent individuals using the approach in isolation, it is often presented via a consultant or facilitator. Thus Naughton (1984) notes that:

"The purpose of this stage is to conduct a structured discussion with the actors about the ideas which are now starting to emerge from the analysis"

and Wilson comments:

"A particular change may appear rational to the analyst, but to a manager who had lived through a particular history, who has to cope with particular relationships and internal politics, they may be anything but rational".

A large proportion of the Kepner-Tregoe method is applied to implementation-related activities such as setting contingency actions and controls in contrast to Checkland where Naughton (1984) comments:

"In its current form, the methodology gives very little explicit advice on implementation ... Quite what the soft approach has to say about situations where ... (rational) assumptions do not hold is not clear".

The Checkland approach combines a closely argued theoretical justification with extensive applications documentation much of which relates to managerial situations although it has relevance well beyond just organisational scenarios. Unlike most of the methods discussed in this chapter, its ability to subsume other tools and techniques within its overall structure indicates greater flexibility and less risk that managers will feel obliged to abandon methods which have an accepted place in industry.

VENTURE ANALYSIS

BACKGROUND

The Venture Analysis system was developed by the Du Pont Corporation and is described in the Venture Analysis Handbook (1971). This appears to be the only source. It was originally developed in the context of new product development but claims applicability beyond that. It is essentially a meta-structure providing an integrated framework for the use of a variety of techniques. Described as a 'systematic and quantitative discipline for organising and processing information to guide business decisions' the handbook then expands on this:

"The essence of venture analysis is the partitioning of a venture into a large number of small, manageable components. To accomplish this, the approach brings together, in a unified format, three primary methodologies: information framework design (or model building), risk analysis, and decision analysis".

The approach is heavily biased towards quantification although it positions itself clearly not as a method for making judgements or decisions but as one which:

- helps to clarify financial implications
- helps to flag needs for data of greater relevance
- helps the planner to establish the area where effort can be usefully applied.

DESCRIPTION

Preliminary analysis commences with the asking of eight questions and the processed information is condensed into a sequence of 14 charts of standardised format. Examples of questions are:

- What is the venture? (Venture scope)

- Why are we risking development money in the venture?
(Proprietary position)
- If successful, what is the venture payoff?
(Commercial potential)
- What are the uncertainties in the venture to be clarified
in the future development programme? (Financial
implications of key assumptions and uncertainties).

There are five principal areas of focus:

- A qualitative overview
- The pre-commercial development plans
- Ten year financial projections
- Markets and marketing considerations
- Key assumptions, uncertainties and their financial implications

Information framework design 'provides a graphical pattern of data and logic which serves as a perspective for viewing individual pieces of information relevant to venture decisions'. The content is directed towards information about the market, marketing forces, costs and investment requirements with the end product being an assessment of the economic value of the venture. Techniques used include:

- Cost of sales
- Working capital
- Return on investment
- Value/price ratio
- Lead times
- Discount factors etc.

Risk analysis attempts to establish the degree of confidence associated with these values. Primarily statistical, it uses:

- Probability
- Monte Carlo sampling
- Assessments of subjective data
- Uncertainty assessment

Decision analysis purports to establish the economic implications of the decisions and utilises:

Decision diagrams

Rollback

Strategies and decision rules

Quoted benefits of the system are:

1. It forces disciplined, quantitative and entrepreneurial thinking.
2. The graphical framework facilitates the discovery of new information patterns.
3. Communication is made easier.
4. Each participant can recognise and demonstrate how his topic fits into a larger whole.
5. It de-emphasises budget centres in favour of profit and uncertainty centres.
6. It aids delegation.
7. The manager can ask experts to contribute whilst retaining his essential prerogatives.

EVALUATION

Venture analysis was developed within industry and can be assumed therefore to have had application potential although there is no evidence that it has been used outside Du Pont. Its attempt to blend industry-based established techniques like Discounted Cash and Materials Costings with statistically-rigorous methods on probability is noteworthy. Even in 1971 it assumed that computing could play a role - 'the framework can be translated to a computer routine' although again there is no evidence that this was achieved. Assimilation into a software package would be quite straightforward as the structure is clearly defined and the mathematical integration apparently uncomplicated. However, the probability is that it is destined for oblivion in the absence of any champion or associated business interest.

Whilst the application of the method would seem pertinent where a specific venture proposal exists it does not address the earlier activities in problem solving aimed at finding out what may be going wrong and designing a solution or solutions. Also, whilst not a fundamental criticism as it could be simply modified, one can recognise its origins in a major chemical company with, for example, ten year financial projections - less relevant to products with short life cycles such as the fashion industry.

WORK MEASUREMENT AND ANALYSIS

BACKGROUND

Often referred to simply as 'Work Study', this approach to problem-solving has been extensively documented over many years. Its main focus is on work processes and it uses a sequence of usually six activities to cover analysis of existing processes and design of new ones. Currie (1963) places it in its historical context suggesting that it has always been practised as an unconscious art, an attribute of individuals, gained through experience and lost in the same way.

Early examples can be found with monks who recorded 'overall times' in the construction of stonework when building their monasteries. A Frenchman, Jean Perronet, studied the complete cycle of operations in the manufacture of pins in 1760. Evolving through Frederick W. Taylor and the Gilbreths, Work Study emerged as a formal discipline in the middle of the twentieth century. By 1959 Currie estimated that there were 1,500 staff engaged on Work Study in ICI alone.

Work Study received formal endorsement from professions such as the Institute of Mechanical Engineers who included the subject as part of the examination for Corporate membership. A City and Guilds certificate is also available. Whilst the 50s and 60s saw it at its most widespread, Work Study remains a key discipline in organisations, particularly where flow processes are evident. Although it had its origins in Manufacturing and Assembly processes its application to the Office environment emerged in the shape of 'Organisation and Methods' (often abbreviated to 'O & M') which was widely used in the Civil Service. Latterly the analysis of methods by a trained specialist has been supplemented by methods which are less formal but involve greater participation from the operators of the processes, an example being Quality Circles.

DESCRIPTION

Work Study splits broadly into two major components, Method Study and Work (Time) Measurement. It is represented by a formal method with the mnemonic, SREDIM, that is, Select, Record, Examine, Develop, Instal, Maintain as follows:

Select	Identify problem
Record	Gather information
Examine	Analyse data
Develop	Design new system
Install	Implement
Maintain	Review

It is differentiated however by its utilisation of rigorous routines such as statistical sampling as well as a strong visual or graphic medium with the use of symbols to represent concepts. Specific sub-routines are employed such as String diagrams and Gantt charts.

In terms of application, it has relevance to any analysis of a flow whether product, people or information. Currie suggests six areas where it was principally used in ICI:

1. Improve basic processes by Research and Development
2. Provide more and better means of Producing
3. Simplify and improve the product and reduce variety
4. Improve methods of operation
5. Improve Organisation, Planning and Control
6. Increase manpower effectiveness at all levels

Nor is it confined to the shop-floor with Currie quoting Sir Ewart Smith:

"Whatever thinking may have been in the past, we have found the impact of Work Study travelling steadily away from the Shop Floor to the Board room. We now regard it as symbolizing the analytical and progressive attitude of mind which is mainly concerned with making management manage better..."

EVALUATION

Work Study attempts to address a particular category of problem that is relevant to a specific group of organisations. Thus Chris Turner, Managing Director of Habitat, comments (Turner 1983):

"90% of our problems are operational; to get the right thing in the right place at the right time is an enormously difficult logistical exercise, but that's what the success of the business depends on".

It is well-known and widely-practised, closely integrated with many company training schemes and has its own professional qualifications and Institute. It is linked with Systems Analysis which reflects the need of the software developer to capture processes and flow-charting software is becoming increasingly available for PCs (e.g. Magna Charter, Freelance, Harvard Graphics).

However it can be seen that a method dependent on examining existing processes (like Kepner-Tregoe) has less relevance when the problem involves the creation of a new design or product or where existing processes are irrelevant.

TOTAL QUALITY MANAGEMENT

BACKGROUND

Examination of the Japanese 'economic miracle' of the late 1970s and early 1980s lent support to the view that notions of 'quality' were an integral part of Japanese business processes although many of the ideas had originated from the USA some years earlier. Quality Circles were re-introduced into the West as a way of harnessing shop-floor driven innovation but the Quality Management processes that followed were more wide ranging but equally, more amorphous. The PA Consulting Group (undated) quote the guru of Total Quality Management (TQM), Dr. W. E. Deming:

"Good quality does not necessarily mean high quality. It means a predictable degree of uniformity and dependability at low cost with a quality suited to the market".

DESCRIPTION

TQM covers a broad spectrum of activities and approaches with much of the literature representing individual views as to how 'quality' can be achieved. However, at the core are methodologies which can be compared with Kepner-Tregoe and others described in the following chapter.

In terms of an overall approach for TQM implementation, four steps are identified:

1. Diagnosis and preparation
2. Management focus and commitment
3. Planned improvement
4. Review, re-inforce and re-start

Within this framework a number of tools and techniques are offered which include Quality Circles, Process Management, Statistical Process Control (SPC) and Just in Time manufacturing (JIT). The UKC Quality Directorate (1988) produced a substantial synthesis of much of the TQM thinking as well as an extensive arsenal of problem-solving techniques. The method which relates specifically to Project management consists of the following phases:

1. Quality Improvement Plan
2. Analysis and Planning
3. Education and Communication of Action Plan
4. Detailed Implementation Plans
5. Implementation

The problem-solving process is similar to Kepner-Tregoe but involves 8 steps commencing Identify Problem, Gather Data etc. and is supported by 26 tools including Decision Analysis, Force Field Analysis, Concentration Diagrams and Solution Effect Analysis along with additional techniques for planning which include Contingency Plans and Critical Path Method.

EVALUATION

TQM provides an interesting development in Industry's own attempts at making problem-solving more structured and orderly. There is an overall theme which is the Quality Goal, a suggested ordered sequence of activities for problem-solving or project administration and a battery of techniques to help 'unblock the roads of inquiry' or structure facets of the problem-situation. There is an extensive literature on the topic, numerous examples of practical applications and widespread internal and external training. As with other approaches which consist of a 'tool-kit' of techniques held within a loose overall framework TQM has both advantages and disadvantages. The strengths come from flexibility and hence wider applicability, the weaknesses deriving from the need for the manager to exercise choice as to which technique to use and when. The latter is addressed by 'look-up' tables which suggest appropriateness, discussed further in the next chapter but there is no evidence that this has been derived from research or anything other than personal view-points.

REVIEW

The methods reviewed here illustrate both similarities and differences which can be related to a variety of different dimensions.

The Checkland approach and TQM can be viewed as 'higher order' meta-methods containing a general set of principles within which framework individual tools and techniques can be deployed. TQM is more loosely structured and was developed within industry whereas Checkland originated in an academic environment albeit tempered by applications within industry.

Kepner-Tregoe is a rational problem-solving method but one which applies principally where a gap or deviation is identified between what should happen and what is happening. Hence, it usually requires a current system which can be examined and analysed whereas Checkland offers the flexibility to take on design of new systems. PDS and NIPPER both focus on a particular aspect of the problem-solving sequence, that of the comparison of options. COPE in its initial form helps to clarify causal relationships whereas the shift towards a more goal-oriented emphasis brings it closer to AIDA and the Strategic Choice area, albeit from a different perspective. Work Study addresses current processes, thus suggesting an affinity with Kepner-Tregoe in this respect whilst Venture Analysis looks forward to the introduction of a new product, service or initiative.

Only Venture Analysis includes specified tools and techniques as part of the overall process although TQM suggests those that might be appropriate in different situations, as does Work Study. Checkland and COPE allow for the incorporation of techniques whereas PDS, NIPPER and Kepner-Tregoe, whilst not barring the use of subsidiary techniques, make little if any reference to them.

COPE, PDS and NIPPER come in computerised forms although it is beneficial but not essential to SODA analyses. Checkland, COPE and NIPPER detail their theoretical origins whereas PDS and Kepner-Tregoe offer only the logical basis for their designs. Work Study, TQM and Venture Analysis are essentially based in practice. Applications are described for Checkland, COPE, TQM, Work Study and to a lesser degree, PDS and Kepner-Tregoe. There is no evidence of applications of Venture Analysis or NIPPER. Checkland, COPE, Kepner-Tregoe, Work Study and, to a degree, TQM have proved to be durable over time whereas PDS and NIPPER are no longer in evidence and the status of Venture Analysis remains an unknown.

Critics have provided an additional dimension to these comparisons. At a general level Bowey (1983) has been particularly critical of what she regards as some of the sterile arguments of organisation theory, commenting:

"Far too much intellectual effort has been spent in organisation theory on attacks from one frame of reference onto another, and on counter-offensives. There has developed an almost unquestioned modus operandi where each new theory coming into the field has been projected as superior to all previous theories (or 'paradigms') and its proponents have sought to discredit those who propounded the earlier theories by 'disproving' them".

Rosenhead (1989) contrasts COPE's concern with organisational goals with Checkland's emphasis on the need to improve system functionality. A shift is identified away from a decision focus to one where the output is visible either in terms of action or policy change or invisible in terms of modified outlooks or perceptions. Rosenhead's review also notes that many of the case studies quoted by proponents of the respective methods are with 'unconventional clients', primarily 'community groups' and whilst problem-structuring methods might be particularly suitable for these their relevance to managerial problems which may be characterised by more precise objectives, the existence of hard data and the requirement for specific decisions may be more questionable.

In addition Rosenhead notes that planning operates at two levels, strategic and incremental, the former setting the broad direction and the latter implementing policy with the emphasis on detail. He notes that most methods make no allowance for this 'mixed-scanning'. Finally, Rosenhead observes that Checkland's and Eden's methods (along with Strategic Choice) have working in groups as a common characteristic and that they are 'irrelevant to the individual decision-maker'. This would

seem to be an extreme judgement and we would prefer 'less relevant'. Nevertheless, group problem-solving is a feature as it is with PDS and and we return to Group Decision Support Software (GDSS) or Groupware in Chapter 4.

Following Bowey's criticism one can conclude that all the methods reviewed here have some relevance to problem-solving. Whilst they may not all be relevant to all problems, they fulfil certain functions that appear reasonable and logical. This is not to say that there is any proof that they add value to current managerial practice as such evidence does not appear to exist. Equally, the fact that PDS, NIPPER and possibly Venture Analysis have 'disappeared' does not indicate that they were logically flawed or in any fundamental way deficient. The exploration of a managerial- support system which has broader relevance - the concern of this thesis - requires that a wide range of relevant activities are identified and in the next chapter we move from a primarily method-oriented perspective to an activity-based one.

The differences referred to above are summarised in the following matrices:

TABLE 1

	General	Specific	Internal	External	Computer
Kepner-Treg.		X	X		X
Cope	X		X		
PDS	X		X		
Nipper	X		X		
Checkland		X	X		X
Venture an.	X			X	X
Work study	X			X	X
TQM		X		X	X

TABLE 2

	Gap analysis	Design	Options	Process	Tools
Kepner-Treg.				X	X
COPE			X	X	
PDS	X	X		X	X
Nipper	X	X		X	X
Checkland				X	X
Venture anal.	X				
Work study			X		
TQM			X	X	

CHAPTER 3**STAGED METHODS, TOOLS AND TECHNIQUES**CHAPTER CONTENTSINTRODUCTIONROLE OF THE MANAGERSTAGED METHODS FOR INDIVIDUAL PROBLEM-SOLVING-Problem identification-Information gathering-Analysis-Option/solution generation-Decision/choice-Implementation-ReviewTOOLS AND TECHNIQUESKEY ISSUESINTRODUCTION

In the previous chapter we reviewed a number of methods which their designers argue are applicable to managerial problem-solving. If we now focus in on the manager at work, what picture emerges of the activities he (masculine gender used for convenience) is carrying out? He may be at his desk with an In-tray to one side accompanied by a telephone and possibly computer terminal. There are likely to be papers filed in drawers and frequently some wall-charts. Or we may see him at a meeting, debating issues, presenting facts or receiving action points. He may be at the work-face inspecting work quality or in dialogue with the work-force. We may see him meeting customers, colleagues or his superiors in one-to-one situations or small group sessions. Can this perspective be reconciled with the activities implied by the methods reviewed earlier?

Two broad perspectives can be adopted as was suggested in the first chapter in which either the job of the manager becomes the primary focus or an individual problem is considered in terms of the solution process. In the first part of this chapter we take a step back to consider the role of the manager and to establish a context within which his problem-solving can be viewed. In the second part the focus is directed towards individual problem-solving but this time attention is directed to the staged or structured methods which, irrespective of the validity of staging, can indicate in greater detail the particular activities that can occur within problem-solving processes. In the third part reference is made to a selection of individual techniques which can potentially aid problem-solving but which do not constitute complete methods such as those covered in Chapter 2 and part 2 of this

chapter. Finally, we identify key issues which emerge from this review which require addressing both in the models introduced in Chapter 5 and the set of requirements for future systems described in Chapter 7. The implied questions are as follows:

PART 1 - ROLE OF THE MANAGER

What does a manager do? What are the principal features of varied but often linked problems he deals with?

PART 2 - STAGED METHODS

What are the main characteristics of staged methods and what activities do they imply? Here the focus has moved from the broad panorama to the detailed, from the job to the problem.

PART 3 - TECHNIQUES

What other techniques are available which could assist the manager solve individual problems?

PART 4 - ISSUES ARISING

What are the significant issues arising from this review?

PART 1 - ROLE OF THE MANAGER

Any attempt, as in this thesis, to suggest a designed framework for managerial problem-solving needs to take account of what managers actually do. Early approaches are typified by Stewart and Drucker both of whom have had an enduring influence particularly on their respective sides of the Atlantic.

Stewart (1963) viewed managers as carrying out four main activities which were:

PLANNING

This included the setting of objectives, forecasting, analysing problems and making decisions.

ORGANISING

This involves determining what actions are necessary for the objectives to be carried out, classifying and dividing out the work to individuals.

MOTIVATING

Here the emphasis is on maximising the contribution from those individuals to ensure they are committed to the actions referred to above.

CONTROLLING

This is a monitoring function, checking and reviewing performance against plans.

This can be seen to be cyclical with planning setting direction, organising allocating tasks to meet these objectives and motivating supporting this allocation with controlling comparing performance with plan. Discrepancies may require changes to the organisational elements or even review of planning.

Drucker (1955) included these four but also added the development of people which expands the role into one which provides the human resource both with the skills to execute the various activities and the motivation to do it without excessive supervision. In addition to these functions he sees managers as being essentially concerned with three main aspects:

- Managing a business
- Managing the managers
- Managing workers and the work

These three tasks are discharged in every action that the manager takes with Drucker noting:

"Management is so complex and multi-faceted a thing, even in very small businesses, that managing managers is inevitably not only a vital but a complex job".

The manager is not only having to consider concurrently the potential impact of these dimensions but he needs also to take account of the temporal dimension and has to "live always in both present and future". Drucker stresses that a key characteristic of management is the necessity to integrate the particularity with the totality, stating:

"The task of creating a genuine whole also requires that the manager in every one of his acts considers simultaneously the performance and the results of the enterprise as a whole and the diverse activities needed to achieve synchronised performance".

In comparing the role of the manager with that of the conductor he comments:

"A conductor must always hear both the whole orchestra and the second oboe".

This signals a characteristic of management which recurs throughout this thesis, the constant and persistent alternation between focus on individual components and focus on the broader view. It is

reflected in Chapter 2's emphasis on individual problems and this section's perspective on the wider role of the manager. It is also manifest in the two models introduced in Chapter 5 which respectively mirror these perceptions.

This grouping of managerial work into principal categories has continued since Stewart's and Drucker's early statements. Shenhar (1990) identified four main skill areas. The first is technical which can be linked with theories, tools and experience. The second is human - essentially people-related and involving communication and negotiation. The third skill is operational- administrative which is concerned with organising, allocating resources, planning and budgeting. Finally, there is strategic- business which sets the framework and direction for overall company operations. Shenhar couples this with the level in the business that the manager is at with the bottom level directing the production of goods and services, controlling, problem- solving and motivating. At the middle level there is still a technical component but human involvement reduces while operational-administrative and strategic-business increases. At the top level both technical and human elements have less significance but operational and strategic aspects are paramount.

This takes us a step further than Stewart and Drucker in suggesting that work components will vary depending on the managerial level but Hirsh and Bevan's (1988) conclusion that 'managerial work in reality is diverse, fragmented and variable' helps to temper the neat categorisations of Stewart and Drucker and to sound a warning note against any simplistic assumptions as to what constitutes the main spheres of activity for any individual manager. But there is a further problem and that is that these perspectives are still far removed from the basic 'fly-on-the- wall' view contained in the opening paragraph of this chapter.

Torrington and Weightman (1987) reported the results of a survey into 52 middle managers in 16 different organisations categorising their time into technical, administrative, managerial and social activities. The balance between them varied significantly although managerial activities (using initiative and making decisions etc.) constituted up to 66% of the time with administration occupying up to 55%. Three features that they noticed were the use of networking with non-hierarchical contacts, coping with uncertainty and day-to-day co-operation.

But the most trenchant criticism of the Stewart/Drucker categorisations comes from Mintzberg (1990). He firmly rejects groupings such as 'planning' and 'co-ordinating' because they 'tell us little about what managers actually do'. For Mintzberg the field of management has for more than half a century not seriously addressed the basic question - 'what do managers do?'

Mintzberg reviews the findings of his own research along with others and concludes that there are a number of myths which need dispelling from which some examples are given here. The first myth is

that the manager is a reflective systematic planner. Mintzberg finds that managers "work at an unrelenting pace" and that their "activities are characterised by brevity, variety and discontinuity". Research suggests that only half of the activities carried out by a Chief Executive Officer last more than 9 minutes. A study of 56 foremen averaged one activity every 48 seconds. Only once every two days did they work without interruption for more than half an hour. They were, in effect, "conditioned by their own work-loads".

A second myth is that the effective manager has no regular duties to perform. Mintzberg found that managerial work involved lots of regular duties including ritual, ceremony, negotiations, processing of soft information etc. Another myth is that the manager requires aggregated information whereas in fact Mintzberg concludes that he favours telephone calls, oral information and meetings. One study suggested that only 13% of mail was regarded as specific and of immediate use. The primary benefit of 'soft' information was its immediacy. Information was used essentially to identify problems and opportunities and to build mental models (such as how customers buy products). But Mintzberg notes an imperative that "the manager is challenged to find systematic ways to share privileged information".

Mintzberg suggests that in his monitoring role the manager is constantly on the look-out for new ideas. Once one is identified he initiates a development project to research and implement the idea. He may supervise as many as 50 at any one time:

"Like jugglers, they keep a number of projects in the air".

Time consequently becomes one of the most critical resources - Drucker (1955) comments:

"Everybody has the problem of time, for of all the resources it is the scarcest, the most perishable and the most elusive".

Judson (1980) sees time as the key difference between scientific and organisational problem-solving and Schon is quoted by Ackoff (1979) as believing that the lifetime of solutions is often shorter than the time taken to find them. Hence Time Management consistently ranks high in demand for information and training by managers. Three of the British Institute of Management's 27 short courses are devoted to Time Management.

Clearly these findings have more to do with describing what managers do rather than what they ought to do in any prescriptive approach but equally where jobs are largely event-driven there may be fundamental difficulties in applying rational, sequential methods. Mintzberg does see scope for improvement noting that managers frequently use models derived from others:

"Analysts can help the top manager schedule time, feed in analytical information, monitor projects, develop models to aid in making choices, design contingency plans for disturbances that can be anticipated ..."

At the conclusion of this section we have reached a point where we have a description that can be reconciled with the picture portrayed at the beginning and key elements will be carried forward into one of the models introduced in Chapter 5 that reflects the manager's role in a broader context. Key features are:

- Large numbers of individual activities
- Most activities of short duration
- High levels of variety and discontinuity
- Much of the work event-driven
- Proactive initiatives similarly fragmented and numerous
- Constant balancing and juggling of the activities

PART 2 - STAGED METHODS FOR INDIVIDUAL PROBLEM-SOLVING

Whilst the manager faces the task of managing the totality of problems, at some point his attention turns to the individual problem. Approaches to problem-solving which are represented in stages or phases are widespread. They are to be found in academic as well as 'popular' management books, in professional journals, training programmes but also extensively inside companies. They vary widely in detail and content as well as in their generality or specificity. Few, if any, give a theoretical or research-based justification for their particular design thus making evaluation very difficult, exceptions being examples reviewed in Chapter 2 such as the Checkland method, COPE/CG and Kepner-Tregoe - although evaluation of the latter is largely anecdotal. Van Gundy (1988) observes:

"Most techniques for analysing and redefining problems ... assume that these functions can be best performed by factoring problems into their basic elements, and achieving perspectives that are remote from the original definition".

There is no intention here to evaluate the merits of staged approaches although when the fieldwork is reviewed in Chapter 6 we can identify some of the difficulties implicit in applying literally the sequential, staged approaches to real-world problem-solving situations. While staged methods appear to bear little relationship to the much more complex observed reality of problem-solving they are sufficiently widespread to suggest that they are meeting a perceived need. Furthermore, whilst debates

on the merits of particular stages or appropriate sequences remain unresolved, the activities implied by the stages are valid indicators of what actions may need to be carried out as part of problem-solving.

Specific objectives in this section are:

To identify and contrast the main characteristics of such methods.

To examine the key differences between in-company and 'external' approaches.

To determine commonality between methods.

To consider the fragmentation of the stages and attempts to integrate tools and techniques within the stage structure.

Irrespective of the validity or otherwise of staging to use the phases to identify key elements within the problem-solving process that can be assimilated within the design described in Chapter 7.

Over 50 methods were examined as part of the research project ranging from those consisting of 4 to 5 stages to those with in excess of 70 specified sequential activities. The question of the validity of staged approaches can be viewed from three perspectives; first as a prescriptive model of how rational problem-solving ought to proceed, second as a research-based description of how problem-solving does occur in organisations and third as an educational device for leading students into certain disciplined styles of thinking.

At one extreme Cohen's 'garbage can' model (Cohen, March and Olsen, 1972) suggests a complete absence of any clear time sequence but most researchers indicate some element of phasing, although many indicate that there can be flexibility in the starting point and order adopted. Reflecting a descriptive approach and on the basis of a study into 25 strategic decisions Mintzberg, Raisinghani and Theoret (1976) found evidence for three steps:

Identification

Development

Selection

although this was moderated by iteration, delays and discontinuities. Their detailed model incorporated the following steps:

- Recognition
- Diagnosis
- Search/screen/design
- Evaluation/selection
- Authorisation

Heller, Drenth and Koopman (1982) in their examination of 56 decisions arrived at four phases:

- Start up
- Developmental
- Finalisation
- Implementation

A typical example of a prescriptive model is provided by O'Shaughnessy (1972) as follows:

1. Objective setting
2. Events description
3. Problem recognition
4. Problem classification
5. Information search
6. Problem explained
7. Problem defined
8. Alternatives defined
9. Consequences identified and evaluated
10. Courses of action taken

In order to illustrate the range and diversity of such methods, three are presented below alongside each other. The first is a general problem-solving model proposed by Van Gundy (1988), the second is a method promoted by Kanter (1970) for the consideration of computer selection and the third is from a Quality Management Systems manual for in-company use (Tools and Techniques 1988). The methods are presented in the order in which they are presented by their authors and the components are then co-located where they would appear to be representing similar activities. Five broad groupings are suggested:

- Problem finding
- Solution finding
- Selection
- Implementation
- Evaluation

The methods are represented side-by-side so that some analogous activities can be seen but it is also clear that there are many differences at both a subtle and explicit level.

VAN GUNDY

KANTER

TOOLS

----(PROBLEM FINDING)----

Search/analyse problem
information

Identify
problem

Generate problem
definitions

Select a problem
definition

State the problem

Establish study
objectives

Analyse cost v
benefits

Identify
problem cause

Determine further
study

Identify root
cause

Determine business objectives

Determine system objectives

Analyse system specification

----(SOLUTION FINDING)----

Search for solutions

Develop alternative solutions

Generate solutions

Explore computer solutions

Generate possible techniques

Select technique

Search for information to evaluate solutions

Generate solution consequences

----(SELECTION)----

Select tentative solution

Determine best solution

Select solution

Evaluate vendors

Calculate Return on
Investment

Present final analysis

----(IMPLEMENTATION)----

Implementation

Develop implementation
plan.

Plan for
implementation

Select/train staff

Implement and test

Design programme
applications

Test computer
applications

Initiate productive
operations

----(EVALUATION)----

Review resulting
benefits

Evaluate performance

Fine-tune running

Continue to
improve

Plan for growth

A number of key points can be seen in this simple comparison which, with some variation, applies to the generality of methods. 'External' methods, i.e. those with an academic and generalist bias, are often front-loaded - that is they have more activities linked to the earlier categories, for example problem identification, analysis, solution generation (e.g. O'Shaughnessy 1972). Internal company methods tend to provide greater coverage of planning for implementation and actual implementation and are consequently often end-loaded. A good example is the Project Management Handbook (1992) which lists the following stages:

Inception
 Feasibility
 Definition
 Development
 Installation
 Pilot
 Roll-out
 Post-implementation

where the last four phases are all based on different facets of implementation or post-implementation. Methods designed with a particular application in mind are likely to have highly specified sub-routines. In Kanter's example we have Return on Investment and in the RIBA method (RIBA Handbook 1963) we find 'construct tools and jigs' and 'test trial batch'. However, the methods listed above and most others reviewed in this research all tend to have some features in common which can be summarised as:

Problem analysis
 Solution generation
 Solution selection
 Implementation

Before proceeding to consider individual phases in greater depth a number of further general observations can be made.

In an attempt to produce stage descriptions which are both pithy and readily identifiable writers often run the risk of losing the subtleties of meaning that a fuller description would reveal. Thus certain phases are frequently described in different ways and it is seldom clear whether this results from an accidental choice of word or some deliberate but unexplained shift in emphasis. For example within our sample the process of gathering information is variously described as 'data collection', 'search' or 'intelligence'. Sometimes the activity is described in technical terms, for example Honey (1986) has a

stage 'produce ITT' - an abbreviation for Invitation to Tender which might mean little to someone unfamiliar with tendering procedures.

One can contrast methods which purport to apply to the generality of problem situations with those which are limited in application. The latter are context-specific and consequently we shall refer to these as Context Specific Methods (CSMs).

It may be useful to distinguish between descriptions of process phases in a project and the practical activities needed to carry out that project. For example Jenkins, G.M. (1969) inserts 'project organisation' as a seemingly separate but sequential phase between two conceptual phases, 'formulation of the problem' and 'definition of the system'. The Severn Barrage Consultative Document (Severn Barrage 1987) lists a programme of activities that need to be undertaken. Of the 9 components, 8 refer to particular phases in the problem-solving process but the ninth specifically details the 'Project Organisation, Procedure and Authorisation'.

One reason for the wide variation in method descriptions is that writers choose to describe different levels of detail. Thus Clifford (1976) refers only to four stages:

Classification
Analysis
Choice
Execution

which contrasts with the RIBA method (1963) which has 34 phases consisting of ten main phases each with its own sub-phases commencing with:

Policy formulation	Establish objectives Outline timetable/budget
Preliminary research	Identify problem boundaries Establish state of art Outline performance specification Identify critical area etc.

At the main phase level it could be argued that methods have general applicability. Thus all categories of problem situation involve some element of choice. However, at lower levels there is greater specificity and detail and this entails relevance to a narrower class of problems. Thus RIBA's phase

'Design jigs and tools' refers only to problems of product innovation and design. These hierarchical elements are neatly encapsulated in Kanter's (1970) method which has three main phases, Analysis, Synthesis and Implementation, each dividing into two or more elements, an example being Synthesis which breaks down into 'Systems Design' and 'Justification'. Kanter refers to these as sub-phases. The sub-phases, in turn, decompose into 'activities'.

Some methods emphasise the need for iteration. Sometimes this is expressed in general terms but a significant variant is the use of a preliminary first analysis to assess initial feasibility - often referred to as a 'quick and dirty' analysis. Optner (1965) refers to two specific phases as:

Obtain partial and tentative total solutions..

Test early solutions

Honey (1986) proposes a six-step method for the selection of office technology as follows:

1. Define objectives
2. Define essential requirements
3. Define desirables and weightings
4. Produce ITT (Invitation to tender)
5. Perform selection
6. Procure equipment

However, this is overlaid with two phases:

"The first phase evaluates options against a set of essential requirements, these are 'absolute' requirements which represent the minimal accepted solution".

Options that fail to meet the requirements are eliminated, whereas those that survive proceed to Phase 2 where the relevant suppliers are invited to tender. In a problem-solving process that is very common in industry a formal process takes place which passes the burden of problem-solving to others whilst leaving the client in a position to make the final selection. It can be argued that almost any management problem can be matched with a contractor, consultant, specialist or professional claiming to be able to handle the particular characteristics of the problem.

Honey's method is particularly interesting in the way in which it combines the conceptual elements for initial screening (option evaluation) with an industry-based method for more detailed evaluation of the potential tenderers. It also suggests a distinction between what is necessary - 'the essential

requirements which represent the minimum acceptable solution' and what would be desirable. The two phases thus represent the route to each aspect.

Revans (1982) introduces a variant whereby the initial iteration produces a first design and this is implemented on a trial basis or simulation. Inspection or audit is then used to confirm the validity of the first design. to modify it or reject it followed by the resumption of the search for an acceptable one. Thus there is an initial conceptual phase but then cognitive problem-solving is supplemented by the test of practice. The expression 'trial and error' is important not only because of the ubiquity of its use in commerce and industry, e.g. prototyping, field trials, test marketing etc., but because it is a variant on the 'build model' routine which can be physical or conceptual.

The use of a 'trial' appears to be an essential component in the way companies develop new product or service ideas, resting on the assumption that no matter how thorough the preparation, it is only practical implementation that will provide an effective measurement of success. This can be distinguished from simulation and modelling which test theories by reference to a representation whether physical or conceptual. With 'trials' organisations test real products and services on real customers in their 'natural' environment and the validity arguments shift from considerations of the validity of a model to the real system to those concerned with the validity of the trial site or sample to the population as a whole.

From a comparison of the methods we can suggest that there are six main stage groupings as follows:

- Problem identification
- Information gathering
- Analysis
- Option/solution generation
- Decision/choice
- Implementation

The difference between this and the four-way split suggested earlier is that here Problem Analysis is further fragmented into Identification, data gathering and analysis. Whilst the selection is somewhat arbitrary it does provide a loose framework within which to consider the individual activities listed by the methods designers. In addition the categories are close to the main groupings proposed by many methods designers. For example Tools and Techniques (1988) differs only in that Implementation is sub- divided into three elements. Similarly Van Gundy (1988) sub- divides Problem-identification into four categories but otherwise the components are similar albeit not necessarily in the same order. For the remainder of this section we can consider each of these broad groupings in more detail and as

separate activities it can be noted that each will form an integral role in helping to specify the design components introduced in Chapter 7.

STAGE I - PROBLEM IDENTIFICATION

Possibly the widest variation between published methods is in the first stage with the principal difference being between those who assume that the problem has already been identified and those who consider the search for problems to be the starting point. It will be argued in Chapter 5 that the difference is crucial and underlies the need to differentiate models of managerial activity.

Checkland (1981) compares the initial phases of twelve hard systems methods published between 1955 and 1976 which produced a variety of responses from 'establish the value or need for the system' to 'describe mission or use requirements'. Mintzberg (1991) has 'Recognition' as his first phase and Cooke and Slack (1991) have 'Recognise problems'. Reference to this and the additional methods surveyed here suggests that three principal sub- categories can be identified:

1. Problem finding

As indicated above some methods (e.g. Van Gundy 1988, Kepner Tregoe 1965) require problem search to be the first element in the process. An internal Post Office (undated) method starts with 'recognising that a 'situation' exists or is likely to develop'. Cooke and Slack (1984) further distinguish between an ongoing process of 'observation' and a subsidiary phase of 'formal recognition'. The Project Management Handbook (1992) describes its 'inception' phase as 'the objective of this phase is to capture new ideas or opportunities and to identify problems and potential solutions'.

2. Problem definition

Sub-categories 2 and 3 both assume that the problem or potential problem has been found. Several methods (Tools and Techniques 1988, Van Gundy 1988) require the problem to be defined, clarified or confirmed. This may also reflect the need to distinguish symptom from cause. Pounds (1969) considered that there were too few methods geared towards helping problem formulation in contrast to those available for problem solution. Turban (1990) splits this process into 3 sub-activities; problem identification, problem classification and problem statement.

3. Objective setting

Many methods (e.g. RIBA 1963, Kanter 1970 and Honey 1986) make an early reference to objective setting although Kanter distinguishes between the study objectives and the business objectives. Optner (1965) starts with 'Fix objectives and constraints' but the concept is clearly used with a variety of meanings. In some cases it refers to the identification of the objectives of the organisation as a whole

(cf. Kanter) whilst in others it refers to the new system yet to be specified. Nadler (1970) starts with 'function determination'. Dill (1964) has a more generalised activity - 'agenda building' - which comprises the definition of the goals and tasks for the organisation and the assignment of priorities for their completion.

Whilst items 1 and 2 above will be differentiated in terms of the models presented later in the thesis, their existence as valid activities creates no fundamental difficulties to the approach adopted here. Where objective-setting relates to those of the project or problem-solving process, e.g. 'terms of reference', there are similarly no significant inconsistencies. However, if the objectives refer to business or organisational objectives, one encounters both logical and practical difficulties. Thus Cooke and Slack (1991):

"During this phase it is necessary to consider what it is hoped the decision will achieve or what goals it should work towards"

and continue:

"... so this phase sometimes involves interpreting a company's overall goals and objectives".

The manager facing a particular problem may well consider the objectives of the organisation. He may even choose to challenge them or cause them to be reviewed but the process of setting and altering company objectives will usually be a separate process. The role of goals and objectives in organisations and discrete approaches such as Management by Objectives are discussed further at Appendix 1. It can be noted that the state and style of key organisation members inevitably have a bearing on this issue and these can vary between executives who do not accept the need to have or articulate objectives; those who have them but have not or cannot articulate them easily and those where business objectives are not only stated but are integrated within a wider in-company system.

Identification and recognition that a problem exists is clearly an important business requirement. Pounds (1969) contrasts problem-finding which he regards as the process of defining differences and problem-solving which is the process of selecting operators which will reduce the differences. There is also extensive anecdotal evidence to support the logical assumption that problem recognition is an important managerial activity.

Clutterbuck (1984) cites an example where "recognising the problem proved to be a major step towards resolving it" and Caulkin (1983) quotes the case of the failure by Wilkinson and Gillette to register the threat posed by BIC's introduction of the disposable razor in 1976. 8 years later disposables accounted for over 60% of wet shaving sales.

However, recognition may not be sufficient in itself. Stainton (1982) argues that it is the will to make an idea work and the resolve to succeed which is of far greater importance than a too thorough analysis of the past. Further anecdotal evidence comes from Van de Vliet (1984) who quotes Trevor Owen of Remploy as believing that the change and retraining necessary for the survival of the firm became possible because the will to survive was there. Conversely Arnott (1983) reports that the Co-operative Wholesale Society always claimed to be aware of its problems but the difficulty was summoning up the energy to overcome the democratic inertia. In military tactics Sixmith (1970) believed that whatever the skill employed, nothing would succeed unless, ultimately, the commanders were determined to press the attack.

A related concept in that it also initiates activity is that of the trigger - an event or individual that causes action to be taken. Segev (1976) contrasts triggers which result from the action of an agent, a member who has the power to start the process and those stemming from an event which might be a suggestion, a report or a change in demand for a product. He suggests that triggers may affect the choice of decision area, the definition of the problem, the nature of the data gathered, the way in which it is analysed and, finally, the action taken. He concludes that as many triggers are based on events that are accidental and exogenous to the organisation, management will increase their chances of being able to exercise some control over the decision-making progress by paying greater attention to triggers.

In historical terms AJP Taylor (1979) commented that:

"The technical reason may not be why a war starts but it is at least the spark".

Examples can also be found in business practice. Mazur (1983) quotes the engineering firm Baker Perkins where the evolution of a more professional approach to the business dated back over the whole of the previous decade but where the spur to move faster to modernise both products and processes came from the 'Thatcher recession'. Wilson (1986) suggests that the 'trigger factor' in the digital revolution would be 'the coming of age of optical technologies'.

Thus for this first phase we can identify a number of discrete activities which may be operating sequentially or simultaneously. There is the need to identify problems - a search, scanning or monitoring activity aimed at identifying deviations or areas of concern. This recognition may not involve any pressure to act. Then there is the trigger which causes action to be taken as clearly managers may choose to tolerate some problems (or not know what to do with them !). Pounds (1969) noted the absence of systems to help managers prioritise problems and Dill (1964) reports research that indicates that administrators have difficulty in estimating the significance of many of the

problems they work on. Both COPE and PDS claim to provide assistance either through ordering and associating objectives or through the ranking and comparison of priorities.

The need to identify problems can be viewed as an expansive activity that would appear different in nature and scope to those which follow. The trigger causes consideration to be given to an individual problem and here we see the third stage, problem definition, where the mode is contracting - the problem being refined to its essentials. Part of this activity may involve classifying the problem (cf. Turban 1990) and this is further discussed in Appendix 2. Having deduced a clear view of what the problem is one can then attempt to relate it to relevant objectives, both in terms of what the problem-solving process should attempt to achieve (problem-specific objectives) and in terms of what company objectives can be identified which help to give a focus and direction to the solution process (relevant organisational objectives). Thus the four elements are:

1. Problem finding
2. Trigger
3. Problem definition
4. Objective setting

Finally, we can note that whilst there is a logic in the order in which these are presented, (e.g. you cannot define a problem until you have recognised it, irrespective of whether it really exists) it is dangerous to assume that these activities take place in clear, discrete stages. Thus, it may be necessary to 'gather information' (see below) before the problem can be defined or indeed before the trigger is activated. The significance of a problem may be dependent on other data before it can be registered.

STAGE 2 - INFORMATION GATHERING

The logical, rational approach suggests that having identified and clarified our problem we then proceed to gather information about it. This is reasonable where it implies the need for further research before decisions are made but is misleading if one infers that it only takes place at this point. Information gathering is usually a continuous process although problem definition or clarification will help determine relevancy. We have noted that scanning, search operations are likely to have already taken place in order to allow problem finding.

We can distinguish three broad dimensions of information. The first dimension distinguishes between internal and external data, the former relating to information produced from within an organisation and the latter to information obtained from outside. The second dimension separates computer-based information from that based on other media, principally paper. The third dimension separates 'hard' data - numbers, charts etc. - from 'soft' data - the grapevine, rumour etc., in total giving 8 permutations. Of these we shall address only two in depth:

1. Hard internal computer-based
2. Hard external computer-based

A proportion of In-company data is increasingly being held on computer and this is addressed in the next Chapter under the heading of Executive Information Systems. 'Soft' data may well be as important from a manager's viewpoint and research from such as Mintzberg (1990) suggests that executives still favour telephone calls, face-to-face discussions and meetings not least because of their immediacy. However, our primary need is to establish a role for the computer in assisting managerial problem-solving so whilst accepting that soft data may be vital there is currently only limited scope for accessing it on computer, as distinct from recording it. Consequently, after considering how methods designers regard information-gathering, our main focus in this chapter will be on external on-line sources.

Before turning to this, however, we can briefly consider information-gathering in terms of the issues it raises as an activity. Dill (1964) refers to the search phase as looking for information that will help in the evaluation of various courses of action. Quade and Boucher (1968) describe the search or research phase as 'looking for data and relationships'. The Post Office system (undated) differentiates between a phase of deciding how to collect the data and a phase of actual data collection. These two headings are shown with further sub-divisions:

"DECIDE how to collect the data

- decide what you want to know
- decide what is easily obtainable
- decide what is too costly to obtain

COLLECT the data

- not only facts and figures but any relevant information which has a bearing on the problem.
- extract the relevant data
- fill the gaps (by intelligent guesswork if necessary)".

A salutary reminder here is that information-gathering has a cost which needs to be recognised. A useful insight is the distinction between information which already exists - 'prior' information - extra information which may be needed - 'additional' information. In either case this may be extensive or minimal.

Some designers see information-gathering as the first phase, as we suggested earlier. Simon (1977) sees the first phase as 'intelligence gathering' which is searching the environment for conditions calling for a decision. Evered (1975) refers to 'making contact with the environment and seeing or sensing the total situation'. In contrast Hogarth (1980) has additional information-gathering as the sixth of seven steps, preceded by problem structuring, assessing consequences, assessing uncertainties, evaluating alternatives and sensitivity analysis. He justifies the position because of the need to maintain relevance:

"... the need for additional information should be undertaken only once the key aspects of the decision have been isolated".

Anecdotal evidence is not difficult to find on business information-gathering. Allio (1972), in describing how planning was undertaken at Babcock and Wilcox, contrasted the sourcing of internal and external information reflecting our distinction between EIS and on-line sources. The RIBA (1963) method provides the detailed functional activities such as:

- carry out study of user requirements
- carry out study of site conditions
- examine planning, design and cost feasibility".

Carson (1971) quotes E. Mogan, chairman of Yardleys:

"Most decisions in business are not intellectually taxing. It's a question of getting the right kind of information".

In the 1980s Naisbitt (1982) identified his first Megatrend as being the movement from an industrial to an information society. However, one can note that whilst information may assist, it may not guarantee good decision-making. Carson (1971) quotes Dr. Laas of the Langeburg Co-op:

"You can get all the studies and information in the world and still make the wrong decision".

Also, how the information is to be obtained is not always well- described. Birch (1984) sees the questioning process as being critical to management:

"The role of the General Manager is questioning, finding out, probing, in the light of a changing industry. I'll look, listen and learn".

Kaufman (1991) stresses that the information has to be available:

"Expertise in problem-solving is highly dependent on the availability of extensive, well-organised domain-specific knowledge".

Thus information-gathering is viewed as particularly important by many as it appears to fulfil an enabling role although it cannot guarantee success.

To turn now to on-line information, we mean by this data which is accessed by computer but held externally to the company. The 1980s saw dramatic growth in the availability and usage of on-line databases and we can review these developments before considering the position for the 1990s.

The US on-line industry paved the way for what would subsequently emerge in Europe. In the mid-80's Holmes (1985) offered the following mix of historical growth and forecasts from different analysts in US \$ billions:

TABLE 3

Frost & Sullivan	1982 - \$0.5b.	1987 - \$1.43b
Link	1982 - \$1.0b	1987 - \$3.0b
Communications Trends	1984 - \$1.4/1.5b	1988 - \$4.4/5b

Analysis was also made of the delivery mode with Communications Trends providing the following figures:

TABLE 4

	1984	1988
Print	76%	65%
Electronic	14%	26%
Face to Face	10%	8%

In one example of year-on-year growth Cuadra Associates listed 1,700 databases in 1983 which in the following year rose to 1878 with the number of on-line distributors increasing from 213 to 272. Between 1982 and 1987 Link projected increases in US \$ millions by sector:

TABLE 5

	1982	1987
Industry specific	\$28.2m	\$73.4m
Industrial directories	\$1.8m	\$8.4m
News archives	\$19.38m	\$130.22m

The greatest expansion in the period up to 1987 actually came from the Marketing sector followed by financial databases and credit information. Packages soon appeared such as Hotline which offered 6 news services, 4 services on company information, 9 services on markets and 5 IT databases. The ICC database claimed to cover every line limited company in the UK and Eire along with over 600,000 dissolved companies including trading addresses, names of Directors, details of activities, SIC codes, profit and loss accounts and balance sheets.

The high growth rates in the 1980s look set to continue into the 1990s. Warlock (1990) estimated the Western European on-line market at between \$1.777 million in 1988 and \$ 2.055 million. Growth rates of 22-25% in the 1980s were expected to drop to 15% by 1992 and then 10% per annum by 1995, but in this year the value was expected to be \$ 6,700 million.

Fischer, Feder and Gurney (1990) see the Western European market as \$2.4 billion in 1990 of which \$2 billion was in financial services suggesting this replaced Marketing as the highest growth sector in the 1980s. Growth rates were running at 19.2% per annum and by 1994 the market was estimated to be \$ 5.8 billion. Steady increases were also forecast for the North American market, as follows:

TABLE 6

1989	\$8.587m
1990	\$9.675m
1991	\$10.916m
1992	\$12.335m
1993	\$13.962m
1994	\$15.829m

Whilst absolute figures may vary, the clear picture to emerge is of substantial and sustained growth with many billions of dollars in both America and Europe being invested in the development and maintenance of information databases.

Turning now to the users of such information a survey by Willis (1986) confirmed the rate of penetration of on-line databases in businesses. Whilst the banking and financial sectors dominated usage in the early years, these by the mid 1980s only made up 9% of business users of on-line sources. Manufacturing accounted for 9% as did Engineering. Other examples were:

TABLE 7

Printing and publishing	4%
Food and drink	3%
Retailing	2%
Farming	1%

The size of organisations was on average 7,500 employees but varying between those with over 75,000 and at the opposite extreme a single farmer. The occupation of the users was dominated by information specialists who made up 33% of the total, followed by managers at 14% and scientists at 13%. Thus managers were already greater users of on-line databases than scientists and in the words of the survey:

"Management are beginning to use business databases as part of their normal function".

The survey also suggested that growth had been recent with 49% of respondents having been using the databases for less than 2 years. Equipment used to access databases came out at 64% for microcomputers and only 5% using dedicated terminals.

The uses to which information was put revealed that the main reason for instituting a search was given as 'helping in decision-making' which occurred in 55% of cases. In contrast Research and Development was referred to in 30% of cases. The area obtaining most benefit was 'all areas of the organisation' at 20% with 'technical' coming out at only 1%. The most common justifications for opting for on-line access were speed, accuracy and wide range of information which were referred to in over 80% of cases. Specific common comments were:

- Provides a wide range of easily accessible, interactive and up-to-date information.
- Selectivity of information
- Sophisticated search parameters
- Flexibility

The computer is obviously in a position to provide increasing assistance to managerial and executive problem-solving. A similar picture emerges in the next chapter when we consider expenditure on and usage of internal sources of information.

Clearly many problems will not be associated with relevant on-line data but equally the research and surveys show that vast sums are being spent on databases and businesses are making use of them, principally to aid decision-making.

STAGE 3 - ANALYSIS

In the sense that the gathered information needs to be understood, 'analysis' can be proposed as the next stage. However, many methods have analysis earlier, particularly associated with problem definition. Some or all of the following may be associated with analysis.

Understanding the information (what it literally means)

Understanding its significance (what it implies)

Identifying appropriate structures for the information

Establishing linkages between the elements of the data

Clearly the term can be used to cover a multitude of different approaches and techniques but there are three aspects that are frequently alluded to by methods designers.

1. Understanding the problem (clarifying)
2. Structuring the data (ordering, classifying, weighing)
3. Modelling (conceptual or physical)

If we take 'understanding' first, Hogarth (1980) suggests that all people in an increasingly complex society share the problem of processing information for judgemental purposes:

"... there can be little doubt that the need today is for conceptual skills, that is the ability to process information and make judgements".

Some argue that comprehension comes with prolonged exposure, for example Stake (1972):

"Understanding comes with repeated encounters. Something worth knowing needs to be looked at from several viewpoints. Even in the greatest ambiguity, that of substance emerges on repeated probing".

The way information is presented can help analysis and managers increasingly make use of graphics to generate insight. The Software Publishing Corporation had findings reported in Audio Visual (1993) that 49% of actual use of graphics software is for querying and analysing information. Furthermore, a particular problem to arise is that the viewpoints of different individuals can vary - Stake again:

"Every aspect ... holds at least as many truths as there are viewers. Each sees value in a different light. The evaluator has no cause to force a consensus but certainly to show the distribution of perceptions".

This has great significance for the manager who has a primary role not only in understanding problems but also in ensuring that varying perceptions are harmonised as far as possible because of the degree of dependency implementation will have on those who are affected by the decision made. PDS allows for the mathematical reconciliation of relative rankings and COPE facilitates the merging

of differing conceptual models. In the first Case Study in Chapter 6 we can examine the varying perceptions that emerge on a specific issue and how successfully these are reconciled.

Turning to structuring. Checkland (1981) explains his 'analyse the problem situation' phase as being concerned with an examination of the Structures and Processes and the Relationship between them. The Post Office (undated) system includes a phase 'weigh the data' which breaks down into a number of sub-issues:

- Ask specifically, "what don't we know?"
- Sift the important from the unimportant
- Consider the reliability of figures and opinions
- Consider width of impact
- Consider policy considerations
- Consider qualitative considerations
- Consider uniqueness.

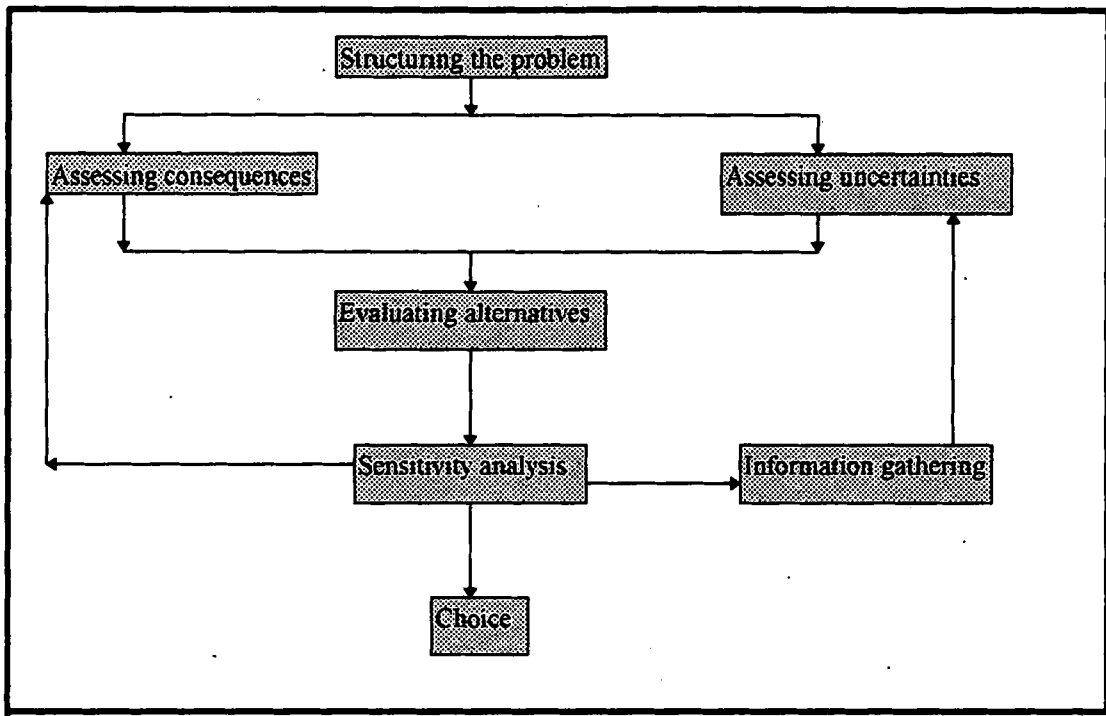
Thus there is an element of ordering and sorting so as to get a better feel for accuracy, relevance and implications. For those associating analysis with problem definition rather than data, structuring is also relevant. Hogarth (1980) considers that techniques of Decision Analysis offer 'the most comprehensive approach to structuring design problems'. For him, all decisions depend on the answer to two questions:

1. What are the consequences of alternative actions? That is, what is at stake?

2. What are the uncertainties in the environment relevant to decision?

Hogarth then suggests a structure for structuring which is depicted as follows:

FIGURE 1



Whilst this may be useful, and indeed valid, the immediate problem it presents is in its assumption that analysis goes beyond the immediate issue of considering the data gathered to include alternatives which for many methods is held back to a later stage. Specifically, also, information gathering appears as a consequence rather than a precursor to analysis. Thus there is an implication which appears reasonable when considering the overall process that analysis can be carried out on more than one facet of the process. We analyse the problem, the data gathered, the processes involved, the alternatives, the consequences and the implementation plan. To assist analysis we can create structures which may often imply a visual representation.

Examples of visual representation from within established business practice are PERT, CPM and Work Study. Methods such as those of Buzan (1974) and Sibbett (1981) also involve structured or semi-structured representation. Earlier applications of COPE concentrated on identifying causation and a variety of techniques can be noted in the next section under this heading. For example Malpas-Sands (1982) describes the use of a matrix which relates symptoms to causes.

A particular and pervasive structure in organisations is that of the hierarchy and it can manifest itself in many situations including the organisation of people, aims, ideas or objects. With people hierarchies Naisbitt (1982) identified the shift from hierarchies to interactive groups as one of his ten megatrends. In practice most organisations continue to have basic hierarchial structures from the Directors and top executives or managers down to the rank and file. Hierarchies may be flatter and

decision-making less bureaucratic but this only means that the shape of the hierarchy may be changing.

Conceptual hierarchies are equally pervasive. Goals and objectives for example are usually based on hierarchical ordering. Hogarth (1980) cites the Woodward-Clyde consultancy which had as its highest statement of purpose:

"The combined efforts of Woodward-Clyde Consultants and its affiliates are directed toward the creation and maintenance of an environment in which their employees can realise their personal, professional and financial goals".

This is then broken down into two main sub-objectives, growth in professional capabilities and financial growth. Each has several tiers of further sub-division involving greater specificity such as 'retained earnings' and 'incentive compensation'.

In a more abstract example from the field of design Eberhard (1970) views complexity in ascending order of generality with the initial issue of the design of a door-knob. This leads to 'the best way to close a door', through 'do we need a door?' and 'do we need an office?' to ultimate considerations of the need for a capitalist democracy. Conversely, through infinite regression the door-knob issue could entail reference to the structure of a man's hand, then metallurgy and ultimately atomic physics.

Finally with modelling we have a particular mechanism which includes, among other attributes, the capability to promote understanding of the functioning of and relationships within a system. Models can serve two principal roles, one being the examination of the model in order to identify how an ultimate system might operate and the other being an explicit comparison of the model with the existing system in order to locate differences and, hence, areas that may require changing.

Models may be physical (e.g. the RIBA (1963) method refers to 'construct prototype'), they may be statistical or they may be conceptual. Stainton (1982) advances the concept of a spectrum of models. Thus with aircraft design they could be:

- A mathematical model of inflight stresses
- A functional model of the layout of the facilities of the aircraft
- Wind tunnel experiments on a scale model
- A prototype which would undergo many hours of test flights

The Severn Barrage project (Severn Barrage 1987) provides further support for the use of multiple models in complex problems. It incorporates, for example, the following:

- A salinity model
- A tide model
- Sediment modelling
- Ecosystem modelling
- Energy capture model
- Risk models

Whilst the application of modelling in engineering situations presents few surprises, there would appear to be less obvious relevance to the more conceptual and intangible problems often faced by managers. Checkland (1981), as we have seen, argues for the creation of conceptual models which are then compared with the problem situation. Kraemer and King (1986) note that models are beginning to establish a role for themselves in policy-making organisations although they suggest that the extent of use derives principally from a desire by bureaucrats and politicians to support their decision-making processes with quantified data. We can also note in the case studies described in Chapter 6, examples of the creation of models and explicit comparison with existing systems, which appear spontaneous rather than resulting from the application of any particular method.

Spread-sheets facilitate the creation of basic statistical models and particular facets of conceptual models can be entered on computer through packages like COPE or Magna Charter which replicates flow-process diagrams. Clearly, more is needed if the varied analytical aspects referred to here are to be integrated into a larger system and we return to this issue in Chapter 7.

Taking the implications of these sections into account, analysis clearly needs to be taken beyond the initial assumption that it is a process concerned with 'dis-assembly' and which operates only after the information has been gathered. In practice it can be regarded as a continuous activity operating on a variety of facets of the problem such as problem definition, objectives, data, alternatives and implementation. Furthermore, the activity may involve understanding the information and structuring, categorising or modelling it. A common sub-sequence is the creation of a model followed by a comparison of the model with the present system or situation. Executive Information Systems, discussed in the next chapter address, amongst other things, making information more accessible and understandable and through hierarchically-ordered layers of detail, allow managers to analyse problems in greater or lesser detail. Some writers, e.g. Kepner-Tregoe (1980) argue that an essential part of analysis is to focus on essentials or 'Driving Forces' and Rockart's (1979) promotion of Critical Success Factors underlies the initial development of Executive Information Systems. The Tools and

Techniques handbook (Tools and Techniques 1988) adopts a similar approach in sub-dividing the Analysis phase into four elements;

1. Identify problem causes
2. Select the most probable cause
3. Decide if root cause found
4. Define root cause of problem.

STAGE 4 - OPTION/SOLUTION GENERATION

Having identified and refined the problem (stage 1), having gathered further data (stage 2) and analysed it (stage 3), the rational approaches suggest that one should generate ideas for solution. Thus Kanter (1970) has, 'Develop alternative solutions' and O'Shaughnessy (1972) refers to 'alternatives defined'. As without choice there can be no decision (Hodgkinson 1978) the basic premise that option generation precedes decision-making appears not unreasonable. There are however problems in accepting the 'rational' approach's suggestion that it must follow information-gathering and analysis particularly where time precludes full analysis and answers must be provided swiftly. On two further counts the role of option generation needs to be clarified and expanded:

1. There is a need for evaluation
2. Options exist at various stages in the process

Firstly, there is more to the activity than simple option generation. Having been identified, options have to be compared and evaluated. We noted Hogarth's (1980) assertion that 'additional information-gathering' follows option generation and is critically linked with evaluation. In addition one of Hogarth's two fundamental questions in Decision Analysis terms is 'what are the consequences of alternative actions?' This suggests that the phase may imply not only generating options but analysing them, for which information gathering may be needed, and comparing them so that a decision can follow. Thus Huber (1980) distinguishes between:

Generate alternative solutions
and
Choose among alternative solutions

whereas Cooke and Slack (1991) have both 'determine options' and 'evaluate options'. The Project Management Handbook (1992) provides even more detail with:

-Reviewing the risks associated with the options and the chosen solution and determining the risk management strategy

and

-Reviewing the time and cost against the options and against the chosen solutions.

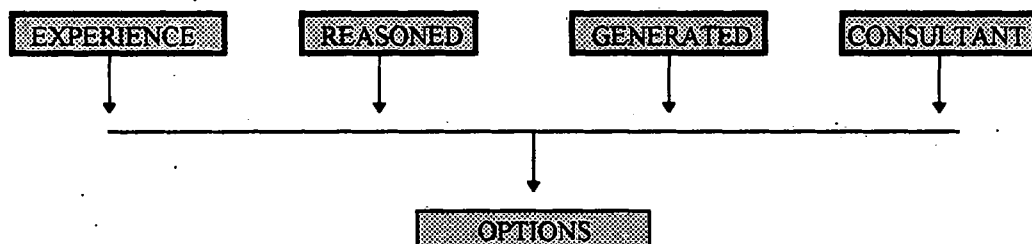
Secondly, one has to question the assumption that the options refer only to the main problem under scrutiny. One can argue that there are options for any of the following:

- Options for tackling the problem.
- Options for candidates for problem-definition
(cf. Checkland's various 'root definitions').
- Options for sourcing any information needs.
- Options for implementation.

The validity of the multiple-option argument can be tested in Chapter 6 when the fieldwork is considered. For the remainder of this section we can turn our attention to two principal areas:

1. The sourcing of options - where do they come from?
2. The evaluation and comparison of options.

To take option sourcing first, if we consider the manager facing a particular problem it can be argued that there are four broad categories for option-sourcing, as shown below, although they are not discrete.



Experience, reasoning and generation are essentially cerebral - the manager can carry out these approaches at his desk using his own mental capabilities. Experience is, as it suggests, use of personal

experience in the past to suggest ideas for problem solution whereas 'reasoned' implies rational analysis of the data to identify solutions. 'Generated' implies the use of particular techniques to sponsor original ideas. With the 'consultant' category the manager turns to other people for ideas although these people may, independently, use any of the first three categories to help identify the ideas. The justification for separating this process is that it requires a different activity on the part of the manager, involving communication with those consulted and this has implications for the system specified in Chapter 7. Each of these can now be considered in further detail.

With experience the problem-solver links his perception of the problem under scrutiny with his experiences of dealing previously with similar problems and applies successful strategies to or eliminates unsuccessful strategies from the new problem. Brown (1981) presents a distinction between options which derive from 'old thinking' which is experience-based and is acceptable 90% of the time and 'new thinking' which may be using old channels in a new way and/or utilising new channels. Few would challenge the assumption that managers rely heavily on experience when generating and selecting solution options. However, the issue with relevance to this thesis is how experience can be captured or stored and then subsequently accessed. The section in Chapter 4 on Expert Systems returns to this theme.

We can also recall the linkage in Chapter 1 between experience and intuition noting L R Sprecher's view (Agor 1991) that 'intuition is really a sub-species of logical thinking'. The view has also been expressed by Eastmen (1970) who relates intuitive design processes to design experience and Kaplan (1973) who considers it to be pre-conscious 'logic-in-use'. Isenberg (1991) notes that practising managers rely heavily on intuition and this can manifest itself in five principal ways:

1. He can sense when a problem exists
2. It can help him perform well-learned behaviour patterns rapidly
3. It enables him to synthesise isolated data and experience into an integrated picture
4. It can act as a check on rational analysis
5. It allows him to by-pass in-depth analysis and move rapidly to plausible solutions.

In our first category solutions present themselves because they have been used in the past, hence experience, which may be directly of the actual original case or via case studies, publications etc., suggests them as candidates. With the reasoning category we use whatever deductive, analytical or other systematic processes we choose to 'work out a solution'.

With consultation there are a wide variety of people that a manager can turn to in order to get additional ideas for problem- solution. They may be colleagues, subordinates or experts within the company. They may be consultants or other companies, particularly where 'borrowing' ideas is concerned. The main issue for an integrated computer system is the implied requirement that it provides the capability to communicate with others and, for convenience, offers a directory of potentially-useful people to contact.

With the generated category we simply mean the use of specific tools and techniques to help create new ideas or unblock the roads of inquiry. One valid approach to creative thinking is to select or recruit those individuals who appear to be highly creative, (cf. Roe's (1952) work on the characteristics of outstanding thinkers). However, our concern here is the use of tools to enhance managerial problem-solving capabilities.

Typical of the more commonly-encountered techniques would be Gordon's (1961) Synectics, Zwicky's (1962) Morphological analysis and Kawakita Jiro's 'K-J' method (Hogarth, 1980). Brainstorming is widely used within business organisations and, in the next chapter, we return to the issue of electronic group problem- solving. De Bono (1977) can also be regarded as having an impact with his concept of lateral thinking. Examples of what Ackoff (1978) refers to as 'exciting' or 'beautiful' solutions are also not difficult to find. Adams (1974) refers to a creative solution to the problem of reducing wastage during tomato picking. Ackoff (1978) describes how fish mortality in a trawler's tanks was limited and Bridges (1984) explains how better use was made of spare capacity on international transport aeroplanes.

However, it would appear to be particularly important in the business context to acknowledge that the generation of ideas is only a part of the overall process and manuals such as *Tools and Techniques* (BT 1988) are at pains to incorporate, say, Brainstorming within a wider process. Another point is Brown and Rickards (1982) suggestion that creativity has become discredited as a topic for management education because of a massive failure to distinguish between what managers think about as creativity which they associate with outstanding scientists and artists and what creativity trainers like Osborne and Parnes had in mind when developing tools to unblock thinking processes. Spender (1952), albeit referring to the poet, stresses the need for commitment:

"A poet may be divinely gifted with a lucid and intense and purposive intellect, he may be clumsy and slow, that does not matter, what matters is integrity of purpose and the ability to maintain the purpose without losing oneself".

Sinnott (1959) notes that insight seldom operates in a vacuum:

"Inspiration ... rarely comes unless an individual has immersed himself in a subject. He must have a rich background of knowledge and experience in it".

This is confirmed by Lodge (1987) whose work is closely concerned with the creative element in new product development and who speaks as a practitioner:

"Much has been written about 'creativity' processes ... and there is a kind of holy reverence about where ideas come from; but inventiveness is no more than very hard work to assimilate the relevant data and then interpretation of these data by lively minds intent on problem-solving".

Finally, Kaufman (1991) observes that there:

"... has been a narrow perspective in the field of creativity research that has focused mainly on the very general capacities underlying creativity at the expense of the extensive domain-specific knowledge and skills that have to be present for high-level creativity to unfold".

Particularly where implementation is concerned constraints may condition or modify the range of feasible solutions. Constraints can be real and highly relevant to the evaluation of options or they can be 'imagined' - a block on the road of inquiry - which creative techniques can help 'unblock'. 'Blocks' may exist because the solution cannot be perceived or because organisational or other interests prevent acceptance. Another category of limiting factor may be personal interests of affected people and their associated power base. In military decision-making Sixsmith (1970) noted that the adoption of novel solutions was often inhibited by vested interests, an example being the refusal to accept the new tactical innovations of Fuller and Liddel Hart because they would have entailed the disappearance of the horse from the British Army.

A crucial issue may well be whether there is any limit on the options boundary. At one extreme are the views of those such as Heath (1970) who suggests that:

"All restrictions which we introduce on any design problem (including the definition of the problem) are to some extent arbitrary and in all problems the number of possible courses of action is infinite".

Others prefer the view that, in practice, constraints do exist. Thus Maver (1970) comments that the:

"... universe of possible design solutions is limited by the client's limited finances".

The Project Management Handbook (1992) includes a specific step - 'Define any project constraints' with particular reference to 'standards, regulatory, policy, timing'. Coxon (1983) considered the

complicated interplay of variables which helped or hindered the range of options possible, citing geography, attitudes and even highly localised issues such as the performance of contractors. However, in another practice-based reference there is a suggestion that the two views are not necessarily mutually exclusive.

Van de Vliet (1986) quotes Watkins, general manager of Lucas Industries:

"Next, I said, imagine you had a greenfield site. How would you structure your business to make it the most professional going? Employ as many or as few as you like, demonstrate the cost structure; you don't need to employ a foreman just because Lucas always has foremen".

Hence the initial thinking was constraint-free and in Watkins' view, more fundamental. However, it was still necessary to reconcile the output with the practical realities - in Watkins' words:

"We didn't have greenfield sites - we had city streets and mud tips and old factories".

Thus for the manager there are a number of choices as to how he approaches the identification of new candidates for problem- solution. He can rely on his own experience or work through the problem logically and rationally. He can turn to a technique to help 'unblock' his thinking which he can use in isolation or, as with brainstorming, with others. The use of input from other people can be extended to include specialists either from within the organisation or, as with consultants, from outside. Assuming some options are identified, the next requirement is to evaluate them.

This can take many forms. Dill (1964) refers to the need to 'test' alternatives whereas O'Shaughnessy (1972) specifies 'consequences identified and evaluated'. Earlier we noted Hogarth's (1980) emphasis on the need to assess consequences to which he added consideration of the environment. Turban (1990) has 'predict and measure outcomes' of the various alternatives, along with verification, testing and sensitivity analysis.

Drucker (1955) suggests that options should be classified in terms of four criteria:

- The futurity of the decision
- The impact of the decision
- The number of qualitative considerations
- The uniqueness or periodicity of the decision

whereas Cooke and Slack (1991) consider that evaluation should take account of Feasibility, Acceptability and Vulnerability.

Latham, Terry and Taylor (1965) developed the PABLA system, abbreviated from Problem Analysis by Logical Approach using forms and standard questions. For example, Section C3 involves a comparison of the different 'methods of fulfilling requirements' by reference to conflicts of theory, practice, size and materials, production aspects and probable costs. Similarly, the Post Office (undated) system suggests the need to have regard to objectives, policies, resources, time, human factors and costs.

The pragmatic BIM checklist includes the following questions:

Have you made a list of possible lines of action?

Have you assessed the probable outcome in each case?

Can problem areas be simulated by scientific techniques of analysis?

A number, e.g. Manheim (1970), propose that alternatives are 'ranked' and we have seen in the previous chapter that systems such as PDS and NIPPER produce rankings based on the input of preferences by one or more users. Manheim also argues for the repeated execution of search procedures, each cycle expanding or modifying the range of options.

Meindl (1982) offers a classification system which relates the numbers of options to the numbers of goals and this reminds us that the existence of multiple goals can considerably complicate the evaluation process. Huber (1980) refers to decisions taken in the context of multiple goals as being 'multi-criterion' decisions and discusses a range of multi-attribute utility models.

Thus considerable analysis may need to be carried out on the options before selections can be made and these can involve considering how practicable the options are as well as how acceptable they will be to those affected by the outcome. 'Political' factors may require analysis in their own right and 'voting' techniques or those incorporating a voting element can be used to externalise personal viewpoints, such as the Castle technique, Electronic voting, sticking dots and NGT (see Van Gundy 1988).

Risk is also a key issue coupled with practical considerations such as cost and timescale. Support methods may involve quite sophisticated mathematics although more basic approaches may also be sufficient. Virkkala (1984) comments:

"it seems that heavy, mathematics-intensive, decision-analysis methods have little use in everyday life. They may even be harmful as compared with simple methods complemented with human intuition and judgement".

STAGE 5 - DECISION/CHOICE

On the assumption that option evaluation has given a clear indication of the relative strengths and weaknesses of the candidate solutions, then in theory Decision-making follows naturally. This can be referred to as 'Choice' (Clifford, 1976), 'Perform selection' (Honey, 1986) or 'Selection of best (good)' (Turban 1990). In others, there is no specific reference to selection e.g. RIBA (1963), Kanter (1970) or the Project Management Handbook (1992) which jumps from Development to Installation.

In two important respects Decision-making can be seen as more fragmented than this. As with a number of other headings we can note that decision-making can take place on a number of occasions during problem-solving and this could include decisions on what the problem definition should be, decisions on how to organise the project and decisions on how the chosen solution is to be implemented. The Project Management Handbook (1992) states:

"The life-cycle provides suitable control/review points so that the project client and the business can make decisions on how the project should progress or be stopped".

Secondly, any number of people may have to agree before the issue can be regarded as 'decided-on'. They may be managers at similar levels but each representing their divisional or specialist interests. Or there could be an hierarchical implication where a decision needs to be referred up for concurrence. This is often referred to as 'authorisation'. For example Mintzberg (1991) has 'authorisation' as a separate phase after 'choice' and Heller, Drenth and Koopman (1982) refer to it as setting the seal of approval on the preferred option.

Another key issue is over the decision-timing. Huber (1980) comments:

"In essence, managers make a separate decision concerning when they should decide - immediately with the available information or later after obtaining more information".

Hickson et al (1986) in their major survey of decision-making in organisations noted that 'timing can be vital'. The point is echoed in a variety of situations from the Seventeenth Century samurai strategist Miyamoto Musashi (1974) who stated:

"There is timing in everything. Timing in strategy cannot be mastered without a great deal of strategy. There is timing in the whole life of the warrior, in his thriving and declining, in his harmony and discord. Similarly there is timing in the way of the merchant, in the rise and fall of capital".

through to E.Huggins. Managing Director of Dow Chemicals (Carson, 1971) who commented:

"The first decision you have to make about any problem is the timing: how important is it that I make this decision and is it a matter of today, tomorrow or next week ... Many decisions have a 50:50 chance of being right and it is often timing that can make the difference".

Thus timing may relate to when it is propitious - when the maximum financial gain can be achieved or when it is likely to be most acceptable. Or it may be conditioned by a deadline which prescribes when the choice must be made. Or it may be affected by priority with the more important issues dealt with before the less significant. Finally, one can note that there is often a 'committee cycle' in organisations that will either be hit or missed.

STAGE 6 - IMPLEMENTATION

Whilst an extensive body of literature exists on the management of change, implementation is usually afforded only limited coverage by staged-methods proponents although, as has been noted, practice-based methods tend to cover it in greater detail. Most, however, accept its importance. Drucker (1955) comments:

"Management is not concerned with knowledge for its own sake; it is concerned with performance".

White (1975) sees it as inseparable from earlier phases:

"The implementation cannot be divorced from the decision-process since implementability must be considered in the selection of courses of action".

Owen (1982) agreed:

"Even top-class strategies are worth nothing if they cannot be implemented ... more attention is being given to ways of improving the rate of success in implementation: better a first-class implementation procedure for a second-class strategy than vice-versa".

Hence, most methods-designers make some reference to implementation. O'Shaughnessy (1972) refers to 'courses of action taken' and Nadler (1970) has 'instal system' whilst Jenkins (1969) adds 'operation'

to 'implementation' as do Cooke and Slack (1991) who couple 'monitor' with 'operation'. Turban (1990) injects 'plan for implementation' and 'design central systems' before implementation.

Practice-based methods often provide much greater detail at this point. Allio (1972) refers to the 'preparation of strategic programmes' and the RIBA (1963) method has 7 of its total of 12 main phases devoted to implementation. Examples are as follows:

'Bills of quantities

- prepare bills of quantities
- prepare tender documents

Operations on site

- provide design and construction information
- implement construction programme
- instal and effect budgetary control
- install and effect quality control'

Poulet (1986) proposes a 7-step approach which also places great emphasis on implementation mechanisms. He comments:

"It may seem incongruous at first sight to relate mundane details of admin. to the exotica of strategy. However, every element of strategy impinges on the way the entire company is managed and administered."

4 of the 8 main stages in the Project Management Handbook (1992) are also associated with implementation although one could argue that the first two are more appropriately associated with 'design' or 'development'. The final four stages are:

Installation.

To put in place, test and prove the deliverables against the acceptance criteria in an operational environment prior to going live.

Pilot

To test the project deliverables in their operational environment so that it can be demonstrated that the benefits stated in the Business Case are achievable.

Roll-out

To replicate the project-deliverables over a wider operating environment.

Post-implementation

To formally close the project, having handed over the deliverables for operational use and with benefits starting to accrue.

The examples illustrate two significant dimensions of implementation. In the first we see highly specific activities, e.g. 'prepare tender documents' which will apply not only to the architectural field in which context the RIBA (1963) method is proposed but to any occasion where contractor-tendering is envisaged. Thus their specificity relates to that particular activity. One can assume that a very large number of function-specific, e.g. engineering, activities or company-specific, in that they form part of the accepted company process, could be identified.

One can also note the protracted 'testing' that takes place, particularly in larger organisations, before the ultimate full-scale implementation occurs. It follows that, as we indicated in the previous section, repeated decision-making cycles may take place, for example after test and after pilot, which sanction continuation or abandonment.

Implementation requires some change to existing practices or processes and could entail communication with those affected, training, changes to documentation, meetings and a whole range of specific actions. The increase in the size and complexity of many projects has been accompanied by greater use of systems or techniques like Critical Path Method (CPM) which provide visibility over the whole range of activities as well as a modelling capability to reflect changes in activities or timescales.

REVIEW

In reviewing this section on staged methods we can note that whilst there are some remarkable similarities between the methods, this survey of staged methods will also have demonstrated the enormous diversity that exists between the various methods and evaluation is made harder by the fact that little justification is given for the sequence of activities and there is even less research on the relative merits or successes and failures on the different approaches. Van Gundy (1988) raises this issue although he is referring to creative problem-solving techniques:

"... little research is available for suggesting which techniques are likely to work best in which situations. This lack of a supporting research base is probably due to disinterest ..."

Kaufman (1991) comments:

"The central questions to be answered here are whether the process of problem-solving can be divided into distinct phases which exist across a wide variety of different tasks and whether they follow a simple and orderly sequence. The answer to the first question seems to be in the affirmative, while the answer to the second is essentially negative".

With several of the stages, particularly information-gathering, analysis, option generation and decision we have seen that these are activities which can occur throughout the process and Kaufman's assertion that no orderly sequence appears must be supported. However, on the basis of the evidence seen here it is doubtful whether we can support Kaufman's suggestion that the stages are distinct and the closer we get to practice-based models, even allowing for the context-specific terminology, the harder it is to reconcile the activities described with the stages of the 'rational' designers. Inviting contractors to tender, for example, is a clear and unambiguous activity within organisations yet is it 'information gathering', 'analysis' or 'implementation' and, even if one could agree on an answer to the question, would it help?

On this basis we can accept that the activities stated or implied in the various methods are valid and relevant to problem-solving. As such any manager-support system should aim to provide tools or facilities that assist in carrying out and managing the activities. However, to use phasing as the basis for the system in the sense that anyone using it would be obliged to follow the prescribed sequence would seem unhelpful at this stage in the light of the unresolved research issues. However, in adopting more of a tool-kit approach, we are not precluded from including phased methods as individual tools in the kit, available to be selected just like any other.

This then raises the question as to whether there are any phases to problem-solving. Kaufman (1991) suggests that there are three phases - preparation, production and judgement - and that these are empirically distinguishable. This appears particularly relevant to 'creating' problems such as new product design. However when we consider problem-solving in a broader context and when repeated activities are eliminated we can make a judgement that there are three general areas which approximate to stages and these are:

1. Problem recognition

Finding out a problem exists, refining and defining the problem, establishing terms of reference where appropriate.

2. Problem examination

Looking at the problem in greater detail, analysing the data, generating alternatives, building models, testing assumptions, trialling options, determining and deciding on acceptable solutions.

3. Implementation

Planning and installing the desired changes, checking to ensure that the systems are operating as intended.

This approach and Kaufman's are not incompatible but the emphases differ. Kaufman's preparation spans our 'problem recognition' and 'examination'. His 'production' appears to be subsumed within our examination. His 'judgement' reflects 'decision-making'. For Kaufman problem-solving appears to stop when a decision is made and it is not unreasonable to take this view in many situations. However, the role of the manager usually requires him to effect any decisions and normally he will be judged ultimately not by his ideas but by the results he achieves which may well reflect success at introducing such ideas.

Each of our stages can involve one or more cycles of data gathering, analysis, option generation and choice. Furthermore, any process that aims to be directly helpful to managers needs to take account of any context or company-specific sub-processes that are already an integral part of business operations such as RIBA's (1963) 'Construct pre-production prototype' and Kanter's (1970) 'evaluate vendors'.

PART 3 - TOOLS AND TECHNIQUES

A number of publications have addressed the issue of linking particular tools and techniques to the sorts of phases described in the previous section. Whilst we have identified difficulties in adopting any particular problem-solving sequence, we can accept that the staged methods reviewed do represent genuine activities which may be repeated on a number of occasions. If tools and techniques are available which can help managers to carry out the particular activities then they merit consideration, particularly as their ability to be communicated on paper suggests an equivalent relevance if communicated electronically within the sort of computer system we shall describe later.

One example of an anthology of techniques comes from Martin (1992). Here the techniques are grouped under headings such as 'Problem finding' and 'Mapping and structuring'. These are then further sub-divided - for example 'Problem finding' is split between:

Looking outwards

Looking inwards

Checklists for exploring

Defining and redefining

Examples from Looking outwards are:

The Search Conference
 Technology monitoring
 Gap analysis
 Alternative scenarios

Other publications relate techniques more specifically to problem-solving stages and we can briefly compare some of these. Koberg and Bagnall (1972) aim their book at the general reader and use the metaphor of the 'Universal Traveller' to provide thematic continuity. Van Gundy (1988) covers 105 techniques in a publication which makes references to 'business' and 'engineering' but has wider relevance. Tools and Techniques (BT, 1988) is an in-company publication designed within a major corporation for use by its managers. All three include broadly similar main stage headings. In the table shown below we list the particular tools and techniques which the authors suggest are appropriate for the 'analysis' stage or activity:

KOBERG-BAGNALL	VAN GUNDY	TOOLS/TECHNIQUES
Basic questions	Decomposable matrix	Brainstorm
Pack rat	Dimensional-analysis	Pareto
Synectics		Cause and effect
Back to the sun	Organised random-	Control comparison
Attribute listing	search	Problem analysis
Put down all you know	Relevance systems	'Is/is not'
What have others done	Input/output	Rating sheets
Analysis models		Consensus reaching
Morphological		Switch on/off-
Matrix		analysis
Search for patterns		Decision analysis
Expert consultant		
Expanding objectives		
Idea dump		
Sensitivity game		
Squeeze and stretch.		

One can immediately note that with a very few exceptions, e.g. 'matrix' and 'decomposable matrix', the lists appear to have little in common although it is possible that some underlying concepts are present, if not evident. None provides any research to support the appropriateness of the quoted

methods so evaluation has to be based on rational arguments and the main components of the activities. One might suggest that a number of Koberg and Bagnall's tools, e.g. Synectics and Morphological, are what one would expect to find under an 'idea/solution/option generation' heading yet the author's perception is that analysis is concerned with 'gaining deeper insights and new perspectives' and hence such techniques can help stimulate original viewpoints.

Further linkage of tools and techniques with activities or situations often occurs. Tools and Techniques (1988) relates methods to elements within 'analysis' which are split into:

- Identify problem causes
- Select the most probable cause
- Decide if root cause found
- Define root cause of problem

So, 'identify problem causes' is associated with Brainstorming, Pareto, Cause and Effect, Control comparison and Problem analysis whereas Define root cause can be linked with Decision Analysis. Martin (1992) describes the Strategic Management Process which links techniques with different 16 strategic types and this is then further sub-divided into a three-step process consisting of Search, synthesis and selection steps. Thus the Search step for the Comprehensive strategic type has Structured Brainwriting with dialectics and synectics as appropriate techniques.

The Project Management Handbook (1992) has a matrix which relates tools to project problems of which five are listed here:

- Responsibilities of team members unclear
- Project plan not being achieved
- Project team not working together
- Stakeholders seen as not being committed
- Project not clearly defined

To take one example, if the project team is not working together at the 'Understand the problem' stage then Cause and Effect analysis is deemed appropriate whereas if it occurs at the Evaluate Solutions stage then Decision analysis and Potential problem analysis techniques are considered potentially beneficial.

At this point in time (1994) it would appear premature to attempt to offer too much in the way of structuring and guidance for tool-relevance so whilst a manager-support computer system would undoubtedly benefit from the inclusion of tools and the references to such tools and techniques (e.g. by

guided index or checklist) this can best be offered as a reference source rather than more pointed directions on when to use them despite the potential for Expert Systems (described in the next chapter) to facilitate such guidance. Hopefully, further research in this area will help clarify relevance and appropriateness although fundamental issues, such as 'what is analysis?' or 'what is problem definition concerned with?', might usefully be addressed initially.

PART 4 - KEY ISSUES

The major contrast in this chapter has been between the rational, orderly and controlled perception of the problem-solving process implied by many methods designers and the fragmented, discontinuous and dynamic picture that emerges when the manager is observed at work. This is not to say that the prescriptive methods are not correct - there is little or no research to support or deny the argument - but that there are likely to be considerable practical problems in imposing orderly methods in an essentially 'dis-orderly' environment. Hence making them available rather than prescribed is viewed as more likely to provide value to problem-solvers.

Staged methods are widespread both in management literature and in in-company documentation although there is little evidence of their actual usage. The general methods which offer around half-a-dozen phases appear initially to suggest a useful framework for considering the problem-solving process but closer inspection rapidly reveals severe inconsistencies and shortcomings in what one can only conclude is too limited a representation although where only a very broad appreciation is needed e.g. in a training context, they may still be helpful.

A primary concern is the implication that stages like 'information gathering', 'analysis' and 'option generation' are separate and distinct whereas, as is implied by a number of authors, they are activities which are likely to occur repeatedly throughout the problem-solving process. The only stages that can exist logically are 'problem finding', 'problem examination/decision' and 'implementation' - logically in the sense that unless you are aware of a problem you can neither do anything about it, nor decide what to do. This is not to say that you cannot anticipate a problem and take action in advance, for example as with insurance. However, the fact that a particular event could occur - a potential problem - is recognised and a solution introduced to pre-empt it.

In addition, one can argue that actions will normally be pre-meditated with the main issue being the degree and thoroughness of the pre-meditation. The other 'stages' become in effect optional activities in the sense that one need not analyse, gather information or generate options however desirable they may be. Equally, one can cycle through these activities for each of our three discrete phases. Thus rather than a sequential list of stages we have a simple matrix with a minimum of three phases against each of which there is a choice of a range of activities which primarily relate to generating options, gathering information and analysis. This enables us to reconcile the often contrasting and frequently

conflicting views of the methods designers who argue for a rational approach but cannot agree on the underlying rationale. It also provides a framework within which practical problem-solving can be viewed. Conversely it is a looser, and consequently less prescriptive, framework that renders it less effective as a tool for those who require highly specified prescription, e.g. trainees. For the purposes of creating a structure which can be assimilated within a manager support system we can suggest that it would be appropriate not to base it on a staged approach firstly because there is little prospect of achieving consensus on what the stages should be and secondly because there are fundamental logical inconsistencies when certain phases are labelled as such whereas the preferred view here is that they are potential activities applied throughout the process. Our design specification need distinguish only between the three stages of problem-finding, decision/choice and implementation although it does need to reflect the different activities, tools and techniques that can apply at different points in the process.

Another fundamental issue to emerge is the existence of the 'context-specific' methods or routines which may apply to a profession, such as architects or construction engineers or may apply to the particular firm or organisation. Thus a firm may require all decisions on capital investment to be submitted in a standard way to a sanctioning body. These can be reconciled with our reduced three-stage scenario, for instance as part of 'decision/choice' but far less easily with many of the staged methods described above. These routines clearly may be more important and critical to the problem-solving process than the more generalised stage descriptions such as 'analysis' and 'option generation'. The issue is closely linked to that of 'process management' and the requirement in any more-comprehensive manager support system must be to capture both the general framework and its associated arsenal of activities, tools and techniques and the 'context-specific' routines which can be either desirable or even mandatory elements in the process.

Finally, in considering the role of the manager rather than the individual problem taken in isolation, we identified a perspective characterised by discontinuity, rapid changes and the existence of substantial numbers of problems existing at any one time. The manager juggles with these but selects between them according to priorities and the time available. Even harder is it to reconcile this with the concentrated, methodical approach implied by many staged methods but even more critical does it become to provide a support system that enables him to maintain visibility of the differing problems, their status and their inter-relationships.

In the next chapter we can consider what progress has been made in meeting these requirements through the medium of, arguably, the manager's principal tool - the computer. This enables us to establish what the computer has achieved and where it has failed and these elements can then be reviewed and revisited when we consider a framework for a future manager support system based on computer applications.

CHAPTER 4**COMPUTING RELEVANCE FOR MANAGERIAL PROBLEM-SOLVING**CHAPTER CONTENTSINTRODUCTIONGENERAL COMPUTING DEVELOPMENTSDECISION SUPPORT SYSTEMSEXECUTIVE INFORMATION SYSTEMSIMPLICATIONS FOR INTEGRATIONCHAPTER REVIEWINTRODUCTION

We noted in the earlier chapters some examples of problem-solving methods which involved the use of computers. The intention in this thesis is to consider the computer as the primary vehicle for delivery of problem-solving assistance but before considering what the content and structure of such a system might be it is necessary to examine the validity of proposing the use of computers to this end. The main issues relate to the extent of penetration of computers into the managerial environment, the ways in which computers are used covering both benefits and problem- areas, the types of applications used and the main thrust in terms of software development on managerial and executive problem-solving.

We can examine how the computer is impinging on the manager and on his job and the emphasis shifts from examining particular problems in depth to the wide range of tasks managers have to deal with at any one time. Here we repeat the theme introduced in Chapter 1 which distinguished between the manager dealing with an individual problem and the manager dealing with the totality of problems.

At the commencement of this research in the early 80's desk-top computers were scarce - now they are commonplace. If ubiquity were to be the main criterion for success then the invasion of the PC would be a success story. But we shall see that the research suggests otherwise. On the one hand managers and Chief Executives are critical of many aspects of the software and its functionality. On the other hand outside observers point to shortcomings in the way managers approach computing applications noting lack of imagination and an inability to exploit systems to the full. The computer remains a vital tool in the development of managerial problem-solving and progress in the last decade has been substantial. However there remain many problem areas and the arguments developed later in this thesis suggest how some of these can be addressed by bringing the software closer to the principal role

of the executive as he manages the multiplicity of different, albeit interconnected, issues on a daily basis. Potentially useful methods like COPE, PDS and NIPPER stand a better chance of moving from the periphery to the hub of managerial job progression if integrated within a system that seeks to encompass, if not the totality, then at least a wider spectrum of the tasks and activities dealt with by managers.

The chapter is structured as follows:

Section 2 provides a general review of computing in the managerial environment concentrating on published research which examines the penetration of computing into the manager's workplace, the usage made of computers by managers differentiated also by Department and by Industry as well as the main application areas.

Sections 3 and 4 examine two key development areas in greater detail. Section 3 concentrates on Decision Support Systems and the main focus is on Expert Systems with brief references to other support systems such as Groupware and Project Management Systems.

Section 4 considers the Executive Information System, arguably the most significant computing development for top executives but with increasing relevance to all managers.

Section 5 reviews the potential and actual integration of Expert Systems and Executive Information Systems along with other applications referred to in the chapter, where they are considered in terms of their relative contribution and their relevance to stage elements covered in the previous chapter.

Section 6 summarises the key findings.

The Chapter enables us to propose some key issues which can impinge on the specification of designs for computing systems for managers which, in subsequent chapters, can be compared with the findings arising out of case studies and field-work carried out as part of this research.

It is reasonable to question why, from the multiplicity of computing topics that might be deemed relevant, we choose to focus on Executive Information Systems and Expert Systems. Kroeber and Watson (1988) identify 6 categories of organisation-based computer system as follows:

Transaction Processing Systems (TPS)

Management Information Systems (MIS)

Office Automation Systems (OAS)

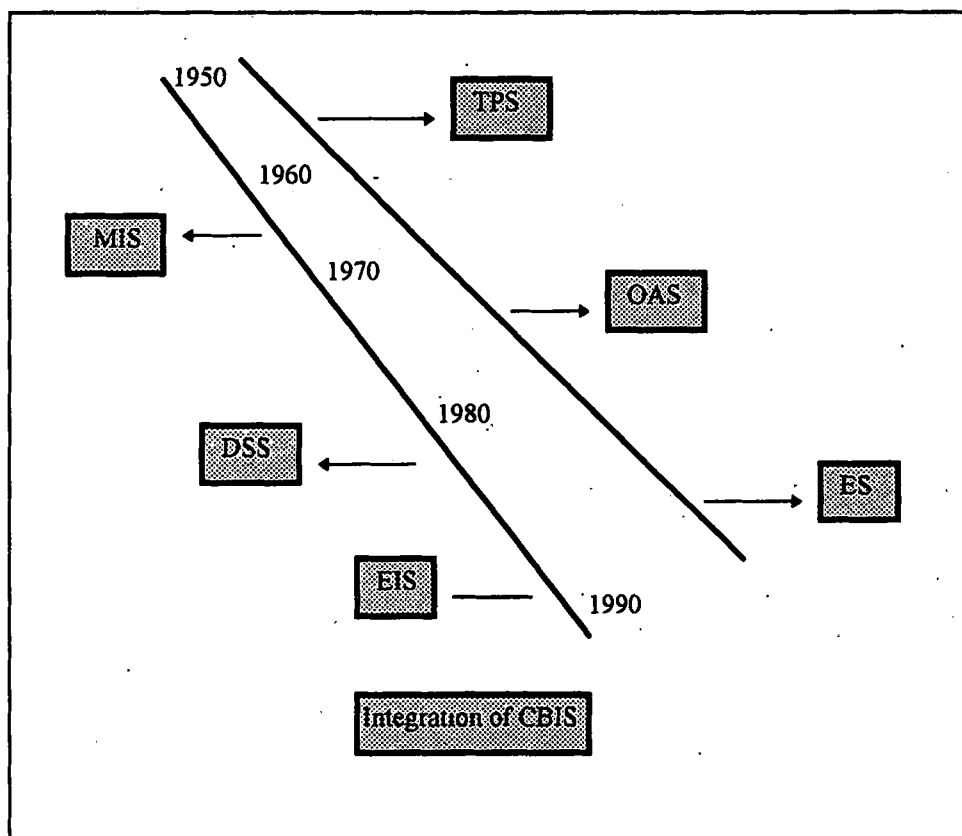
Decision (and Group) Support Systems (DSS and GDSS)

Expert Systems (ES)

Executive Information Systems (EIS)

and this is adapted and represented by Turban (1990) as shown below.

FIGURE 2



From this a development path can be seen which leads towards DSS, EIS and ES as the most recent developments with the current trend towards merger within Computer Based Information Systems (CBIS). Turban regards DSS, EIS and ES collectively as 'computerised management support systems'. Not only are they the most current developments but it is argued that there is a synergy between them that will potentially play a crucial role in computer-aided problem-solving developments in the next decade.

GENERAL COMPUTING DEVELOPMENTS

After a general introduction this section covers the following topics:

- Hardware and software volumes
- Computer usage
- Usage by sector or department
- Applications and developments
- Application benefits and shortcomings
- Review

Three significant issues were responsible in the 1980s for providing the impetus for greater use of computers by managers.

1. Micro-computers, now widely referred to as PCs, dropped in price, increased in power and became a practical proposition for the practising manager to use.
2. Software became more 'user-friendly' requiring little or no programming knowledge.
3. Packages were developed for and marketed to managers with practical application and market forces determining which survived.

At the beginning of the 1980s there were many confident predictions suggesting exponential growth in the rate of take-up of computing by managers and it is interesting to compare the original forecasts and predictions with what is happening in the 1990s. Rockart and Treacy (1982) noted the increasing use of computers even at Chief Executive Officer level, attributing it to the fact that:

"... user-oriented terminal facilities are now available at an acceptable price; executives are better informed of the availability and capabilities of these new technologies; and, predictably, today's volatile competitive conditions heighten the desire among top executives for ever more timely information and analysis".

By the middle of the decade King (1985) was reporting:

"Microsystems are no longer news. They are now as commonplace in offices as wastepaper bins and those that don't choose to adorn their working lives with them appear to the converted as quaint as flat-earthers".

This initial impetus has been both maintained and consolidated with Saunders and Jones (1990) noting:

"Computer-based management information, decision-support and knowledge-based systems are increasingly relied upon to improve organisational decision-making."

Hardware and Software volumes

Corroboration for such generalised statements can be found in objective data relating to shipment volumes. Roberts (1985) notes that in 1984 IBM sold more processing power on its PCs than on all its minis and mainframes and in 1985 more was actually spent in value terms on PCs than mainframes. His estimate was that by 1990 75% of all office workers would be using PCs. Early prognoses of sales showed exponential increases. Frazer (1985) reported business software sales in Western Europe as projected to increase in the following thousand units:

TABLE 8

1983	259
1984	558
1985	904
1986	1,400
1987	2,084
1988	3,074

Data Management (1985) predicted 1.2 million PCs being shipped in 1990 for professional and business use a figure three times higher than 1985, although with dropping prices the value would be \$2.5 billion compared to 1985's \$1.1 billion implying an average unit value declining by 30%. In 1987 Which Computer published the results of a major survey carried out by the National Computing Centre. An average of £750 per head per annum was being spent on computing by businesses with particularly fast growth in the senior management sector where desk-top computers were forecast to increase by 400%.

Quite clearly, reality has for once not disappointed the prophets. Remenyi and Money (1991) estimate that UK companies did in that year spend £10 billion on IT which represented 1.2% of turnover. The Public Sector (excluding the Ministry of Defence) spent a further £2 billion.

Software volumes are also still being matched by hardware sales as the following table indicates, the data provided by IDC (1992):

UK - PC shipments (thousands)

TABLE 9

1990	1,416
1991	1,550
1992	1,617
1993	1,755
1994	1,918
1995	2,087
1996	2,263
1997	2,436

Bird (1992a) quotes an estimated figure for 1991 expenditure on applications programmes by European Companies as 5 billion pounds, an increase by a factor of ten on a decade earlier. One of the most comprehensive surveys of spending on IT is by IDC (1991a) from which the following total spend figures in \$millions are derived.

TABLE 10

	1990	1991	1995
USA	111,380	117,750	165,610
UK	18,083	18,963	26,017
Total World	307,376	332,797	488,787

Similar figures for PC expenditure are shown below again in \$millions:

TABLE 11

	1990	1991	1995
USA	25,600	25,800	32,850
UK	4,030	4,174	6,227
Total World	66,597	72,108	103,521

and the following shows solutions software expenditure in \$millions:

TABLE 12

	1990	1991	1995
USA	6,980	8,100	14,100
UK	1,157	1,389	2,308
Total world	16,801	19,834	36,205

Thus high growth levels are expected to continue. Ovum (1992a) comments as follows, having completed a survey of the marketplace:

"The meteoric growth of the PC market during the 1980s is no longer sustainable. Nevertheless the forecasts show a healthy market with average growth of 18% during the period between 1990 and 1995".

Computer Usage

It is one thing to predict exponential increases in hardware and software sales but quite another to achieve similar increases in executive usage. A number of surveys have provided indicators to the actual usage of computers by managers. Talbott et al. (1982) considered a particular firm which had already invested in computing. 40% of managers logged on every day with 65% of them using electronic mail, 15% using the calendar facility and the remaining 5% spent on miscellaneous activities. As a result, less time was spent on coordination and supervision, report preparation and arranging meetings but more time was spent on travel and absences from the office. Thinking and planning time doubled but this still represented only 2% of the total.

Quillard et al. (1983) examined managers who were users of IT. They spent an average 12 hours a week on their PCs and the most important applications were:

TABLE 13

%

Financial Analysis	93
Specialised Analysis	43
Reports and Graphics	23
Word Processing	23
Monitoring	19

The EOSYS survey (1986) covering 300 major organisations in the UK found 38% of top executives to be using screen-based systems although high-intensity usage was rare. Long (1987) found 40% of managers having access to some form of electronic mail system. Rowe and Herbert (1990) reported an

earlier DTI survey as concluding that IT was not seen as a strategic tool in Manufacturing industry although it was in the Finance sector. Chief Executives were making little use of it themselves although they were becoming concerned in case their competitors might be gaining advantage by its exploitation. The authors quote another survey, this time by BOC, which reported a poor response by Directors to IT, contributing, they believed, to the UK becoming increasingly uncompetitive. Rajan (1988) found that 75% of managers surveyed had had no exposure to screen-based systems of any kind with only 9 of the 150 companies contacted confirming that screen-based systems had had a considerable impact on their business operations.

The Humberside survey (Cumbers and Tomes 1986) found over 80% of Chief Executives claimed to make some or a lot of use of computers with 75% claiming to have high expectations of their application. However, and equally significantly, they had not extended their own personal understanding of computers. Less than a third had received any kind of training and overall they were better able to articulate company needs than personal needs.

A recent survey by Microsoft and reported by Bird (1992b) covered 1,500 managers and provides a current perspective on progress. 76% have direct access to screens and keyboards, three-quarters perceiving IT as essential and 34% saying that they could not do their job without it. There was general optimism for the future with touch-sensitive screens and mouse-pointing devices simplifying usage.

Again, the survey reveals contradictions and areas of concern. Only 6% believed that their computers were being used to maximum effect and only 11% used IT to share information. As many as 92% reported that managers were uneasy with computers. There are echoes of the Comsell report (1988) which reported on 971 professionals, managers and administrators. 64% of Chief Executive Officers never touched a keyboard. 68% of the total sample had access to a computer but only 20% made regular use of it. 33% felt their own efficiency would not be improved by the use of computers and 55% had never received any training on computing. The Microsoft survey concluded that managers were isolated, short-sighted and unimaginative in their use of IT.

We can also relate the impact of computing back to the principal activities identified in the previous chapter's review of staged methods. Fanaecian-Nour and Kleiner (1992) provide the following table showing impact levels by activity and by managerial layer.

TABLE 14

Function	M A N A G E R S		
	Top	Middle	Operational
Identify improvement areas	Scant	Scant	Some
Analyse areas	None	Scant	Some
Develop solution	Scant	Moderate	Moderate
Evaluate solution	Scant	Moderate	Moderate
Implement decision	Some	Moderate	Heavy

This also demonstrates the bias towards middle and operational managers but equally a tendency for impact levels to increase as the sequentially later activities are considered.

Usage by sector or department

Clearly one factor is the differential rate of penetration and exploitation of computing in different sectors of industry and in different departments within firms. Gamble (1988) found only 28% of firms in the Hospitality industry using computers which he attributes partly to the existence of less tertiary education amongst managers and an almost complete absence of formal computer training. Raymond (1988) found that in the small business sector, computer training and education were critical factors. Rowe (1988) carried out an analysis which involved plotting both the availability of computing technology and understanding of IT by department. Accounting came out highest on both measures with Marketing lowest on awareness. The Honeywell survey is quoted which addressed application areas split into word-processing, terminal and PC. Use of the PC was highest in Accounting at 40% compared with 16% in the Legal Department. Yet use of word-processing showed Legal highest at 63% with Operations lowest at 34%.

Both departmental 'culture' and work characteristics can influence usage. Finance is characterised as high in terms of information retrieval and analysis but low in word-processing and communication. In Production the 'culture' is not considered conducive to computing being essentially decentralised and stimulus-driven. Research and Development paradoxically is not at the forefront of new technology and the systems they use are self-contained with little inter-linking. Marketing appeared as a computing 'backwater' whereas Sales, whilst overall awareness was low, does show itself to be making increased use of specialist applications. Despite the potential, most in Personnel have little involvement with computing, attributed to the mainly arts and social science background of the managers. Personnel is perceived as being historically narrow, specialised and reactive. Even the Computing Department is traditionally associated with mainframe applications and managers appear to have little appreciation of IT applications, PCs and new developments.

A key conclusion to emerge from Rowe's analysis is that a critical factor is the inter-linking of systems. Company-wide integration of computing systems has been researched by Cumbers and Tomes (1986) who found that major benefits can accrue from programmes which can 'talk' to each other, for example, by producing an invoice, simultaneous changes can be made to related applications with the sales order balance reduced, the customer's debt and sales ledger recorded and updated and the stock reduced. Thus linkage between systems can operate at two levels. It can enable managers to communicate with each other and it can facilitate the mirroring of cause and effect relationships within a company whereby one action, such as an order, can cascade through the company, generating a series of consequential activities. Furthermore a system which can reflect such cause and effect relationships requires less modification if such relationships are to be subjected to hypothetical 'what-if?' iterations. This is a central feature of the proposed design for an integrated managerial job-management system which is described in subsequent chapters.

Applications and Developments

Having identified both the pervasiveness of the computer as a tool for managers coupled with varying degrees of misgivings about their applicability and potential we can consider what applications are available and which are most used.

The desk-top PC has come some way from the first significant development which Bjorn-Andersen (1986) identified as the introduction of the correction stroke on the early IBM type-writers. The second significant development he saw as the introduction of the desk-top metaphor characterised by the Apple Macintosh range. Whilst the use of Ikons and selection by mouse or touch-screen, linked with the ability to view and work on a number of screens simultaneously has become increasingly common, much of the software in organisations is still driven by 'MS-DOS'- type requirements resulting from the major investment needed to upgrade. When seen in association with the limited training available to or taken up by managers it is understandable how 'difficulty of use' rates high amongst managers' perceptions of computing - an issue that we shall return to later in this section. Recognising the importance of this area of development, the generic term Graphic User Interfaces has been coined with Broadhead (1990) noting extensive work being carried out and citing examples such as 'Presentation Manager', 'Windows', 'Open Look' and 'Netwave'.

Many of the initial applications of computers within organisations involved the computerisation of existing transactions such as the accounting ledgers or payroll system. Experience gained in implementing these does have relevance to managerial problem-solving and we revisit this issue in Chapter 7. Once basic data about the operations of a firm are contained within the system it becomes possible to extract sub-sets of this for management information, an issue covered in greater depth in the Executive Information System section later in this chapter. Rather than evolving from this, the

emergence of the PC brought primarily stand-alone applications such as Word-processing, spreadsheets and databases. A particular feature of subsequent development has been convergence and integration as more and more applications and technologies are brought together within a single unit of hardware or software. Long (1987) sees the 80s and 90s as representing the second stage of computing development with:

"...the outright elimination of many intermediary (routine information handling) functions ... the movement towards the ultimate integration and interlinking of the three underlying technologies (data processing, telecommunications and office machines) is now underway with the development of the multi-function work station".

As with animal evolution, not all-convergence has turned out to be viable. The convergence of computing and voice-based communications attracted much attention in the early 1980s. McFarlan and McKenney (1981) referred to the merging of Office Automation, telecommunications and Data Processing technologies as resulting from a variety of factors, not least being the high level of physical interconnections which increasingly take place between them. Early microcomputers required a modem to access other computers over private or public-switched networks. Products like ICL's One Per Desk (OPD) subsequently had this facility integrated within the unit. It combined telephone and micro-computer enabling the operator to use word-processing and spreadsheet facilities, automatic access to Prestel and mainframe systems as well as allowing standard voice-based telephone calls. The system attempted to go beyond the simple welding of a telephone onto a computer by providing the synergy of computer-based search of Directories followed by automatic dialling of the required number. Similarly the QWERTYphone, on offer in 1987 at £399, combined the facilities of a Featurephone with a large Directory showing names and addresses along with a clock, calendar and calculator. On the computing side it offered a very basic messaging capability with access to dial-up services. Communications Management (1987) referred to the 'Path 1' system developed by Pitney-Bowes which combined facsimile, microcomputer and telex links.

However, the momentum was not maintained and although in 1992 there are still products available which combine computer and telephone handset the convergence has not proved to be a mainstream development. Two principal reasons can be advanced for this. Firstly, the products concerned, in attempting to combine the features of two different technologies, ended up doing neither particularly well and the added value of having both combined was marginal as compared with the relatively poor functionality. Secondly, and most significantly, it can be viewed as an engineering development seeking a market rather than a customer-needs driven innovation - a not uncommon occurrence in the software and hardware development arena. More recently there have been references to the emergence of Personal Communicators, e.g. Cane (1992), which combine pocket telephone and PC. Clearly the

arguments for convergence in this area with weight and space at a premium make its prospects for success more encouraging.

More successful has been the convergence of software. An early example can be found with the Lotus 1-2-3 product which rapidly became one of the world's best-selling software packages. Its originality lay in its integration of spreadsheet, database and graphics on one software package with easy interchangeability for the user between the three applications. Other software developers soon copied this principle of marrying together software applications that previously would have been regarded as separate and Lotus further enhanced the idea in its Symphony package which added Word Processing and Communications facilities to the three original programmes. Frazer (1985) reported:

"Above all the Lotus concept has created an expectation among software users that integration will be a feature of business packages offered in future. This does not only mean modular integrated systems like 1-2-3 and Symphony which provide a number of applications programmes on a single disk but also operating systems and tool-kit programs which enable programs produced by different vendors to work together as part of a system tailored to individual requirements."

Ovum (1992a) forecasted that through the mid 1990s it is the Graphics software and suites that will experience higher than average growth. Conversely, spreadsheets and word-processing, which have already provided much of the impetus to PC usage, will grow at lower than average rates.

A number of systems offer a mix of applications software and facilities. One example is IBM's Professional Office Systems (PROFS). In addition to word-processing and electronic mail to other users it offers:

1. A Diary system which can be viewed and changed by the user but only viewed by others. The system can search diaries and recommend suitable dates for meetings.
2. Document storage, filing and retrieval.
3. A reminder system printing a message on screen at the specified time.
4. Distribution lists and nicknames which can be used in preference to User IDs.
5. Telephone number Directories.
6. Miscellaneous information.

7 Action lists.

8. Access to other databases.

The Yankee Group (1987) report the results of a case study which examined the introduction of PROFS into an oil company. The most frequently used application was electronic mail but the calendarising facility was also popular. Other uses include:

- Phone book
- Bulletin boards
- Broadcast messages
- Spreadsheets
- Tickler files
- Standardised documents
- Wordprocessing
- Electronic publishing
- Transportation schedules

The Yankee group found user satisfaction to be high although the Management Information Systems department found the inability to delete documents led to increasing storage problems. The report concludes:

"According to the Oil Company, PROFS plays a key role in future computer purchase decisions. It will become not only the company standard for office automation but represents a major investment in dollars, customisation and training that will not be abandoned in the near future."

Ashton-Tate's 'Framework' package combines word-processing with data management, financial modelling, graphics and communications, all being directly accessible from the main menu. Window-working is a basic feature and there is the facility to move frames around the screen. Filters can be used to convert other formats such as dBase into Framework. A more recent example is Acumen (Effem 1989) offering a range of facilities including database, financial modelling and graph generation. Data access can be achieved both to internal and external data sources and Electronic mail compatibility is also claimed. Data monitoring can be facilitated through automatic high-lighting of variances against pre-set criteria and navigation through the layers of organised data, referred to as 'drill-down', provides visibility of the underlying trends and patterns (See EIS section below). Further analysis on the introduction of Personal Information Managers (PIMs) is given in Chapter 7.

Case studies do give some indications of how organisations are using their computer systems although as the medium is often computer companies' journals, some element of bias and lack of criticality can be expected. Apple Enterprise (1992a) describes the use of computing by consultants and auditors, KPMG. An internal network, ICON, linked the many PCs operating within the offices. Specific applications include:

Accessing a database for information on projects.

Looking at CVs to construct project teams

Extensive use of graphics

Global linkage using electronic mail

Linkage with clients through the same medium

Transportability using 'Notebooks'

In terms of hardware, a significant recent development has been the introduction of the small portable PC releasing the manager from dependence on his desk-top PC just as the cellular phone has increased his potential to remain in touch when away from the office. Toshiba's launch of Dynabook, weighing only 2.7 kilograms, set a precedent followed shortly by NEC, Sharp and Fujitsu. Mitsubishi revealed details of its Maxynote 386 in October 1990 with an 80 megabyte capacity. Cross (1990) reports on a market assessment which suggested that just under 20% of PCs sold in Japan in 1990 will be notebook devices increasing to over 40% by 1994. Coupled with this, Palframan (1992) forecasts the arrival of the 'nomadic' computer in 1995 or 1996 which is dependent on worldwide wireless networks. Developments such as these can only enhance the usefulness and relevance of PCs to managers.

Application benefits and shortcomings

So far in this section we have noted the proliferation of desk-top computing and the increasingly wide availability of computing power to managers. However, whilst access to the PC has been greatly facilitated, actual exploitation of the potential of such systems has met with varying degrees of success. We can now examine in greater detail what the managerial response has been to the standard software available with the object of deriving a set of user needs that can be incorporated into the system specification described later in the thesis. Initially we can consider the potential benefits which commentators have argued could accrue. Long (1987) distinguishes between 'managers' and 'professionals' with the former co-ordinating and supervising other staff whereas the latter does not. Long sees IT having greater relevance to Professionals with examples such as the use of CAD by

engineers and computerised ledgers by accountants, lower levels of management and those doing routine coordinating and control functions being highly subject to automation. IT is identified as increasing office productivity in three ways:

1. The facilitation of current activities.
2. Elimination or automation of activities.
3. The stimulation of improved quality of performance or the provision of newer and better services.

Long noted that the earliest applications tended to focus on 1 and 2 above although he argued that the greatest potential was for 3. It was the most neglected because of the great difficulty in proposals surviving the traditional cost-justification requirements. However, the key issue is that the major benefit will come from applying automation to professionals and managers, not support staff as the latter account for only 10% of office labour costs and the former between 60% and 75%.

Turning to actual business experiences we can note that companies encounter problems in implementing new computer systems. Cumbers and Tomes (1986) in a study of companies in the Humberside Region found that all experienced problems during system selection and the introduction of the new software. Most were happy with the hardware but a number of misgivings were expressed about the software. Most companies, however, reported significant increases in productivity and competitiveness as a result of:

- reduced operational costs
- an increase in management information
- better financial control
- improved customer service
- a decrease in stock and lead times.

One can also note the main reasons that motivated the companies to invest in computer systems expressed as percentages of the times they were quoted:

TABLE 15 %

Handle increased volumes	48
Improve internal controls	38
Reduce costs	34
Give better information	21
Perform new functions	8
Improve customer service	4

The main application areas were as follows, again expressed as a percentage of times reported:

TABLE 16 %

Production control	62
Integrated accounting	61
Payroll	51
Sales Order Processing	50
Purchase Order Processing	48

Thus the main use has been to perform operational and functional tasks. The study concluded that the main requirements for managers were techniques of systems analysis by which data can be manipulated to support decision-making and inquiry systems which were capable of allowing managers to design their own reports.

Eosys (1986) carried out in-depth interviews with a selection of top executives and found that messaging facilities were the most used. Ease of use was identified as being critical with executives reporting that it can be easier to ask someone for the information than to interrogate a database. In this context a haphazard paper system may be better than having to remember codes and menus. Communications News (1993) reported the results of a survey confirming that over 70% of the 'Top 100' companies admitted to document conversion problems. The Eosys findings were that executives' requirements were modest and should not have been difficult to provide. They included:

-A 'contact' database

-Up-to-date information on the progress of major projects

-Access to summary financial and manpower figures

-To be able to respond quickly to identified problems rather than wait for information from the data-processing department

-Modelling to explore the effect of capital programme changes on tariffs

-Access to external information on other companies

The report provides an impression of very busy people who have little time to spend on any one particular task. Senior executives tend not to be sat at PCs but are at meetings or communicating sophisticated information. The main stimulus for greater use would be the availability of additional information or facilities but difficulty of use proved to be the main constraint. The benefits of messaging were well understood but there needs to be a critical threshold of other users. A number of perceived benefits were noted in terms of speed and responsiveness, cost savings, quality of service and sheer necessity. Diary systems were found to be useful to record engagements and to save time in arranging, going to and recording the results of meetings. From this emerges a need for horizontal utilities, i.e. contacts, and vertical such as business-unique applications.

Finally, Eosys gave some insights into executive aspirations for the future. These included improved communication with other people and, increasingly, systems which made it easier to contact anyone worldwide. There was a perceived need to filter and prioritise incoming messages in order to keep the volume manageable and for information interrogation keyword search was proposed as a benefit. Modelling and information manipulation, the ability to play with information and test assumptions and means of establishing cause and effect relationships were also mentioned.

Ilan and Shapira (1986) reported that most managers stated that use of the PC did not save time but enabled them to do things which previously would not have been possible. The quality of their jobs was said to have improved and the PC had the potential to trigger new ideas, allow different perspectives and enhance creativity.

Gillingwater (1987) carried out a survey into the use of computers in manufacturing industry and found that only 54% described their systems as 'adequate'. However, the potential was widely recognised with acceptance that IT can help the Production Manager make complex decisions about sequencing and timing, in particular meeting delivery deadlines and using the resources more efficiently, minimising stock levels and maintaining production quality. The highest level of satisfaction recorded by the survey was on 'system reliability' but even here the satisfaction level was only 50% and bespoke systems proved to be little better than those purchased 'off-the-shelf'.

Rowe and Herbert (1990) found that the main wants of Chief Executives were decision-support systems to aid strategic planning, more up-to-date information, better summarised and more relevant data, comparative data on competitors and improved graphics. The authors suggest three main categories of information can be identified. Firstly there is information to support straightforward decisions, secondly what they term 'comfort' information which helps to confirm or contradict predictions and finally 'so what?' information epitomised by Decision Support Systems.

REVIEW

Despite the apparent inconsistencies in some of the research quoted here, a number of fundamental points do emerge. The use of computing within firms and organisations to carry out tasks and transactions is firmly established and this provides a potential storehouse of information that can help managers identify and solve problems although the degree to which computing is exploited varies between firms and within firms between departments. In addition the availability of the desk-top computer to managers and executives is now widespread. However, managers often have a critical view of the software and the perception by a number of commentators is that managers frequently fail to exploit the potential of the systems that are being used. Indeed, Rowe and Herbert (1990) stress that executives can articulate company computing needs better than their own personal needs.

The actual use to which computers are put frequently relates to relatively simple applications such as word-processing and diary systems. Yet there is evidence for a more sophisticated set of wants relating to decision-support, modelling and data-manipulation and the need for better and more timely information is consistently advanced as a key element. Thus one can suggest that with constraints such as the limited time and training available to managers, the need for future development in this application area is integration of the three main elements; information derived from internal transaction-based computer systems supplemented by external databases, existing word-processing, database and administrative applications such as diary and directory systems and finally, the more complex decision-support, modelling and data-manipulation systems. Integration would appear critical just as Cumbers and Tomes (1986) found it to be so at the transactional level.

DECISION SUPPORT SYSTEMS

This section includes the following topics of which the first nine relate to Expert Systems or systems which are sufficiently closely related to Expert Systems to be regarded as part of the Expert System generic and the subsequent sections to other software developments which can directly or indirectly support management decision-making and job progressing and which are usually included under the heading 'Decision Support Systems' (e.g. Ovum 1992b):

1. Expert System introduction
2. What Expert Systems are
3. Expert System potential
4. Applications and developments in the 1980s
5. Applications and developments in the 1990s
6. Benefits
7. Browsing systems
8. Blackboard systems
9. Neural networks
10. Workflow management software
11. Project management systems
12. Multimedia
13. Groupware
14. Review

Expert System introduction

Our main concern here is with Expert Systems which emerged in the 1980s and whilst the initial applications were developed in areas only indirectly related to management, their direct impact on managerial decision-making is considered by many to be a critical feature of the 1990s. To quote Tom Peters (Feigenbaum et al. 1988):

"I conclude that any senior manager in any business of almost any size who isn't learning about AI (Artificial Intelligence) and sticking a tentative toe or two in AI waters, is simply out of step, dangerously so".

Scott-Morton (1983) distinguishes between three categories of Management Support System. First are the Data Support Systems, frequently associated with Management Information Systems (MIS) and characterised by passivity, control by the Data Processing Department and information both pre-specified and provided on request. Development was slow resulting from technical difficulties and security constraints. This category is not discussed further as it is historically the oldest and is increasingly being supplanted by the the other two categories (see Turban 1990 chart at the beginning of the chapter). The second category are the Decision Support Systems which provide modelling and some implication of optimality and the assessment of possible outcomes. This category includes the Expert Systems which are described in the remainder of this section. Finally, there are the Executive

Support Systems which are exploratory and iterative and these are described in greater detail in the next part of the chapter.

In many respects the field of Expert Systems might seem furthest removed from practical relevance to managerial problem-solving but several analysts believe it to have considerable future potential and its role within an integrated system can be more clearly seen in the concluding part of the chapter. Thus Feigenbaum et al. (1988) noted that "across all applications we found Expert Systems used as intellectual assistants - intellectual power tools - for decision-makers and professional problem-solvers".

Turban (1990), for example, states that Expert Systems:

"... may be one of the most important future breakthroughs in computerised decision-making".

With the developments in Artificial Intelligence and the increasing availability of low-cost computing power the area referred to as Expert Systems quickly started enjoying explosive growth with the worldwide market for Artificial Intelligence estimated by Wiig (1986) as \$1 billion in 1986. Hewett (1986) estimated that the Expert System element of this would have reached \$1.9 billion by 1992. The Expert Systems field was identified as a potentially important element in this research for a number of reasons.

1. It has attracted considerable effort and resource from both the academic and business environments with the intention of improving or enhancing problem-solving.
2. It has moved from the purely theoretical arena to the practical and there is increasing evidence of documented practical application in a wide variety of situations.
3. Although Expert Systems vary in cost, power and complexity, there are a number of packages which can be run on standard PCs and whose cost puts them within reach of the mass of desk-top computing users.
4. The indications are that the momentum will continue and that their relevance to managerial problem-solving systems will increase. In 1992 Hewlett-Packard included an artificial intelligence tool as part of its basic New Wave package. Its function is primarily to automate daily tasks.
5. Expert Systems are perceived as having a particular role to play in the design of integrated systems and a number of practical applications are beginning to appear.

What Expert Systems are

Firstly we should offer some indication of what Expert Systems are. Feigenbaum, quoted by Miller and Walker (1988) provides a conventional definition:

"... an intelligent computer programme that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution".

Holligum (1990) puts forward a more basic description:

"They simply store, in a sort of database, the knowledge which is put into them by humans - who may or may not be 'experts' - so that it can be manipulated, used to infer results and represented or applied in an orderly fashion as it is needed".

It seems reasonable to propose that Expert Systems can potentially provide a useful role within a wider problem-solving system to aid the processing of sub-problem elements which may be characterised by repetition but with sufficient complexity to warrant the provision of assistance to otherwise purely mental processing. Examples shown below support the argument that not only do Expert Systems have potential to assist a specified, albeit narrow, category of problem-solving situations but that an additional, and possibly more crucial role is to assist in the operation of other problem-solving systems.

Expert System potential

Johnson (1984) suggests that the growth in the computer industry has been driven by a series of major innovations and concludes that 'Expert Systems promise to be another such major innovation' as well as being the 'leading practical application of the techniques developed in artificial intelligence research'. He sees four particular advantages in Expert Systems. First they allow previously unprogrammable tasks to be computerised. Second, they are easier for non-programmers to understand. Third, they allow for a spectacular increase in the productivity of computer programmers and finally they can provide a 'genuine extension of human capabilities'.

One can note the argument advanced by Walker, Director of Sperry's Knowledge Systems Centre (Frazer 1985):

"It is estimated that numeric type activity represents about 10% of the activity pursued by humans, the other 90% being of a symbolic-oriented nature. The symbolic manipulation which is inherent in

Artificial Intelligence can thus be seen as a superset of traditional computing, extending the power of the computer into domains that have previously been very difficult to approach."

Nadkarni and Kenny (1987) see Expert Systems replicating the normative processes of decision-making with benefits in terms of speeding up the search for alternatives, selective pruning of alternatives and helping to cope with decision complexity by trading off between resources rather than looking for an optimal solution.

McDonald and Wilson (1990) identify the following factors on the basis of early applications of Expert Systems with a '+' indicating positive features and a '-' negative ones:

- + It is possible to build support systems in complex areas.
- + They provide consistency to human decision-making.
- + They force deep thinking in a structured way.
- + They enhance decision-making and improve analysis
- More complex and amorphous expertise is difficult to capture.
- Expert Systems attract high potential cost and require tight project control.

Although the term used here is Expert System it should be noted that the expression is increasingly being replaced by Knowledge Based System or KBS. Interpretations of what constitutes an Expert System vary but a useful distinction between Decision Support Systems and Expert Systems is drawn by Berkin (1986):

"A Decision Support System is one which provides a trained user with the analytical methods and tools to solve a problem ... An Expert System on the other hand will give an expert opinion and will explain that opinion to the satisfaction of various levels of user. It does not however encourage the user to obtain the in- depth understanding necessary to form that opinion".

Johnson (1984) defines an Expert System as a 'computer system which emulates human expertise by making deductions from given information using the rules of logical inference'. Rich (1983) refers to

Artificial Intelligence as 'the study of how to make computers do things at which, at the moment, people are better'. However Schwoerer and Frappa (1986) see a distinction between the approach of those trying to programme computers to imitate human intelligence and those whose main interest is solving 'practical and commercial problems'.

Expert Systems can be categorised in a number of different ways according to functionality, application domain, structure or language. For example, D'agapeyeff (1985) distinguishes between systems that are informative and those that are advisory. He suggests that advisory systems aim to replace the human expert while informative systems attempt to help without aiming for completeness or taking over the functions better performed by people.

Applications and developments in the 1980s

The rapid development in the number of Expert Systems available on the market was dramatic during the 1980s. Prices for systems quoted in the Expert System User magazine varied considerably with examples such as ART at \$65,000 and VP Expert at \$99. In 1986 Softsync reduced the price of its Expert Ease package from \$695 to \$99. An important element in the marked cost reductions associated with Expert Systems has been that the large programmes necessary for such applications could be incorporated in fewer components such as Texas Instruments Compact Lisp Machine which uses a single 'megachip' to provide the complete Explorer processor. Wiig (1986) forecast that Expert Systems which at that time could only run on special AI machines would run on the more powerful PCs within 3 years and home computers within 6 years, a prediction that was achieved. Fintech (1986) reported a survey by California-based Spang Robinson underlining the extent to which major US Corporations were building production systems on PCs using Expert Systems. The main application areas in percentage terms were:

TABLE 17 %

Diagostics	24
Manufacturing	22
Computers/electronics	14
Geological exploration	14
Chemistry	6
Military	6
Agriculture	5
Medicine	4

The Proceedings of an International Conference on Knowledge Based Systems held in London in July 1986 included papers on applications in Insurance by Butler (1986), Investment Appraisal by Norris

(1986) and Employment Law by Keen and McBride (1986). Pogson and Brown (1985) refer to a number of applications of Savoir, such as Cousellor for evaluating the risk of crop disease, Syslag for selecting thermal insulation and Feasa for helping specify structural analysis problems.

The late 1980s saw the appearance of a number of Expert Systems with particular relevance to the manager and these are likely to see further dispersal within the managerial community during the 1990s. Miller and Walker (1988) reported an increase from 136 registered Expert Systems in 1984 to 1025 in 1987. 1987 saw a growth rate of between 300 and 400% and forecasts for annual sales in 1990 varied between \$1.7 billion for hardware and \$2.5 billion for software from DM Data Inc. to \$643 million for hardware and \$519 million for software from Ovum. In 1987 IBM were developing 70 Expert Systems and considerable investment was being expended by leading companies such as Shell, ICI, BP, Midland Bank and British Airways. Miller and Walker note that news of applications is still not widely available because successful developers are reticent to communicate for commercial and security reasons.

Applications to the field of management were scarce in the 1980s although Johnson (1984) saw potential benefits in the capability of Expert Systems to cope better with uncertainty and to represent heuristic and informal knowledge. Clearly both the software and the lack of experience in developing applications were constraints with Wiig (1986) comparing Expert Systems to the 1901 automobile:

"It has solid tyres, it belches smoke, runs at a top speed of 10 mph and there is no support in terms of good roads, gas stations, repair shops, spare parts or even standards for fuels".

Equally, evaluation at the time was hampered by the limited knowledge on applications with Curnow (1986) noting:

"To date, publicly available information about the impact of KBS is scarce, patchy and biased".

The initial enthusiasm had become tempered by more sober assessments with Taylor (1986) identifying a number of reasons why development had been slower than expected.

1. Typical systems developed were applicable to only one specific task and domain and the knowledge was not in any useful sense general.
2. There was very limited scope for modifying or extending the systems in the light of performance or experience.
3. The current systems were not particularly friendly, much less intelligent, to the user.

4. Expert Systems were not cheap to deliver and maintain in terms of documentation or acceptance testing.

A further problem appeared to relate to the way in which applications were developed, characterised by prototyping but with considerable development effort still needed to convert the prototype into an operational system. Martschew, Pope and Witt (1985) also noted the evolutionary aspect:

"That is anyway, in our opinion, the case of most AI products - a quick first delivery followed by a never-ending evolution towards some hopefully asymptotic maturity".

Other problems relating to knowledge acquisition have been documented by Welbank (1983), McDermott (1984) and Trendelenburg, Zeler, Krautter and Schmitt (1985). Many of the disadvantages are summarised by Miller and Walker (1988) amongst which are:

- High cost of building Expert Systems
- Knowledge acquisition ties up experts for a long time.
- They can be slow and expensive in execution speed.
- They are only feasible for narrowly-defined problems in some domains
- They do not gracefully degrade when they reach the limits of their understanding
- There are not many proven successes
- They cannot be left to run autonomously for long periods
- A development methodology does not yet exist

On the positive side Lin (1986) identified Expert Systems as having greatest potential for routine repetitive decisions because of an accumulation of the required knowledge, judgement and experience. However, Lin also reported that there were very few business applications and even those referred to were for specific technical issues within the managerial environment. Lin identified the main reasons as being the large number and greater ratio of behavioural variables present in business situations, the rapid changes in the business environment and the requirement on managers frequently to handle the unanticipated. Expert Systems are usually confined to a narrow domain whereas many managerial decisions are based on 'broad interdisciplinary knowledge'. Finally, business needs a steady flow of innovative thinking and Lin concluded that new ideas could not come from Expert Systems.

Ablett (1986) commented:

"While in their present form Expert Systems can be useful in certain, restricted applications, they are not much use in real-time environments and they are certainly not built to cope with (possibly) conflicting information from a number of different sources"

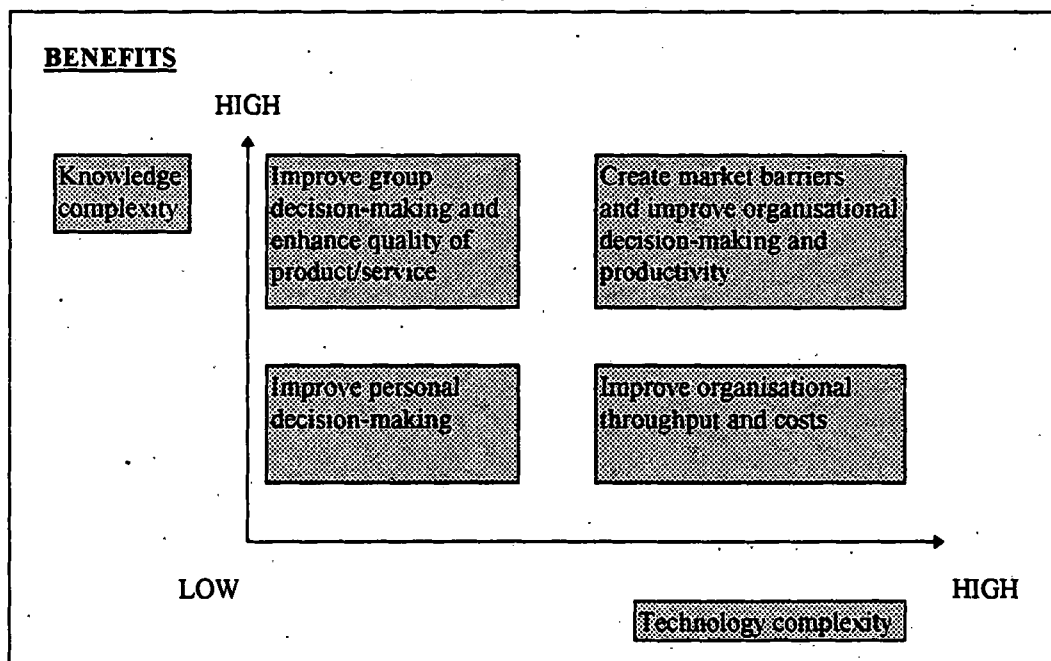
However, on the issue of 'success stories' more examples are coming to light and Feigenbaum (1988) gives a selection including applications in many major corporations such as, Northrop, du Pont, American Express, Toyota, Westinghouse and Texas Instruments.

Applications and developments in the 1990s

Despite these set-backs Expert Systems applications within industry and commerce look set to have a bright future in the 1990s probably emerging stronger from the experiences of the 1980s. Datapro (1992d) reported that 43% of major financial services institutions were using, developing or actively researching Expert Systems applications. 90% of the firms using or developing Expert Systems believe that these systems will be crucial to the success of the organisation and one third of firms not currently involved in Expert Systems plan to be in the early 1990s.

Case study material on applications within the business world which were scarce in the 1980s are more evident in the 1990s albeit still in relatively small numbers. Fanaeian-Nour and Kleiner (1992) describe the introduction of an Expert System into the Mrs Fields Bakery chain with a system in each store giving advice on production and labour scheduling. Datapro (1991) reports on applications within Lincoln National Life and Stone and Webster. From research into these and other examples the authors conclude that the best method of organising an Expert Systems project depends entirely on the application. Two key dimensions to emerge are Knowledge and Technological complexity and the benefits are tabulated as follows:

FIGURE 3



Furthermore, there is greater evidence for the development of applications with relevance to managers. Miller and Walker (1988) list 55 packages for management under the 'general' heading. These include systems for the strategic management of technology, purchasing, asset management, distribution and career planning with titles such as AI Market Analyser, Class and Dabkon. Specific areas like Financial Planning have a number of developments already in use with examples such as Cash Value and Plan Power. Whilst it is notable that many are tailored to highly specialised problem areas, increasing numbers of applications have wider relevance.

Documentation Browser facilitates the perusal of documents or on-line data. Manager's Assistant contains a knowledge base, a database of projects, a general database and a library of procedures. Extensive research development work continues to be carried out in the Universities. The Georgia Institute of Technology is aiming for a system containing company or business knowledge with the organisation's task environment, goals and plans, structures, operations and procedures, memories, management processes and computer-based systems. The University of Southern California has Manager - a general purpose graphic analysis tool that uses Expert System technology to examine management models and to provide explanations and interpretations. Xanalogy from UCLA attempts to allow managers to capture and re-use previous managerial experiences.

Conneighton (1991) notes the role that Expert Systems can begin to perform in supporting other systems:

"Many of the rules of business are universal. It does not require a traditional Expert System shell and customised developments to follow the gains and losses in common financial statements. Vendors are beginning to offer tools which act as 'agents' of the user, watching databases for data that goes out of range - then taking action automatically."

Three further Artificial Intelligence development areas can be noted before we review the impact and future potential of Expert Systems in the managerial environment, browsing systems, blackboard systems and neural networks. Brief reference is then made to other Decision Support applications.

Browsing systems

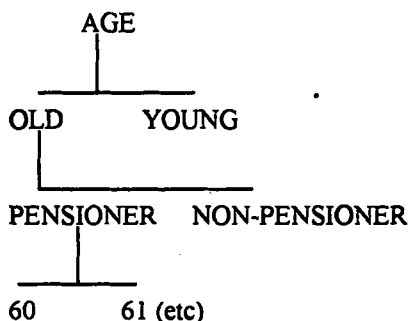
'Browsing' systems are much as the word suggests where information is being accessed and filtered. The next part of the chapter examines Executive Information Systems and the particular role of browsing systems is likely to be as an intelligent interface between the user and the basic data that is being accessed. Particular relevance is likely to emerge in the accessing of on-line data. Pettit (1986) provides some examples:

"Browsing is thinking you know what you want but realising you didn't when you find it. Browsing is not knowing what you want until you find it. Browsing is all of these compounded by not knowing what is available ... or how to ask for it."

The common use of the term, as say in a bookshop, applies equally to electronic databases. The method by which they operate is that the user assembles a partial description which can then be criticised and refined by reference to retrieved examples. Based on psychological models of human interaction, Pettit identifies two principal modes, 'modification of examples' and 'retrieval by reformulation'. Pettit cites the following case where the three different descriptions each apply to the same person.

- A woman of 61 wearing a dress
- A person of pensionable age in clothes
- Something old in rags

The connections are readily identifiable with the three generalisations on age representing relationships within a network which can be displayed hierarchially. 'Age' can be subdivided into 'young' and 'old'; old could have a sub-division 'pensionable' and this in turn can be broken own into specific age groupings. Each of the three descriptions can be captured within the hierarchy.



Thus the difficulty of knowing what word or expression would be used by another person is circumvented by using the underlying concept as the search key. It has been suggested that information search is a critical element in much managerial problem-solving and there is considerable scope for extending this example to managerial situations. For example, selection of a Market Research agency could be by reference to the following:

- A large agency specialising in Information Technology.
- An agency with turnover in excess of £1 million with experience in computing
- One of the top 20 agencies in size with commissions from IBM, ICL or Honeywell.

Pettit places browsing systems clearly within a support rather than replacement context:

"People are very good at viewing a set of examples and finding reasons for their similarity and difference. They are also excellent at distinguishing subsets of examples within the original set. A browsing system uses these intelligent capabilities to provide a sensible support system."

Blackboard systems

'Blackboard' systems are another sub-set which appear to offer potential for the longer term although they do represent more recent introductions and have received minimal coverage in the published literature, not least because of their association with Defence applications. Ablett (1986) comments:

"For centuries humans have been putting their heads together around a blackboard - or a clear area of sand - where they can all see what is going on and pooling their individual and collective expertise in an effort to solve complex problems in a real and changing world".

The blackboard system operates in similar fashion enabling the experts to see all relevant contributions which can be viewed as separate expert systems in their own right. A control mechanism weighs the value of the various inputs selecting access on the basis of relevance. The blackboard itself is the critical feature, variously referred to as the 'solution space' or 'global database'. Ablett reports that blackboard systems give "rise to the possibility of creating general purpose, problem-solving software" and quotes Tony Morgan of Systems Designers:

"The power of the blackboard system is its ability to tackle problems incrementally and opportunistically. The solution to a problem is not '42' - it is built up piece by piece".

Peltu (1986) sees particular advantages for blackboard systems in situations where there are a number of experts noting the substantial learning that resulted from 'talking to others'.

Applications to managerial problem-solving are likely to be some way into the future but a principal application area could be when linked into Group Decision Software (see below).

Neural Networks

Finally, note can be taken of the increasing interest in and investment applied to the field of neural computing. Although the principles behind neurocomputing were first described in the 1950s it was not until the 1980s that technological improvements facilitated the introduction of marketable products. Hecht- Nielsen (1988) describes neurocomputing as a 'fundamentally new and different information-processing paradigm - the first alternative to algorithmic processing'.

The neural network reflects the gross structure of the brain, operating on the basis of parallel-processing and is believed to be appropriate for complex pattern-recognition problems. Caffrey (1991) identifies a number of projects underway including examples to reduce overcrowding on London Underground stations, to assess the purity of distillates by British Nuclear Fuels, to analyse historical data on gas consumption and to filter out extraneous information on Air Traffic Control systems. Cross (1991) notes that the main emphasis of Japan's 'sixth generation' computing project will be neural computing which is likely to bring it into the mainstream of computing development. At this stage it would be premature to assume any direct relevance to managerial decision-making but the ability to cope with imprecise or 'fuzzier' inputs mirrors the non-algorithmic nature of problem-solving emerging in this research. Whilst major corporations like Fujitsu and IBM see little prospect of neural networks having any short-term impact, others such as Mitsubishi, Matsushita and NEC and already committing major sums to neurocomputing research and development. In February 1993 Neural Computer Sciences launched NeuDesk, a basic neural network for the PC operating in a Windows environment and priced at £385.

Datapro (1992b) summarises the key differences between Expert Systems and Neural Networks. The former are particularly applicable where there are few data samples, where experts are available and accessible and where an explanation of how the answers are derived is essential. Neural networks, however, come into their own where there are hundreds of examples and where experts are either not available or cannot be accessed.

Increasingly, Expert Systems and Neural Networks are to be found in practical applications in conjunction with each other. Datapro (1992b) quotes an example where a large utility company uses a neural network to monitor power-plant performance. The network then defers to an Expert System for possible operator intervention whenever performance does not meet expected values. The Datapro article then proceeds to introduce the concept of an Expert Network which is offered as a bridge between Expert Systems and Neural Networks.

Finally, before reviewing this section we can note briefly some other application areas currently under development which do suggest some potential positive impact on managerial work and problem-solving but which are not included within generic Expert System categorisations.

Workflow management software

Ovum (1992b) provides a summary of the current status of such systems which are claimed to be one of the great enablers of the 1990s. We noted in Chapter 3 the importance of 'process' management and the emphasis given to workflow analysis. Conformance with the BSI standard BS 5750 requires a significant element of documentation of processes and systems are being developed to meet these needs. The software packages allow computer systems to demonstrate the actual business process

rather than simply to support discrete tasks and they are described as 'proactive computer systems which manage the flow of work among participants'. Some examples of current software are shown below:

IBM	'EC FORMS'
ICL	'POWER FLOW AND POWER SUPPORT'
FCMC	'STAFFWARE'

Ovum predict that -

"By the end of 1993 all computer system suppliers whose products are used in the office will have added a workflow product to their offerings".

By 1997 there are expected to be 600,000 users generating a 1996 revenue of \$1.8 billion.

Project Management Systems

We have noted the ubiquity of Project Management as a discipline, not only for the traditional major projects but also increasingly on a day-to-day basis by many managers. Project Management software has been in existence for some years although early versions tended to be mainframe-based. Such systems have as their basic function the automation of the three major steps of a project - Planning, Scheduling and Control. Specific activities covered include Resource allocation, controlling tasks and project break-down into Work Breakdown Structures (WBS). Milestones are a key feature and Datapro (1992a) note the recent emergence of 'roll-up' or 'linking' which facilitates the management of multiple projects, a feature of particular relevance to the model of managerial activity presented in the next Chapter. Examples of packages are from the low end of the market - 'Harvard Project Manager' and from the top end 'Open Plan'. The Datapro report notes that typically such packages cannot perform task analysis or chart dependencies and one can note the potential role of COPE-type software here.

Multimedia

Ovum (1992c) describes these as:

"Those computer platforms and software tools that support the interactive use of one or more of the following types of information:

Audio

Still image

Motion picture."

Whilst in 1992 the market was worth \$0.5 billion in the US and Europe, it is forecast to grow to \$9 billion in 1997. A whole range of potential applications becomes possible from simple graphics as part of presentations now matched by film or stills to Virtual Reality in those situations where 'walk-through' is deemed beneficial. However such developments are very much embryonic and only limited research evidence is yet apparent on applications. Keenan (1993) cites examples of firms using multimedia which includes Zanussi, ICL, and American Express although these are primarily demonstration applications rather than reflecting managerial use. Keenan proposes that multimedia will develop in three main stages:

1. Early customised systems
2. Packages software for business use
3. Desk top communications

Whilst potential clearly exists it is premature to claim any significant relevance at this stage to the broader spectrum of managerial problem-solving situations.

Groupware

Chapter 3 referred to group problem-solving and note can be taken of the software developments aimed at this activity. Datapro (1992c) sees them as occurring where there is a conjunction of certain TECHNOLOGIES with certain USERS (often small self-directed professional groups) and a WORLDVIEW which emphasises convivial working relations. One case study is described by Martin (1992). This covers the use of the collaborative management room run by the University of Arizona to explore a problem of the Greyhound Financial Corporation. Here the main emphasis is on 'computer-supported group work with direct input from the user' rather than on the use of particular tools. Key conclusions are that such systems are still very rare so objective evaluative evidence is limited. Overall there would seem to be potential for such systems in helping a group generate ideas; process structuring is facilitated and conversation becomes more focussed.

Finlay and Marples (1992) identify three varieties of Group Decision Software (GDSS), which they also refer to as 'Meetingware' and these are:

PCs linked by a LAN

Decision-conferencing (sensitivity modelled on a computer).

Strategic options and Developing analysis
(e.g cognitive mapping).

However, Datapro (1992d) sees the main differences as being in terms of vision, split as follows:

Data and forms orientation

Agent-centred orientation

Work-centred orientation

Transaction-based orientation

Gallupe et al. (1992) review comparative evidence on conventional brainstorming when evaluated against electronic brainstorming, noting that, with electronic brainstorming, performance increases as group size increases whilst with conventional brainstorming it stays constant. However, despite such positive research findings the current market impact is limited. Datapro (1992c) note that there are numerous prototypes but very few commercial systems. Many applications have not got off the ground partly attributed to the newness of the technologies and partly the clumsiness of the earlier applications. They conclude:

"We need a more substantial shift from technological utopianism to social realism in the (groupware) literature."

Review

Expert Systems are clearly a permanent rather than a transitory feature of modern computing and the current level of investment by the major Corporations suggests that they expect a significant pay-back in their financial commitment. Whereas applications to the field of management were scarce in the first half of the 1980s, the second half saw a major shift towards the development of applications for managers, initially for specific problem types but latterly on a more generalised basis. Miller and Walker (1988) see the main advantages as being that they permit the automation of some tasks, they can act as a productivity multiplier and they can facilitate the retention of 'corporate memory'. Conversely, they are expensive to build, the experts required are tied up for lengthy periods as their

knowledge is acquired, they may be slow and expensive in running speeds and they can only be applied to narrowly defined problems in certain domains. The probability is that they will be integrated within larger systems for which they perform a specific sub-task. Kelly (1986) supports this view:

"In practice a KBS is likely to be one component of a system which requires the integration of a wide range of other technologies and capabilities. In the case of Decision Support a complete system is likely to comprise components such as KBS, databases, interactive graphics and mathematical/statistical models".

Typical managerial problems can be fragmented into sub-problems and sub-elements which can be viewed hierarchially. In some cases these sub-problems may be examples of repetitive routines which may still be crucial to the effective resolution of the problem-solving process. Common examples might be:

- Placing a contract
- Organising a meeting or presentation
- Instituting an information search

Current research and development indicates the likely future scenario for the manager to be one where there could be three principal categories of Expert System available to him. Firstly there would be the specific customised Expert Systems developed within the company for application to an internal process, many of which will be technically biased. Secondly there will be the more basic Expert Systems offered as part of the PC package and integrated with spreadsheet and word-processing software. In this case the manager would be constructing his own applications. Finally, there could be one or more Expert Systems which might be visible or invisible and which are designed to improve system navigation, that is the problem-solving and administrative process contained wholly or partly within the PC functionality.

We can also note the appearance and development of additional software like Project Management software and Groupware which would appear to have potential, as judged by investment and analysts' view of growth rates, to assist in specific aspects of decision-making. Again, the key future development would seem to be how these can be integrated.

Having reviewed the role of Executive Information Systems in the next section we then return to the topic of Expert Systems by considering both their positioning along with Executive Information Systems and their potential role in an integrated system.

EXECUTIVE INFORMATION SYSTEMS

In this section we cover the following main topics:

- Definitions
- What an EIS is
- Current applications and developments
- Background
- Review

Software vendors that are close to the managerial marketplace have been paying considerable attention to the development of Information Systems which are variously referred to as:

- Management Information Systems (MIS)
- Executive Information Systems (EIS)
- Executive Support Systems (ESS)

Definitions

In the previous section a distinction was drawn between the Management Information System (MIS) and the Executive Information (EIS) and it is the latter, coupled with the Executive Support category which we shall focus on in this section. However, it can be noted that there is considerable divergence between commentators in their attempts to classify and define information systems. Definitions of an EIS vary depending on the particular viewpoint of the designer but a typical one is the following advanced by Crandall and Kerber (1985):

"An Executive Information System is a very easy to use electronic method for creating and delivering the information that managers use for status reporting, planning and decision-making".

Levinson (1985) distinguishes between two main types of support systems:

1. Executive office automation focusing on efficiency, emphasising personal management and communication tools
2. Business oriented systems focusing on effectiveness, emphasising decision support tools based on a business problem".

Certainly the uses to which what are described as 'EIS' are put can vary considerably. Bird (1993a) reports Moore Stephens, an accountancy firm, as regarding their system as a 'repository of corporate knowledge':

"It records what we know, who we know, where they are located and what our relationship with them is".

This is some way from those systems which are based essentially on quantified data. Possibly Turban's (1990) conclusion is safest:

"There is no universally accepted definition of Decision Support Systems".

What an EIS is

EIS developments are computer-based systems which aim to improve managerial decision-making effectiveness. They lead to commercially available products which can be independently evaluated. The constraint and associated limitation is that their bias is towards the informational aspect of problem-solving with, as yet, little relevance to problem-structuring, option generation, evaluation or implementation.

Initial management information systems (MIS) failed to make an impact on senior executives and Martin and Clarke (1990) attribute this to:

1. The systems were aimed at management support and were not capturing the essence of the executive's real work activity.
2. Executives still rely on traditional sources and informal feed-back.
3. Executives have difficulty in learning how to access systems.

Bird (1993a) also stresses the third point referring to the colour graphics and touch-sensitive screens in EIS packages to make access and navigation easier. Key features of an EIS are, according to Martin and Clarke (1990), the Executive Summary which provides the main overview and helps basic inquiry. This is supported by a critical element - 'drill down' - which enables the user to pass down through successive layers of data in order to pinpoint causes at lower levels of detail. Typically a budget overspend, say on Marketing, can be investigated by examining component parts of Marketing, e.g. Market Research or Publicity and ultimately the system should be able to identify individual

invoices. It combines text, numbers and graphics and simplifies the interaction between these and the data layers. Bucknall (1991) adds 'exception reporting' to drill-down, that is, the automatic reporting of significant variances exceeding pre-determined thresholds.

Before turning to the background and theoretical justification for the EIS approach one can note the level of impact on businesses already generated by such systems.

The evolution of the EIS has been charted by IDC (1991a) as in the following table:

TABLE 18

STAGE	DATE	FACTORS
EIS launched	1985	Command centres
Graphical User Interface	1987	PC ease of use
Different platforms	1988	LANs and PCs
More vendors	1989	New technical approaches
Information structure	1990	Access to operational databases
EIS for all	1992	EIS user interface spreads to more applications

Thus a combination of hardware and software developments as well as applications improvements have led EIS systems to widespread acceptance in less than a decade. The IDC (1991a) survey also identifies changes in the EIS tool-kit components.

<u>COMPONENT</u>	<u>Original</u>	<u>Current</u>	<u>Future</u>
Relational database	X	X	X
Character user interface	X		
Graphic User Interface	X	X	X
Personal use tools		X	X

	(Original	Current	Future)
CASE-like tools (Computer -aided software engineering)		X	X
Direct data pipeline		X	X
Decision support tools			X
Text management			X
Image processing	X		

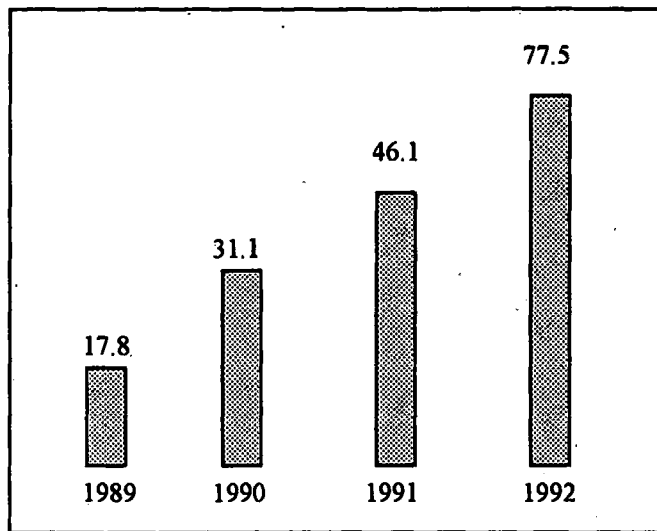
Again, one can note the evolutionary nature of EIS developments with new technology and user demand facilitating the introduction of new elements whilst practical experience causes other features to be re-prioritised.

Current applications and developments

There is increasing evidence to suggest that firms are taking EIS developments seriously and are prepared to invest substantial sums to introduce them. Computerworld (1989) reported that 50% of large US Corporations had EIS developments installed or underway. Bullinger and Huber (1990) report the results of a survey into companies which found that of planned software applications, EIS was the most frequently mentioned. Rowe and Herbert (1990) identified four main packages, the Intelligent Office System, Resolve from Metapraxis, Pilot from Thorn EMI and the Commander System from Comshare. In concluding that these were highly appropriate to the needs of the Chief Executive, Rowe and Herbert forecast substantial growth during the 1990s albeit from a low base. Palframan (1991) reported that Sony Europe was determined to supplement its qualitative and financial information with quantitative data and chose an EIS purchased from Thorn EMI to act as the delivery medium. This was regarded as a key element in the firm's growth 'through rationalisation' strategy.

Bird (1992a) quotes from Business Intelligence the following figures which represent in millions of pounds the value of Executive Information Systems in Europe of which the UK makes up approximately 80%.

FIGURE 4



Bird (1993a) also contrasts the results of a 1991 survey which found that senior managers were not seeing tangible benefits in EIS developments with one carried out the following year which found that 41% of organisations were using an EIS.

In order to understand why this might be so it is worth considering the needs that EIS developments attempt to meet. Martin and Clarke (1990) identify senior management's needs as follows:

1. Information which addresses information needs and work roles.
2. Facilities which support the communication of ideas with others.
3. Minimal requirement for technical learning.
4. Highly efficient data selection and retrieval methods.
5. Highly effective data presentation.

and the features which Executive Information Systems can deliver in meeting these needs are:

1. Information based on Critical Success Factors (see below)
2. Supports idea sharing with electronic communication
3. Minimal keyboard inputs
4. Discretionary data selection
5. Sophisticated graphics

In a survey by Hague and Watson (1983) into management's role in the approval of Decision Support Systems the following reasons were cited for investing in large-scale DSSs:

TABLE 19

REASONS	% citations
Accurate information	67
Viewed as organisational winner	44
New information needed	33
Management mandated DSS	22
Timely information needed	17
Cost reduction	6

Thus information needs whether in terms of accuracy, new requirements or timeliness emerge as key features.

Background

If we consider initially the sourcing of information at a general level one can note Zmud's (1982) contrast between three views of the uses to which information can be put. Firstly, the traditional view sees information as an input to decision-models and is associated with the reduction in uncertainty surrounding different options. A second approach perceives information serving as cognitive cues or cognitive conditioners with cues triggering certain decision models and conditioners triggering specific information processing modes. Finally, information can be acquired for its own sake to support power structures or substantiate legitimacy. Zmud also distinguishes between formal systems - official memos, plans, budgets, directives, reports etc. - and informal systems - 'inspection tours, personal contacts, private records etc. 'Formal' is characterised by precision, rationality and objectivity whereas 'informal' can be viewed as soft, ambiguous, verbal or visual. Zmud argues that financially successful organisations are biased towards informal systems and decision processes and that informal systems are richer in content and convey more information to knowledgeable members. Zmud reports that most implemented systems involve formal information processing and argues that in future systems should attempt to incorporate informal information processes.

"As currently implemented, the DSS concept essentially remains a formal DSS: narrow, tightly-structured problem specifications; processing capabilities largely dictated by a few individuals, often other than the user; and information elements of an economic, quantitative nature".

Whilst acknowledging that EIS developments only address a sub-set of the potentially-relevant information available to the manager, that sub-set is still seen as critical both by managers and EIS designers. Many designers refer to Rockart's (1979) paper as a starting point for the specification of the new systems. In it he identifies 'four methods for identifying executives' information needs

summarised as 'By-product technique', 'Null approach', 'key Indicator System' and 'Total Study process'. With the 'By-product' case, the information that is passed to top management is a spin-off from operational systems such as billing or payroll. In the 'Null' approach the dynamic and fluctuating nature of the business is recognised and the conclusion is that no computer-based system can make any meaningful contribution. The 'Total study' approach is typified by IBM's Business Systems Planning methodology, incorporating a wide-ranging survey of managers' information needs. However, the Key Indicator or Critical Success Factor approach is argued as being most relevant and with the greatest potential for actual application.

Rockart proposed three main concepts; first the selection of key indicators of the health of the business, second exception reporting and thirdly delivery of the information to the Manager using new screen-based technology. He also stressed that Critical Success Factors are 'manager specific', reflecting the 'constant flux with new reports being developed as needed to accommodate changes in the organisation's strategy, environment or organisation structure'.

Key components are identified by Crandall and Kerber (1985) as being:

1. A development facility for individualised human interfaces
2. Packageable micro/mainframe communications
3. A security system
4. An information collection, administration and distribution library
5. An open environment for distributed applications, e.g. Lotus, and access to mainframe products
6. A decision-support facility for condensing data into desired information, reports and charts.

They identify the failures of earlier commercial systems as resulting from combinations of the following factors:

1. They were not what the executive wanted
2. They required training or learning time to be used effectively
3. They responded too slowly when information was requested
4. The information was difficult to access
5. The micro/mainframe technologies were unreliable

Whilst the early systems had only limited success in the marketplace, the software industry remains convinced of the potential underlying perceived benefits of electronic delivery of information, namely:

- Reduced data overload by more selective delivery of relevant information
- Greater focus of attention on critical items

- Faster access with the elimination of manual filing and retrieval
- Easy to locate 'official' sources of accurate information

Roberts of the EDS Corporation (1985) suggests that the EIS should focus on the strategic role of the executive which he believes is comprised of five elements:

1. Developing and focusing the company on the 'Big Picture'.
2. Allocating resources effectively
3. Acting as a change agent
4. Managing conflict and culture
5. Generating agreement and commitment

From this develops the theme of the EIS targeting the following:

1. Facilitating insight and understanding
2. Provoking discovery and change
3. Enabling or accelerating change
4. Providing competitive advantage

Roberts then proceeds to identify different priority levels in a business all of which he believes should benefit from the application of an EIS. Each level he perceives as being dependent on the one below it. Level 1 includes business strategies and organisational goals; level 2 functions such as Manufacturing or Personnel; level 3 processes such as interpersonal communication and information processing and level 4 activities and actions such as meetings and report writing. The implication is for a more sophisticated workstation with a knowledge base, a means of accessing sources and the ability to manipulate the data.

Crandall (1987) also sees potential beyond the original design criteria:

"The more you use an EIS, the more you can see other useful applications for it. For example, another communications asset for executives in companies that have installed electronic mail systems is to integrate the EIS and Electronic Mail. With this connection, questions that arise from perusing the EIS can be asked of remotely located managers via E-mail. The goal stays the same - improving communication, reducing data overload, increasing relevance, timeliness and the ease of accessing information for the entire management team":

Review

It seems reasonable to propose that EIS developments now rate amongst the three most important application areas for most businesses using or contemplating using computers. Firstly come the internal transaction-based applications, processing invoices or orders or preparing the payroll which provide the bed-rock of computing processing as well as making potentially available the information relating to the volumes and values of these transactions. Secondly there is the proliferation of PCs bringing basic applications such as spreadsheets and word-processing. Thirdly the EIS developments attempt to impose some coherence and structure on the information-provision component and, as has been indicated, they are prominent in the list of priorities that businesses currently identify.

As with all other aspects of computing we have considered in this chapter, development progress has been hesitant and subject to reversal. The logic behind the initiatives are readily understandable with the focus less on problem-solving and more on problem-finding. Offering iteration on-line reflects more appropriately the typical problem-solving line of inquiry where one issue leads to another. The static standard reporting of the MIS does not lend itself to this process of inquiry.

Long (1987) saw relatively little impact for EIS systems when taking industry as a whole, identifying four main causes. The concept was still quite new and literature on the topic scarce. Each system had been designed for different needs and each system was shaped by the management style of the user. Finally there had been a tendency to draw on old and inappropriate development processes. Conversely, but commencing with the larger Corporations, executives are now increasingly seeing EIS developments as critical. Datapro (1992d) quotes R. Wallace, President of Phillips 66:

"Companies that are reluctant to move electronic information into the executive suite are naive ... and this will be a significant limitation on their managerial and competitive ability in the 1990s."

Finally, whilst much of the initial focus of the EIS was on the senior executive, usage is increasingly spreading within organisations. Bird (1993b) reports that in 80 companies worldwide the EIS is used by over 100 executives and that in some organisations it is approaching 1000 users.

IMPLICATIONS FOR INTEGRATION

So far in this chapter the systems have been described in isolation but in this section we attempt to bring the disparate components into an integrated framework not only in order to clarify their respective roles and contributions but more specifically because we are beginning to see the first examples of practical integration of some of the systems. In one of the National Computing Centre studies Remenyi (1990) suggests the following distinction:

	Automatic processing	Satisfying needs	Shaping strategy
Transaction processing	MIS	X	SIS
Querying and analysis	X	MSS	SIS

This suggests that Management Information Systems (MIS) relate primarily to data which is automatically processed and derived from Transaction Processing sources. In contrast, when it is necessary to consider the satisfaction of genuine needs where the mode is querying or analysis then Management Support Systems (MSS or DSS) are more relevant. MIS systems tend to produce standard reports whereas MSS provides greater flexibility to pose questions. Remenyi also refers to Strategic Information Systems (SIS), a particular category of Decision Support Systems aimed at 'shaping business strategy'.

Turban (1990) provides a slightly different perspective on the systems which is illustrated on the next page:

Control type →	Operational control	Management control	Strategic planning	Support needed
Decision type ↓				
Structured	Accounts receivable, Order entry	Budget analysis, Short-term forecasts, Personnel reports make/buy analysis	Financial management, Warehouse location	MIS Or TPS
Semi-structured	Production schedules, Inventory control	Credit evaluation, Budget preparation, Project scheduling, Reward systems design	Build new plant, Mergers, new product naming	DSS
Unstructured	Magazine cover selection, Buying software	Negotiation, Executive recruitment, buying hardware	R & D planning, New technology development	DSS ES

Whilst represented differently, Turban's perception is similar to Remenyi's with the more predictable, structured issues being addressed by MIS and basic processing systems whilst DSS systems offer greater flexibility to the process of inquiry. In considering TPS, MIS, DSS, EIS and ES systems collectively Turban observes that all five are unique classes of information technology but that they are also inter-related with each supporting some aspect of managerial decision-making. MIS focuses on structured flows of information whereas DSS can address ad-hoc and unstructured issues. MIS works to long timescales because it is relatively inflexible whereas DSS can vary outputs in the short term.

The DSS can also be contrasted with the ES (Expert System) and Turban cites a wide range of differences from which the following examples have been taken:

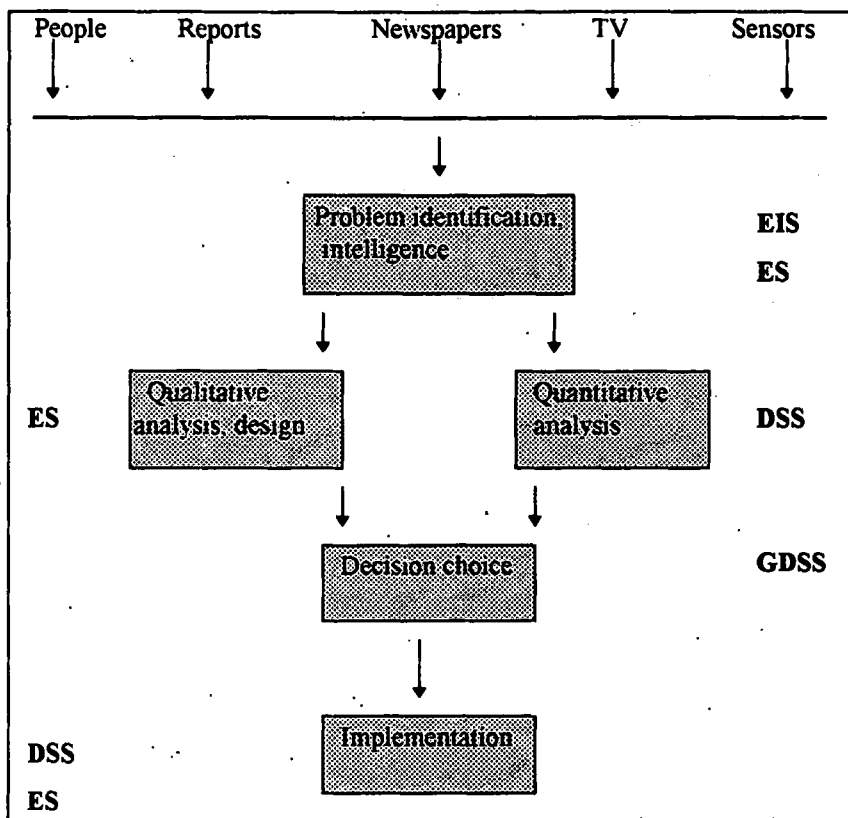
TABLE 20

DSS	ES
Assists the decision-maker	Replicates human advisers
Numerical	Symbolic
Complex, integrated	Narrow domain

Some writers are noting the links with the activities identified in Chapter 3 within the staged problem-solving approaches. For example Meador, Keen and Guyote (1984) comment that of the following 8 stages the first 7 are addressed by DSS systems whereas the eighth can be helped by Expert Systems.

1. Specification of objectives, parameters, probabilities,
2. Retrieval and management of data.
3. Generation of decision alternatives
4. Inference of consequences
5. Assimilation of information
6. Evaluation of consequences
7. Explanation and implementation .
8. Strategy formulation

Turban (1990) also attempts to relate information systems to staged activities as follows:



Each of the systems can be seen to align with specific activities but Turban also suggests that there is a relationship with job role. Thus the DSS is essentially used by professionals and middle managers whereas the EIS sits primarily within the domain of the Chief Executive. However, a significant current development is the integration of a variety of systems. Turban comments:

"Great benefits can be derived also when [DSS, EIS and ES] are integrated with each other ..."

For example, Expert Systems can provide guidelines to the use of models, can conduct cause and effect analyses and can help interpret results. They can also help database management and provide an interface to on-line systems. Examples of the shift towards integration are 'GURU', an Expert System shell in an environment that supports spread-sheets, text, graphics and business communications and 'EXECUTIVE EDGE' which combines DSS and EIS with some elements of ES.

Despite problems of integration which are identified as hardware and software incompatibility, behavioural problems such as the difficulty in establishing how Expert Systems arrive at their decisions and time delays with the many man-years needed for ES developments, considerable resource is being allocated to the introduction of integrated systems. In Manufacturing IBM has its 'Logistics Management System' and another example is Decision Stimulation or DSIM. In Marketing a system called 'PROMOTER' considers the effects of running promotions and in Financial Services 'FINEXPERT' demonstrates the combination of DSS and ES. 'EXECUCOM' is an integrated system

with an Expert System facilitating drill-down interrogations. PMSS, developed by the Defense Systems Management College, has a variety of different but integrated elements. There are Functional Modules such as on Programme development and Budget generation. 'Program' provides a 'top view' instant visual overview and there is executive support material including calendar, directory, briefing presentation aid, word-processing and spreadsheets. Data from all functional areas is fully integrated.

These practical developments are consistent with a logical approach if one accepts that within the problem-solving processes, individual activities will find greater or lesser degrees of relevance from the various systems discussed. Furthermore, when used in combination, the strengths of each system can help balance the weaknesses of other systems, thus providing the potential for the integrated system to make a significantly greater impact in future than has been the case.

CHAPTER REVIEW

In this chapter we have considered the usage actually being made of computers as well as the applications and software that are available. A number of key themes have emerged. Firstly the accessibility of hardware and software to the average manager has increased substantially and there are no indications that the rate of penetration into the managerial profession will not continue to develop. Whilst the extent of usage varies between organisations and within organisations between departments increasing numbers regard the computer as essential to the job they do.

Analysis of the usage of computers by managers cannot sensibly be divorced from overall in-company usage which historically developed from transaction-based applications such as payroll, accounting, invoicing or stock control. Thus, much of the key information that is critical to managerial problem-solving is derived from in-company databases.

The introduction of the desk-top computer came as a secondary evolutionary strand offering basic word-processing and spread-sheet capabilities and it is these relatively unsophisticated applications that are currently the most widely used. As such, the manager's exploitation of the computer for his or her on job is still immature and fragmented. However, MIS and EIS developments have aimed to bridge the gap between the in-company transaction-based systems and the desk-top PC.

As yet, there is little evidence for the usage of the sorts of systems described in Chapter 2 so the gap between design and widespread usage remains substantial. However, developing integration and a desire on the part of manufacturers to gain market share by innovation can be linked with the desire by at least some managers for more sophisticated applications particularly in the field of decision-support and modelling. It can be argued that most of the designers referred to in Chapter 2 adopt a problem-specific approach whereas most developments in this chapter, i.e. actual managerial usage,

are job-oriented. The latter cover a wide range of potential problems but at a basic level whereas the former take individual problems and subject them to a more comprehensive and rigorous analysis. The reconciliation of these two viewpoints and the development of a structure which accommodates both perspectives is the primary concern of this thesis.

The accessibility of hardware is undeniable and the analysts estimate that there is ample spare capacity in the hardware to accommodate future developments. Software applications have lagged behind the hardware but with the Industry's commitment to making systems more user-friendly one can expect acceptability levels to continue to increase. Internal developments have concentrated on making information accessible to managers, initially through MIS and latterly through EIS. With information access and analysis being addressed through EIS systems, Expert Systems are beginning to provide an 'intelligent' interface to information-based applications whilst also providing stand-alone applications.

With the components discussed in this chapter providing the main channel for managers to enhance their problem-solving via the computer, any designs for a more comprehensive management-support system need to accommodate the structures and processes already reaching maturity. Thus the additional features and functionality described in the remainder of this thesis build on and around these elements rather than seeking to replace them.

We started with an albeit simplistic representation of a manager, Sandy, considering a range of potential problems facing him. In the early chapters we reviewed the scope of using methods to help the problem definition and problem solving process. Certainly they would appear to have relevance to how Sandy could tackle some of the issues both at the macro level with, say, Kepner- Tregoe or Checkland, or at the micro-level with PDS or COPE. However, the review of computing developments in this chapter will have suggested a number of complementary systems which might be available to help Sandy.

He is likely to have a PC with a range of facilities and data available to him via that medium. Transaction-processing systems may well have information on, for example, the telephone calls problem, and were he to have an EIS it is possible that he would have been alerted to a potential problem with the system exception-reporting rather than be alerted to it by the Finance Director. Drill-down should enable him to pursue a line of inquiry that pinpoints the location of the volume variances if not the cause. But clearly the developments outlined in this chapter could take him considerably further and in the final chapter we can consider the potential of a more fully-developed system to impact on Sandy's problem-solving and analytical capabilities.

Thus we have moved from the position reached following chapters 1 to 3 where we could begin to see potential roles for using method, coupled with the constraints, to one where greater inroads can be made not only to the limited selection of problems facing Sandy but the much broader spectrum of issues facing the managerial community on a day-to-day basis.

CHAPTER 5**MODELS FOR VIEWING PROBLEM-SOLVING****CHAPTER CONTENTS****INTRODUCTION****ROLE-CENTRED VIEW****PROBLEM-CENTRED VIEW****MODEL RELEVANCE**

Problem identification

Problem definition

Objective setting

Information gathering

Analysis

Option identification

Option evaluation

Decision making

Implementation

INTRODUCTION

Two models are presented in this chapter, the role-centred and problem-centred perspectives, which offer a framework both for incorporating the disparate elements of problem-solving encountered in the earlier chapters and for proposing a structure for a computer-based managerial job and problem-progressing system which is discussed in Chapter 7. The chapter describes the models and then suggests how the staged approach and the resulting activities can be related to the models.

The first four chapters have identified the considerable variety of approach with the methods, tools, techniques and more general perceptions of problem-solving issues characterised by commentators on the topic. Whilst there may be a singular lack of unanimity there is no reason to believe that the views are not complementary, offering different but valid insights to either differing types of problem or different elements within the problem-solving process. In order to assimilate these disparate elements we now propose two basic models that help to describe managerial activity in relation to problem-solving. In Chapter 6, fieldwork is presented which can be compared with the models to identify common ground and discrepancies and from this validation process emerges a more tightly specified set of requirements for computer systems to support this aspect of managerial behaviour.

It is necessary to distinguish first between what can be termed 'problem-centred' and 'role-centred' activity. The latter describes the totality of the work units a manager deals with. In simplistic terms it

is his 'In-tray' made up of a variety of different reports, memos, letters and forms although, as the detailed discussion indicates, the model extends beyond that of the physical 'In-tray'. The manager is likely to be carrying with him a cognitive collection of thoughts, questions and 'must do's' which along with scraps of paper, 'post-its' and diary notes make up an overall 'mega in-tray'. When Stewart (1963) describes managers as planning, organising, motivating and controlling she reflects the 'role-centred' viewpoint. Managers have to manage this totality and it is the implications that flow from it which comprise the 'role-centred' elements.

When a particular work unit (see below) is subjected to detailed analysis it conforms with a 'problem-centred' approach and this is the dominant perspective of most writers referred to in the earlier chapters. Whilst there is no implication by the writers that a 'role-centred' perspective is not valid, nevertheless their primary emphasis is on the single problem rather than the totality facing a manager at any one time. To return to Sandy's set of problems in Chapter 1 the problem-centred approach might focus on how Sandy copes with the problem of the aggrieved customer, for example. In contrast, the role-centred approach would reflect how Sandy deals with all current problems, which he deals with and in what order and how they impact on each other.

The two models are descriptive, not prescriptive, although both are capable of incorporating prescriptive sub-routines within them.

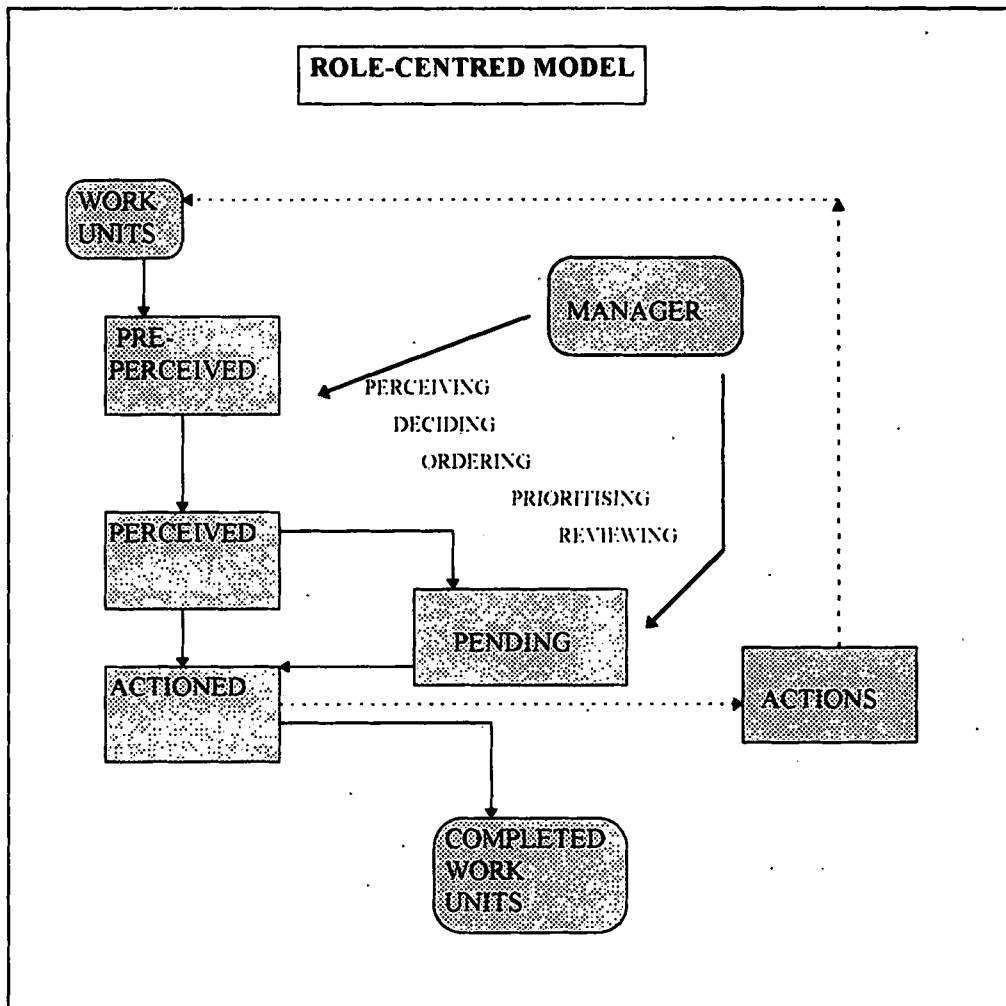
The term work unit is used above to distinguish it from an activity, task or action which may flow from that work unit. It approximates to the raw material, energy and information inputs in the Open Systems model (cf. Kast and Rosenzweig 1972). A work unit could be a report or memo which may require 'action' in terms of reading it and a further action if a response is required. It could also be a 'must do' retained in the mind of the manager, for example, 'must check with Jim to see if sales have improved'. A work unit is inert until a connection is established between it and the manager.

There are a number of reasons why the 'Role-centred' view cannot simply be regarded as a collection of 'Problem-centred' units or a particular variant of the latter.

1. Issues and problems are often linked with each other and the manager can best understand the linkages if the totality is visible to him.
2. The management of groups of issues (role-centred) implies differing design requirements from that of a single issue with greater emphasis on prioritisation and competition for limited resources.

3. A system which aims to cover a wider spectrum of managerial activity should potentially have greater attraction than one which only addresses dealing with individual problems.
4. Many computer-based and non computer-based systems and approaches such as 'time management' and 'electronic mail' which are extensively used by managers reflect the holistic approach.

FIGURE 6



ROLE-CENTRED

The main features of the role-centred model are shown in the diagram above. It reflects primarily Mintzberg's (1990) description of managers dealing with large numbers of short duration activities 'characterised by brevity, variety and discontinuity'. Managers tend to deal with a range of different work units, some of which are dealt with sequentially, but many of which (and in particular those referred to as 'problems') are stored and re-addressed periodically.

The model suggests that work units are the basic inputs and the activities managers carry out affect the status of the work units with the outputs being both completed work units or associated actions.

Work units, of which 'problems' constitute a sub-set, arrive from two sources. They can be delivered, many through the 'In-tray' but also by telephone or personal discussion. These may be originated externally but issues will also be identified by the manager when he scans the environment. Scanning may be:

1. Reading internal or external reports.
2. Physical visits to the work-place or market-place.
3. Formal (meetings) or informal contacts with other people.

In these cases the manager generates his own potential actions. Thus the work units will normally have a physical existence as reports, memos, requests for information, instructions, complaints or messages. They may, in turn, depending on the judgement and perception of the manager give rise to required actions.

The actions and issues either derive from work units which are delivered to the manager or are directly apprehended by him. Work units may have arrived but are not yet 'apprehended' in the sense that their contents are understood by the manager. These are termed 'PRE-PERCEIVED'. As an example they may be in his 'In- tray' and he may know that he has many items waiting attention but their contents are as yet unknown. Once a 'work unit' has been read or listened-to it is 'PERCEIVED'. This process may not occur at a single point in time. Documents may take some time to read - Mintzberg (1990) noting the regular interruptions that characterise manager's jobs - or their significance may not be immediately or totally understood.

Pre-perceived work units are not simply undiscovered problems as the externally-generated ones have a physical existence as unopened mail, unread reports or unheard voice messages. Their particular significance is that they exist in the computer-based system to be described later in the thesis and it is possible for the system to carry out simple actions on some of them (e.g. prioritising, re-formatting or re-transmitting) without the direct involvement of the manager.

In simple terms a work unit is recognised and a decision is made whether to deal with it completely, partially or to put it in 'pending'. Partially-actioned items will be held in pending until all necessary activities are completed. Periodically, the manager reviews his 'pending' item, considering priorities and inter- relationships.

The work unit can go in one or more of four possible directions.

1. It can have a transformation carried out on it by the manager. He may sign the form giving authority to proceed or edit a text.
2. He can generate an associated action, as when a request for information results in a response giving that information.
3. It can leave the system unaltered as when a report is read but no action is required. This is not to say that the report may not have changed the manager's knowledge or perception of a particular situation.
4. It can go into a 'meta-tray' which will include the physical 'in-tray' but also any electronic equivalent and the cognitively-held 'must-dos' or 'action points'. The reasons why issues are put there can be many and varied. It may be because the issue is less urgent or because he wants to wait until he has time to consider it. It may be held because further information is needed and having asked for it, he is awaiting a response. In some cases the manager may not know what to do and in others he may know but cannot proceed because of some constraint.

Whilst we have no direct concern in this research in the respective merits of the strategies operated by managers in dealing with their 'meta-trays' we can suggest that four main approaches may be operating either separately or in conjunction with each other.

1. 'Top of the pile'. Here the items are taken and dealt with in the order in which they are physically available.
2. Priority. Here, criteria are used such as 'urgency' or 'potential impact' to order the items in some form of prioritisation.
3. Deadline. This is variation on 'priority' in that items which have some internally or externally-imposed deadline are addressed in such a way as to ensure the deadline is met.
4. Trigger. In this case an external trigger may alter the priority. A simple example might be the manager's desire to improve the appearance of a display area. This low priority item suddenly becomes high priority when he hears that the Managing Director is to pay a visit. (Cf. 'triggers' discussion in Chapter 3, Segev 1976)

Two additional features characterise the role-centred model. Firstly, there is the concept of 'LINKAGE' by which we mean that the work units and issues and actions arising from them are linked irrespective of whether they are pre-perceived, perceived or pending. These sets of linked work units may be direct - for example, a manager promotes an existing employee rather than recruiting from outside to resolve one issue which is 'filling a vacancy' but this also helps to address a separate issue which is low morale caused by perceived lack of opportunity for advancement. Linkage may be also be indirect - all work units compete for time and attention and with finite resources, expenditure on one item leaves less in the budget for the remainder. What we refer to as sets of linked work units is very similar to Ackoff's (1979) 'messes', referred to in Chapter 1, - the complex systems of changing problems that interact with each other, although the connotation of 'mess' is that the networks of work units are not fully understood.

It is also possible to group items either according to some criterion - certain items may be 'must do today', or according to some conceptual categorisation. The scope for categorisation is endless but a distinction should be drawn between those which may be useful to the analyst or consultant, for example strategic, technical, marketing etc. and those where the categorisation offers some potential to be integrated within the design introduced later in this thesis, e.g. grouped by deadline or potential impact.

Some of the features of the role-centred model can be illustrated by referring back to Sandy and his collection of 'work units'. One was the letter from the aggrieved customer. When Sandy has read it he has 'perceived' it in the sense described above. He may decide to deal with it immediately or put it in 'pending'. When he comes to deal with it he might choose to generate say three actions. One is to find out what happened. When he has found out and decided on an appropriate course of action he writes to the customer and that may well 'close' the original work unit. However, Sandy may also be concerned (through 'linkage' with other complaints) that service standards need improving and he writes to the Service manager making some suggestions. This creates a new work unit for the manager but also Sandy who will monitor for a reply. A second thought may be that better quality of service measures are needed and Sandy determines to introduce some measures - a second new work unit which may sit in 'pending' until an opportunity arises. Thus the work unit has ended up as one completed work unit and two new ones. Key concepts are 'queueing' as work units compete for attention and 'fragmentation' as work units generate subsidiary, associated or new actions.

Whilst there can be no clear dividing line between the 'role-centred' and 'problem-centred' approaches it is still feasible to recognise that issues are subjected to the degree of attention and analysis that is implied in the descriptions in Chapters 2 and 3. In effect, the problem-centred perspective is an expansion of what happens to move a work unit from 'perceived' or 'pending' to 'actioned'. Thus whilst

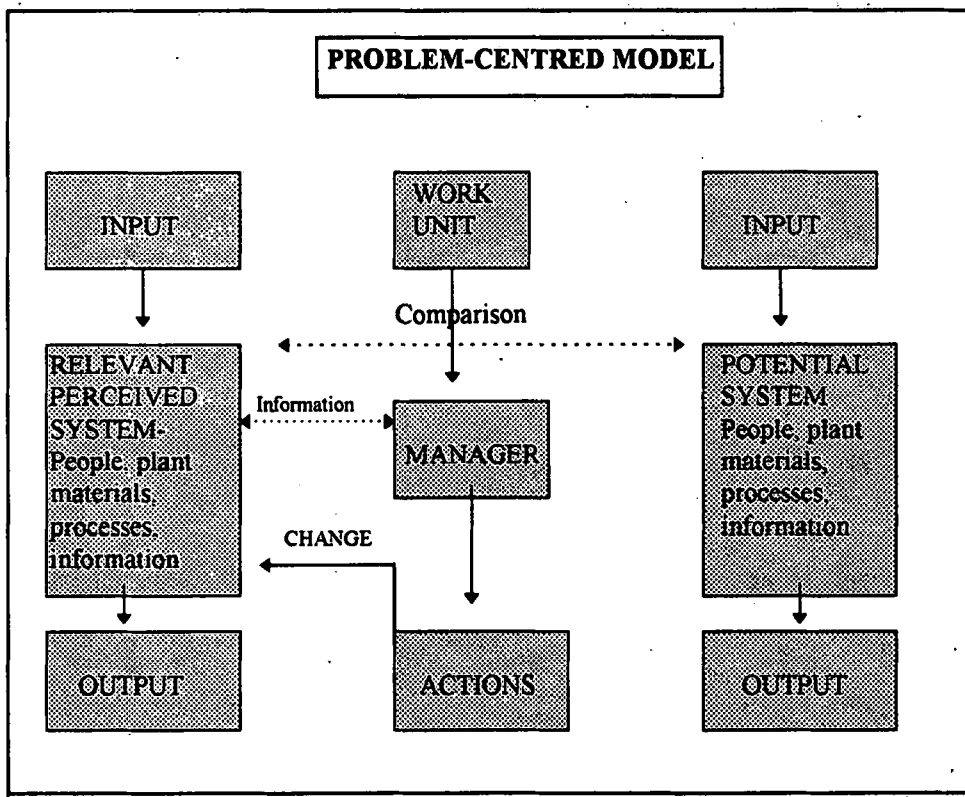
it is not visible on the role-centred diagram, the activities implied by it can be inferred from the status changes to work units.

PROBLEM-CENTRED

Whilst Mintzberg (1990) suggests that only half the activities of a Chief Executive last more than 9 minutes, there is nevertheless an implied change in focus from the whole job to the individual work unit. The image presented is one of dynamic tension between the two approaches with the manager oscillating between detailed analysis and rapid resolution whilst maintaining cognitive or paper-based linkage between the issues, problems and sub-problems. No research specific to the existence of this in the managerial context has been identified although there are superficial similarities with, for example, Etzioni's (1968) 'mixed scanning' where the oscillation is between strategic planning setting the broad direction and incremental planning which implements policy and for which detail is of the essence. Hodgkinson (1978) cites the analogy with space technology 'where spy or weather satellites have the ability to alternate between the broad overview and close-up'.

The principal elements in the problem-centred approach are as is shown in the following diagram. In the role-centred approach, the primary perspective is on the work unit but here the view is of a conventional systemic perspective with the object being the organisation or a relevant sub-section of it.

FIGURE 7



'Reality' exists but what the manager sees is a Perceived System and the perception takes place via his Monitoring system. We can suggest that it is useful to regard this Perceived System as consisting of a mix of People, Machines or Plant, Materials, Processes and Information which operate on a range of Inputs and convert them into a range of Outputs. Turban (1990) proposes a similar model when he states:

"Management is a process by which certain goals are achieved through the use of resources (people, money, energy, materials, space, time). These resources are inputs and the attainment of the goals is viewed as the output of the process".

Outputs can have multiple characteristics, that is they can have independent and differentiated qualities. Hence a manufactured product is a physical entity for the Distribution staff whereas for the Accountant it is an asset with a value of £X. It may also be useful to distinguish between renewable and non-renewable items. Non-renewable refers to items like raw materials which enter the system, have some transformation carried out on them and then leave the system permanently. They are, in this sense, transitional. Renewable items are, for example, people and machines which have greater permanency within the system but which also enter and leave it. People enter the system by travelling to work and leave when they go home. Machines are switched on and off. Entry and exit can be long-term as when staff are first recruited or finally retire. New machines can be bought in and old ones scrapped. These can be regarded as cyclical elements.

The final critical element in the model is the Potential System. There can be a number of these and they represent what the manager feels the Perceived System ought to be. This can vary over time - 'what ought to be happening now' and 'what ought to be happening in 5 years'. A second contrast could be between what should be happening now and what should be happening after some desired change has been put in place. Objectives and goals thus become outputs from Potential Systems. For example a goal of 'achieving an increase in sales of 10%' is an output from a Potential future system. Potential systems can be conceptual but also physical or numerical which is where modelling can make its own unique contribution.

Thus the model consists of two separate but interacting components. One is the perceived relevant organisational system, the other being the manager with a distinct 'work unit' input. The manager uses information to monitor the perceived system and both information and thinking to identify how and why the Perceived system differs from the Potential system. The process then results in Actions which aim to change the relevant Perceived System to accord with the Potential System.

One of Sandy's examples is the increase in his section's telephone bills. The work unit is the call from the Finance Manager asking Sandy to explain it. The relevant perceived system is his section and the associated inputs and outputs. One output, the telephone call, is a drain on the organisation's resources (and possibly Sandy's budget). Sandy has a view of what the output should be, e.g. the budget or an 'expected or average' usage level, and must identify what is causing the gap between perception and potential. Actions, e.g. banning personal calls, can then be instigated to reduce the size of the gap. The original work unit is completed with an acceptable response to the Finance Manager although associated actions may have been generated which have a longer life.

Key concepts are monitoring and the need for information, comparison between perceptions and expected or ideal performance, understanding the processes that convert inputs to outputs and deciding on actions that will have the desired effect of reducing any gaps.

Whilst the operation of highly complex systems has here been greatly simplified it does provide a basic framework against which the methods described in the earlier chapters can be viewed. The PDS and Nipper methods compare and contrast different Potential Systems (or their outputs) whereas Work Study focuses on capturing the flow of elements within the Perceived System. Various financial iterations such as Discounted Cash Flow and Internal Rate of Return attempt to measure a Potential System output. Organisational disciplines lean towards a similar specialisation. Personnel Departments concentrate on the People element whereas Purchasing addresses mainly the input of materials. Transport and Distribution groups concern themselves with the movement of materials and products. Computing Departments have the information element, its capture, storage and dissemination as their primary area of interest.

Formal models referred to in Chapter 2 can also be seen to be consistent. Kepner-Tregoe focus on gap analysis, identifying the causes as to why a Perceived system diverged from expected performance. Checkland uses Root Definitions - seminal output statements - to generate new perspectives, thus Potential systems, which are compared with the Perceived systems to reveal change requirements.

MODEL RELEVANCE

The purpose of the two models is to provide a consistent framework within which the theories and methods of problem-solving reviewed in Chapter 2 and 3 can be placed. The main sections emerging from the initial review were as follows:

- Problem Identification**
- Problem Definition**
- Objective Setting**
- Information gathering**

Analysis
 Option identification
 Option evaluation
 Decision-making
 Implementation

It should be added that for any problem there will be two separate cycles, the one addressing the intrinsic problem, the other addressing the process for considering the problem. An example could be where a manager needs to identify why sales are falling. This gives rise to another problem - how should he tackle it? Does it need a committee or should a consultant be brought in? The essential issue is that, whilst the second problem is not in any way fundamentally different from the initial problem and may require some or all of the above categories to be brought to bear, it still merits separate attention and the two, whilst linked and inter-dependent, should not be confused.

We can now briefly consider each of the headings and establish their position in the twin models.

PROBLEM IDENTIFICATION

This is primarily a role-centred activity. Many problems will emerge from the Work Units which our model showed arriving from outside the system. Others, however, are created or identified proactively by the manager through the likely medium of the following:

Physical inspection
 Environment scanning (general data, reports etc.)
 Management Reporting System (MIS or EIS)
 'Informal' data (calls, conversations)

As indicated in Chapter 3, the problem may be in one of four stages. It may be undiscovered; that is the manager is unaware that a problem exists. Whilst this sits outside both of our models, one part of the role-centred models is specifically concerned with identifying the existence of such problems through the scanning or monitoring mechanism. The second stage is when a work unit arrives - it may be in the manager's in-tray, on his fax-machine or in a Voice-mail box - but has not been 'apprehended', that is read or listened to. The third state is when a work unit has been understood and a problem recognised but no action taken - it is 'pending'. The fourth state is when the manager decides to take action on a specific issue, prompted by the reasons given earlier which may be because the issue is now 'top of the pile' or because a 'trigger' has caused the manager to re-prioritise it. At this point we move from the Role-centred model to the Problem-centred model.

PROBLEM DEFINITION

With the focus now on the individual problem, some attention may need to be given to clarifying the nature of the problem. As part of this process Business practice may often be to establish 'Terms of Reference' or to produce 'Client Requirement Definitions' (CRDs) or 'Project Requirement Definitions' (PRDs). The Terms of Reference may include an overt or implied statement of what constitutes the problem as well as the requirements of the inquiry - see next section.

OBJECTIVE SETTING

Whilst many of the methods referred to in Chapter 3 made no specific reference to objective setting, others, such as Honey (1986) include this as a discrete early item. The 'role-centred' and 'problem-centred' models can be used to distinguish different aspects of objective-setting. Business, company or personal objectives would normally be stated, reviewed and revised as part of a separate, high level process - see discussion on Management by Objectives in Chapter 3. One activity within the problem-centred model is comparison of the output of either the Perceived system or Potential systems with the output specified in that Potential System which has Company objectives as an output. Thus, in a simple example, the Company objective may be to achieve a Return on Capital of 10%. The Perceived System is showing a Return of 6% and the Potential System envisaged by the manager after changes have been instituted should have an output of 11%.

A second level of objective-setting follows on from the Terms of Reference - that is the specific objective of the Inquiry which might be 'To produce a report by ...' etc. The third main item is where the Problem-solving process identifies the need to revise company objectives, thus creating a feed-back loop into the Company objective-setting process.

INFORMATION GATHERING

This is both a Role-centered and Problem-centered activity. It is part of the scanning and monitoring process which links back to the discussion on Management Information Systems and Executive Information Systems in Chapter 4, helping to identify problems. It is also part of the Problem-solving process within the Problem-centred approach where, with the problem already identified, information-gathering can help define the problem, establish models of the processes and activities, generate and help evaluate options and assess how implementation could or should take place. Hence, information-gathering can concern virtually any aspect of the model - the Perceived system, Potential systems, external systems (such as the market-place) or the inputs and outputs related to any of these.

ANALYSIS

In the standard rational model the 'information gathered' is then 'analysed'. However, as with Information gathering, we can note that it applies to both Role-centred and Problem-centred models.

In the former the data scanned must be subjected to some analysis in order to register the existence of or nature of the problem. The EIS methodologies referred to in Chapter 4 identify 'drill-down' as the key analytic tool - the ability to move down through layers of detail to identify the precise location of the variance.

In the problem-centred model analysis takes place throughout the process, reflecting the point made earlier that Information gathering is continuous or at least repeated. Analysis can either be of raw numerical data, soft informally-gathered data, causal relationships or processes. Work Study has this as the 'Examine' phase between 'Record' and 'Develop'. It can, in model terms, be analysis of the inputs and outputs or relationships and links within the systems.

A key element within analysis is the creation of models of Potential systems and their comparison with the Perceived system. Checkland (see Chapter 2) refers to the comparison of Conceptual models with the 'problem situation expressed' but comparisons also constitute a fundamental activity in business practice. A manager's budget is a Potential System and MIS and EIS technologies are frequently structured to provide a comparison and 'variance analysis' against actual results, i.e. the output from the Perceived System. Similarly, Critical Path techniques create a Potential System in flow-chart form and as critical milestones are achieved (or missed), project completion is revised from the comparison between original target dates and those achieved. Quality procedures for BS 5750 require a formal review to be carried out between the Potential System specified in the documentation and practice as deduced through observation. 'Corrective action' should then be taken to remedy any variations.

OPTION IDENTIFICATION

The rational models in Chapter 3 which referred to Option Identification e.g. O'Shaughnessy (1972), Kanter (1970), imply this as a discrete stage with 'options' being 'solution options'. The RIBA (1963) method, being more closely based in practice, suggests options will be considered at more than one point at 'Feasibility Study' stage, 'Design Development'. For the Problem-centred model options can be 'candidates for the problem', 'candidates for causation', 'options for Potential Systems' and 'choices of implementation path'. There are also choices to be exercised throughout the related Problem-solving process administration, such as whether to form a committee or not, who to consult, etc.

OPTION EVALUATION

Methods such as PDS and NIPPER (Chapter 2) offer approaches to evaluation using preferences and ranking. Evaluation could be in terms of Potential System structure, Potential System processes or the Inputs and Outputs associated with the Potential Systems. Examples would be Organisational analysis, Quality Circles considering processes or measured performance in volume or financial terms.

DECISION-MAKING

Noting our earlier distinction between problem-solving and decision-making, the latter refers to the exercise of choice with an implied action or actions. Again, decision-making in practice is not a single activity within the Problem-centred model but just as options present themselves throughout the project, so also must decisions be made repeatedly. We can also note that layers of decision-making may be needed. The manager may decide which option he wants to go for but this may require sanction from his superior - Mintzberg et al's (1976) 'authorisation'. Major schemes may need to be sanctioned by many groups such as Financial Approval Committees or the Board:

IMPLEMENTATION

This is essentially the range of actions and activities needed to change the Perceived System from its present state to one approximating to the chosen Potential System - Checkland's (1981) 'action to improve situation' or O'Shaughnessy's (1972) 'courses of action taken'. Some methods include a further stage involving monitoring, feed-back or review which equates to identification of Perceived System output and comparison with Potential System output.

Thus the individual activities contained in the methods described in Chapters 2 and 3 can be reconciled with the Role-centred and Problem-centred models and these help to distinguish between aspects which relate primarily to the manager viewing the totality of his job and the manager considering an individual issue. We have also noted that several of the headings cannot sensibly be regarded as single discrete stages but realistically are activities which are repeated a number of times throughout the duration of the project.

So far in this section we have concentrated on the General Methods but account needs to be taken of the Context Specific Methods (CSMs) to assess whether these can also be assimilated within the models.

One grouping of items within CSMs appears simply to be General Methods headings expressed in terms which are context-specific. For example, RIBA (1963) has 'construct prototype', 'construct pre-production prototype' and 'construct trial batch' all of which are instances of model-building (here physical rather than conceptual), followed by measurement and evaluation. One can note that in this example there are at least three instances of model-building at separate stages in the sequence. Kanter's (1970) 'calculate ROI', (return on investment) is a particular way of measuring output from the Potential System.

A second grouping consists of iterations which are often common within business practice but which do not fit easily into rational problem-solving sequences. One such would be Honey's (1986) 'Produce Invitation to Tender' which in his approach equates to 'generate alternatives' in that it is followed by

'perform selection'. However, 'Invitation to tender' can also be regarded as a discrete self-contained cycle with its own 'information- gathering' and 'analysis' activities. Another example, also from Honey, is 'procure equipment'.

The third grouping contains items which have administrative connotations but which are deemed to be essential in business practice of which examples from various methods would be:

'Prepare design documentation'

'Present final analysis'

'Communication of Action Plan'

In conclusion, comparison of the methods discussed in Chapters 2 and 3 with the twin models introduced in this chapter suggests that whilst it is difficult to reconcile sequentially and discretely phased methods with practical problem-solving, nevertheless the headings reviewed above do indicate categories of activity that have relevance to problem-solving but are typically not separate phases but sequences that are repeated regularly throughout the overall process. Thus the methods fail to provide an easy framework within which to assimilate specific business activities such as 'letting contracts' and can mislead by implying that the phases are sequential and discrete. Having suggested that this apparent inconsistency exists we can now examine both how the methods compare with business practice as evidenced by a number of case studies and can assess how successfully the twin models provide a framework for describing practical problem- solving.

CHAPTER 6**CASE STUDIES**METHODOLOGYCARDIFF CONTROL CASE

BACKGROUND

CARDIFF CONTROL CASE EPISODES

ANALYSIS

GAS BOARD CASEACS CLEANING CASENEW ROADS AND STREET WORKS ACTCHAPTER REVIEW

The previous chapters in this thesis have concentrated on published sources of information on managerial and related problem-solving and the hypotheses that have been derived from them. In order to validate them against experience in the field four case studies are reported in this chapter which help to provide insight into how problem-solving processes actually operate and specifically to explore how computerised applications potentially can assist the processes and what use is currently being made of them.

In the first three case studies the choice of problem was entirely at the discretion of the manager being interviewed. In each case the individual was asked to select a current or recent problem which they felt was particularly complex or difficult to resolve. No further conditions were set, such as choosing problems which might be amenable to the application of method. In the event, two of the three revealed potential for the application of computer-assisted methods and techniques whilst the third suggested little or no possible potential. As the case studies took place before desk-top computers had become widespread the primary concern was to establish if structured method had or could be used and from that to deduce the potential for applying computer-driven method. A valid issue is whether the case studies could be construed as representative to which one the response cannot be definitive. They were taken from three different industries, two utilities, the third a private firm. The first two are large organisations, the third small; the two former quasi-monopolistic, the latter highly competitive. As the problems were selected by the managers there was no base of 'problems selected by managers' with which to compare these but with the main requirement being insight rather than a survey of representative problems. Nevertheless one can identify no valid reason to believe that the problems were untypical or that critical features of organisational problems were missing from all case studies.

The fourth case study was selected on the basis that there was evidence that computing was being used to aid the decision-process although the extent and success was unknown. The Cardiff Control case is the main study and this involved a detailed analysis over 8 months of the development of a project to assess how an Engineering Works Control could be re-organised. Whilst this took place in 1982, it has the particular advantage that it occurred in a pre-computing environment so work practices and managerial aims and tasks operated essentially without reference to whether computing might or could impinge on the solution process. Analysis of the perceived constraints and failures in the process reported by the participants suggests areas where the subsequent and future development of software could play a potential role. The second study concerned a project in the Gas Board and this serves to provide a basis for comparison with the initial study but from within a different organisation. The third study moved to the opposite end of the spectrum, dealing with a small firm and a problem situation which served to underline the limitations of computer aided problem solving. The final study presents a current perspective by describing a project spanning 1992 and 1993 thus providing an opportunity to see how managers are exploiting the computing opportunities described in the earlier chapters and which the first three case studies suggested potential for.

METHODOLOGY

The primary purpose of the fieldwork was to gain insight into problem-solving processes and this is endorsed by Glaser and Strauss (1967) who distinguish between theory generation and theory testing. For them 'a single case can indicate a general conceptual category or property; a few more cases can confirm the indication'. Gummesson (1991) supports this viewpoint arguing that a case study provides an opportunity to take an holistic view of a process and can help to identify issues which may be difficult to anticipate.

The first three case studies relied mainly on in-depth interviews with key players although the Control Case was supported by extensive documentation. The fourth case study still used interviews but because it was possible to examine the actual software applications being used, these assumed a greater prominence.

All except the Cleaning Company case study took place in 'real time', that is the interviews took place as the problem-solving processes developed. They covered, in effect, both what Heller, Drenth and Koopman (1982) refer to as 'tracing analysis', essentially after the event, and 'process registration' which takes place during decision-making. The approach follows that of Schon (1983) who suggests that insight is derived principally by listening to the practising manager as he describes and comments on his practical problem-solving experiences. Schon contrasts the failure of the professions in the 1960s to provide effective prescriptions for organisational problems with the many examples of practising managers succeeding at their tasks and displaying artistry and judgement when circumnavigating the complex web of issues, causes and constraints that are a central feature of

problem-settings. The dominant model of professional knowledge had been that of Technical Rationality and this contrasts with the spontaneous and intuitive understanding that characterises how we live our everyday lives. Although articulation may be problematical, it is difficult to argue against the existence of tacit knowledge or 'knowing-in-action' which can be demonstrated by the application of know-how as when a tight-rope walker negotiates the wire.

With 'knowing-in-action' comes the recognition that it is possible to think about what we are doing which Schon terms 'reflection-in-action'. He suggests that practitioners do reflect on their 'knowing-in-action' and that, furthermore, this can serve as a corrective to overlearning. Schon sees the study of reflection-in-action as crucial. Insight is to be gained into managerial problem-solving by listening to managers reflecting on their problem-solving and recording how they go about solving problems. However, there are some attendant problems. In contrast to post-hoc selection of incidents there is always the gamble that the problem being examined may not turn out to be in any sense useful or relevant to the researcher. If the problem-solving process is of short duration a certain level of failures can be tolerated, but some managerial problems may be of long duration.

Many of Schon's examples are of problem-solvers reflecting in finite time as when a designer is sat at his drawing board working on a specific problem. Most managerial problems cannot be so easily examined with this sort of approach. It is not normally practical to ask a Chairman of a committee to give a commentary on how the committee is progressing as the discussions unfold so it may be necessary to interview the manager as soon afterwards as possible but with the risk of some post-hoc rationalisation. More recently video has become a potential aid for recording such discussions although the presence of the camera may affect the participants' behaviour. Another difficulty for the researcher is the pace at which the process may evolve. Nothing may happen for several weeks and then a critical issue may take place without warning. Vigilance is needed to pick up these issues as soon as they occur and before the trail goes cold. The researcher always has to balance being close enough to the project to be able to pick up the detail yet not to be so involved that he begins to alter, albeit unwittingly, the process of problem-solution.

Some managers appear to find it easier to articulate their thoughts by referring to specific cases and examples so the case Studies provided this focus. Yin (1984) comments that:

"The case study allows an investigation to retain the holistic and meaningful characteristics of real-life events".

Thus the main requirement in this research was to identify and record the processes associated with actual problem-solving. Schon's argument that in this context managerial reflection is a more powerful mechanism for gaining insights than theoretical analysis can be noted and provides the basis

for this approach. The first and main case study took place in the same organisation as the author was working in and this is seen as providing the particular benefit that understanding is enhanced through familiarity with the subject matter. Clearly this brings attendant risks of the analyst identifying with business colleagues' perceptions so verification of interpretation is required. This was achieved by providing feed-back to the participants and inviting comment. One example of a response, in this case a junior manager involved in the Control case, is as follows:

"The author has certainly got under the skin of the Control and must have appeared receptive to staff ... my criticism would be that it is weighted and one-sided to the staff ... no credit given to management".

The interviews were all recorded and transcribed verbatim and a sample of the transcriptions were referred back to the interviewees for comment although feed-back from this related mainly to clarification of comments made rather than any re-appraisal. In addition some retrospective interviews were carried out a few months after the final report posing similar questions to those used in the earlier interviews but seeking to validate the views expressed. These revealed no significant changes in viewpoint, quite possibly because the project had died a death and the participants had had no reason to reflect further on the original developments.

CARDIFF CONTROL CASE

BACKGROUND

In this case study a manager is given the task of coming up with re-organisation proposals for a unit known as an Installation Control - distributing work for field engineers to complete. His brief requires him to come up with a report to present to the main Board and he chooses to set up a Working Party to help come up with ideas and get staff involvement. The report is produced but is not accepted. The proposed changes are overtaken by national developments which propose introduction of one of the options the Working Party rejects. This is a fairly extended narrative reflecting developments over a year and the reader may wish to skim quickly through the story to the analysis on page 176.

In 1982 British Telecom was operating as a public corporation which had lost parts of and was in the process of losing further parts of its monopoly in the provision of telephone service. The financial state of the business was healthy with the financial year ending April 1982 turning in a profit of £457.8m., well up on previous years. Similarly the financial return performance target of 5.0% (Percentage of Capital Employed at Replacement Cost) had been achieved with a 1982 result of 6.5%. BT at this stage remained a large organisation with a turnover of £5,708m. and fixed assets of £8,313m. Staff numbers amounted to 245,882 an increase of 377 on the previous year. However, loss of monopoly and privatisation prospects were leading to the progressive tightening of control over

costs manifesting itself in a reduction of recruitment. This produced a reversal in the trend that would lead to lower staffing levels a year later. The case study occupied a period from the last quarter of 1982 and throughout 1983. The Chairman, Sir George Jefferson, in his statement to the Accounts (Report and Accounts, 1982) reported:

"The transition to an independent, competitive trading Corporation has been welcomed widely within the business. A substantial start has been made on the task of transforming the organisation to one more suited to a competitive Corporation, responsive to the diverse needs of the market. The task is a big one and will take several years to bring fully to fruition."

and

"The projected new changes will add very considerable uncertainties - and possibly opportunities - to a business already undergoing changes far more radical than experienced in the past seventy years and at a pace faster than experienced anywhere else in the world, and will make major additional demands on management and staff already heavily stretched by current changes."

A personal message from the Chairman was sent to all staff which "emphasised the need for change in attitudes and ways of working in order to increase efficiency, cut costs and meet the challenge of competition".

The importance of these themes is evidenced by their recurrence throughout the study. Whilst the future threatened uncertainty, the main structural and organisational changes had occurred so far only at Headquarters. Processes had been dictated mainly by written instructions which had evolved over many years in a relatively stable environment. The scope for local initiative had been limited and consequently the primary requirement of local management was to implement strategies and processes that had been dictated from the Centre. However, changes in the environment were beginning to percolate downwards through the organisational structure and the opportunity presented itself to local managers in Cardiff to effect an organisational change to meet the evolving external needs. This Case study describes what triggered the process, how the various participants reacted to the project, what their views were and what finally transpired. We can identify similarities and contrasts with the models of problem-solving proposed by other commentators and referred to in the earlier chapters and refine the structure proposed in the previous chapter. In addition we can suggest areas where the use of currently-available software could potentially have been used to assist the problem-solving process.

Appendix 3 gives further detail on the organisational structure surrounding the Control, the grades and responsibilities of the staff and the associated Unions. In essence, the Control processes orders for

telephone service, checking that lines are available (Routeing and Records - R and R) and distributing the work to field engineers (Distribution - DO).

The main players are:

- GM - General Manager
- JT - Installation manager (reports to GM)
- KB - Control manager (reports to JT)
- SS - Special Services manager (reports to JT)
- VP - Inspector on the Control (reports to KB)
- DJ - Sales manager
- KL - Union secretary
- PD - Union chairman

CARDIFF CONTROL CASE EPISODES

In this section each of the main twelve episodes in the life of the project are described. The basis for the facts reported are the interviews supported by documented minutes of meetings and memoranda and letters sent to and from the participants. For each section comment is also provided and this is essentially the interpretations and perceptions of the researcher. This section is completed with a brief reference to how the Control environment developed in the following decade.

EPISODE 1 - INITIAL INQUIRY

In August 1981, KB, the manager in charge of the Cardiff Installation Control, institutes an inquiry into the broad functioning of the Control. He chooses VP, graded Inspector, who had previously been in charge of the Control for over two years to carry out the exercise. He is given broad terms of reference covering finding out "ways in which it could be improved". Knowledge about the project is officially confined to VP, KB, The Head of Division - JT - and the current Control Inspector.

The outcome of the inquiry which lasted three months was a "collection of notes" which recommended that the Control be re-organised on the basis of a split in responsibility between the Inner City area and the Outer Suburban perimeter. However, this recommendation, reached in November, was not immediately implemented because of a backlog of work on the Control which would have to be cleared before any re-organisation could be implemented.

There is little formal documentation during this phase so the interviews are the main source for identifying how relationships were developing and what tactical approaches were being worked out. One theme to emerge is that KB has already made up his mind as to what the report should recommend - in his own words:

Question "Had you, when you commissioned the report from him, concluded in your own mind what the solution ought to be?"

Yes, on the split of the Controls, so for 75% of the report, yes - it came out exactly as I thought it myself".

and

"I gave him very broad terms of reference and because I wanted to condition it I also said I wanted to see him regularly to see how he was going".

COMMENT

The fact that KB has already determined the final solution has potentially serious implications because these conclusions work their way through to the final Working Party report. In this report the recommendations made arguably ultimately led to the wrong decision being taken. The suspicion about the existence of this inquiry also heightens tensions amongst the Control staff. Starting a process to solve a problem is setting in train concerns that are beginning to create another potential problem. JT remarks:

"During this time the staff knew what was going on and they'd asked a lot of questions and I had just simply said 'yes, he's looking into aspects of the Control with a view to changes and the re-organisation of the Control'. But of course they were anxious to know, naturally, what was going to happen. I was aware of their restlessness, if you like, that there were changes on the way and not knowing the detail".

The Unions were clearly aware of it as PD, the Union Chairman, reports:

"When the first meeting took place KB came along with a preliminary report which at one time we were told hadn't taken place but we were fairly convinced it had and that it was carried out by VP".

EPISODE 2 - CHRISTMAS INCIDENT

A circular is issued on the 3rd December entitled 'Christmas and New Year Holidays 1981/2', signed by the GM and circulated to all managers, the Controls and Union secretaries. Amongst other provisions it specifies that the Installation Controls will close from 25th December to 3rd January and the Installation Control staff should report to External Maintenance for maintenance duties.

The unhappiness of the Control staff is manifested in Union representations that the Controls be kept open, culminating in a formal letter from the Union secretary to the GM, dated 18th December, threatening industrial action. On the 24th December the GM agrees with the Union a compromise whereby the Controls are to be closed but a joint management/union Working Party is to be set up to look at the Control situation. JT and PD are notified of this by telephone. KB is particularly concerned at this development as he sees it as taking away from him responsibility for proceeding with the implementation of his preferred solution on his Control.

"I was very unhappy about it being taken out of my hands ... I didn't enjoy that Christmas as a result - I felt deserted in a way. I felt that my own requirements to work on the problem had been taken out of my hands for the wrong reasons".

The GM takes a more clinical view:

"The Working Party was a method of de-fusing - trying to get to a workable situation without anyone losing face."

For the Unions it was an opportunity to bring into the open their formal involvement the issue of Control re-organisation which they believed was being examined 'in camera'.

COMMENT

A chance and indirectly-related event (chance in terms of the co- incidence of Christmas and the initial inquiry) has created an opportunity for some of the actors, in this case the Union, to resolve their main problem of non-involvement. This contrasts with the rational and sequential problem-solving processes described in Chapter 3 with their implication that there is a greater degree of control over the process than in practice applies.

Also, the complexity of the problem-situation has increased and the boundary has been expanded. Both top management and unions are now involved and there is an enforced linkage with the arguably separate issue of staffing arrangements over Bank and Public Holidays. KB no longer has just his manager to convince of the merits of the changes but now must persuade other parties both in management and on the Union side of the advantages in his solution. What was previously informal and low-key is now formal and subject to wider assessment. What was previously described as a 'collection of notes' must now be minuted in committee and presented to the Board in report form. Finally, a further sub- problem has been generated - that of the motivation of KB who perceives his responsibilities to have been eroded.

EPISODE 3 - WORKING PARTY CREATION

This phase is essentially concerned with setting up the Working Party machinery. On the 20th January, 1982, the GM writes formally to KL, Union Secretary, confirming the negotiated solution and suggesting Terms of Reference. On 25th January, JT writes to KB, SS (ex-Control manager) and DJ, Sales manager giving terms of reference and setting a date for the first meeting of 8th February. Other nominations, e.g. committee secretary, are decided upon and contacted directly. Separately the Union decides that the Chairman, PD, is to be the official representative accompanied by HC who works on the Control and is the Branch Representative on the Union committee. HC is a DO, not an R and R which leaves the R and Rs not directly represented.

COMMENT

Whilst the official correspondence suggests the problem-solving process is proceeding without difficulty the interviews suggest the existence of undercurrents of uncertainty amongst the managers as to why they are involved. The first concerns the choice of managers to attend the Working Party and the extent of their briefing. Several managers report that they received little briefing; for example DJ comments:

"I simply had an invitation ... and JT came to me and said 'the GM had charged me with getting a report out by Easter'. because there were problems in the Installation Control and they wanted someone from Sales to be involved".

However, there is no suggestion that this becomes a critical issue. JT, who has been nominated to chair the committee is confident on all but one aspect:

"Perhaps my only fear is that there is no R and R involved".

With the wisdom of hindsight could JT have ensured that the R and Rs were represented? The issue is not that simple with JT observing:

"... it wasn't a conscious decision to exclude them - it was difficult to include them, purely because it was set up as a management/union working party. If the Union didn't choose an R and R man there's nothing I can do about it. I suppose I could have brought in an R and R from our side".

Some other grades are not represented but few problems arise. The Survey Officers and Jumperers feature little in the project but they are in the main external to the office environment. What some might regard as the routine, administrative function of setting up the inquiry mechanism is also proving to have implications that will have a direct effect on the ability of the organisation to institute change.

EPISODE 4 - WORKING PARTY MEETING NO.1

The first meeting takes place on 8th February 1982 and lasts three hours. It is attended by JT, KB, DJ, PD, SS, HC (the DO Union representative) and JS (representing the management union). KB's report, based on VP's research, is introduced and the minutes essentially cover consideration of the report. Issues raised are the existing imbalance on the Control, the number of R and R posts, new performance targets applying in March, the link with the 'field' engineers, customer relations, barriers between DOs and R and Rs, loadings and the need to see jobs through from start to finish. Four principles are agreed at the conclusion:

1. The need to improve communication between management and staff.
2. The need for close organisational links between Sales and Installation.
3. A need to consider the DO and R and R relationship.
4. Future issues for debate to be:

-Organisation

-Working methods

-Loading

JT comments:

"... I ended up by going through the history and terms of reference, discussing the surface problems and then building a picture on that of the real problems ... we got a good picture and that was really the scope of the first meeting".

The Union members are also reasonably satisfied with the content of the meeting, PD commenting on the VP report:

"I suppose, in fairness to him, it wasn't a bad report".

COMMENT

The emphasis has now shifted from the mechanism for enabling the Working Party to make progress to the constitution of the Control itself. The progression of KB's original preferred solution through the VP report now proceeds unchecked with the Working Party. Whilst JT believes the report has all the facts this can be seen to relate purely to the local circumstances in the local Control. A later

meeting alludes to possible changes at HQ that could have a bearing but by then the preferred option will have been accepted by the Working Party members.

Both minutes and interviews suggest an absence of any attempt to define the problem in any detail or depth and the formal sessions make no reference to possible causation although strong individual views emerge in interview which are further described in the next section.

EPISODE 5 - WORKING PARTY MEETING NO.2

The second meeting took place a little over a week later on the 16th February and lasted three and a half hours. The same members are present. The minutes record the need for consideration to be given to Organisation, Working methods and Loadings. Discussion takes place on the various re-organisation solutions presented in the VP report, three of which are geographical and the fourth splitting Business customers from Residential. The 'conclusion' expresses the Working Party preference:

"Agreed reorganisation of Control to Inner and Outer would be a possible rearrangement" and "This proposal was generally the most acceptable".

The minutes also record the need to consider the DO and R and R loadings and to assess if physical re-arrangement was possible. It is at this point that further differences begin to emerge on the direction of the project. JT still sees progress going along the lines he is hoping for.

"It was fairly obvious all the way through that they wanted the last option ... that we were going for in the first place".

A different option, the Business/Residential split, is reported in the minutes as offering 'the advantages as stated in the report' but without further reference. SS privately in interview expresses his misgivings:

"I was pushing the Bus/Res split line rather than the recommendations we ended up with because I thought that was going to tie in with the rest of what was happening on the reorganisation front but I got no support for that".

COMMENT

It emerges later that the Bus/Res split is the approved HQ solution which was subsequently imposed on all Telephone Areas. Four options are being considered of which one is preferred, two of which receive no support and one of which receives minority support. One can doubt whether all possible options were evaluated and even where options were presented, as here, whether they received due

consideration. The degree to which SS expressed his arguments in the meeting is difficult to corroborate, the memories of the other actors being hazy on the issue.

Further fragmentation of the overall problem continues with the introduction of several sub-problems that need addressing such as loadings and desk distribution and layout. Related issues are also appearing such as the co-siting of the Control management.

EPISODE 6 - WORKING PARTY MEETING NO.3

The third meeting takes place at 9.15 am on the 14th March, lasting two hours and with all members of the Working Party present. In commenting on the minutes of the last meeting it is recorded that SS was more in favour of the Bus/Res split option indicating that he wishes to emphasise his dissent from the majority view. HC reports back that the DOs are broadly in favour of the suggested reorganisation but a sub-problem that has arisen is the possible consequential overloading of two DO posts. DJ offers to provide a statistical analysis of various relevant work units - surveys, invoices and telephone populations - to help resolve load balancing. He is also requested by the committee to report back on the proposed Sales Division reorganisation which the Engineering Division has only just heard about. The office desk layout is discussed covering who goes where and what pattern of desk arrangement seems most appropriate.

Overall, JT still regards progress as satisfactory, commenting:

"It seems to have been productive, perhaps surprisingly so ..."

He sees the main sub-problem requiring analysis as being the office layout:

"I can see only one major hurdle left now (CAs sitting next to DOs). So in re-arranging the accommodation we may have to jump that hurdle".

PD, for the Union, also accepts that it is preferable for the CA to work alongside the DO but records that it is against his Union's policy. Thus, while accepting the logic of the argument, PD is suggesting that the suggestion will be opposed. JT, however, appears not to see a fundamental problem here as he looks to the future:

"... then it becomes a question of me producing a paper for distribution to the staff. That's the next stage and it's the final hurdle of tying the thing into shape".

COMMENT

The Working Party members are now attempting to resolve the many sub-problems that have emerged throughout the duration of the project, examples being the co-siting of DOs and CAs, incorporation of the Sales team and the location of the junior managers. Three aspects of the problem fragmentation can be noted. Firstly a change in the overall structure of the project implies changes in the component elements. Secondly, the changes have implications for linked systems such as the Sales Division which needs to be recognised. Thirdly, consideration must be given to how the changes are to be effected which entails consensus reaching, decision making and implementation. Potential conflicts are also coming to the fore such as Union policy requirements with the implication that yet other external systems are impinging on the process.

One can note that here the main option selection has been carried out before the detail is addressed. This provides less scope for iteration if a particular sub-problem proves to be intractable. In addition a reorganisation being planned in the Sales Division introduces the example of separate problems in a separate work unit being perceived as having a direct bearing on the problem facing the Working Party.

EPISODE 7 - AD HOC MEETING

KB, PD, SS and HC have been deputed by the Working Party to analyse and recommend options to resolve the loadings and accommodation sub-problems. They meet on the 17th March at 10.30 am but as SS (the management union representative) is unavailable, discussion is restricted to 'POEU' matters. The loadings issue is examined with some precise quantification of Advice Notes (invoices) and with the Inner/Outer option now fragmented into six DO loads. A suggested structure for the 'field' engineers (i.e. those performing the physical work and reporting to the Control) is proposed. The minutes note that consideration of skills may require further modification to the loadings proposals. No comments were received from the interviewees that add anything significant to this episode.

COMMENT

The sub-problems are both consuming a substantial managerial resource and are making it harder for JT to remain in control of the process, a particular case being the delegation of the loadings sub-problem to a sub-group. Administrative issues continue to affect the problem-solving process with difficulties in fixing meetings and ensuring attendance. Whilst the unavailability of one member may not appear critical, there is a later letter from the management union raising questions about some of the numbers involved in the quantification process which possibly could have been avoided if the relevant Union representative had attended the meeting.

EPISODE 8 - WORKING PARTY MEETING NO.4

This meeting takes place a week later on 24th March commencing at 2.15 pm and lasting one and a quarter hours. KB is absent. The minutes of the 'ad hoc' meeting are distributed and the conclusions discussed. The DO loading issue is stated as having been resolved but the loading of the R and Rs is now presenting difficulties, particularly in respect of one Telephone Exchange area. A suggested floorplan showing the integration of Engineers and Sales is proposed and accepted by the Working Party in principle.

The issue of managerial control is raised - who should look after the jumperers and survey officers? This is assigned to SS to investigate further. Finally, it is agreed that the overall package of proposals must now be discussed between Unions and staff before the report is prepared. JT states that his original intention had been to produce the report and let the staff see it afterwards but here he bows to union pressure and allows discussion first albeit with some trepidation:

"I've arranged for them to have time off the Control to discuss in general the principles and that I see as a little bit of a gamble".

Whilst JT is not unduly pessimistic about the prospects KB refers to this in interview as tactically inept.

COMMENT

Problem fragmentation continues with the level of detail now down to the smallest unit, the Telephone Exchange area, of which there are around 30. With the DO loading issue largely resolved, the R and Rs are emerging more significantly as a sticking point. The process of hiving off issues for consideration by people other than the full Working Party continues with the R and Rs to be involved on loadings, SS on managerial control and the Unions on workforce opinions. This further complicates JT's task of keeping track of all aspects of the process. Again, the problem of getting all the actors together at the same point in time recurs with KB's absence and it is KB who is subsequently most critical of what he sees as tactical errors at this stage.

EPISODE 9 - UNION RESPONSE

The POEU consults its members in the Installation Control and reports back to JT that the R and Rs reject the proposals insofar as the changes affect them. The POEU tells JT that the problem is now one for management to resolve. Management approach the R and Rs in order to resolve the differences but achieve no success. No documentation exists for this stage as the consultation and reporting back were all done orally. However, the interviews demonstrate agreement between the various actors on what took place.

JT states:

"The POEU came back and said "we're in trouble now" because they were being accused by their members of siding with management. They reported back to me that the R and R problem was a problem for me to resolve".

JT gives his perception of what happened when management intervened to attempt to reconcile the differences exhibited by the R and Rs:

"They appeared to go away in a constructive frame of mind. And as so often happens they come back and say 'we can't think of anything and we don't like what you said'".

PD on the union side comments:

"... if they were adamant about anything, the R and Rs were absolutely adamant that they did not want to be working physically on the same desk ..."

COMMENT

Clearly there is now one fundamental problem for management to resolve - the likely opposition of a key group of staff to a key recommendation that the Working Party is proposing. Whilst sub-problems such as accommodation and loadings may be successfully solved, the package as a whole cannot proceed because of its perceived unacceptability. It could be argued that at this stage the problem is 'solved' in that, albeit with minority dissent, there is a conceptual solution accepted by the Working Party. However, whilst this 'solution' has been designed, implementation will now become dependent on the exercise of authority with either that of the manager prevailing over the R and Rs or the latter with unspecified union support prevailing over that of the manager.

EPISODE 10 - WORKING PARTY MEETING NO. 5

A gap of some months elapses before the final meeting of the Working Party commences on the 1st July, starting at 9 am and lasting three hours. During this time JT has been preparing the Working Party draft report. The report is 15 pages long and covers the origins and objectives, issues considered, conclusions reached under five headings, recommendations and detailed implications. JT presents members with copies of the report and in the ensuing discussion five amendments are made relating to promotion prospects, grade restructuring, changes to the floor plan, possible future moves away from a geographically-based organisation and, finally, further detail on individual loadings. Further recommendations are made on responsibilities and managerial control. Otherwise, the report is endorsed by the Working Party without dissent. JT sees the session as being concerned with refining the report:

"We sat down at that meeting and dotted the 'i's' and crossed the 't's'... then I went away to reproduce it".

For many of the other members of the Working Party the apparent resurrection of the project comes as a surprise as DJ indicates:

"... we all met in the Conference room and the first comment made was ... 'I thought this had died a death'. So did most of us".

COMMENT

The deadline of an Easter completion set in the Terms of Reference has been missed. To the observer it would appear that the momentum has slowed and some of the Working Party members were under the impression that the project is no longer active. The problem-solving process is becoming focussed on JT and his managers and away from the Working Party as a unit. Nevertheless a process of negotiation between members of the Working Party does result in some material changes to the constitution of the report.

EPISODE 11 - BOARD MEETING

The final report is produced and distributed for discussion at a Board meeting on 15th July. The minutes state:

"Cardiff AN Control

Working Party investigations into re-organising the AN Control were now completed. As part of the market-led approach, the Board recognised and endorsed the proposals as providing far greater flexibility and better team working but would generally have liked to have seen more integration of Installation and Sales".

For the first time for some months the composition of those involved in the process widens. Whilst generally in sympathy with the tenor of the report, the Board, including the member for Sales, is clear that the recommendations could have gone further. JT, however, is not convinced that the Board's suggestion is practicable:

"We can only work in the engineering field and that's what we've said so we've made recommendations that stem from that".

COMMENT

JT's main concern now is where to go from here. He has alienated the R and Rs for going as far as he has, the Union has distanced itself from the recommendations and the Board has expressed the view that the proposed solution does not go far enough. Overall there are at least five potential solution arenas in conflict:

1. The solution agreed by JT and the majority of the Working Party.
2. The minority view of SS.
3. The dissenting view of the R and Rs who appear mainly concerned to support the status quo.
4. The Union view which is not clearly defined but which by implication does not accord with 1. above.
5. The Board view which differs from 1. on certain aspects, essentially the links between the Installation and sales Divisions.

EPISODE 12 - FINAL STAGE

With the Working Party and the Board having formally expressed their views it is now the turn of the Unions to record their arguments in detail. During August both PD, POEU Chairman, and KL, POEU Secretary, issue reports stating their reactions to the Working Party report. PD's comments amount to six paragraphs which, although entitled 'minority report', represents in his own words "my thoughts on the Working Party and what we'd done".

KL however provides detailed comments running to eight pages and including four recommendations. Whilst not opposing the report his main conclusion is that it is 'limited' and 'disappointing'. He is concerned over the lack of detail:

"I was expecting a report with some detail on how the Control would overcome some current and future problems - this has not been done".

and concludes:

"... the report fell well below my expectations so much that I have my doubts as to whether the introduction of the recommendations contained therein are not just cosmetic".

The management union, SPOE, responds on the 20th August in a letter from the Branch Secretary which gives 'in principle' agreement to the splitting of the Control but reserves formal agreement until issues of detail, such as Field Inspector loadings, are clarified. It is also critical of the detail:

"Some of the figures in the report caused considerable confusion and bear no relationship to the existing situation".

From this point on the project appears gradually to run out of steam. No further meetings take place nor is any correspondence exchanged. This is mainly attributed by the participants to an increasing realisation that a mandatory re-organisation is to be imposed nationally by HQ that will run counter to the Working Party recommendations in proposing a basic functional separation between Residential and Business customers. The GM sees the Union position as being contradictory suggesting that they do agree in principle:

"Yes, we need to get it organised this way ... but the minority was, bang! - back to square one".

PD, however, sees himself in a difficult position:

"On any Working Party if you're Union you're on a bit of a loser ... but the Union's got to be represented".

The GM also implies criticism of KB:

"I think I'd have said 'I'll pay you an hours overtime; let's sit down and thump this one out'".

In contrast SS suggests KB might have been the saviour of the project:

"... if KB had been Chairman of the Working Party we'd have seen a more realistic approach".

COMMENT

KL's report raises a number of issues that do not appear to have been addressed by the Working Party. He refers to the Rolls report, produced by the Regional HQ unit, which was a management report which resulted in the separation of DO and R and R. The Rolls report is arguably a critical document in determining the current Control structure and the Union implies that it would have been in JT's interest to examine the arguments contained therein because of their relevance to Control structuring. A comprehensive search for relevant reports and documentation might have provided JT with a fuller appreciation of the varying options and findings that might already have existed.

The SPOE letter takes issue with inaccuracies in the Working Party report both of omissions and of examples where the figures were inaccurate, thus distracting attention from the main thrust of the recommendations. This lends support to the view that the project was both initially under-researched by the managers and subsequently superficially administered in terms of the detail which supported the overall arguments and conclusions.

ANALYSIS

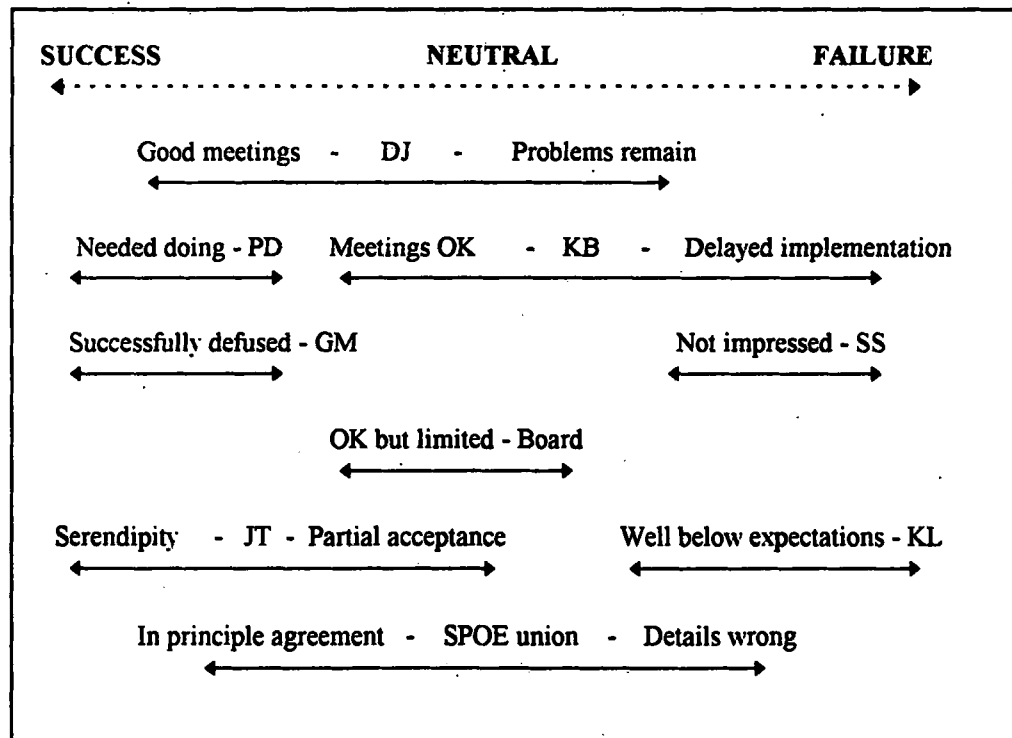
Clearly, case studies such as the one we have just described can be interpreted in many different ways and can be used to generate insights and hypotheses about many facets of the problem-solving process. Here we focus on three main areas:

1. Project success. Did it achieve its objectives and where were the positive and negative aspects?
2. How does it compare with the models discussed earlier in the thesis?
3. What scope exists for using current (1994) software to address some of the identified shortcomings?

PROJECT SUCCESS

Implicit in the consideration of computer-assistance is the assumption that problem-solving is often sub-optimal - that it can, in however marginal a way, be improved in certain cases. To this end the first question we can address is 'what scope for improvement was there?' The perceptions of the actors are quite varied. The terms 'success' and 'failure' are both relative and subject to value judgements. Content analysis indicated 18 occasions on which interviewees or writers made statements implying a judgement on whether the exercise had been successful or a failure. The diagram below illustrates how these judgements can be represented.

FIGURE 8



The diagram has been built up as follows. First, the statements referred to are subjectively assigned by the researcher to a point on a continuum which represents endorsement or rejection of the Working party process with a neutral area in the middle. Second, most actors made more than one statement, in some cases favourable. in others unfavourable, so each actor's views are represented by a line spanning a range of opinion. Third, it is clear that in several cases the actors are referring to different aspects, usually the recommendations but occasionally the Working party process. Finally, one can note that there is no clear division between management and union viewpoints. Amongst those most in favour are DJ (manager) and PD (union). The most critical include KL (union) and SS (manager). From those in favour come comments like those of DJ:

"I thought the meetings went very well ... I think (JT) was very, very patient and possibly through being very patient got what he wanted".

and PD:

"I'm firmly of the opinion that the exercise needed doing ... I think the Working Party did a good job because as soon as we settled into it it was fairly obvious that I think our thoughts were much the same".

For those against come assessments such as SS's:

"It doesn't do anything for JT's reputation I think in that he was given the Working Party to chair personally and see through and it all fell around his ears".

and KB's:

"I think at the end of it I would have got as much out of it as the Working Party got out of it. I think what we can now do we could have done within weeks of the beginning of the year".

and DJ's qualification of his earlier enthusiasm:

"The one thing I think is important in it - it isn't solving the original problem at the moment. Whatever problems they had in the Installation Control back at the beginning of the year ... the problems must still be there, except that they must have been spoken about now; people know they are being talked about".

Some of the differences in assessment can be attributed to the differing perceptions and objectives of the actors. The GM's main concern was to head off threatened disruption by the Unions. For him the Working Party was a means of defusing a potentially explosive situation. It is a point of fact that during the course of the project no industrial action was taken by the Union officially or unofficially by the members. However this may not be so significant with a Union which tended to take action only as a last resort. JT, whilst accepting that the recommendations are not implemented, sees the main reason as being external:

"From my point of view I know why it wasn't implemented. (National reorganisation) cut completely across what this was trying to do".

He also argues that KL, for the Union, in rejecting the Working Party recommendations, aligns himself more closely with the HQ- imposed reorganisation which overtakes events:

"... he said 'I don't really agree with this - it should be something different', which was in effect a golden opportunity because what he was saying fitted in with re-organisation".

It should be stressed that whilst sub-optimality is of primary interest because it implies scope for improvement, areas of positive achievement are also important because they signal opportunities for the transfer of 'experience' or 'best practice' and there is always the possibility of further improvement. JT, for example, notes the potentially beneficial side-effects which can accrue by serendipity but which were not specified in the original objectives. He refers to several of these:

Change in atmosphere:

"They recognise we're going through a process. They recognise that we're dealing with it in an open constructive way and the people are involved and they're beginning to believe that we're trying to do something".

Regular meetings:

"When I came the only liaison appeared to be at my level. There are now regular meetings on Control matters. And this came out of the sessions we were holding".

Knowledge of events:

"In going towards it we've discovered a lot of things that will be happening that we didn't really know were going to happen".

Change in attitude

"There's been a greater acceptance as we've gone along of these facts - the attitude now is 'if the price is right that is what it will be'".

and later, responding to a question about the benefits of the exercise:

"Conditioning of people to the need to change".

The Learning process:

"It interested me going through it that it was possible to go from outright opposition to something ..."

Overall, the case study suggests that the terms success and failure may both be applicable depending on the expectations and viewpoints of the participants. For those who specifically wished to see the Working Party arriving at a solution that was implemented it was essentially a failure. For those who saw it as a means to other ends or who were content with the by-products it generated it did justify its existence. Nevertheless, it would be difficult to argue with the view that numerous examples arise through the duration of the project which indicate difficulties encountered by the participants in developing the project or arriving at solutions and it is these that we can turn to now.

Whilst success and failure emerge as perception-directed judgements we can summarise the positive and negative elements referred to above as being:

POSITIVE

- Improved atmosphere
- Regular meetings
- Managers better informed
- Changing attitudes
- Positive meetings
- Process was essential

NEGATIVE

- Delayed the decision process
- Fundamental problems remain
- Not implemented
- Different conclusion from HQ

We now focus more closely on the process shortcomings. Content analysis was carried out on the interviews to establish the nature and frequency of the problems reported by the participants that were encountered during the problem-solving process. 57 instances were identified and these were reasonably evenly distributed through the interviews although inevitably some individuals report more problems than others. Clearly some instances are repetitions by the same individuals or relate to the same issues reported by different people so actual numbers have no quantitative significance. Nevertheless they provide through their frequency an insight into which problems were being registered and some indication of their criticality. 12 groupings emerge, listed as follows and ranked by volume of frequency:

TABLE 21

PROBLEMS REGISTERED	Citations
Simultaneous external change	10
Need for/lack of representation	9
Lack of evaluation	6
Differences of opinion	5
Lack of consultation	3
Tactics	3
Measurement difficulties	2
Rejection of options	2
Communications	2
Administration	2
Relevance to perceived problem	2
Miscellaneous (individual cases)	11
TOTAL	59

Some issues relate primarily to the problem, e.g. simultaneous external change and measurement whilst the majority relate mainly to the ways in which the project was managed such as representation, consultation, tactics and administration. This duality was introduced in the discussion in Chapter 3 and this case study helps to accentuate the two dimensions. Constant changes to the external environment alter the fundamental problem characteristics and this requires regular updates to how the problem is conceived conceptually. In contrast, the project aspects are distinct as for example when people disagree with the conclusions not on the merits of the arguments but because they were not consulted. Both aspects need to be addressed by the manager.

As a rough guide we can allocate the items as follows:

PROBLEM

External change

Evaluation

Opinion differences

Measurement

Relevance

PROCESS

Representation

Consultation

Tactics

Rejection

Communication

Administration

In the next section each of the main 11 sections is taken in turn. A brief comment is given on the category and alongside this in the corresponding column suggested key-words are provided that correspond to the grouping.

PROBLEM GROUPINGSCOMMENTS

1. SIMULTANEOUS CHANGE

Throughout the project external changes are taking place which directly or indirectly impinge on the efforts of the Working Party to resolve its own problem areas. These occur both locally as with the simultaneous re-organisation in the Sales Division or centrally as with the impending national computerisation of the work functions.

Theme 1. Keeping abreast of external developments. (Key terms - communication, information exchange).

Theme 2. Assessing impact of external change. (Key terms - qualitative or quantitative modelling).

This has two effects. firstly implying a constant need to revise and re-evaluate earlier analyses and secondly complicating any possible desire to carry out a sequential, rational problem-solving approach.

2. REPRESENTATION

This concerns both the choice of representatives to sit on the Working Party by Unions and management and the choice of Unions to be represented.

Theme 3. Meeting needs of different groups. (Key terms - stakeholder analysis, risk analysis).

3. EVALUATION

This is a broad heading which relates to the time and effort spent considering the issues and facts, evaluating them and arriving at a range of solution options.

Theme 4. Problem-handling procedures. (Key terms - problem structuring, analysis).

4. CONSTRAINTS

A wide variety of constraints manifest themselves. One example is that the grade structure is fixed centrally and the Divisional organisation also follows national patterns. JT comments:

Theme 5. Recognising constraints. (Key terms - analysis, mapping)

Theme 6. Determining whether they can be challenged. (Key terms - risk analysis, judgement).

"There is a limit to what we can physically do."

5. TACTICS

There are tactical implications in many of the other factors but there are also specific references. Both KB and SS see tactical errors contributing to failure - KB:

"We demonstrated a lack of understanding of the tactical approach to dealing with staff associations".

6. MEASUREMENT

A substantial proportion of time is spent by the Working Party and its offshoots in wrestling with the measurement of loadings and workflow data. JT comments:

"It's a case of a mathematical approach, almost, rather than a lateral approach".

7. REJECTION

Clearly, rejection of the proposals by different groupings makes implementation much more complicated. The resistance of the R&Rs provides a fundamental stumbling block but they are not the only problem area as DJ notes:

"... so there would have been a problem in accepting the accommodation in Sales Division."

8. COMMUNICATION

The apparent lack of communication between the key players is implied more than once. DJ remarks;

"It was a long way into the first meeting before I realised what was wrong". (E.g. no prior briefing)

Theme 6. Assessing motives, needs and calculating appropriate actions. (Key terms - risk analysis, experience, negotiation)

Theme 7. Quantifying workloads. (Key terms - modelling, measuring).

Theme 8. Gaining acceptance (Key terms - participation, negotiation).

Theme 9. Keeping people informed (Key terms - document circulation, briefing)

9. ADMINISTRATION

Delays occur which JT attributes principally to the difficulty in arranging meetings. He also justifies the lengthy time between some of the meetings as attributable to constraints and priorities.

10. CONSULTATION

There are several references to failure to consult. The original Christmas incident is one example with JT noting:

"They got the circular, read it wrong. There was no negotiation on it as there should have been".

11. RELEVANCE

Whilst there are only two references to this aspect the criticism is clearly fundamental. DJ's point that the Working Party is not addressing the real problem was noted earlier. PD for the Unions, also speculates on whether they are missing the point.

Theme 10. Project administration. (Key terms - project planning, organising meetings).

Theme 11. Gaining commitment (Key terms - stakeholder analysis, risk analysis, tactics).

Theme 12. Problem analysis (Key terms - causal analysis, judgement).

In Chapter 3 we identified five broad headings that represented high level stages in problem-solving. The final one - evaluation - is appropriate to post-implementation situations and as this project was not fully implemented it is disregarded here. The other four stages are as follows:

1. Problem finding (inc. understanding, defining)
2. Solution finding (inc. analysis, modelling)
3. Solution evaluation and selection (decision)
4. Implementation (both solution and project)

This basic framework is now used to focus consideration of these aspects as far as the Control case was concerned.

FINDING AND DEFINING THE PROBLEM

Whilst the problem is technically given with the GM's instruction to JT there is little or no formal attempt to define and clarify the problem and we have noted DJ's suggestion that it was some time through the initial meeting before he began to identify what the cause of the concern was. All the participants have a view of the Control based on their perceptions of what is happening, their own past experience and future expectations and their understanding of what developments are taking place outside the system. KB, who initiates the inquiry process, refers to five aspects which, for him:

"... built up into a picture where changes had to be made in the Control".

These are:

1. Simple errors by his managers which he attributes to an excessive work-load.
2. The 'imbalance' between one Inspector who is very busy and another who is managing routinely.
3. The frequent excuse by one manager when things went wrong that he did not control any 'field' staff.
4. The need to develop one manager in terms of career.
5. Unacceptably large travel claims from one manager.

The Unions are also aware of Cardiff being a problem Control:

"We seemed to be getting trouble with members over there over various things both workwise and involvement with management and it had been on the cards that something should have been done".

They identify a cause:

"The Control is big ... the space that it takes up is big and we did feel that there was the partition beginning to develop between the people on Routeing and Records and the Distribution Officers".

SS verifies this view:

"Well, it's a lot bigger than the other Controls - none of the others are much more than half the size".

JT agrees:

"I had only one strong view I think - my strong view was that it was too big ... it wasn't a family atmosphere, divisive ..."

This was confirmed objectively in that the Control was the largest as measured by staff numbers and work volumes. However, although size features strongly, other interviewees record a wide range of causes such as DJ who refers to the existence of 'troublemakers' on the Control and an absence of firm management combined with the fact that the loadings had grown differentially over time leading to imbalances.

If one considers that the bulk of the interviews were completed after the meetings had been held it is clear that the process has done little to achieve unanimity in what constitutes the main problem and hence, where the solutions should be directed. Possibly the meetings themselves contributed to the disagreement although this is not confirmed by the minutes. This, in turn, can be argued as having contributed to the variety of opinions already noted as to whether the exercise is deemed to have been a success or failure.

SOLUTION FINDING AND ANALYSIS

Measurement, work-loads and bottle-necks recur regularly as references throughout the interviews and documentation and are sufficiently problematic to require the setting-up of sub-groups to consider them. Measurement and analysis in these terms are part of the perceived solution-finding process in the sense that one (albeit questionable) assumption is that when the cause or source of the problem is located, the solution automatically follows.

The speed of movement of the 'Advice Note' is a principal measure of the efficiency of the Control and managers measure the performance of the unit in a number of ways backed by a formidable array of quantified statistics including:

Grade of Service targets

- Appointments made by Sales
- Appointments made by Engineers
- Non-appointment orders
- Service not given on the appointed day

Labour cost control system

- Job categories
- Job types
- Support costs
- Quarterly Installation Cost Statistics

This is supplemented by more qualitative measures;

- Letters from customers
- The '1053' procedure (faults occurring within three months of connection)
- Surveys and site meetings
- Inspection of completed works

There is a perceived problem with work volumes as KB notes:

"I could see that the one was very, very busy all the time - I could see that the other one had a routine job rather than a job on which he was chased".

Thus quantification and measurement are perceived as being significant elements in the problem-solving process with considerable attention being given to related aspects such as the balancing of work-loads. Equally, there are problems in getting the figures right. The response from SPOE, the management Union, to the Working Party report includes the statement:

"Some of the figures in the report caused considerable confusion and bear no relationship to the existing situation ..."

SOLUTION EVALUATION AND SELECTION

The fundamental decision option that defines the subsequent inquiry is the choice of an Inner/Outer split for division of the Control. Little effort seems to be expended in generating new options and JT confirms that his view of what the best solution is does not change in the course of the inquiry:

"No it wasn't - it was reinforced and that's the only danger I see in the whole process ..."

Elsewhere he is quizzed on whether he has fully evaluated all possible options and he admits:

"That's my greatest fear to be honest".

However, he also considers that he is subject to limitations in which options he can reasonably consider:

"There are a limited number of options. If you throw a management structure in the air and let it come down it can only come down in certain ways".

Three main organisation options are recorded in the minutes as having been debated by the Working Party and an attempt is made to summarise the advantages and disadvantages of each. Thus for one option:

"Advantages

- EC4 would have control of his priorities
- Unified attack on stores delays
- Unified direction and motivation

Disadvantages

- Lack of PBX work might cause staff shedding
- Major re-arrangement of reporting procedures involving Inspector/AEE posts".

JT gives some insight into how the Working Party approached the issue of evaluating the options:

"We talked round and round it, sort of getting the feel of it and then we came down and went through the ones that VP had produced and it was fairly obvious all the way through that they wanted the last option which was Cardiff Inner and Cardiff Outer".

The minutes reveal little of the debate, for example recording only for the Bus/Res option - "the advantages to be as stated in the report".

Yet it is this option that SS believes is the correct one and for which he says he receives no support adding:

"... there was, as I said, very minimal discussion".

There are a number of other examples of options, for example with the loadings. JT comments:

"... a vast number of permutations of which work units you put on which DO and you come up with packages and it's a question of which packages are most logical from a moving staff about view-point".

Thus we can note that option evaluation and selection does form a significant element in the process and there are attempts to impose some structure to the evaluation.

IMPLEMENTATION

The case study supports the view that there are two dimensions to problem-solving which are distinct yet closely linked. Firstly there is the object of the inquiry, in this case the Control, the people that work there or have an interest in it, the factors that impinge on it such as external change, the problems it is generating and the solutions that are under consideration. Secondly there is the process of inquiry that takes place that can be as simple as sitting at one's desk and thinking about it or, as here, creating a formal structure such as a committee, project team or working party. Project management is a key component of implementation and we can extend the consideration of process issues by comparing the pattern that emerges with the prescriptions and suggestions of methods designers referred to in the earlier chapters. Differences should not be taken as indicating that either the designers on the one hand or, say, JT on the other were wrong. The purpose in the comparison is to highlight potential difficulties in applying the methods to such cases.

JT considers that he is adopting a methodical approach:

"I suppose really ... I like to have a plan of what I'm going to do. I don't like going into an open situation. Providing I've got a skeleton then I'm quite happy and I feel in control. It doesn't matter if the skeleton changes but I need a skeleton on which to start".

There is also some evidence for process stages with an initial exploratory phase:

"... discussing the surface problems and then building a picture on that of the real problems. So we then had some idea of what we were dealing with. Quite a lot came out of that... So we got a good picture..."

However, from that point on a different pattern emerges from that of the 'rational' problem-solving protagonists and that is fragmentation. The iterative and fragmentary nature of the progress is illustrated in Figure 9. This takes only a sub-set of the overall process as it is manifested in the minutes of the five Working Party meetings, ignoring what happened before, what happens after and what is happening at the time but is not minuted. The full picture would be that much more complex. In the left-hand column it is seen that external changes impinge on the Working Party's perceptions throughout the project. The 'issues' and 'sub-problems' columns illustrate that rather than there being a comprehensive initial analysis, progress tends to be through the exercise of choice on an option which in turn raises a sub-problem in its implication which is then addressed.

An example is where the decision to opt for an Inner/Outer re-organisation necessitates considering the new loadings that that involves. DO loadings are taken first and resolved in general but with the exception of DO2 and DO3. When this sub-problem is resolved the Working Party find themselves having to consider the resultant R and R loadings. These, in turn, are resolved but with the exception of the one Telephone Exchange which constitutes its own sub-problem. Similar processes apply to the proposals to consider integrating various groupings. JT gives his perception of the overall process;

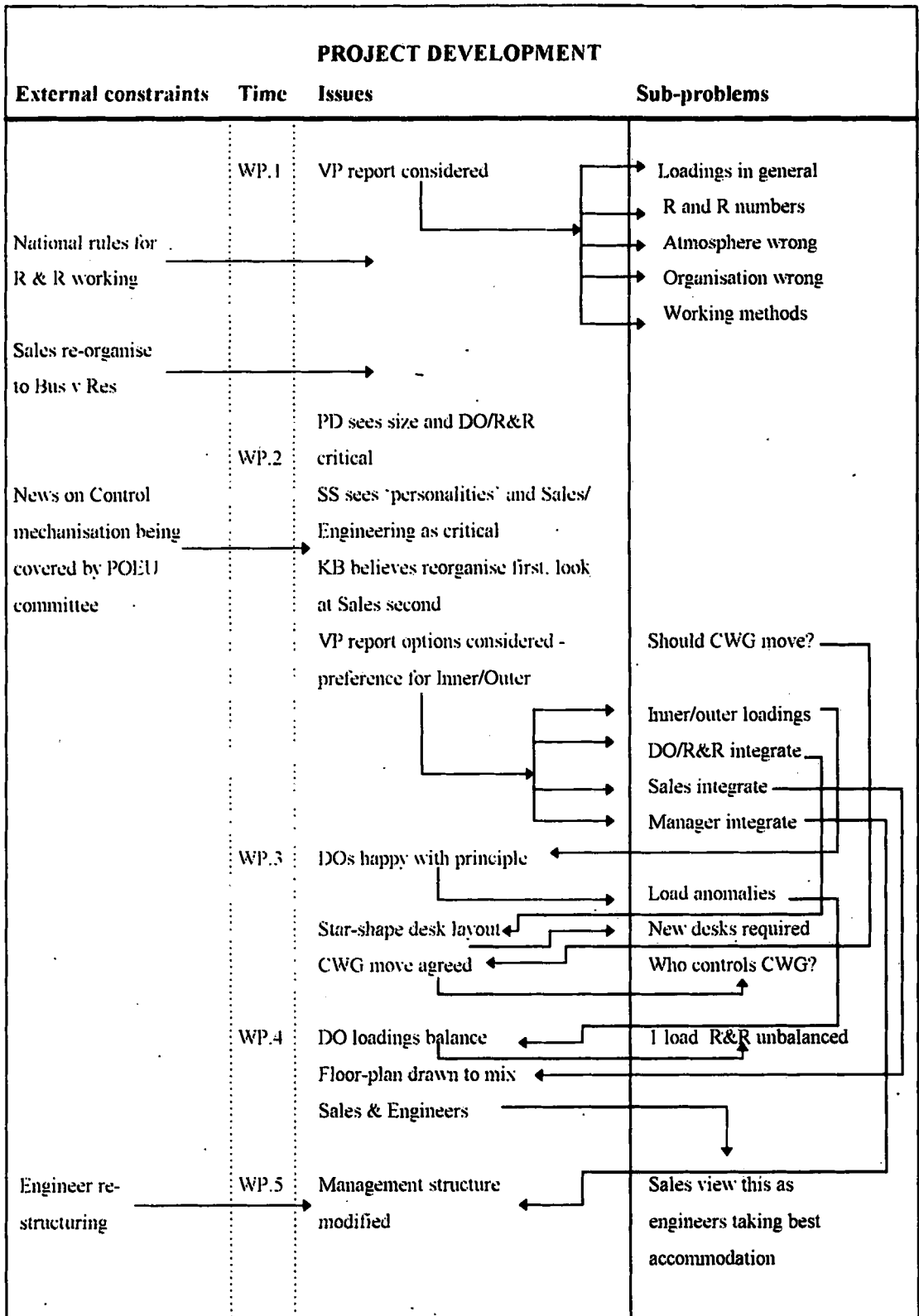
"I don't think it was really a case of 'now here's a problem, how can we solve it?' but I think it was more a case of 'this is a set of facts and this solution suggests itself', so it was an easement of a path".

The fragmentation is both conceptual and practical in that sub-groups are created to consider some of the sub-problems. Each demonstrates at least two phases, analysing and deciding, but beyond that the picture varies. Some have formal information-gathering phases, others go through modelling iterations, for example when considering the office layout plan. Clearly, controlling this fragmented process cannot be easy for JT and we have noted both the delays which occur and the mistakes that are made in the data presented. Project management, whether through the use of formal methods such as the Critical Path variants, or through customised programmes, are now extensively-used in commerce and industry and increasingly for the more modest-sized projects of which this case is typical.

COMPUTING IMPLICATIONS

We have noted areas where the application of method could potentially have aided the problem-solvers or enhanced understanding of the issues. Equally, current software developments could assist in the administration of the project.

FIGURE 9



Failures can be noted in PD's reference to "... delay - obviously JT had problems in getting everyone together" and SS when he comments that "... it dragged on and on for literally months..."

The deadline set by the GM for presentation of the report is missed, mistakes are found in the data that is presented. Setting up meetings and agendas, preparing and distributing minutes, communicating with the participants outside the meetings and the preparation and presentation of data are all activities which are integral to facilities offered on PCs, such as diarising, word processing, monitoring action points and preparing graphics and spread-sheets. Indeed, the PC can arguably provide greater assistance to these administrative functions currently than it can to the more complex issues of problem structuring, cause and effect analysis and evaluating options. This theme and the implications of the case study are developed further in the subsequent chapters.

POSTSCRIPT

Finally, we can review the situation in the Cardiff Control currently and note how subsequent developments compare with the position the case study recorded a decade earlier.

By January 1993 BT is a private company, in competition with a range of other companies for the provision of telecommunications apparatus and networks. In 1986 the Cardiff Telephone Area was subsumed into a new 'District' structure combining the Cardiff and Swansea Telephone Areas. In 1988 this South Wales District merged with North Wales and the Marches District to form a new Wales and the Marches District, co-inciding in terms of boundaries with the original Wales and the Marches Region. In 1991 a fundamental national re-organisation abandons geographical units to create separate divisions dedicated to serving Business customers and Residential customers respectively. In 1992 29,000 staff accept voluntary redundancy as BT continues its rationalisation process.

The Control structure has changed accordingly. Firstly comes a split into two Controls, one dealing with larger business customers, the other with small business and residential customers. A second change combines all business customers in one control and all private (i.e. residential) customers in the second control. As the Business Customer Division concentrates its resources many local Controls are closed, including Cardiff, with customers being served from Birmingham. In 1992 a further split is announced, this time between business customers and 'major' customers, i.e. those with a significant national or global presence. A further separation splits out installation work (new orders) from maintenance (repair) and the R and R function has left the Control and is contained in the Local Line Planning Group. All Controls are much bigger than they were in the 1980s. In October 1993 a further re-organisation is announced following analysis by external consultants that splits the engineering

functions away from the Sales and Marketing wing but heralds the re-combination of residential and small business engineering within a single large unit.

The staff grades are essentially the same although the Control Inspector grade has disappeared as a separate entity and been absorbed as a band in the management structure. The process of taking orders, issuing them, logging faults and processing them is performed wholly on computer so the Advice Note, as a paper document, is no longer evident. The computer-system that runs the processes is one of the largest in the world providing on-line access to all customer details. Management has on-line access to work-volumes and the status of jobs and the terminal has become the primary means for monitoring work. A Management Information Systems (MIS) is available to all managers from the same terminal which gives, in non-real time, quality and grade of service performance, productivity and failures measures. All managers have access to PCs although usage is often no more than basic word- processing. Some extract data from the MIS package and input it to spread-sheets which they consider more readable and compact.

Of the individuals involved, the GM went on secondment to the CBI and took early retirement in 1991. JT took promotion to another District and then took early retirement in 1991. SS also took promotion to another District. All other major players have retired except for KL who is secretary of the NCU(E), the Union which replaced the POEU.

CONCLUSION

The Control case supports the views expressed by various authors in Chapter 1 (e.g. Hickson et al., 1986) that the actual course taken in real-world problem-solving tends to be characterised by discontinuity, fragmentation and iteration. The environment is constantly changing not only requiring close monitoring to identify the changes but also reviewing analysis, modelling and solution evaluation to ensure they are still valid in the light of the developments. Rather than starting with a blank screen and then using a rational and logical approach to generate the solutions, actual problem-solving tends to be incremental. Experience suggests solutions from the outset and these may then be confirmed or modified in the light of the improved understanding emerging from whatever problem-solving activities take place.

This is not to imply that rational problem-solving is not valid - indeed the conclusions of this case would suggest that there are enough shortcomings in the process to endorse the need for greater method - but rather that any simplistic attempt to impose a specified sequence would encounter fundamental difficulties. A key area to emerge is the need to structure problems in such a way that the constituent elements - the sub-problems - can be identified and then managed, particularly as the conceptual fragmentation may be matched - as it is here - by process fragmentation as sub-groups are set up to address the sub-problems.

Segev's (1976) distinction between cause and trigger is confirmed in this case. The problem had existed for some time - indeed an investigation was already taking place - but a trigger, the unrelated Christmas incident, propels JT into the mainstream of the problem-solving process both determining and limiting what is required of the process.

The further distinction between the problem, in this case the functioning of the Cardiff Control, and the process designed to analyse and recommend solutions to this problem, here the Working Party with all its implications for representation and administration, emerges as critical. The success or otherwise of the process conditions acceptability of the solution, irrespective of the nature of the solutions proposed. Thus managing the process becomes as significant as finding the right solution with implications for the importance of implementation.

A number of specific areas of sub-optimal performance were noted and it is not difficult to find issues where the application of method would appear to have potential to help such as Kepner- Tregoe or Checkland on the overall approach, COPE on analysis or PDS on option evaluation. Group Decision Software might have helped to ensure that minority views were not ignored and Project Planning techniques could have assisted administration. Indeed the fundamental issue becomes not whether methods, tools and techniques have a role to play but which ones to use and when.

GAS BOARD CASE

The second case study took place in the British Gas Corporation. Having established from the Control case some general insights into the potential areas for problem-solving enhancements and having compared it in general terms with designer prescriptions, the intention here was to validate these findings against an unrelated case in a different organisation.

BACKGROUND

The data emerged from discussions with the Technical Services and Development Manager (TSM) for the Welsh Region of the Gas Board. In hierarchical terms he worked alongside four Area Service Managers and an Administrative Manager reporting to the Regional Sales Manager. At the same level as the latter was the Regional Sales Manager and both report to the Director Marketing.

The problem as initially stated was that of communicating critical new information to 800 service engineers in the field while operating under tight time constraints. New Gas Safety Regulations had emerged from Government in 1982 and the Board had assumed the role of policing the rules, while reporting to the Health and Safety Executive. The regulations had been presented in September 1984

with a requirement that they be implemented by 24th November. The interviews with the TSM took place during November of that year.

Unlike the Control case where there was some discretion for management as to whether to act or not and any related timing, in this case there is little choice. The legislation takes effect from a specified date and if the Board has not put its house in order by then, the consequences could be prosecution. Again, in contrast to the Control case, there is no existing problem at working level. What is shifting is the expectation of what should happen at that level.

However, whilst at one level the choices for action would appear to be limited, closer examination indicates the existence of options. A decision is made that all those in the Region should be trained by the critical date but in some other regions an alternative approach was adopted which entailed an initial briefing by the critical date followed later by the in-depth training. Balancing the risk of failure and its consequences appear to have led to differing conclusions.

The essential reason for the problem being described as difficult was its urgency. A rapid decision was needed as to whether training could be achieved within two months to achieve the 24th November deadline. Rather than being progressed in committee, a small team was created reporting to the TSM and consisting of a technical expert and a trainer with occasional input from a third. They were tasked to go through the relevant legislative documents paragraph by paragraph and to produce a complete re-write of the Service manual. The TSM stressed that problem difficulty was exacerbated by the uncertainty over timing - when, and to a lesser extent, how, could they get to a situation where the training package was ready for the trainers. The time constraint was perceived as actually helping in one respect because there would be no time for a committee approach and the Area Managers, knowing this, did not expect to be fully involved.

PHASING

Four phases emerged from the interviews which can be broadly described as follows;

- A. Understanding the problem.
- B. Comparison with existing practice.
- C. Deciding on changes required.
- D. Implementing changes.

From the viewpoint of the Welsh Region it was perceived as follows:

1. Earlier in the year receipt of the original document from the Department of Energy, described as a 'frightening document'.

2. Request to the Regions to comment on the draft.
3. A formal Technical Committee was formed in Wales which went through the document paragraph by paragraph.
4. The resulting views were fed back to HQ with the TSM sitting on the HQ committee which had responsibility for co-ordinating the Board's response.
5. Some months later following discussions between the Gas Board and the Department of Energy the modified Gas Safety Regulations emerged which were regarded more favourably by the industry.

This was the point reached by September when the local project commences in earnest although we can note that a cycle of 'understanding, comparing and recommending' has already taken place. The regulations can now be subjected to very detailed analysis. In contrast to the Control case, a substantial portion of time is spent clarifying and understanding and the impetus is coming from outside the organisation rather than from within. The wording of the legislation is in some cases ambiguous and there were initially a lot of queries, many of which were answered by HQ - hence communication with experts is helping the clarification process. Again, in contrast to the Control case, the consequences of failure can be potentially critical with litigation, prosecution and adverse media comment all possible.

The second phase ('B' above) involves comparison of the implied 'correct' practice from the legislation with current actual practice. This comparison is analogous to the reconciliation in the Checkland methodology between the models emerging from root definitions and the present systems and the consequential change required to bring about the new desired states. In this case study, the comparison produces a range of activities needing attention and leads to the problem fragmentation that we noted in the first case study.

The third phase ('C'). deciding on required change, fragments into two main portions which also carries through into the fourth stage, implementation. The first was concerned with the documentation. Where a defect was found on an installation it was necessary to serve a Safety Regulation Certificate. Certificates and labels needed to be changed from those quoting the 1972 regulations to the latest 1984 ones. To achieve the production deadline for the new labels it was necessary to rely on another department which had its own priorities and scheduling difficulties.

Then there is training. The training of the installers was a key element in the project but the process could be incorporated in the existing training processes and structure. On one of the initial training

courses an omission was identified. The Service Engineer always carried an identity card but this quoted the 1972 regulations. This document had been overlooked by the two-man team deputed to identify and amend all documents showing the 1972 regulations.

COMMENT

The case supports a number of issues emerging from the Control study. Problems and their solutions are embedded in existing structure and whilst it is theoretically possible to question all structures, processes and relationships, in practice there may not be the time and it may well be of questionable benefit to carry out such an exhaustive inquiry. Equally, the problems are being addressed in 'real time' and the environment is in a constant state of flux. Here, whilst the legislation may be fixed, interpretation is likely to vary over time and the local organisation in the Gas Board will be subject to change. Phases are discernable but not in any neat, prescriptive pattern and fragmentation implies the creation of sub-problems with their own discrete characteristics and problem-solving iterations. Enforced linkage with other problem areas appears in that the TSM uses the project to develop one of the engineers, a non-critical problem awaiting an opportunity for resolution. Options, and the need to compare and contrast them, features as it did in the Control case. It is particularly valid to note that different Regions reached different conclusions in their debate on the options relating to the extent of training that should be done by the deadline date. According to the TSM none proved to be unacceptable but the differences reflected the varied assessment of the risks of non-compliance and availability of local resources.

SCOPE FOR PROBLEM-SOLVING ENHANCEMENT

Communication and the exchange of information appears as critical here as in the first case. There is a need to link to the centre where questions of interpretation require answering; there must be contact with other units locally to ensure that vital aspects of the delivery process are completed on time and it could well be argued that contact between the different Regional working parties and teams could have helped avoid duplication of effort and greater consistency. Project management could have been useful and in 1993 could be expected to be a standard practice in such cases, although the scope of this project is limited and the benefits of formal project management less obvious.

Comparison of the new model with existing working practices could have been done formally with a structured questioning process but there is a clearer argument for the use of a formal method such as Method Study for establishing working practices. The assumption is that a comprehensive analysis would have reduced the risk of the identified mistake occurring.

ACS CLEANING CASE

In order to identify any differences that might emerge with a small company, the third case study involved the ACS Cleaning Company and the interviews took place with JM, the manager of the Wales and West operation.

The ACS Cleaning company is concerned mainly with industrial cleaning, that is, shops, offices and factories. The office based in Cardiff covered a geographical area extending throughout Wales and East to Bristol and Oxford. There are two Directors based in Cardiff with JM as the overall manager. He has 12 manager/supervisors working to him and 8 site supervisors. There are 80 full-time employees and between 600 and 700 part-time employees. The turnover is around £2 million per annum. ACS nationally has a turnover in excess of £12 million and is part of the Hampson group.

The case selected by JM concerned a contract he had won to carry out the plant cleaning at the firm of Llanelli Radiators which, as the name suggests, was responsible for the manufacture of radiators. The work involved cleaning a variety of different areas including paint booths and tanks for which there were 30 separate operations. The plant was over 30 years old. The cleaning had previously been carried out by the company's own staff with 8 men working 6-hour shifts and being paid the overtime rate of 'time and a half'. The consequential very high cleaning cost had convinced management that it was necessary to contract the work out and ACS had won the contract with an annual value of around £100,000.

The contracting-out of the function had not been well-received by the plant staff and unions and after the contract had been running for a few weeks JM was called to the plant. Approximately 25% of the workforce had gone on strike over the issue and JM was faced with an impromptu meeting involving the senior plant management, union officials and shop stewards. Accusations were made by the Union that the cleaning standards were poor and that lead-contaminated dust was lying about on the floor. Following extensive discussions it was agreed that the local safety representative for the Plant would be paid overtime to 'oversee' the cleaning operations. Over time a working relationship between all concerned was established and the cleaning contract subsequently ran smoothly.

The group affected by the issue involved a sub-set of the Plant and includes from Llanelli Radiators the original cleaning staff, union representatives, the managers most closely involved and the safety representative. For ACS there is JM and his six cleaners. A further sub-set is involved in the initial meeting which excludes the ACS cleaning staff and the plant ex-cleaners.

The Llanelli Radiators cleaners have not lost their jobs but they have lost their overtime which amounted typically to £20 a week. The Plant and the wider Llanelli area are characterised by a

tradition of strong union militancy. The manufacturing operation is subject to legislation concerning working conditions where there is a health risk in terms of contamination, in this case specifically lead from the paint.

Clear distinctions emerge in the viewpoints of the three principal antagonistic groupings. Llanelli Radiators management want the cost savings that the contract is expected to bring but do not want the costs of an industrial stoppage. The Union wants a return to the status quo where their members are carrying out the cleaning and JM wants the contract to run smoothly and to retain the business.

Cognitive perceptions can be expected to have differed and one distinction that does emerge is that the Union perceives the present state of the Plant as unacceptably 'dirty' and management and ACS see it as acceptably 'clean'.

The Union representatives commence the meeting by advancing the view that the standard of cleaning is very poor and quote the requirements of the 'Lead at Work Act'. JM challenges this and it appears that whilst evidence is gathered for the existence of some dust it is accepted that cleaning standards have improved with the contract.

It is pointed out that whilst no-one at Llanelli Radiators has lost a job, six staff have been recruited locally by ACS. Such is the nature of the local community that all six would have had relatives or social acquaintances working in the Plant. In an area of high unemployment and strong support for job creation this is a difficult argument for the Union to counter. It is accepted, however, that for the individual Llanelli Radiators cleaner who still has a job but who has lost around £20 a week overtime there will continue to be some resentment or misgivings.

The compromise solution is that the safety officer is required to monitor the situation and this resolves the immediate issue of the work stoppage. Over the ensuing months the contract settles down, albeit with some further minor 'incidents'.

Our particular concern here is to focus on potential problem-solving tools for the manager and a cleaning operation such as this could be viewed as the antithesis of the subjects in the previous case studies. There is minimal technology involved, the operations are quite straightforward, the staff are unskilled and most communication is face-to-face. From the discussions with JM one can only conclude that it would be very difficult to find any possible contribution that a designed problem-solving system, computerised or otherwise, could have made. JM describes himself as having to 'think on my feet' and 'fly by the seat of my pants' and such clichés emerge in the interviews in abundance. There is no time to indulge in problem-solving iterations and there is little that can be measured or quantified. JM sees the prime problem-solving requirement as being experience both of the cleaning

business and of dealing with such situations over a period of time. JM does not feel that he can summarise any internalised 'rules' for handling the situation that would be of benefit to a novice manager and concedes that he would not know how to identify the requisite characteristics if recruiting someone for his own job.

However, JM also volunteers the information that a Directorship is a possibility for him in the future and he perceives a number of differences in his methods of operation that would be necessitated by such elevation. Contact with the 'grass-roots' through personal contact and face-to-face discussion is no longer feasible other than when the occasional opportunities arise and he sees a greater dependence on information through other sources emerging. These typically would involve cost and revenue performance by contract supplemented by feedback from clients, normally manifested as complaints.

Thus, the reasons why this might be a highly unsuitable problem for the application of method can be attributed to four main characteristics which are not related to the size of the firm:

1. Timing and situation
2. Manager abilities
3. Problem type
4. Organisational structure

The first, and possibly most critical aspect, is the timescale involved. Both of the first two case studies took place over several weeks allowing time for analysis, research, reflection and discussion. Here the problem essentially develops in a very short timescale and takes place in a meeting room. There is not the time for the more considered and structured approach implicit in methods and techniques. However, one could take the view that managers can, and often do, anticipate such situations arising and pre-planning can help to pre-empt these occurrences but in the final analysis situations will arise which have not been anticipated, as here.

The second aspect is more contentious and concerns the abilities of the manager. If it is accepted in the absence of evidence to the contrary that JM is fully conversant with his industry and has extensive experience in dealing with such situations, it is clearly problematic to argue that his decisions could be enhanced by the application of method. There are, of course, counter arguments such as better anticipation preventing the problem from occurring in the first place. Noting Brown's (1981) assessment referred to in Chapter 1 that 90% of problem-solving can depend successfully on experience, it is probable that the remaining 10% will be conditioned by the total experience of the manager as well as the relevant experience.

Thirdly, the problem type falls into the 'negotiation' category where a workable solution must be found which will involve debate, compromise and concession. Whilst analysis of negotiation and the development of strategies for dealing with such situations has been researched there are few supporting software packages although COPE can be used to good effect and CONAN is described by Rosenhead (1989).

Finally, and of primary relevance, decision-making in ACS on this issue is not split between managers. In the larger and more complex organisations of the first two case studies, the principal managers cannot make complete decisions in isolation but are dependent on others for concurrence or for the making of decisions which are necessary but are 'owned' by another unit. In contrast JM can make the decisions on this issue and he does not need to contact others and seek their respective inputs.

Whilst, for the many reasons given earlier, a firm like ACS might have less need for computer-aided problem-solving, it does not follow that no need exists and JM implicitly accepts this. One can, however, suggest that problems that conform with the characteristics identified here provide less fertile ground for the development and application of method than those identified in the first two cases thus providing one of the boundary conditions for this study.

NEW ROADS AND STREET WORKS ACT

The final case study stretches from 1991 to 1993, thus taking place a full decade after the Control case. It was chosen to assess progress in the application of computing to managerial problem-solving and to indicate actual usage rather than the potential usage implied by the first three cases. It can give some indication of applications deemed useful but also the pitfalls and constraints that inhibit faster or more comprehensive progress.

In 1991 the Government passed the New Roads and Street Works Act which effectively replaced the 1950 Public Utilities and Street Works Act. It is concerned with activities carried out in the public highway and principally involves the County Councils, Local Authorities, Public Utilities (now private companies) or any other firms or contractors carrying out work in or on the highway. Whilst the Act is passed in 1991 this is purely enabling legislation and the Act came into force on January 1st 1993. There are two aspects of the case which merit particular attention here; firstly the national computing issue and secondly the application of computing to assist problem-solving within one of the major companies involved. The documentation involved is so extensive, running to some 500 pages with a further 100 pages of process diagrams, that only a broad overview is practicable here.

We noted in the Cardiff Control case that the imminence of transaction computerisation was impinging on the attitudes of the principal protagonists and was effectively constraining the solution

options. Here the initiative was from within the company but with the New Roads and Street Works Act the key driver is the Government. The Act requires notice to be given to the Highways Authority of any activity due to be carried out in the highway and the Act specifically states in section 54:

"(1) In such cases as may be prescribed an undertaker proposing to execute street works shall give the prescribed advance notice of the works to the street authority...

(3) The notice shall contain such information as may be prescribed..."

The vision of the Department of Transport is that all information of this nature will be exchanged electronically and at the time when a July 1992 implementation date was expected the Department publishes its assumption that this will come in three phases:

1. Interim system (paper based) - July 1992
2. Interim system (electronic data interchange) - July 1993
3. Full Computerised Street Works Register (CSWR) - July 1997

Thus, there is an enforced spur towards computerisation with the requirement to communicate notice information electronically. Initial costs for a statutory undertaker purely for computing are estimated at £2 million capital with running costs around £270,000 per annum. But computerisation is clearly going to be complex with interests represented by the Highways Authorities, statutory undertakers and private contractors attempting to agree a specification and the apportionment of costs. Some key stages can be noted in the development of this project.

On 1st November 1991 a paper is presented within BT, which along with the Gas, Electricity and Water companies has a major role to play as a statutory undertaker. The paper concerns standardisation of noticing procedures and as part of this exercise special software is being developed with an outside software company - Blick. On 18th December 1991 an internal memo is distributed which refers inter alia to the computing developments. A critical passage reads;

"I am aware of approaches to Zones by several reputable companies to market computer equipment suitable for handling statutory notices. What is of concern is that several companies are promoting the concept that their product will meet both the existing PUSWA and the New Street Works Act and CSWR requirements ! I believe that a brief note to 'X' warning them that any purchase of this kit should be assessed in terms of limited life expectancy of no more than 2-3 years and that to delay a decision until further information on the CSWR interim system is available in about 8-10 months would be advisable".

Overhead slides for a presentation in December 1991 summarise a range of unresolved issues, e.g. "In which part of the organisation should 'reception' be located?" (that is, where should the terminals be located?)

By January 1992 detailed technical analysis suggests that there are four options, as indicated by the following extract from official minutes;

"The four options available would be:

- Change existing systems
- Post and fax
- PC generated notice
- Workstations and servers"

At this point a decision is made to go for option 3. However, in addition to the discussions going on within the private companies, other bodies are also wrestling with the complexities. One such is the National Joint Utilities Group (NJUG) which in late 1991 publishes recommendations on the format of the interim post and fax system. The Highways Authority User Council (HAUC) commissions consultants, KPMG, to make recommendations on System Architecture, Finance and Management. KPMG are also to provide a final 'user requirement' document prior to invitation to tender for the system. Inevitably there are some additional lobbies. In Scotland the Susiephone is already being used to exchange notices and a series of presentations are made to local NJUGs and HAUCs.

In June 1992 a paper is presented within BT giving the latest position. This reports that "there will be one central national system that could be housed on more than one site. The local systems would link into the national systems by a network interface". This significant development encourages the trend we have noticed for the various interest groups to develop their own systems because it permits them to interface with the ultimate national system, thereby extending their life-span.

By July 1992 the national HAUC has decided to set up a PLC to manage the computerised register. This PLC will have an advisory management board with representatives from the Utilities and the Highways Authority. The battle for the interim systems continues unabated. Concern is expressed in England that Scotland is likely to opt for Susiephone endorsed by a meeting in August between the Scottish Office, the Department of Transport and the local HAUC representatives. Within BT a struggle is developing between proponents of a new interim system, designed by KPMG, and an existing in-house system, Cavalier, which it is believed can be adapted to provide a notice-sending facility and for which there is 'political' support as it promotes the opportunity to extend usage of the system from its present base in London to the whole of the UK.

Whilst the system described above is primarily concerned with basic transactions, there is a managerial interest. As with any other transaction-based system, in the monitoring and control data that emerges from it. Earlier chapters demonstrated how problematic the implementation of computer systems already was within companies. Here the complexity factor increases because the system will span a number of private companies along with all Highway Authorities on the UK mainland. Notwithstanding the technical difficulties, the water is muddied by vested interests and pressure-groups which are intra- as well as inter-organisational.

It is also instructive to examine how one of the statutory undertakers, BT, tackles the problems presented by the legislation. The response is similar to that adopted by the TSM in the Gas Board case. A working party is created consisting of around a dozen middle and senior managers with representation from training, finance, legal and the relevant operational units. The working party will have been in existence approximately 18 months before the implementation date although this duration is partially attributable to delays in getting the secondary legislation in place which in turn causes the implementation date to go back from April 1992 to July 1992, October 1992 and, finally, January 1993.

One of the first conclusions of the working party is that there is a need to fragment the overall problem. A number of sub-working parties are created to specialise in key areas such as 'policy issues' or 'producing documentation'. Process considerations lead to a different but over-lapping fragmentation covering work areas such as 'field operations' and 'planning general'. These sub-groups work under the aegis of the main working party, known as the Project Control Board (PCB). The main function of the sub-groups is very similar to the Gas Board team. They must interpret the legislation and then define work processes that will enable the units to meet the requirements of the Act. Unlike the Gas Board team, however, they are not responsible for implementation. This function, which includes comparison of existing practice with the models emerging from the secondary legislation and codes of practice, is down to Zone Implementation Teams, each of which has a Project Control Board member on the team. The Zone teams, which are geographically based, must report progress monthly to the Project Control Board.

The PCB appears to adopt a quite structured approach to the problem-solution process which is externalised and published. Chart A (Charts follow at end of chapter) provides an initial flow-chart but another version appears later in the papers and this is shown on Chart B. Key activities are;

- Analysis and interpretation
- Comparison with current procedures
- Identify relevance

- Brainstorming
- Developing and analysing options
- Designing procedures
- Documenting

Other documents give an insight into the variety of methods employed which appear to have been introduced spontaneously. Chart C shows a simple use of cartoon characters and Chart D a 'mind map'. Information is formally gathered on a number of occasions using structured questionnaires with Chart E showing one example. Matrices also appear frequently with an example at Chart F. Structured diagrams are used in the documentation but also as part of the official minutes to communicate concepts and relationships as can be seen at Chart G. All work processes are flow-charted using standard conventions for process description as illustrated at Chart H. The process documentation is in excess of 100 pages. Formal project management techniques with an example of Critical path output is shown at Chart I.

Whilst this reveals extensive evidence for the use of a variety of formal and informal methods our concern is equally in the actual use of computers to assist these processes. An analysis was carried out of computing applications which involved interviews with the main working party members and further discussions with three of the Zone working parties.

PERSONAL PC USAGE.

Only two of the twelve members of the Project Control Board use a PC on a regular basis. One other is very keen on computing and carries out consultancy work, i.e. writing programmes for firms where he has friends as managers, but he does not have a PC for office use. The main reason given by the managers is lack of need as they have clerical staff who can carry out word-processing and spreadsheet writing functions for them. As the numbers using a PC would seem untypically low for a major engineering-dominated organisation it can also be suggested that their main work area, external provision of duct and cable, is at the opposite end of the spectrum from the more technologically-sophisticated functions such as network or telephone exchange management.

PROJECT MANAGEMENT

Both the main PCB and the Zone Implementation Teams use project management disciplines to forecast and monitor costs, to identify key dates and monitor slippages and to communicate activities and timescales with the example shown above at Chart I. Superproject is the software used consistently within the organisation.

FLOW CHARTS

Chart H showed the use of flow-charting software which speeds up the drawing of the charts and greatly facilitates amendments. However, a problem identified here repeats itself on numerous occasions. A variety of software packages are used, principally Harvard Graphics, Freelance and Magna Charter II, none of which are transferable. Because there is no national policy on which software package should be used for any given application - and there are many good reasons for not doing this - it is inevitable that different divisions and geographical areas end up with different software, often incompatible.

DATABASE

A subsidiary aspect to the main computerised street-works register is the need for anyone working in the highway to know if the street has been designated as 'traffic sensitive', of 'special engineering difficulty' or 'protected' as there are implications for noticing procedures. Whilst paper records are adequate there are drawbacks and some see clear benefits in using an electronic database. The 'enthusiast' referred to above manages to borrow a lap-top and constructs a simple database using dBase software. This then becomes the basis for a comprehensive and fully-supported system introduced by the computing group using Focus software. In late 1992 they are still evaluating the prospects of transferring the information onto hand-held Psion terminals used by the field engineers.

OFFICE AUTOMATION

Whilst some have access to 'office automation' packages, these are for the most part incompatible. Some Zones use a package called HOST and others a package called PROFFS. Some have no access. The packages offer basic diarising facilities along with the ability to communicate with other users. But HOST users cannot communicate with PROFFS users and vice-versa. A national project is underway, called BOAT, which aims to provide compatibility but the capital investment required is considerable and divisions may have to demonstrate savings before they can proceed and this is proving problematic. Some users have access to other electronic mail packages such as Gold and Intermail but no initiative is taken to arrange access for all members of the team. In view of the need for constant interchange of information between team members and the possibility that questionnaires could be distributed and completed electronically there would seem to have been some merit in having this capability although it is equally possible that the investment required would have precluded this as a possibility.

WORD-PROCESSING

Wordstar is the basic word-processing package used within the organisation and is used by the few managers on the PCB who do use a computer. It is also extensively used by their own staff thereby facilitating transfer of documents between units. However there is growing unease with the older versions of Wordstar which many perceive as more complex and less feature-provided than more recent packages.

CONCLUSION

To a degree this case illustrates how attitudes to and usage of methods, tools and techniques have gone full circle. The initial over-enthusiasm in the use of formal methods followed by disappointment and even cynicism might appear to have filtered out both the less useful methods and refined the relevant application areas. Whereas 'within-industry' methods, such as Work Study, Project Management, Flow Charting have developed and evolved steadily over time it would seem that, if this case is typical, there is clear acceptance of the need for method and structure in managing the problem-solving process. Furthermore, whilst formal structures are used, tightly defined in project management manuals backed by software, to run the project plan, individuals do not appear to be inhibited from using creative techniques such as brainstorming, doodling, mind-mapping and graphics within this structure to generate insights and clarify thinking. With the increasingly widespread use of PCs, described in Chapter 4 and reflected here, the principal need becomes integration so that not only can linkage be simplified between these component activities but also the manager's total job - the role-centred perspective - is as much part of the system as the individual problem - the problem-centred model.

CHAPTER REVIEW

The case studies researched and reported on in this chapter purported to identify implications for the application of method as well as indicating progress in the actual take-up of any computing packages in the final case study. It was also hoped that it would be possible to compare the actual progress of problem-solving processes with the prescriptive sequences reported on earlier in the thesis.

To take the latter issue first, whilst it is clear that individual examples of GATHER INFORMATION -> ANALYSE -> DECIDE can be found and are often repeated several times within a process, real-life problem-solving does not appear to reflect any prescriptive order beyond that. This is not to say that problem-solving should not follow such prescriptions but evidence from the case studies suggests a number of reasons why it is very difficult in practice to do so. The primary reason is that problem-solving occurs in real-time in dynamic and turbulent environments. For example, information-gathering as a phase cannot be completed before moving to the next phase because it always requires updating and modifying. Another reason is fragmentation which tends to confound sequential phasing because the fragments are discretely operating their own sub-cycles within the overall programme.

Fragmentation emerges as a key concept in the case studies. Organisations break down complex problems into sub-problems and conceptual fragmentation is mirrored by physical fragmentation as sub-groups are set up to inquire into the fragmented elements. This is not to say that holistic and

integrating activities are not carried out. Thus the Working Party in the Control case and the PCB in the New Roads and Street Works Act case perform precisely this function. It is at this level that more wide-ranging consideration, evaluation and review activities can be carried out with the sub-groups concentrating on more focussed and specific problem-solving. With fragmentation adding to the complexity of managing the problem-solving process it is clearly advantageous for any problem-solving packages to include facilities to aid the management of fragmentation.

Another important issue to emerge is that of linkage or inter-dependency. Not only are the consequences of actions taken in relation to a specific issue linked to other issues, individuals and organisational groupings but problems also provide opportunities to managers for resolving indirectly related problems. The AIDA package (Analysis of Interconnected Decision Areas - Rosenhead, 1989) is closely linked with these aspects. In the Control case KB uses the report preparation as a tool to develop a member of staff as does the TSM in the Gas Board case. The ability to recognise linkage opportunities can potentially be assisted by systems which simply hold and display the range of potential issues, a facility that is included in the specification described in the next chapter.

In the decade between the first and last case study we can note progress in the accessibility of PCs. Yet, as many research reports quoted earlier suggest, actual usage of PCs by managers may still be quite limited. However, the final case study points up a critical distinction between actual personal usage which may be limited and usage by subordinates to support managerial requirements. Actual applications used in this case were:

- Word-processing
- Database
- Project management
- Process flow-charting
- Office automation

Additional potential applications derived from the case studies include the following;

- Problem fragmentation
- Problem anticipation
- Project administration
- Load balancing
- Organisational structure
- Working methods and processes
- Option comparison
- Physical lay-out and re-organisation

Linkage between problems, actions and intentions

Quantification and measurement

Arranging meetings

Achieving consensus

Keeping aware of related developments

Communication with team and others

Building conceptual models

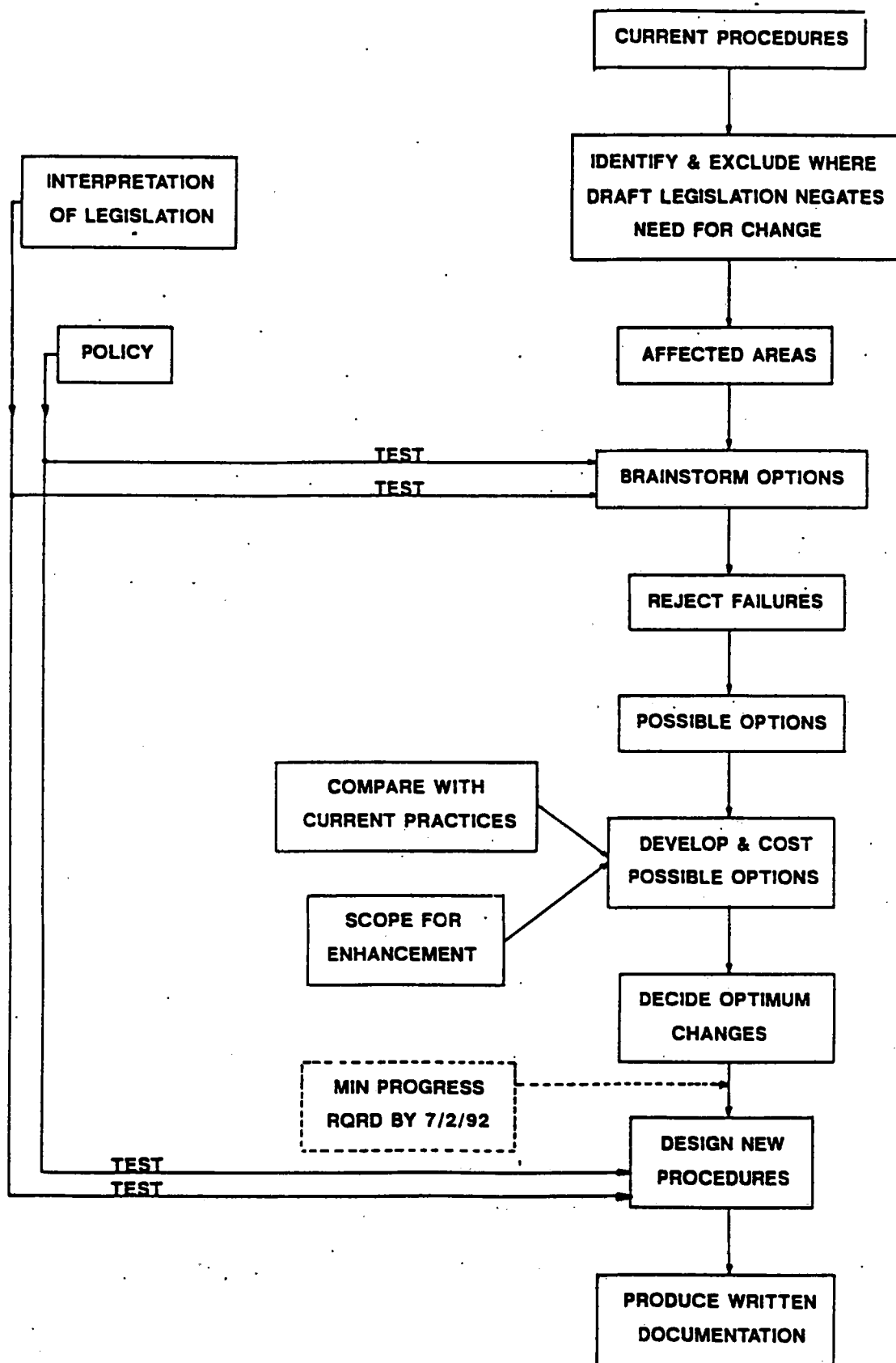
Project management

Comparing models

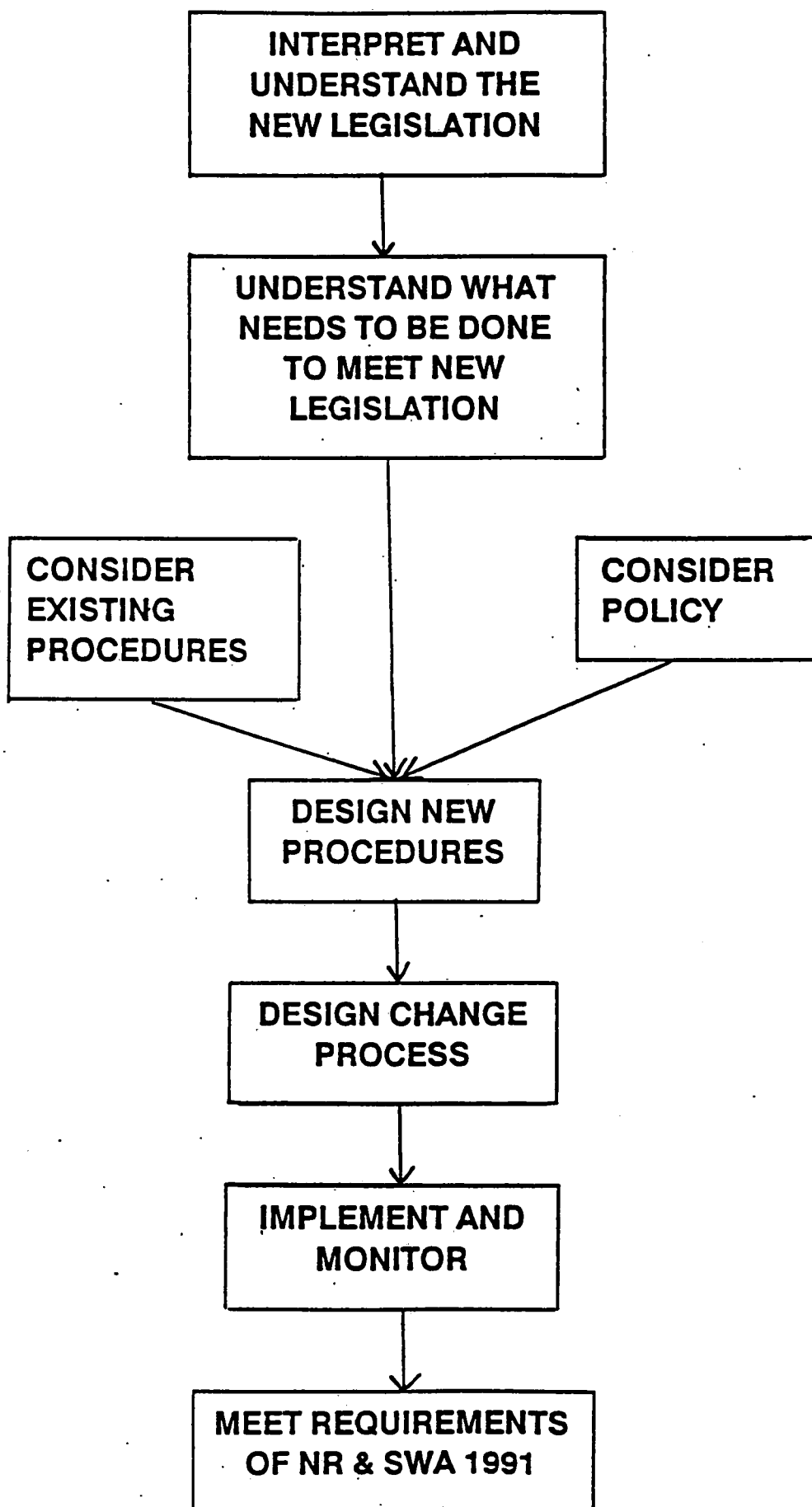
Flow-charting processes

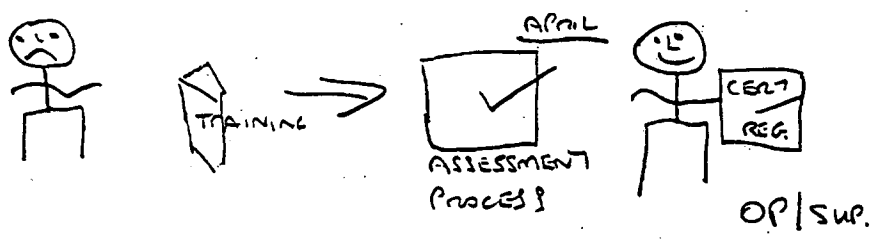
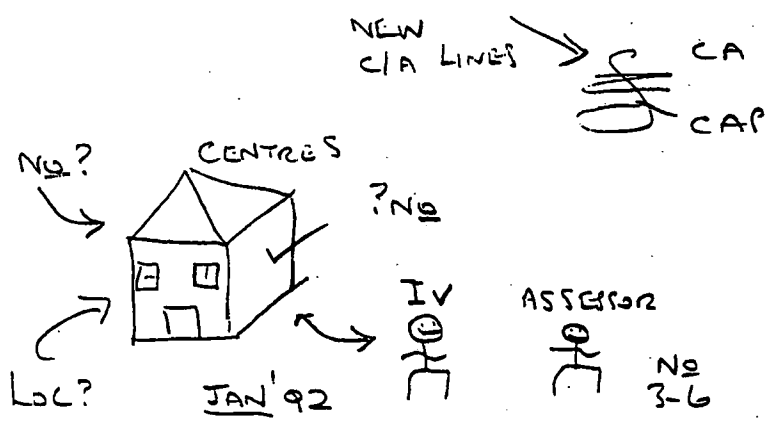
In addition brainstorming and unstructured representation such as mind-maps and 'doodles' can be potentially captured on software although it cannot be argued that there is any overwhelming evidence as yet for the benefits of so doing. In principle, the computer should make it easier for such activity to be performed collectively (cf. CSCW) but software availability is still limited (see Chapter 4).

Finally, it was noted that not all 'complex' or 'difficult' problems demonstrate potential for the design and use of applications software, particularly those incorporating structured problem-solving method as the ACS case revealed. Equally clearly, in the other cases, potential is evident although there are aspects within each of the cases where one can argue both for existing usage and potential but other aspects where little or no potential exists.



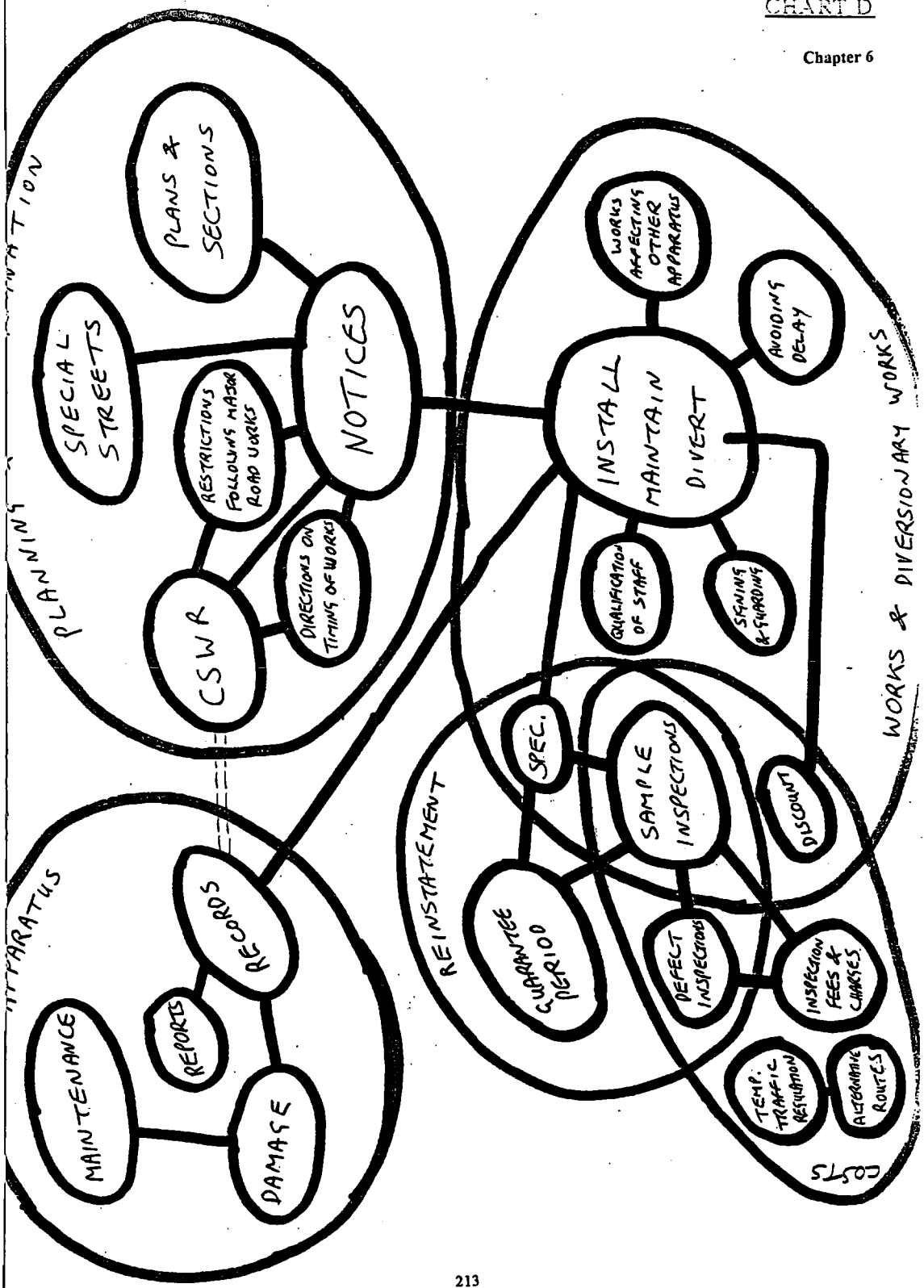
OVERALL PROCESS





AUTHORS NOTE:

author hereby disclaims any responsibility for the quality of the
ve picture, on the grounds of artistic incompetence.



j) Who within your Zone issues 28 day PUSW Act Notices for Payphone purposes

- PC as Agents
- Other, please specify

Further Information

.....

.....

.....

.....

k) Who within your Zone issues 7 day PUSW Act Notices for PC purposes

- Wayleave Duty
- EWC
- EPMC
- Planning Group
- Contract Supervising Officer (CSO)
- Field Works
- Field Mtce
- Drawing Office
- Other, please specify

Further Information

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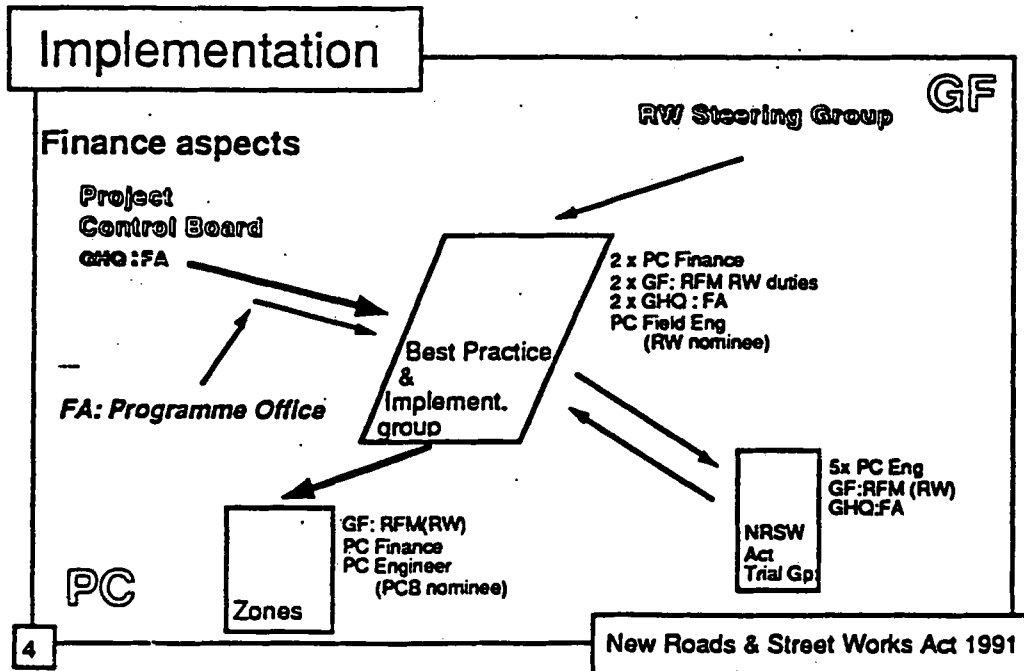
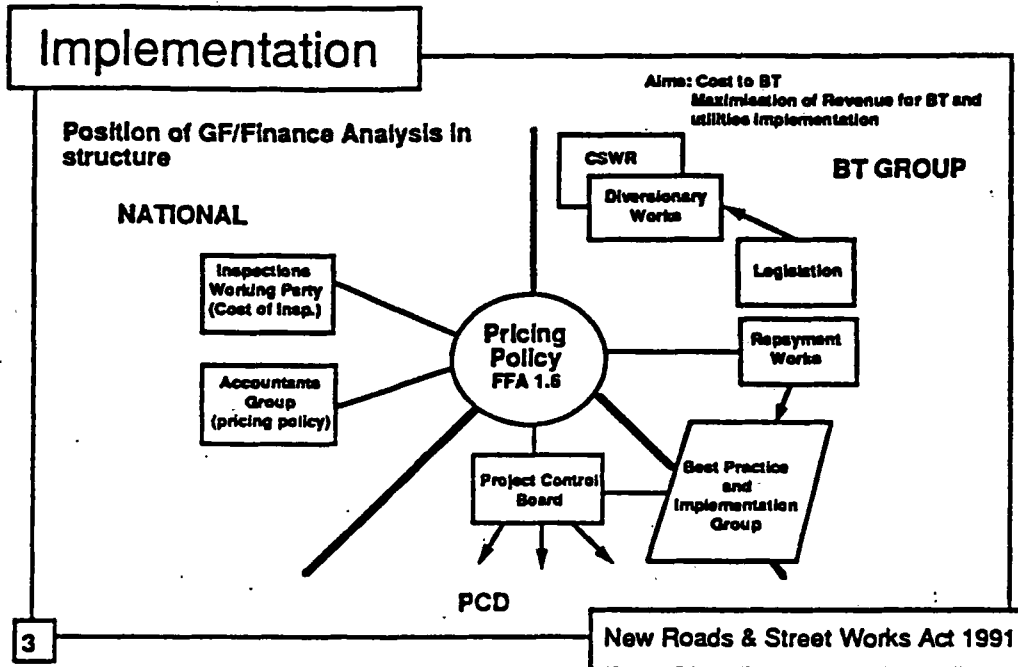
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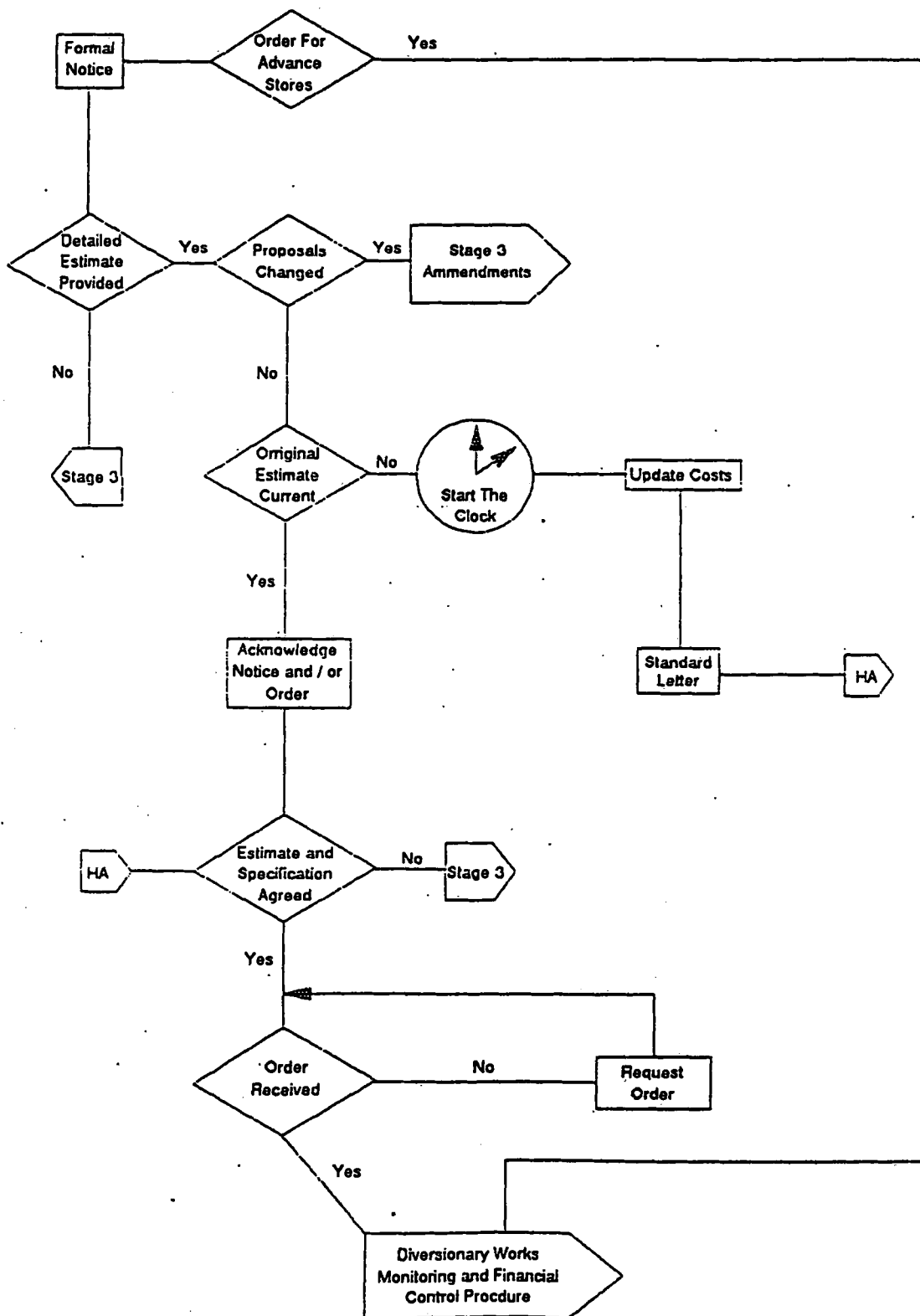
LEGISLATIVE REQUIREMENTS

	Reinstatement Specification	Inspections	Notices / CSWR	Co-ordination	Diversiory Works	Signing & Guarding	Records incl Traffic Sensitive Routes etc	WP No Dealing						
External Planning	X	X	X	X	X	X	X							
EWC			X	X	X		X							
Direct Labour Cable + O/H	X	X	X	X		X	X							
Direct Labour Civils	X	X	X	X		X	X							
Contract Cable + O/H	X	X	X	X		X	X							
Contract Civils	X	X	X	X		X	X							
EPMC			X	X			X							
Network Mtce	X	X	X			X	X							
RSC BC			X											
RSC PC			X											
CA & L Mtce BC			X			X	X							
CA & L Mtce PC			X			X	X							
Installation Control BC			X											
Installation Control PC			X											
Installation Field BC			X			X	X							
Installation Field PC			X			X	X							
Drawing Office			X		X		X							
Wayleaves			X											
Repayment Works Account Group					X			5						
Contracts Letting & Billing Duty	X	X			X	X								
Materials Management (Stores)	X			X	X	X								
Mechanical Aids	X					X								
Motor Transport	X					X								
Computing			X	X	X		X	5						
Documentation + QA Authors	X	X	X	X	X	X	X	2						
Purchasing	X					X		5						
Accommodation	X		X			X								
Safety Officers						X								
Worldwide Networks			X	X	X	X	X							

NRSW Act 1991 : Project Control Board



STAGE 4
Formal Notice
Advance Order



BT/CSWR INTERIM SYSTEM PLAN

CSWR Project

Task 5 Days Per Column	Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Scheduled Start	Scheduled Finish	Actual Start	Actual Finish	Pct Comp
CSWRPJ		██████████	██████████								03/01/92	01/10/92	03/01/92	03/01/92	23
CLIENT REQ. DOC.		██████████									03/01/92	27/03/92	03/01/92	03/02/92	99
FEBILITY STUDY		██████████									03/01/92	03/02/92	03/01/92	03/02/92	100
OPTION SELECTION		██████████									03/02/92	07/02/92	03/02/92	07/02/92	100
BUSINESS PLAN				██████████							16/03/92	03/04/92			0
BUSINESS CASE				██████████							16/03/92	03/04/92			0
REQUIREMENTS SPEC.				██████████							10/03/92	29/05/92			0
DESIGN SPEC.				██████████							13/04/92	13/07/92			0
CONSTRUCTION SPEC.				██████████							14/07/92	10/08/92			0
ACCEPTANCE TESTING				██████████							14/07/92	07/09/92			0
INSTALLATION				██████████							11/08/92	01/10/92			0

██████████ Critical

██████████ Noncritical

CHAPTER - 7**RECONCILIATION OF MODELS WITH SYSTEM DEVELOPMENTS**CHAPTER CONTENTS1. INTRODUCTION2. ROLE-CENTRED PERSPECTIVE

WORK QUEUES

PIMs

3. PROBLEM-CENTRED PERSPECTIVE

BASIC STRUCTURE

INPUT

ADMINISTRATION

HOLDING MODULE

DATA

SEARCH

TOOLS

RELATING

OUTPUT

4. APPLICATIONS

CARDIFF CONTROL CASE

SUMMARY

1. INTRODUCTION

In this chapter we can attempt to build the conclusions derived from the preceding chapters into a suggested framework for a design for a computer-based manager support system. Chapter 2 enabled us to assess the potential role of some major methods and to examine the context in which they might be applied. The justification for using method in managerial problem-solving was endorsed but whilst the methods reviewed could be deemed to have a role to play in problem-solving most would appear to have shortcomings if viewed as comprehensive systems. The review continued in Chapter 3 which considered the scope for using staged methods as a basic framework for the design. The conclusion was that a staged approach reveals both logical and practical difficulties in real-world problem-solving. Only a few basic essential stages can be identified but the analysis did reveal a range of activities which could be carried out throughout the problem-solving process which should be key elements in the design. In addition the chapter confirmed the existence and significance of intra-company iterations and routines which may be a necessary part of gaining authorisation for any decision.

Chapter 4 established the role of the computer as a tool of rapidly developing importance for managers. With ubiquity largely confirmed, the crucial issue for the 1990s becomes exploitation. The current pattern is for widespread use of very basic facilities such as wordprocessing, spreadsheets and electronic mail. However, the increasing availability of low-cost software covering a range of other facilities is causing more extensive use. Organisations are also investing substantial capital sums in developing software applications and two major areas with particular significance for problem-solving are those of Executive Information Systems and Expert Systems. The former, with its theoretical underpinnings and widespread practical development is central to that element of problem-solving that relates to information search, examination and display. Expert Systems have a number of specific applications developed but also offer potential to assist more general problem-solving through system-navigation or when linked to other systems such as Executive Information Systems.

Chapter 5 proposed two fundamental models; the problem-centred model which reflects conventional approaches to problem-solving with the primary emphasis on problems in isolation and the role-centred model which more closely approximates to the manager at work. Essential elements in the latter are the multiplicity of different problems that co-exist, the limited time available to consider them, the fragmented and discontinuous way in which processes develop and the need to relate, compare and contrast these work units with each other. The fieldwork in Chapter 6 helped to confirm a number of the preliminary conclusions. Staged approaches fail to reflect the dynamic environment in which problem-solving takes place and appear too simplistic for the highly complex and fluid patterns that emerge in practice. The existence of candidate solutions at the outset, the need for information flows between any number of people who could constructively contribute to the debate and the tendency to create conceptual models against which existing practice or proposed solutions can be measured, are all features which emerge in the case studies. A crucial element is also the distinction between the process needed to examine the problem, reach conclusions, make decisions and implement them and the problem and solution itself. The former is characterised by the need to focus on administrative elements such as creating and forming working parties or committees, arranging meetings and achieving deadlines. The way in which problem-solving processes unroll in organisations can be a significant element in conditioning acceptance. The final case-study also revealed the inroads being made by PCs, the uses to which they were being put and the potential areas where further use could be made such as with mapping, model comparison and project administration.

Thus there are a number of issues which have to be reconciled and merged. These are as follows:

1. Actual usage of computers by managers (chap.4)
2. Current developments in software (chap.4)
3. Major methods for problem-solving (chap.2)

4. Techniques for problem-solving (chap.3)
5. Managerial problem-solving needs (chaps,2,3,4 & 6)

In the first part of this chapter we adopt a role-centred perspective as the fundamental framework for the proposed design. This reflects the view that the starting point should be a system which helps the manager manage his job onto which one can subsequently build those facilities which help him assess and review individual problems. The latter part of the chapter then shifts to the problem-centred perspective and suggests a structure for incorporating the varied methods, tools and techniques which can help problem-solution. For each element or activity grouping we can assess what facilities and functionality are offered by current software and how that compares with the proposed set of requirements.

1. ROLE-CENTRED PERSPECTIVE

With the role-centred perspective we find the manager concerned with a multiplicity of jobs, shifting rapidly from one to the other, balancing competing demands for time, priority and resources. The primary requirement for a manager-support system thus becomes the ability to capture and update the tasks, to view and reflect on them whether considering solution options or when they must be completed. to relate the implications to resources such as time, money and manpower, but essentially to be able to maintain visibility over the sum total of the jobs with the option of viewing sub-sets and to creatively relate tasks to each other where they may be complementary, mutually exclusive or more loosely linked. In effect, we are primarily concerned here with helping managers manage their jobs rather than solve individual problems. The link to the latter is that jobs may be or become problems and problems or the actions taken to correct them may affect jobs.

WORK QUEUES

Software designers do not normally take the management of managerial jobs as a starting point and in this respect the direction of this research is fundamentally different from the norm. The role-centred mode can be seen to be similar in a number of respects to the functioning of a clerk, technician or operative, whether technical or otherwise. This involves the arrival of work units, possible ordering of those units and periodic review and then the completion of whatever activity was required (cf. Sandy in Chapter 1). The accounting clerk might be dealing with invoices, the maintenance engineer with reported faults or the service personnel with customer complaints. These are the TRANSACTIONS which form the core elements of most organisations' computing applications. Examination of, for example, Logica's basic design for an order, fault and complaint-handling package indicates a number of fundamental elements which are described below and we can assess their relevance to the manager's situation. This is a mainframe system specifically developed for transaction- processing.

JOBS

With a fault the basic unit cannot be decomposed but a job consists of a number of activities which might have to be completed before the job can be closed. This structure applies equally to complaints. Thus there is an implied hierarchy with jobs capable of being sub-divided into subsidiary units. Dependencies can be built in such that activity 'A' has to be completed before activity 'B'. This structure would appear wholly compatible with that of the manager's work units. However, because of the variety in the latter it would probably not prove practicable in most cases to input dependencies. However, complex problems which utilise project management disciplines could expect to have dependencies input. Thus we can regard the manager's work units as broadly similar at this level to the basic transactions of rank-and-file company operatives. A number of tasks arrive and are dealt with although not all immediately. The system displays these along with associated relevant data.

ORDER NUMBER

Each order, fault or complaint has a unique number allocated by the computer. This simplifies monitoring, reporting and analysis. This would seem appropriate for managers' jobs as well.

PROGRESS LOG

The computer automatically registers inputs so that access to the log reveals when an issue was first input and what subsequent amendments were made and when.

COMMITMENT DATE

In basic transaction processing this is usually pre-set to a target time and date but with the facility for the operator to over-ride it, for example if a customer wanted an appointment outside the commitment period. Managers' jobs would not normally have a standard commitment timescale but a deadline would either be provided as part of the original stimulus or could be created by the manager as part of his expectation of job completion.

LABEL DATA

A variety of related data can be affixed to the job which could include some or all the following:

TITLE

NARRATIVE DESCRIPTION

SOURCE

CLASSIFICATION (useful groupings)

COMMUNICATION TYPE (letter, call etc.)

JOB OWNER

QUEUE

Transactions are usually presented as queues allowing the operative to have visibility over his workload. The manager should have the ability to view his work units in a similar way. Basic electronic mail systems already provide something analogous to this although they may not adopt a specific queue structure. that is. they are lists rather than ordered queues. The ordering for transactions usually depends on commitment times or, failing that, times when entered with the oldest at the top. Hence the operative sees his oldest jobs first. The principle is still relevant to the manager although he might require a more sophisticated ordering system which took account not only of commitment times but priorities.

JEOPARDY AND FAILURE

This entails three vital concepts; 'jeopardy' and 'failure' which are communicated through 'flags'. Jeopardy concerns jobs which have not been closed but are close to failure. 'Close' is pre-determined in transaction-processing but would be manager-set in our system. This may need to vary depending on the length of time required to complete the job. Thus one which takes a week's elapsed time to complete should have a jeopardy flag set no less than a week before the commitment date whereas one which only takes an hour could cope with a shorter gap between the two. Failure implies that the commitment time has been passed. The flag is usually a simple 'F' or 'J' alongside the job. It should be possible to report out failed jobs and jeopardy jobs.

RE-PRESENTATION

Where queues are large - we noted Mintzberg's (1990) suggestion that managers juggle large numbers of jobs at any one time - additional queue-management facilities may be needed. One such is 're-presentation' where irrespective of jeopardy or failure date but, by implication, before either of these two, a job is held in suspense and then presented at the determined date. In basic transaction-processing this often entails the use of two queues, one a comprehensive queue of all outstanding jobs, the second covering only those jobs which are past their re-presented date. The effect is to place a job into a 'pending' tray until a pre-determined date and this helps to reduce the size of the queue. This has particular relevance to managerial jobs with their varied timescales and priorities.

STATUS

This allows the status of the job to be displayed and is dependent on the determination of suitable categories. At the most basic level jobs will be either 'open' or 'closed'. Further refinements are:

-'Read' or noted. This is common on electronic mail systems where items which have not been read are distinguished from those which have been.

-Actioned. Here the user has taken some specific action on the issue, for example, assigning it to someone to carry out the work.

-Executing. Here, activities have commenced on the job - it is 'in progress' but not completed.

-In 'delay'. In this case the job has been put 'in delay' or is in suspense for some reason. A further refinement is to introduce delay categories. With the manager examples might be 'awaiting resource' or 'authorisation'.

Thus, the starting point for the design of a manager support system can be seen to be something which offers the same underlying functionality and disciplines as is used by other staff with existing transaction-based computer systems. There is no reason to believe that managerial tasks are inherently different to those performed by operatives. They may be more complex, varied and discontinuous but the Mintzberg (1990) proposals which suggest high volumes of short duration work units reinforce the similarities with operational transactions. In the next section we can briefly review whether current PC-based software offers these essential facilities.

PIMs-Personal Information Managers

We noted in Chapter 4 examples like PROFFS of systems which begin to provide some of the general organising facilities that we are suggesting should be at the foundation of any manager-support system. However, these mainframe-based applications are primarily aimed at the corporate sector and much of the current investment and innovation concentrates on PC applications. These are generically referred to as PIMs or Personal Information Managers and a review of some of the main packages on the market in February 1993 follows.

PIMs appear to be the most relevant category of software to the role-centred model because they are primarily concerned with helping a manager to organise his working day and keep track of the many things he has to do. The packages reviewed include the following:

Act! for Windows by Contact Software International

Act 2.1 by Contact Software International

Info Select 2.0 by First Hand Software

Instant Recall 2.0 by Protek

Organizer for Windows by Lotus Development (UK)

PackRat by Polaris Software

Sidekick 2.0 by Borland UK

TMI Key Results by TMI Technology

Timelord 1.4 by Sterling Data Services

WordPerfect Office by WordPerfect UK

Way You Work by I Squared

Evaluation of the packages was carried out principally by referring to company literature, independent bench-mark tests carried out by software publishing houses and direct use of 'demo discs' where these were available from the suppliers. Whilst none of the packages offered all of the following facilities, they can be found in at least one of them.

1. Database containing contact names, addresses and telephone numbers. Where the PC is linked to the telephone the PIM will also dial the number. 'Act! for Windows' has cards with pre-determined fields but also some which can be customised. Associated with the card are 'notes' which hold additional information about a contact and 'history' provides a link between an activity performed within the software and the individual to whom it relates. 'TimeLord' unusually includes a document database which permits searching of text files.

2. Diary functions. 'Organiser for Windows' offers a very lifelike representation of an open diary with calendar and the ability to set the time and length of appointments. There is also an Anniversary section for annual events. 'Instant Recall' associates a Schedule and Reminders list with diary dates that suggests similarities with some elements of the transaction-based model described earlier. Jobs can be prioritised and those which are not yet completed appear in the reminder screen.

3. Schedule appointments. Most packages allow the facility to search through a diary system and schedule appointments. 'Instant Recall' links with the task manager module to flag up time conflicts for the user or others in his or her work group.

4. Set alarms. 'Organizer for Windows' allows alarms to be attached to appointments as does 'WordPerfect Office'. 'Way You Work' combines an audible alarm with a small dialogue box at the top of the screen.

5. Project management. 'PackRat' amongst many others has a Project Management facility including resource scheduling.

6. Data import. Many packages have the ability to import text and graphics from other applications. 'PackRat'. for example, can be integrated with Excel, Word, WordPerfect for Windows, Ami Pro and Da Vinci email.

7. Contact management. Here free text notes can be placed alongside names, addresses and appointments and stand-alone 'contact management' software can be obtained. 'PackRat' is one of several packages offering these facilities. 'Tracker Professional VI' allows one to add up to 10 Notepads to a client entry.

8. 'To do' lists. 'Organiser for Windows' allows three levels of priority as well as 'to be done by' settings. TMI Key Results also includes an 'elephant task' which has to be carried out over a period of time. 'Tracker Professional VI' permits annotation of entries with 'cancelled', 'completed' or 'delegated'.

9. Groupware. Many packages can be linked using a LAN offering the ability to view other diaries and schedule meetings. None of the packages considered here included anything more sophisticated than this. 'WordPerfect Office' comes with a groupware version costing around three times the stand-alone version.

10. Planners. These are adaptations of diary systems which involve an annual calendar on a matrix basis - the familiar office wall planner. 'Organiser for Windows' includes the ability to present events in a choice of fifteen different colours.

11. Time planners. These can involve combinations of the above. 'Sidekick's' Time Planner combines calendar, diary and To Do list on one application and include the facility to search for appointment slots, to set alarms and add explanatory notes. SideKick gives daily, weekly, monthly and time usage views.

12. Communications. This often combines with contact databases (see 1 above) to facilitate auto-dialling. 'Packrat's' Phone Book allows automatic dialling from entries in the book, the call is timed, notes can be added and a follow-up alarm set. 'WordPerfect Office' has a particularly powerful electronic mail system which facilitates contact with many other platforms.

13. Tools. Other facilities may be available such as a Calculator with 'SideKick' which also offers a scientific, business and programmer's calculator.

14. Notepad. 'Info Select' provides windows for entering text and these are then held as 'stacks' which facilitates cursor-controlled browsing. 'Sidekick's' Notepad is complemented by a Dictionary and Thesaurus. 'Organizer for Windows' requires each note to have a heading title which is used to create a table of contents, thereby facilitating retrieval. PackRat includes a multi-account finance manager which allows one to book costs to different accounts.

PackRat offers at a basic level the sort of cross-facility linkage that has been identified as so potentially useful to manager-support systems. Once a letter has been typed using the 'Word' facility, use of a PackRat command automatically sets up a 'To Do' item to check for a reply by a given date and a reminder to charge costs. Another good example comes from TMI Key Results. As details of the tasks one is working on are entered, there is an automatic cross-reference to the diary module which presents a comprehensive forward view. The package also offers Key Areas whereby one is presented with a window in which the task is defined and the deadline for completion stated. Responsibility can be allocated to whoever is involved and the task can also be fragmented into further sub-tasks and activities.

PIMs can be seen to be offering some of the facilities required for a manager-support system and which were discussed in the previous section. 'To Do' lists approximate loosely to work queues and there is the capability to prioritise these and associate alarms or flags to alert the user to potential jeopardy. Many of the administrative issues identified as part of project (i.e. problem solution) control noted in the field-work review in Chapter 6 can be assisted with diary and calendar applications particularly when combined with the ability to schedule meetings and appointments using networking.

Problem-centred methods designers might regard these facilities as some way removed from their more sophisticated problem-structuring iterations yet PIMs are beginning to offer more advanced relational facilities that could in the future help to integrate the output from the major methods into the action-oriented environment of the working manager. Whilst overall volumes of sales are difficult to obtain, individual claims of, say, 85,000 for Tracker alone give some indication of the potential for these products.

Thus PIMs provide a basis for the development of manager-support systems and we can begin to see the appearance of more sophisticated functionality that links different modules together. The element that should provide the core activity is the 'to do' list as it is the closest conceptually to the work-management systems described at the beginning of this chapter. However, whilst some offer basic ordering and prioritising capabilities, the 'to do' list remains very unsophisticated and a far cry from the requirements identified earlier. Adoption of a role-centred perspective implies the need for significant development by software firms in this area with a view to delivering core products which offer queue management, job ordering, jeopardy and failure reporting and analysis. With foundation systems clearly established one can then consider the additional problem-structuring and solving facilities that can be made available at the discretion of the user and which can provide the more detailed and involved approaches embodied in the methods described in chapters 2 and 3.

3. PROBLEM-CENTRED PERSPECTIVE

BASIC STRUCTURE

In the first instance the work-unit recorded in the 'to do' list may consist of little more than a title with associated 'labels'. e.g. date, priority, category etc. It will either have arrived as an incoming electronic mail item or will have been entered by the user. For a proportion of work units the manager will wish to carry out more detailed research, analysis or reflection and to assist this process he should have a variety of different tools, facilities and techniques available to him. We noted in Chapter 4 that the main usage of PCs by managers was in terms of word- processing, spreadsheets, information access, production of graphics and electronic mail so these sorts of facilities are essential for the integrated system. The fieldwork emphasised the need for administrative utilities including diarising and time management, project management and process and concept charting. There was also an implied need for modelling capabilities although these were not so much mathematical as conceptual and process-related. Key developments by business organisations can also be seen with Executive Information Systems which become the primary channel for accessing intra-company information and Expert Systems which are increasingly beginning to impact on problems or sub-problem elements which are repetitive.

There is a clear need with the fragmented and disjointed nature of software developments to propose a structure into which these disparate elements can be integrated. The current focus by software development companies is on the technical and hardware- related issues so as to circumvent compatibility problems. Whilst there are packages which we shall refer to below and the evidence of the PIMs discussed above which indicates that groups of tools and facilities are being combined by developers, equally clear is the lack of any coherent structure for this and the job- management element which follows on from the role-centred model is almost completely absent. In the remainder of this chapter a structure is proposed which attempts to cover the potential facilities, modules, tools and techniques which appear to offer help to managers using PCs and which reflect some of the development trends already evident in the industry.

To understand the variety and complexity inherent in the wide range of possibly relevant problem-solving tools and activities we can here restate the principal features emerging from the earlier chapters. Chapter 4 identified the following facilities, techniques, packages and modalities:

- Electronic mail
- Calendar
- Diary
- Document storage
- Reminder system ('tickler' files)

- Distribution lists
- Directories
- Action lists
- Bulletin boards
- Spreadsheets
- Financial modelling
- Graphics
- Project control
- Data on company finance and manpower
- External data on companies etc.
- Information interrogation capabilities
- Function specific systems (e.g. production, sequencing etc.)
- Expert systems
- Workflow management
- Project management
- Multi-media
- Groupware
- Executive Information Systems

Chapter 2 adds a range of more sophisticated facilities often, but not exclusively, directed at conceptual problem-solving which include the following:

- Option comparison
- Model comparison
- Causal analysis
- Strategic analysis

Chapter 6 provides a range of potential needs taken from fieldwork experience, as follows:

- Problem fragmentation
- Problem anticipation
- Administration of project
- Load balancing
- Organisational structure
- Working methods and processes
- Option comparison
- Physical layout and re-organisation
- Linkage between problems, actions and intentions

- Quantification and measurement
- Arranging meetings
- Achieving consensus
- Keeping aware of related developments
- Communication with team and others
- Building conceptual models
- Project management
- Comparing models
- Brainstorming
- Producing and sharing mind maps
- Flow-charting processes

It can be seen that some needs can be met by facilities currently in existence, hence the need for project management can be met by a variety of packages currently on the market. However, there are aspects of problem-solving which appear to have less relevance to computer-assistance, such as tactics and constraints. so, whilst they may be highly important to problem-solving they are not addressed in detail in this document.

Finally there are the activities contained within problem-solving in its broadest context which are neither sequential nor inevitable in that problem-solving is likely to use a selection of them rather than all and these are as follows:

- Problem identification
- Problem definition
- Objective-setting
- Information gathering
- Analysis
- Option identification
- Option evaluation
- Decision-making
- Implementation
- Administration

These may contain sub-elements as when we choose to include model-building as an 'analysis' activity and we may witness iterations and cycles either of individual activities or groups of activities, e.g. information-gathering followed by analysis.

CONCEPTUAL FRAMEWORK

The items can be linked as follows. Activities are carried out in order to move the process of problem-solving along which in turn give rise to sets of process needs. Relevant to these needs are tools and techniques or facilities such as using spreadsheets or interrogating databases. Thus:

ACTIVITY >>(leads to)>> PROCESS NEEDS >>(met by)>> TOOLS & FACILITIES

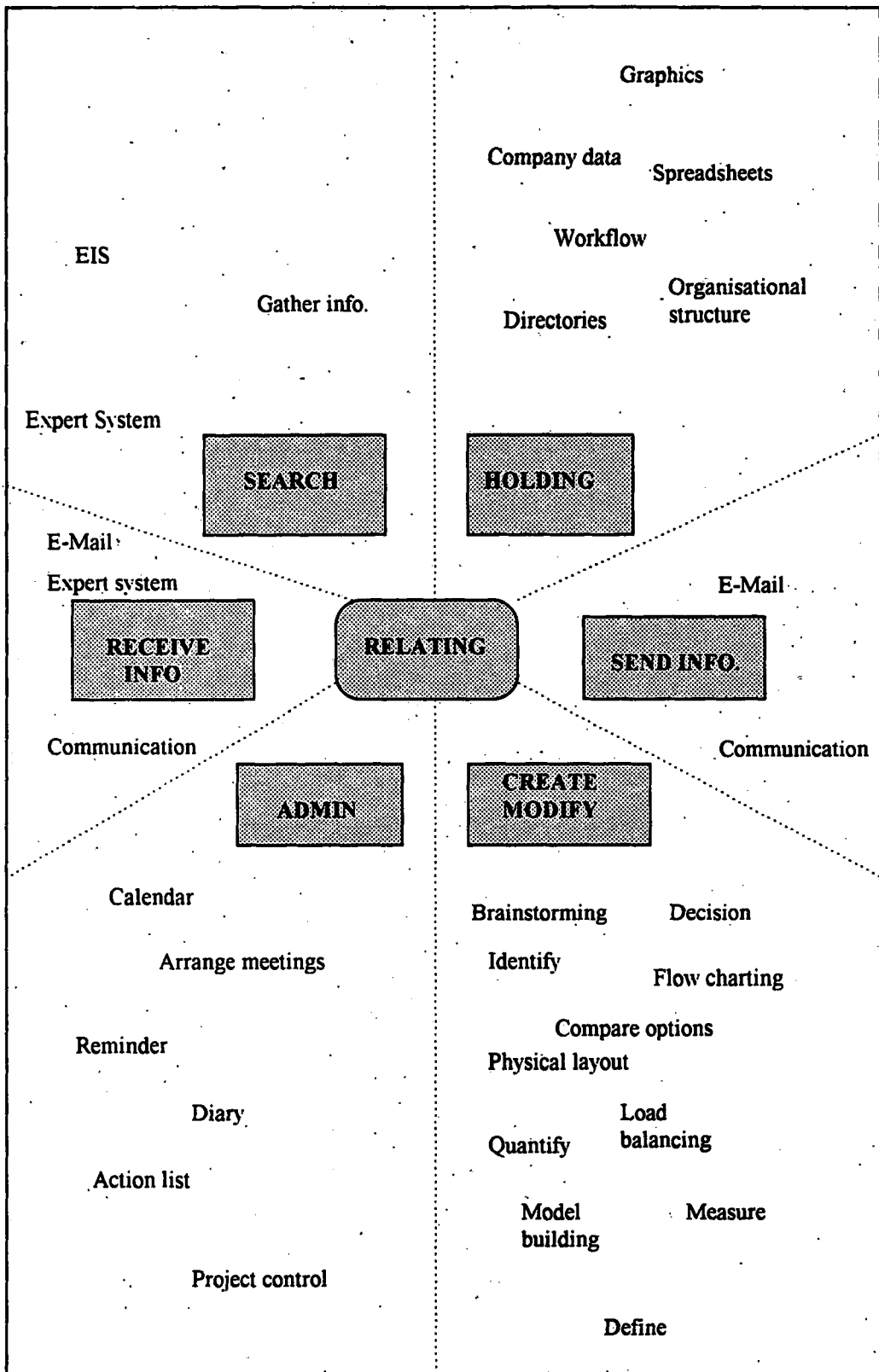
It should be stressed that the needs in these examples are not those which give rise to the activity in the first place but the needs necessary to deliver the activities. Thus a manager may establish a requirement (initial need) as part of problem-solving to find out some information and this information interrogation becomes the activity. This gives rise to a need or sets of needs for channels to deliver this requirement which may be met by on-line database interrogation or sending an electronic mail message to a colleague.

As has been indicated, a wide variety of activities, process needs and the tools, techniques and facilities which may help deliver those activities exist, currently in a somewhat arbitrary and unstructured way. The intention here is to group the identified factors into categories although this does not extend to any implication that managers should use particular facilities or sequences of activities when addressing problems although the potential for developing movement in that direction is considered via Expert Systems as discussed in chapter 4. In addition, by providing a more comprehensive, yet integrated, range of tools and facilities the synergy of the linkage between work units, problems and actions can be exploited.

The initial broad categorisation is shown on the following page.

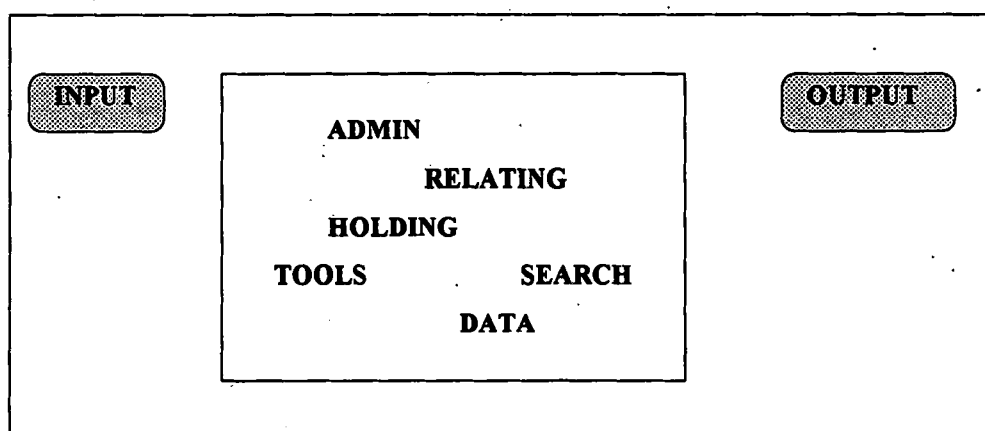
Here we have seven main categories. Data can be sought, received, held and despatched. It can be also changed or modified. The manager 'administers' both to control his overall job and the specific problems and issues. Examples of tools and facilities are shown on the outer ring as means for delivering or helping to deliver the associated activities. Whilst they are shown alongside specific groupings they may apply to more than one. For example, E-Mail has elements of searching for, receiving, sending and holding information. 'Relating', the least definable of the groupings, reflects the patterns of relationships that exist between issues, problems, resources and time.

FIGURE 10



Whilst these groupings may apply where the manager is concerned, some modification is needed when we turn to the computer-support system under consideration for helping the manager. The cerebral activities implied by the 'create and modify' grouping cannot satisfactorily, as yet, be carried out by computer. although there is no reason to believe that further progress cannot be made in this direction and that such a grouping may not need to be defined at some point in the future. For the time being it is not considered worth identifying separately. Furthermore we distinguish between Data, which may exist anywhere, and Holding, which specifically refers to the information held pertinent to job or problem management. Thus the groupings for the computer- support system are shown below. Each grouping is discussed in more detail before we return to the diagram showing some of the relationships between the components.

FIGURE 11



INPUT

The principal requirement for input mechanisms is that they should be able to capture work units in a variety of ways whether input direct by the user, arriving from an external source as with electronic mail or, increasingly in the future, incorporating new media such as video.

Thus computer input may be:

A.) Operator-driven via any of the usual interfaces, e.g

- Keyboard
- Mouse
- Light-pen
- Scanning (includes Optical Character Recognition)
- Data-transfer (pre-programmed)

B.) Externally driven. e.g.

E-Mail

Fax

C.) Interactive

Data transfer (includes on-line interrogation)

Exception or variance report (cf. EIS, PIMs)

Electronic mail is particularly relevant because of its potential capability to facilitate communication (essentially in terms of speed, message modification and multiple distribution) but there is a requirement that incoming items are integrated with the PIMs 'action list' rather than sitting discretely within a self-contained 'in-tray'. Early advances were significant with Data Management (1986) suggesting that the leader in E-mail systems, Telecom Gold, had sold 36,000 postboxes. At that time there were over 30 suppliers offering some form of electronic package. However, Ablett (1987) noted that while wordprocessing facilities were deemed essential by executives, some 60% considered that electronic mail was of marginal or no use to them with the main reason being given as the general inadequacy of current systems.

Subsequently, E-mail systems have fragmented into those which are LAN-based, i.e. they interconnect a limited number of, usually, intra-company personnel and those which, like Intermail, can be subscribed to by anyone and are, in effect, global. For example Internet, a network of networks, claims in 1992 to have 30,000 sites and one million users all potentially communicating with each other.

Current developments display the increasing sophistication of software and the merger between facilities which on a more comprehensive scale is the theme of this part of the chapter. For example, BeyondMail from ESP is a hybrid between electronic mail and office automation. It can intelligently respond to incoming mail, stripping relevant figures out of an incoming spreadsheet, updating a central data bank and sending collated information out to other users. It can also automatically sort into files based on date, priority or subject. Microsoft's Mail 3.0 sorts according to sender, carbon copies, subject or with a search string in the message. cc:Mail by Lotus Development scans mail and flashes and squawks when it finds a new item. Scrutiny of mail and automatic generation of actions is referred to as Dynamic Data Exchange (DDE). For example, Da Vinci eMail 1.8 by Nett will automatically generate messages when a pre-set criterion is reached. M-Mail by InterActive Anglo European Systems can have messages that combine text, sound and images. Winmail by Finansa includes a Secretary function, 'pop-up' section which looks out for new mail, sorts it into folders on

the basis of subject, priority or content. Thus E-Mail systems are beginning to offer facilities spanning a wider range of the seven categories than purely the 'input' and 'output' categories.

Electronic mail needs a critical mass of people before it can be attractive or effective. It must be easier to use than telephone or paper and must be used every day. There are still problems with lack of standards which inhibits compatibility and this is being fought out between Novell's Message Handling system, Messaging API by Microsoft and Apple's Open Collaboration Environment.

Little needs to be added for the other operator-driven input mechanisms such as light-pen and scanning as these new technologies all help to facilitate input but do not materially alter the content of the work units. Scanning, for example, allows quantities of text, graphics or pictures to be assimilated into the computer with minimum effort, being regarded by Wilson (1986) as the 'trigger factor' in the current digital revolution. We can also note examples of the recurring theme of convergence, such as between fax and PC where text can now be downloaded direct and transmitted without the need to take hardcopy (Mill, 1987).

Finally on this section we can note that GDSS systems represent a particular form of electronic input although much of the benefit of these systems derives from the operations carried out on the group input, notwithstanding any benefits deriving from NGT in itself. Products such as VS1000 by Mentec allow videoconferencing via PC although the cost of £12,000 (1993 prices) is likely to limit market penetration. At the cheaper end of the market products like Windows for Workgroups from Microsoft offer peer to peer networking and a resource sharing system - mail, scheduling and chat facilities. The Clipbook includes data from anyone on the network and the Group scheduler has a collective list of meetings.

ADMINISTRATION

The Administration range of facilities essentially represents the role-centred model and is concerned with managing totalities of work units rather than individual problems. Many of the facilities that might be regarded as useful and were recorded on the lists shown above are already contained within the PIMs systems described earlier in the chapter and these include calendars, diaries, action lists, reminder systems and bulletin boards.

The primary shortcoming is that action lists are too simplistic in functionality offering at worst a list that can only be added to or deleted and at best a range of useful but limited functions such as Packrat's linkage with other modules, Organiser for Window's prioritisation or Tracker Professional VI's annotation. In order to be fully effective the 'To do' lists need to offer the functionality of operational transaction systems and include operators described earlier such as:

Reference number
 Progress log
 Commitment date
 Label date
 Queueing
 Jeopardy and failure flags Re-presentation
 Status

This would help meet the demands of the role-centred perspective and would place the manager-support system at the core of the manager's activities although a primary requirement is that setting up these structures should entail minimal managerial time and effort. Linkage to the 'INPUT' module is that items would either be input directly by the user but those arriving from other users or systems would be filtered, labeled or prioritised either on a pre-programmed basis or by an Expert System interface. This sort of functionality is described by Richman (1987) who refers to packages such as 'Information Lens' which discriminates between electronic messages sorted in terms of criticality and 'Co-ordinator' which tracks the electronic conversation of users and reminds them of pending commitments.

Thus the primary purpose of the 'ADMINISTRATION' module is to record all work units which arrive from whatever 'INPUT' mechanism, assimilate and integrate them automatically having filtered, prioritised or in other ways categorised them and then facilitate presentation, control and monitoring of the work units until such time as they are completed when they can either be deleted or archived. It should be possible to view the work units in a variety of ways with filtering operating according to priority, categorisation or one of the other 'labels'. The secondary purpose of the module is to offer optional support tools such as calendars and planning charts.

HOLDING MODULE

Most work units arriving via the INPUT module should be recorded in the Action List within the ADMINISTRATION module. This would certainly apply to Electronic mail items, those identified by EIS systems or those input directly by the user. Exceptions may be where the user wishes to record an item but exclude it from the Action List although this entails the risk that an element of visibility is lost.

However, what is recorded in the Action List is simply a title with limited character length and associated labels. A fuller text may exist which needs to be kept separately and this is retained in the HOLDING module. The analogy would be with a folder in the 'desktop metaphor' which could contain a number of documents, tables, charts or illustrations relevant to a particular work unit. Whilst this metaphor is the most common, variations are evident. 'Rooms for Windows' by Xerox has an

Overview which contains a number of rooms. Each room is in effect a copy of the normal Windows environment. Anything added to the Overlay room is automatically added to all rooms. With New Wave 4.0 from Hewlett-Packard the desk-top is referred to as an Office. Any files not required for use are archived in a filing cabinet, an essential sub-element within the HOLDING module.

Thus whilst the ADMINISTRATION module reflects the holistic, role-centred perspective, analogous to the 'In-tray' and 'pending tray', the HOLDING module is the principal mechanism for retaining and displaying the detail of an individual work unit - the problem-centred model. The choice of metaphor is not critical as the probable justification for differentiation is likely to be marketing rather than user-driven. What is required is a mechanism that offers hierarchical ordering with individual documents, tables and diagrams in turn contained within assemblies or sub-assemblies. In the Apple metaphor the documents are contained within 'folders'. An additional requirement might be a Directory or Index that allows the user to scan both the contents of the HOLDING module or the contents of a particular work unit folder.

These first three modules are critical to the functioning of the manager-support system. In a simple example, a work unit - possibly an electronic mail document - arrives via the INPUT mechanism. The document itself can go either directly to the HOLDING module, i.e. it is the original verbatim, or could be held in a 'pending' part of the HOLDING module until it is read by the user. Simultaneously the title of the work unit - a separate field on electronic mail systems - is directed to the Action list part of the ADMINISTRATION module with whatever labels can be directly generated, e.g. source, date, type, unique number. The user logs on and views his Action list which indicates that amongst many other items there is an electronic mail item awaiting his attention. A simple selection process takes him to the full document in the HOLDING module which he can view and decide whether to retain, develop, modify or 'bin'. Automatic processes should ensure that 'binning' transactions are carried out simultaneously in both ADMINISTRATION and HOLDING modules.

Development of the work unit, which might be any of the activities in Chapter 3, e.g. information gathering, analysis, can be aided or automated by the exploitation of other modules described in more detail below such as 'information search' or establishing cause and effect through use of a particular tool. The output from these examinations and iterations become additions to the HOLDING module just as when a manager adds a new set of figures or the output from a brainstorming session to a manual folder on a specific issue.

Most of the processes described here are part of existing software packages which can be summarised as follows:

Action lists (PIMs)
 List management (Transaction processing systems)
 Holding mechanisms (Apple, Xerox)
 Admin. facilities (PIMs, basic tools)

This thesis offers integration by arguing for the inclusion of the disciplines of queue management contained in transaction- processing systems in Action lists - in effect work unit queues, and further reflects the differentiation between the role and problem-centred perspectives in the segregation (albeit linked) between the ADMINISTRATION and HOLDING modules.

DATA

In Chapter 3 the role of information both in terms of helping to analyse identified problems as well as helping to identify the existence of problems in the first place was clearly established. From the user viewpoint the distinction between DATA and SEARCH, which is discussed below, is not evident as the process is seamless but it is useful in the description in this thesis to distinguish between the two.

The Executive Information System, described in detail in Chapter 4, provides the template for this module. It has been well- researched and development effort is considerable. In only one significant respect - the linkage of the output from the DATA module with the ADMINISTRATION and HOLDING modules - does this thesis extend the functionality of existing or planned EISs.

Three broad categories of data can be identified:

1. In-company performance
2. On-line data (external)
3. Reference data

1. In-company performance

The primary purpose behind the EIS is to improve and simplify access to performance data. If a problem is being examined, 'drill-down' - the ability to proceed up or down through layers of data - can help to refine the identification of problem causes. However, as suggested above, scanning an EIS can lead to the identification of a problem or in advanced systems, significant variances or exceptions may be reported automatically. In these cases the link there is a link through the INPUT module into the ADMINISTRATION and HOLDING modules.

2. On-line data.

The growth in the external on-line market was documented in Chapter 3 and there is little that requires adding at this juncture. We can note that professional organisations such as the British Institute of Management are making increasing quantities of information available on-line. The BIM provides electronic 'distance learning packages' and a 'Best Practice case study bank'.

3. Reference data

Although this has been represented here as a category of DATA, there are equally valid arguments for regarding it as a basic component within the ADMINISTRATION module. Reference files may be developed within a company or can be 'bought-in'.

The Apple journal (1992c) referred to the British Petroleum culture change database for finding your way around Britannic House in London. There was also a human resources directory and a group directory. Another large corporation, BT, has a special database containing information on management styles and cultural differences across the globe, directed mainly at people working abroad. It gives advice on protocols, greetings, meals and how to behave in meetings.

An example of a 'bought-in' package is the Collins Electronic Dictionary and Thesaurus 1.0 from Reference Software which claims to be able to add value over the paper copy. It will search for words based on the definition supplied and the search can use wildcards. It will also search for anagrams of any word that is input. Another example is that of the 'Idea Bank' (Dickey 1988). Here ideas can be labeled and packaged according to similarity, complementarity or time sequence.

Examples such as these tend to illustrate the variety of data increasingly becoming available with some items being more relevant to administrative, role-centred activities and others more relevant to problem-solving iterations. As the extent of source data becomes larger the emphasis on user needs tends to shift to accessing, scanning, filtering and then importing selected data back into the HOLDING mechanism. The SEARCH module, discussed next, addresses these aspects.

SEARCH

Whilst this has been labeled the SEARCH module its scope in fact extends to the wider range of facilities referred to above which include the following:

1. Seamless access to a variety of databases.
2. Mechanisms to filter out irrelevant data.
3. Facilities which enable scanning of the presented data.

4. The capability to transport selected data back into HOLDING files.

The content of databases has been described in the earlier chapters so at this point the principal focus is on the functionality required of the manager-support system. Palframan (1992) observes that the machines of the mid 1990s are likely to create a 'revolution' in information access - optically-based encyclopaedias, newspapers - much of which constitutes information for 'competitive' advantage'. To match this an extensive range of 'Text Retrieval' software is being developed, some of the main characteristics of which can now be considered in outline. Text retrieval software provides tools to create databases of documents, to search stored documents and retrieve data in an orderly manner, thus fulfilling a significant element of the requirements listed above.

Lotus's 'SmarText' uses artificial intelligence to build electronic documents. Much of the current software employs free text searching or scanning summaries but a number of newer packages extend to whole volumes of data. Key words may be held in a separate file - the 'index' and the number of items retrieved is held on screen. 'Topic', also by Lotus, allows searches to be based on concepts or ideas.

With 'Assassin PC' by Associated Knowledge Systems all words can be indexed or only those words contained with brackets - <>. There are three levels of reporting: short consisting of 3 fields, medium consisting of 6 fields and long which contains all fields. 'Folio Views 2.1' by Catalyst Electronic Publishing involves the setting-up of hyperlinks between text with more powerful indexes and contents pages. The user can add footnotes and annotations and searches can be made for text, pictures and sound.

'SmarText' and 'Personal Librarian' use a single but more complex query process and produce list of 'hits' ordered by how well they match the search criteria. 'Idealist' by Blackwell Scientific Publications in contrast uses a simple search process which can subsequently be refined. The former may be considered better where a lot of similar information exists on the database much of which is likely to be less than useful. The latter may be more appropriate where the extent of the potentially relevant data is less. 'Personal Librarian' by Systematic Upgrade Computer Consultants includes a bar chart which attempts to demonstrate the relevance of a particular document to the query criteria.

There are a number of other variations on search facilities. 'Idealist' offers 'sound-alikes' so Smith would get Smithe and Smyth. 'Isys' by Equisys allows definition of synonym rings e.g. computer, PC, desktop, micro which can be regarded as simple 'fuzzy' searching.

Finally, one can note that a number of packages offer the sorts of tools or facilities that have been described within the context of the ADMINISTRATION or DATA modules such as 'Personal Librarian' which provides a Dictionary and Thesaurus.

Thus, mechanisms to enhance data interrogation are being developed, although as we noted in the examination of PIMs, each of the packages can lay claim to some originality or additional facility but none is as yet comprehensive. It would appear likely that a number of different facilities, such as detailed search specifications which lead to fewer but more relevant 'hits' versus broad searches which produce more but many less relevant 'hits' which currently characterise different packages, will at some stage be offered as different options within an integrated package.

Finally, we can note that the SEARCH and DATA modules, when taken together, represent the main elements in the EIS developments that the research in Chapter 4 suggested are perceived as so vital by business organisations currently.

TOOLS

Within the TOOLS module we find the bulk of the techniques and facilities promoted by traditional problem-solving designers such as those described in Chapter 2. Whilst to the user they may be presented as a series of options, it is helpful here to categorise them into the following six groupings.

1. Facilities
2. Tools and techniques
3. In-company routines
4. Functional packages
5. Expert System applications
6. Meta methods

1. The 'Facilities' section includes the many basic packages already offered by software houses such as word-processing, spreadsheets, graphics, desk-top publishing and project management. The choice of packages is considerable, particularly for the first four items. Project Management is also becoming more prevalent, an example being ProjectGuide by Marin Research. This offers basic Project Management functioning with hierarchical layers similar to Outliners and each line has an associated dialogue box for comments. Flow-charting is another common requirement which can be met by graphics packages such as 'Freelance' or 'Harvard Graphics' or by customised software such as 'Magna Charter II'.

2. Tools and techniques are analogous to the 'activity' level identified in Chapter 3. They may be existing packages such as PDS on option evaluation or may be computerised versions of what exist currently as manual or form-based iterations. They might typically consist of some of the following:

- Option comparison (e.g. PDS)
- Cause and Effect (e.g. Ichikawa, COPE)
- Brainstorming (e.g. including Idea Fisher)

In addition, it is here that one would access 'checklists' which may be derived from within or outside the organisation.

3. In-company routines are those iterations which have been developed within the company. There may, for instance, be standard procedures and formats for assessing capital investment suitability, work-flow process documentation or authorisation. Thus Venture Analysis (Chapter 3) would be included in the Du Pont in-house system.

4. Functional packages refers to those which can be purchased on the open market but which relate to a particular application area. For instance 'Matmar' is specifically designed for the development of Marketing strategies. It uses familiar business techniques, such as Ansoff, Boston and the Directional Policy matrix and simply uses prompts to guide the user through the defined sequence. Another example would be 'Floorplan Plus' which helps to automate the process of drawing up and amending building floor-plans. It sits somewhere between 'Paint' software and CAD, offering basic tools to draw walls, circles, arcs etc. as well as providing a library of around 100 objects which can be pasted onto the drawing. 'Success' by Success International addresses business planning and is aimed at those aiming to set up small businesses. It offers guidelines on over 300 points such as market research, product development, profit and loss and managerial skills. Whilst the topic makes it less relevant to the corporate user who is the most likely candidate initially for the manager-support system, it does serve to illustrate the variety of packages on offer.

5. Expert Systems applications would not be those which assist the functioning of other packages, (e.g. Conneighton 1991 - discussed in Chapter 4) but refers to applications, usually designed 'in-company', which cover particular problem-solving activities or processes. It has close similarities with section 3 but would also offer an Expert System shell so that local applications can be developed by the user.

6. This section includes the 'meta-methods' some of which are referred to in Chapter 2, such as Checkland and Kepner-Tregoe, and this signals a significant departure from the assumptions on problem-solving approaches implicit in the first five sections. With these the basic assumption is that

the user determines the activities to be carried out as part of a problem-solving iteration, just as he or she tends to do in a non-computerised environment. He may choose just to use, say, word-processing, spread-sheets and option comparison, or some other combination. However the meta-methods impose a discipline on the total process although there is nothing to prevent a user referring to individual activities within the overall process, much as is advocated by Wilson (1984) in respect of the Checkland process.

Thus, the 'Tools' module offers the user a wide selection of different facilities and techniques much as they would currently be offered in a 'Windows' environment with the selection left to the discretion of the user.

Finally, one can note that the output from the Tools applications, which may be tables, charts, structures or basic text, will be transferred to the HOLDING module for reference just as an analysis may be placed in the folder relating to a specific problem.

RELATING

The RELATING module is clearly the most problematic and least developed of those identified here and a major re-conceptualisation is probably needed before more closely-defined structures can be stated. At this point we can offer only a fairly simple mapping of the relevant territory.

The concept of offering a range of different tools and techniques to users is not new. For example 'Systemstar' contains a relational database, spreadsheet, forms painting, custom report generation, multi-table access, statistical analysis, forms management, business graphics, text processing, and a link to GURU inference engine. 'Paradox 4.0' is an example of a new database which incorporates text, text editor, graphics and multimedia. 'Wordperfect Works' is another case of an integrated package which includes word processor, spreadsheet, graphics editor, database and communications package. And to prove that the major computing firms are also developing similar applications 'Legato' from IBM can be seen to offer Word processing, charting, spreadsheet, card file database and report generator.

However, whilst these 'integrated' packages offer a choice of facilities in a consistent environment, (cf. Windows), there is little or no inter-facility 'relating'. We can propose that whilst it is useful to have the range of tools and techniques suggested by developers of integrated packages and described in the TOOLS section above, a greater impact and more extensive user benefit would derive from attempting to replicate the cognitive 'relating' processes carried out by managers as part of cerebral problem-solving. Examples were identified in Chapter 6 but it is likely that the full range of potential developments requires specific further research into how different problems and aspects of problems may be inter-related and of which account needs to be taken by managers.

We can distinguish two categories of 'relating'. The first reflects the problem-centred approach but the relationships concern different parts of the problem. Thus, an application of COPE is to identify causal relationships within a particular problem arena. The second has closer affinities with the role-centred approach where linkages are made between different problems, the causes of the problems or the actions being considered to resolve the problems. This would appear to be a critical, yet neglected, area in terms of methods design and, as with the identification of the problem/job-centered differentiation, a crucial insight in this research programme.

The following illustrate some of the potential relationships.

1. Work units, using the terminology introduced in Chapter 5 may be related to each other causally, i.e. one problem is leading to another or the linkage may be looser where two or more work units are part of the same category, e.g. 'owned by Fred' or 'stores problems'. Grouping may be by time - Young and Harris (1986) refer to depth-first traversal where selection is on the basis of the most recent or, as is often used in organisational applications, by territory.

2. Components within the work unit may be related. For instance a causal examination using COPE-type analysis can identify networks of linkage also evident in the Mac Cadd software, (Jones 1986). Warfield (1982) refers to 'temporal dependence' where the completion of one activity is necessary before a second can take place, also implicit in Critical Path. Patterns of interaction within hierarchical sub-structures is a component of the Hypergame approach described by Bennett, Cropper and Huxham (1989)

3. Resolving problems consumes resources, all of which are finite but some, such as budgets, may be precisely specified. The action associated with a solution may cost money, thereby depleting the available budget with a knock-on effect on other problems. The RELATING model here may provide formal links with, say, the EIS by checking on available resource and then deducting from that when a decision is made.

4. Solving one problem may solve another or it may provide the means for solving another as was noted in the Gas Board case study. Here the manager needed to develop one of his supervisors and by using him in a project team to solve the problem associated with the new regulations achieved just that. The implication was that the manager held a number of problems cognitively awaiting the opportunity to resolve them. Thus using the manager-support system to present the list of outstanding problems (cf. PIMs Action list) is a basic approach but it is hoped that more effective linkage could be programmed, possibly by using keywords or categorisation.

5. A fundamental element in many mathematical or logical relationships is where items are compared or contrasted on the basis of, say, 'X' being higher priority than 'Y'.

6. Relationships may be structural as when Jones (1986) refers to the ability of the MacCadd software to incorporate hierarchial relationships in tree structures and non- hierarchial in bubbles. Young and Harris (1986) describe 'parent and child' relationships and Warfield (1982) Definitive and Spatial relationships.

7. Automatic updating of different files or packages which are 'related' is a key application of the manager-support system as it is ideally suited to computing. The principle is practicable and not new as the PIMs 'Packrat' and 'TMI Key Results' already offer such functionality, albeit on a limited basis. The scope for extending key links is considerable as the following suggested connections indicates.

- Actions or data from TOOLS to HOLDING
- Actions/changes from HOLDING to ADMINISTRATION
- Changes between ADMINISTRATION modules, e.g. records, appointments etc.
- INPUTs to HOLDING and ADMINISTRATION

Thus the RELATING module offers the key to genuine integration, replicating the patterns of linkage which managers appear to use but enhancing these by automating some connectivity and reminding the manager, through presentation, of a more comprehensive list of potential links than he might recall cognitively. It offers both a wide range of structuring and ordering facilities to help comprehend complex problems which has already attracted the attention of methods designers as well as enhancing the ability of users to manage the total network of work units which constitutes the job-centered dimension.

OUTPUT

Finally, brief note can be taken of the OUTPUT module which is likely to be in one of the following media:

- Screen
- Paper
- Electronic (E mail)
- Disk
- Sound
- Data transfer

Representational styles need to include text, graphs, diagrams, maps as well as the mixed-media applications described in Chapter 4.

4. APPLICATIONS

In the preceding sections we have attempted to reconcile user needs with current software facilities. The basic thesis presents a distinction between the role-centred and problem-centred models with much of the traditional methods design effort concentrated on the latter. In contrast, many of the applications used by managers relate more closely to the role-centred perspective. Emerging from this are a number of themes and assumptions, listed as follows.

1. System designs need to reflect firstly the role-centred perspective so as to provide an overall framework within which to pursue problem-solving.
2. The nature of managerial work indicates similarities with basic transaction-processing (e.g. invoices, orders) and the disciplines that have been developed on this are equally relevant to management work-processing.
3. The systems that come closest to providing role-centred functions are PIMs on which much development work has been done. Whilst these offer a useful starting point they do not offer the disciplines referred to in 2. above, nor are they integrated with problem-centred tools and techniques.
4. Having established a loose framework to cover 'job' management, one can then consider what should be provided to meet the need to consider problems in greater detail - the problem-centred perspective.
5. Neither prescriptive methods nor staged methods have proved to be useful to other than a sub-set of problems (Chapters 2 and 3). Equally most methods have not been proved 'wrong' but can be assumed to have relevance, and indeed benefit, to either a specific set of problems or to elements within the problems.
6. It follows that methods, tools and techniques can be offered as an arsenal to be drawn on at the discretion of the user although optional guidance can be provided through checklists, expert systems or other prescriptive mechanisms.
7. Whilst there is little evidence to support generic sequentially-staged methods, the research confirms that sets of activities, e.g. generating options, data gathering, do occur, often repeatedly within problem-solving cycles. The tools and techniques can assist with many of these activities.

8. Whilst current software environments, e.g. Windows, simplify running a series of packages on a PC and offer simultaneous visibility and the capability to move figures, text or graphics from one application to another, the functionality is very limited. We have argued for the enhancement of automated linkage, primarily through the Relational module which can replicate the cognitive linkage which the fieldwork suggested was manifested by managers.

9. The proposed structure incorporates not only many of the independently-designed methods such as COPE and PDS but also reflects the EIS developments that are at the centre of current managerially-oriented software investment.

The thesis has suggested a number of trends already occurring in software developments with which our proposed system is consistent, albeit offering much greater functionality and integration than exists at present and some elements, such as work queues, which are not evident in any software packages. For example the Apple Corporation, which has been at the forefront of such development, records its perception of the role of the key elements (Apple Enterprises 1992b) which are:

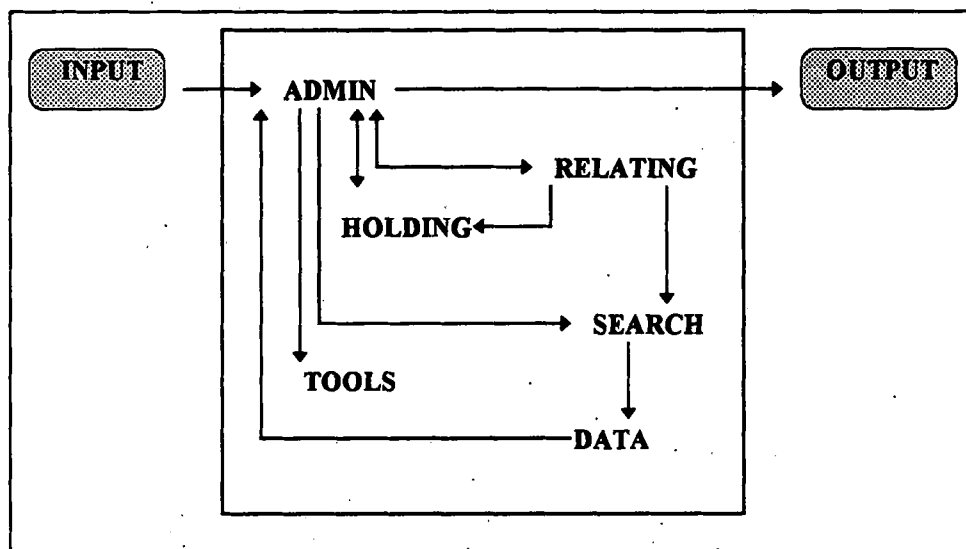
1. Repository
2. Data capture
3. Data access
4. Desktop integration
5. Systems infrastructure

Repository is similar to both HOLDING and DATA, with Access reflecting our SEARCH module. Data capture, desktop integration and systems infrastructure all reflect the more technical and hardware-oriented position of the PC manufacturer.

The section on PIMs earlier in this chapter and the references to systems such as PROFS in Chapter 4 help to illustrate the movement towards more comprehensive integrated systems but also the limitations in such designs. Another example is 'Commence' produced by Logix UK. This has an 'organiser' (ADMIN) and enhanced database (DATA) supplemented by time management (ADMIN), letter-writing (TOOLS) and contact lists (ADMIN). There are also address books, 'to-do' lists, calendars (all ADMIN) and project planners (both ADMIN and TOOLS). Information can be filtered out of the database (SEARCH) and presented as a Gantt chart (OUTPUT or TOOLS). Thus the package offers a substantial portion of what we would expect to see included in ADMIN albeit without the Work queue, some capability on DATA and SEARCH but very little in the way of TOOLS other than basic Facilities. Similarly RELATIONAL functionality is limited to principal usage of Windows - non-automated pasting of data from one application to another, although programming to offer relational capabilities is available to more advanced users.

Having outlined the fundamental structure that would be required, we can now consider the ways in which a manager might use the system. This is speculative because no such system exists but, where possible, the findings of the computing usage surveys in Chapter 4 have been reflected. Initially we can consider how the system might be used in general terms, reproducing our earlier diagram but indicating the potential linkages.

FIGURE 12



Work units are likely to impact on the system firstly either on the ADMIN or HOLDING modules but, as has been indicated, linkage between the two is essential. An electronic mail item or automated report derived from the EIS arrives in the ADMIN module. The title or header becomes the Action List or Work Queue entry and the full text or report, if required, is retained in the HOLDING module. Alternatively, the user might choose to input an entry directly into the Work Queue - a 'to do' item. Equally, initial access could be to one of the Facilities, such as Word-processing or Spreadsheet, with the results of that transferred to both HOLDING and ADMIN modules. Finally, reviewing results via the SEARCH and DATA modules could generate an Action that needs inserting in the ADMIN module. Thus the system accommodates the two principal activities, 'identifying problems' and 'dealing with problems'.

The role-centred approach reflected in the previous paragraph can then be contrasted with the problem-centred perspective where the work unit is further analysed or developed using the TOOLS and TECHNIQUES module enhanced by the RELATIONAL module. The output from a causal analysis (COPE) or comparison of options (PDS) transfers back to the HOLDING module just as a manual file is built up as new information, communication or insights are added.

CARDIFF CONTROL CASE

In order to explore applications potential in greater depth one can consider how the Cardiff Control case might have developed were the computing capabilities described above to have been available to JT as the principal protagonist. This scenario development is essentially hypothetical. Desk-top computers were not used by other than a small minority of managers at that time whereas by the end of the 1980s all operational managers in British Telecom would have had at least one terminal used for accessing data, word-processing, spreadsheet and graphics preparation, messaging and administrative desk-top functions. Nor can it be assumed that JT would choose to use any such system in the way described below or that the use of such a system would guarantee that the project would have developed in a different way. The primary purpose is to consider how a fully integrated and enhanced system could impact on this particular problem situation and how it might promote JT's ability both to cope with the complex network of issues involved, to gather data faster, to integrate the findings into an overall decision strategy and to administer both project development and any subsequent implementation.

This thesis assumes that problem-solving will always involve a range of 'manual' activities, i.e. those occurring outside the computer system which will vary depending on the topic, the organisation and the capabilities of the manager to use computers, coupled with his or her experience. These are highlighted in bold in the following description.

WORK UNIT ARRIVAL

JT receives an oral briefing from the GM and is given the Terms of Reference

It is quite probable that JT might already have had an item in his work queue relating to the problem on the Control as KB had previously commissioned VP to produce a report. This suggests that JT might also have an active file in HOLDING indicating further details on KB's project.

NOTE

This is a good example of a trigger (Segev 1976), here externally sourced, causing an item to be re-prioritised.

1. If JT has not already registered the issue on his work queue in ADMIN he now does so, also creating a file in HOLDING where he inputs the Terms of Reference. He adds a due date in ADMIN of 'Easter' (translated to March 27th) with a jeopardy flag set four weeks before. It is allocated a high priority. It is given a number of categorisation labels (in effect keywords that will be identified by the SEARCH module) which include 're-organisation', 'Control', 'Union' and 'Project'. Affect areas (again keywords for future searches) include 'Control', 'Cardiff', 'DO', 'R & R' and group references for KB and SS.

2. JT now provides some structure to his file in HOLDING. He creates a sub-file entitled 'objectives' and transfers the Terms of Reference into it.

3. JT creates a second sub-file entitled 'activities' and jots down his immediate thoughts on what needs to be done, e.g. 'set up working party' and 'consult colleagues'.

4. Feeling that he should have more activities, JT searches the DATA file and locates a checklist on 'Project Management' which generates a number of additional activities which are added to the activity file.

5. Having satisfied himself that the activities are valid JT calls up the relevant screen from the RELATIONAL module which enables them to be duplicated in ADMIN, both in the work queue and any diary system with discrete due dates and keyword linkages.

6. JT electronically messages his key managers giving them a brief of what has and what will be happening. JT creates a new sub-file 'archive' and locates the message and its recipients in it.

Because KB is personally affected by this turn of events JT rings him to discuss the issue, considering discussion to be both more personal and effective for an exchange of views.

7. JT electronically messages HQ to establish whether there are any plans or negotiations ongoing which could have a bearing on Control organisation. He also requests any research that might be available on Control operations. Filed in 'archive'.

8. JT electronically messages his Board colleagues to let them know what is happening and to seek their views on whether they have any re-organisation proposals which could affect his project. Filed in 'archive'.

9. JT initiates a series of data-gathering requests which include:

-via the EIS (i.e. DATA and SEARCH), performance data on the Control showing achievement against target and comparative analysis against other local Controls. Other data includes work volumes, productivity and work pipelines.

-via Reference files in DATA, organisation charts for the Control, job descriptions of relevant staff and flow-charts showing the key processes.

-via the Work queue and Holding files any other pending issues relating to this Control or staff working on the Control. Search is established through keyword 'Control' and issues concerning job references starting with 'I1', i.e. KB or subsidiary duties.

-via Reference files maintained by the Personnel unit for which he has limited security access all agreements with the Unions affecting Control operations and the duties of DO and R & R. Via the same files, any relevant references in the forthcoming Union conferences to motions affecting Control operations.

-via Reference files maintained by the Board Secretariat, any reports affecting office-based engineering operations.

10. JT tentatively considers a date for an initial meeting with his key managers. Peruses Diary commitments and those of KB and SS in ADMIN module. Identifies a time slot, messages KB and SS to this effect (filed HOLDING) and makes a diary entry.

The meeting is held with JT briefing and consulting with KB and SS. KB passes over a copy of the notes prepared by the Control Inspector VP who has been looking at the Control operation and who recommends a reorganisation with the split being between Cardiff Inner and Outer. KB confirms that he agrees this option is best.

11. JT creates a new file 'Data' and inputs the figures included in VP's 'collection of notes'.

12. JT creates a file 'Options' within which he makes an entry with a document entitled 'Reorganisation options' indicating the Inner/Outer option and the arguments proposed by VP in its favour.

13. JT then goes through his electronic mail receipts which include a range of items some of which are related to the project.

-a message from HQ indicates that although no final decisions have been made, the likely future development of the organisation as a whole is towards a split of responsibilities between Business and Residential customers. JT creates a file 'External issues' and files the message in it. He switches to the Options file and adds a second option - the Business/Residential split.

-a message from the Sales Manager indicates that they are planning a reorganisation with the closure of an office. JT files this in 'External issues'.

-the EIS produces a range of performance data about the Control which JT files in 'Data'.

-the Reference files produce the relevant job descriptions and organisation charts which are filed in 'Data'. The files also indicate that Control structures, manning levels and the co- location of clerical staff are to be discussed at the next national Union conference.

-the RELATIONAL module identifies two other issues which may have a bearing. One is the pending transfer application into the Control from a Distribution Officer who has moved into the area. The second is a suggestion from the Buildings Planning group that as the leasehold of the building in which they are working expires in three years time alternative accommodation may need to be found. JT has been asked to forecast his requirements. Whilst these are separate items they are cross-referred from his project files because of their possible relevance to the Control project.

-the Reference files identify a report produced a year earlier in the Regional office referred to as the Rolls report which covers, amongst other things, the relative merits of different Control structures.

NOTE

Automatic facilities in the system will be creating an index of items contained within the file which is already expanding rapidly. This will simplify JT's ability to scan the contents.

At this point JT switches from an 'assimilation' mode to a 'review' mode, taking each file in turn and browsing through the documents and figures. He notes from the EIS data that the performance of the Control in quality and service terms is above average although not the best. However, on productivity measures it has a higher work unit output per manhour than any other. He notes that work pipelines, the individual jobs queued and awaiting completion, are high which might account for an element of the good achievement but the thought also strikes him that economies of scale might be in operation and that there might be an argument in favour of greater concentration.

14. JT creates a file 'Questions' and makes an entry - 'Do bigger Controls offer scope for greater efficiency?'

He reads the job descriptions and work-flow charts feeling as a result that he has a more comprehensive grasp of the processes involved. He considers the opportunities for changing work practices but concludes that with the forthcoming Union conference and the shift towards a national re-structuring that it would be imprudent to institute any dramatic changes. The belief that is emerging in his mind is that he has the option of making no structural change in the knowledge that a national move towards a Business/Residential split is likely or he should anticipate this and attempt to get such a structure introduced in advance. He is saddled with having to create and run the Working

Party but now sees this as an opportunity to get commitment to whatever solution emerges as approved over the ensuing weeks. At this stage he is undecided as to how he should deal with the inconsistency between the Corporation's move towards a Business/Residential split and KB and VP's conclusion that an Inner/Outer split is to be preferred.

Conscious of the fact that much of what he has so far found out has been from written sources JT decides to 'walk the job'. In a visit to the Control he notes office layout issues, attempts to sense the mood of individual staff and discusses their problems. He notes a number of features which support what he has been told by KB but retains these cognitively.

The first meeting of the Working Party is held. JT explains the background and provides a brief on the functions of the Control supported by some figures on its performance. He suggests that this is an opportunity to bring in some changes but emphasises that the Corporation as a whole is looking at organisational structures and the Working Party needs to take account of any relevant changes in direction where they become apparent. He does not suggest what this direction might be. The Working Party then, at JT's suggestion, splits into two syndicates to consider what the objectives of the Control should be. When this is completed there is a group discussion which results in a list of objectives covering a range of ideas from 'providing quick and efficient customer response' to 'providing a career structure for engineers' and 'using resources effectively'. Next an open discussion by the members attempts to identify candidates for what constitutes the 'problem' in the Cardiff Control.

15. When next logged on JT adds the Control objectives produced by the Working Party meeting to 'Objectives' and the minutes of the meeting are electronically received and filed in 'Archive'. A further response from the initial data interrogation has produced a definition of Control aims and objectives contained in a training handbook. This is added to 'objectives'.

16. JT creates a new file 'Sub-problems' within which he creates separate documents each corresponding to a problem candidate produced by the Working Party. This includes items such as 'inaccurate figures', 'trouble-makers' and being 'too large'.

17. Anticipating a perceived later need JT reviews the contents of Data and External issues with a view to establishing what other activities or groups are affected by Control outputs. This is mainly identified through reference to the flow-charts supplemented by JT's own knowledge. Using a standard mapping option (TOOLS) these are represented diagrammatically. JT creates a file entitled 'affect areas'.

The second meeting of the Working Party considers the sub-problems. Taking each in turn, suggestions are elicited on what is causing the sub-problems and what the solutions might be. Discussion next turns to re-organisation options which generates three main options; Inner/Outer, Business/Residential and East/West. These are discussed in terms of the arguments for and against with reference back to the objectives and implications if implemented. JT asks them to consider the list of 'affect' areas and confirm if they are valid. This discussion leads to some additions and some deletions. They then identify which 'affect' areas are likely to be impinged on by the three options and rate them in terms of extent of 'affect'.

JT feels that he has a good grasp of the system under study in terms of the elements involved, the interactions between the elements and the measurement both of the interactions and the conversion of inputs to outputs. He has a number of candidates for what is constituting the 'problem' and candidates both for overall re-organisation and what might be done to address some of the sub-problems. He also has candidates for the areas that will need to be considered in the context of any implementation. There are some issues unresolved in his mind, however. He is aware of the likely Corporate move towards a Business/Residential split but does not feel that he can refer overtly to it yet. He has noted a preference within the Working Party for an Inner/Outer split led by KB and VP which suggests a possible area of conflict. He is also undecided about the merits of Control size when considering efficiency. He has three candidates for overall re-organisation but in addition there are six additional problem areas the solutions to which would be unaffected by Control re-organisation per se.

18. JT then maps the options and solution strategies onto a meta-map (TOOLS adapted from AIDA, Rosenhead 1989). The process starts with a COPE-like iteration to establish causal relationships and then switches to option-compatibility comparison. JT now concludes that an Inner/Outer and Business/Residential split are not necessarily incompatible. It is feasible to initiate a Business/Residential split at DO and R & R work-load level but to have an Inner/Outer split at managerial level. Whilst he is aware of the fact that as a compromise the solution package may not be optimal he sees it as more likely to be accepted both by the Working Party and the GM whilst not prejudicing impending national changes.

JT has noted the comment by one of the Working Party members that there is some unease at grass-roots level about what the Working Party is doing. In his weekly bulletin to staff which is sent electronically JT summarises the objectives of the Working Party, leaving it open to staff who are concerned to contact him. This subsequently produces responses querying who is representing the interests of the R & Rs which JT acknowledges and then arranges for an R & R to be drafted onto the Working Party.

The next meeting of the Working Party debates the various problem areas, solution options and affect areas. They agree to use a PDS- type facility to record priorities and preferences. With the PDS output and following further discussion there is a consensus that an Inner/Outer split at managerial level matched by a Business/Residential split for the staff is feasible. There is also agreement that the closure of the Merthyr Sales office provides an opportunity for the Control to follow suit thus increasing the size of the Control. JT has the transfer application from the DO which is linked with an R & R working at Merthyr but who lives closer to Cardiff whose transfer to Cardiff would help to reduce JT's expenditure on overtime and travel. Thus he considers that staffing the Cardiff Control with an increased workload can be achieved without undue staff disruption. The Working Party agrees that the two main sub-problems requiring attention are the rebalancing of the loads and accommodation re- arrangements. These are allocated to a sub-group to consider in detail.

19. JT updates his files and starts to prepare his report to the GM. He uses an 'Outliner' (TOOLS), to help provide structure to the report and then commences writing it. Supporting figures and graphs are pasted from other documents in HOLDING. His arguments refer to the objectives of improving service to customers and the Corporation's impending likely move towards a Business/Residential split. He explains that by building this split into the lowest building-block level he can switch to a full Business/Residential split quickly when the expected mandate appears. His own research has suggested he can achieve economies of scale by increasing the concentration of Control staff at Cardiff as well as reduce costs. The proposal will be acceptable to the Working Party who see an Inner/Outer demarcation as a positive development. There are additional benefits which JT lists including the option of combining a future re-arrangement with a switch to a new building. For the purposes of this description one can assume that the GM concurs.

20. At the same time KB and SS are considering loadings and accommodation options and for each they are using packages contained in TOOLS. The former uses an algorithm including parameters in terms of maxima or minima, the numbers of customers per Telephone Exchange area, growth factors and geographical constraints. The programme allows them to consider different combinations of loadings and results in their belief that the preferred combination reduces some of the current inequalities. For accommodation they refer to a spatial routine which maps the available space and allows different combinations of desk lay-out subject to constraints related to proximity to natural light and the provision of walkways and emergency exits.

21. JT, KB and SS meet and agree on the loadings and accommodation solutions. They use a Project Planning routine from TOOLS with linkage to ADMIN to identify appropriate activities and timescales which they allocate between themselves. Thus JT will present the proposals to the Board and Unions with the object of getting their agreement. KB will prepare a request to Buildings

planning for the accommodation re-arrangements and seek budgetary authority. SS will identify the power and telephony needs and put training requirements to Personnel. These activities are in each case input to the respective work queues.

SUMMARY

This scenario helps to illustrate the principal conclusions in this thesis. It suggests that PC software can in principle enhance managerial problem-solving and administration and there is considerable scope to extend and integrate the current fragmented and disjointed packages, building in additional facilities which operate within the potential synergy that can result. The emphasis, however, is clearly away from prescriptive mechanisms and towards 'tools and techniques' which can be used flexibly and at the discretion of the manager. The degree to which the software is used will depend on the problem with cases like the ACS Cleaning case (Chapter 6) offering little potential but others offering much more. It will also depend on the attitude and experience of the manager as well as the degree to which the software delivers usability. The way in which the Cardiff Control case has been described above is just one view. Others could, equally validly, use different tools and facilities.

Routines such as COPE and PDS have a role to play as have the administrative facilities such as project planners. Key developments such as EIS and Expert Systems can also be reconciled within the structure. To provide coherence, such systems need to include work queues which are currently only imperfectly developed in PIMs systems. Furthermore, using relational concepts, the linkages between work units, problems and actions can be identified - if not comprehensively, then at least partially, thus mirroring the cognitive processes suggested by the fieldwork interviews.

CHAPTER 8**REVIEW AND CONCLUSION**CHAPTER CONTENTSTHESIS REVIEWSANDY'S PROBLEMSFUTURE DEVELOPMENTS

THE MANAGER OF THE FUTURE

COMPUTING DEVELOPMENTS

PROBLEM-SOLVING DEVELOPMENTS

THESIS REVIEW

The opening chapter started with an extract from the Professional Manager journal introducing a manager - Sandy - and the problems he faces at the start of the day. The problems may not be the major, complex, strategic problems often described by methods designers yet they are no less valid for all that. The perspective is also significant in that it reflects an approach that is considered critical in this thesis which starts with the individual manager and his job first and then moves to problem-solving second. This contrasts with analysts who take the specific problem as a starting point. This theme leads to the development of the role-centred model and subsequently to the positioning of PIMs systems at the core of the proposed computer-based system. We note that managers face large numbers of problems, many of which are linked and inter-dependent and 'mixed-scanning' - switching between the overview and detailed examination - becomes a central mode of operation.

Referring to the published literature a number of themes can be identified. One covers the arguments for and against the use of method. There is the considerable scope for using experience and intuition versus the psychological limitations of information-processing etc., with a possible conclusion being that problem-solving requires a mix of experience, creativity, method and 'footslogging' effort.

Historically the presentation of methods as panaceas, particularly Decision Theory, in the early post-war era resulted in disappointment and, in some cases, cynicism in the managerial community. Problems included the language used, the great degree of generalisation and the fact that some methods were 'disgracefully oversold'. After this reaction, however, a more even relationship emerges characterised by a greater willingness on the part both of designers and practitioners to work together. Throughout this period intra-industry methods such as Work Study and Project Management continue to evolve and develop. The cynic might wish to suggest that the introduction and rejection of these

methods is based on 'flavour of the month' but a genuine attempt to identify new methods to suit a changing environment seems more likely.

Further themes discussed include the the arguments over whether decision-making is rational or irrational, problems of definition with the terms 'problem-solving' and 'decision-making' and the difficulties in penetrating the thinking processes of decision-makers. The problem-focussed equivalent of mixed-scanning, whether to focus on key elements or retain the holistic viewpoint, is considered and the focussed strand continues later in the thesis with Critical Success Factors and their emergence as the basis for Executive Information Systems. Most significantly we note the importance of 'context' for problem-solving with this context in a state of flux and containing other linked problems both within the purview of the Sandys of this world and his colleagues.

In the second chapter attention is focussed on a selection of methods with claimed relevance to the managerial community. Those adopting a broader perspective include Checkland, Kepner-Tregoe and TQM whereas methods like PDS and Work Study are more constrained in terms of application potential. We note that the different methods reflect the differing perspectives of the designers and are arguably relevant to different types of problem or different activities that can be carried out within problem-solving. Some methods emerged from within Industry, others from without. Some are computerised and some are paper or cognitive-based. Certain methods incorporate subsidiary tools and techniques but some make no specific reference to the topic. Some are more suitable to examination of existing systems, e.g. Work Study and Kepner-Tregoe - others look forward to the design of future systems, e.g. Venture Analysis. Some essentially operate in group settings, others on an individual basis.

The variety in the approaches serves principally to illustrate the wide range of options for considering methods design. As yet there is insufficient evidence to assess the relative merits of the different viewpoints but each provides an insight into particular aspects of problem-solving. Thus Work Study is not in absolute terms better or worse than PDS, but when examining existing work processes Work Study is likely to be more relevant and when comparing and evaluating solution options PDS will probably be more helpful.

This examination of methods continues in the third chapter when we considered staged or phased methods. First, however, an assessment was made of the role of the manager which is characterised by brevity, variety and discontinuity conditioned by the ubiquitous constraint of time. Despite this, commentators see an opportunity for methods designers to help in scheduling, planning and modelling.

The survey of staged methods revealed how extensive these were both within and outside Industry. Externally-designed methods tend to emphasise earlier phases such as problem definition - internal ones to concentrate on later stages such as implementation. Again, considerable variety was evident in the approaches of the designers. Some were more general, some highly specific with the latter reflected in the activity described e.g. 'design tools and jigs'. Practical problem-solving often necessitates variations on sequential, 'rational' problem-solving. One theme to emerge is that of the test so that an initial cognitive cycle is followed by a practical 'test' to confirm validity or the need to modify, followed by further design refinement before ultimate full implementation. This can be viewed as 'structured trial and error'. A variation on this is a first cycle consisting of a broad review with options failing to meet minimum criteria being eliminated. A fuller analysis then takes place on the fewer remaining options.

Six potential stages are then discussed. Initially there is problem finding, problem defining, the role of triggers and relationships with objectives. Information gathering concentrates on external on-line sourcing with internal sources held over for discussion in the following chapter. Analysis emerges as a constant activity which can benefit from the use of tools such as modelling. Options for solution need to be generated and then evaluated with selection coming through decision-making which in turn leads into implementation.

Overall, any simplistic adoption of sequential problem-solving encounters difficulties once one moves from a broad conceptual approach to practical application. Thus analysis and decision-making are activities that are carried out throughout the duration of a project. Also cyclical iterations and the use of tests and trials suggest alternative processes which are extensively applied in organisations. Two final themes in this chapter are the existence of context-specific methods which may have more relevance but to a more narrowly defined group of problems and the attempts to link tools with problem situations.

In the fourth chapter we assess the role for computing in general and Personal Computers in particular to assist managerial administration and problem-solving. In the 1980s the PC moved from scarcity to relative ubiquity and exponential increases in the volumes of PCs produced is matched by expenditure on software. Benefits for managers can be seen in the facilitation of existing activities and the automation or elimination of others; the stimulation of improved performance and new services and a general improvement in the quality of the job. However, a wide range of problems and shortcomings are also noted. Implementation of systems frequently causes difficulties and a substantial proportion of managers and executives consider systems inadequate.

The July 1993 edition of the Professional Manager (1993b) reports the findings of a survey of over 700 managers by Aspen Business Communications. Most managers appeared to believe that informa-

tion technology had speeded up communication but for less than half had there been any improvement in relevance. Only 15% fully understood the potential of their IT system and less than a quarter believed IT was being fully exploited. IM Director General, Roger Young, comments:

"Restructuring combined with greater use of technology is leading to easier and faster communications but much of the information speeding around companies is poorly targeted and of little relevance to the recipient.

Integration emerges as a key theme in terms of hardware (e.g. PC, fax, telephony) and software. An example of current (June 1993) moves towards hardware integration is AcerPac from Acer UK Ltd. It combines all of the following features:

1. Telephone answering machine. Receives and records voice and fax messages complete with date and time.
2. Facsimile. Transmits and records fax messages on-line or at pre-determined times.
3. Music centre. Midi hi-fi system with radio and CD player.
4. StartSmart. This self-activates to receive incoming messages or send pre-timed fax transmissions.
5. SaveSmart. Automatic back-up.
6. PC. 486 chip with MS Windows, MS Works, MS Bookshelf and entertainment pack.

Most significantly we can see the emergence of packages combining a wide range of applications - tool-kits containing word- processing, spreadsheets, graphics as well as administration functions such as electronic mail and diaries. The variety of approaches to and activities entailed in problem-solving would appear to lend itself to the tool-kit perspective which offers flexibility to the user without requiring commitment to a specific, constrained and inflexible method.

Expert Systems are then reviewed with the conclusion that not only do analysts see a major role for them to help enhance decision-making but the considerable sums being invested in their development both by suppliers and potential users indicates a clear conviction from within Industry that applications will increase substantially. Turning to Information Systems, we see the emergence of the Executive Information Systems from the earlier Management Information Systems which were enabled by basic transaction-processing systems causing large quantities of company data to be available on computing systems. Whilst part of the impetus was to facilitate access for executives one

can note that additional 'useful' facilities are being added such as diary systems and graphics - hence the same trend as was noted in the tool-kit discussion in the previous paragraph is repeated here.

Expert Systems and Executive Information Systems offer, in their respective ways, the greatest potential computing impact on managerial problem-solving during the 1990s but we can also observe the first indications of attempts to reconcile these two software-based developments with the variety of activities and problem-types seen in the first three chapters. Thus Turban (1990) relates them to decision-types; Meador, Keen and Guyote (1984) to problem-solving stages and Remenyi (1990) to activities like transaction-processing or enquiring.

There can be little doubt from this review that the PC is identified as the main vehicle for delivery of enhancements to managerial problem-solving and decision-making for the future. However, the difficulties encountered, particularly in the early stages of implementation, with PCs, Expert Systems and Executive Information Systems point to the fragmented and incremental approach of designers arguably coupled with a lack of an overall coherent framework. Chapter 5 proposes a framework within which the variety of problem-solving activities can be viewed and which provides a structure within which software development can be assessed.

The 'mixed-scanning' theme leads to the proposal that there are two models needed, one - 'role-centred' - which considers the manager dealing with the totality of his jobs characterised by brevity, volume, flux, administration and linkage between the 'work units' and the other - 'problem-centred' - which reflects the need to focus on individual problems and 'manage' them through to completion. Whilst two models are considered helpful to distinguish the two types of approach, they are clearly linked and the problem-centred approach will in practice operate within the role-centred structure. Thus a manager may review the contents of his 'in-tray' - role-centred - but each item, at least in microcosm, requires problem-centred consideration. In describing the latter we use the activities identified in Chapter 3, specifically referring to problem identification and definition, objective setting, information gathering, analysis, option identification and analysis, decision-making and implementation. Essentially the problem-centred model is an input/output one with a distinction between Perceived systems and Potential ones.

Chapter 6 reports the findings of fieldwork on a number of cases. The cases vary in that some took place before PCs were generally available and the final one occurred when the managers were actually using them. Overall the cases lend support to the arguments in favour of the use of method although the ACS case tempers this by indicating that some problem-solving situations do not lend themselves to 'on-the-spot' iterations.

Principal issues to emerge were:

1. Constant flux in the environment requires those managing problem-solving processes to be particularly alert to and receptive to these changes.
2. These changes in turn may require reviewing conclusions to date or even revisiting causal models where these have been created as part of the analytic process.
3. Following traditional rational problem-solving sequential methods has only limited benefit at a general level. The actual course of problem-solving, conditioned by the constant flux, is more complex, iterative and irregular.
4. The more complex the project the more likely it is that the overall problem will fragment into sub-problems. This conceptual fragmentation is often matched by structural fragmentation as sub-committees or work teams are set up to support the controlling role operated by the 'Control Board'.
5. The linkage proposed in the role-centred model means that effects or actions often impinge on other problems or opportunities. Understanding and then managing these networks of inter-dependencies is a key task.
6. The administration of the process set up to solve a problem not only is a complicated operation but it would appear directly to affect the conceptual solution process and the acceptability of the recommended option.
7. A wide range of tools and techniques either has potential to be used based on the deficiencies identified in the processes observed or is actually being used, albeit only partially in an electronic environment. This includes both role-centred facilities, e.g. time management or scheduling, and problem-centred from quantified spreadsheets through conceptual or mathematical models to brainstorming and mind-mapping.
8. Existing in-company data sources which increasingly exist electronically based on transaction-processing systems may provide the informational input to differing degrees.

In Chapter 7 we attempt to pull together the themes described in the earlier chapters. The initial emphasis is on the role-centred perspective and the need to identify systems which can help a manager control the totality of his job. Transaction-based systems suggest pointers as to how one can manage large numbers of short duration activities and these include typical queue-management facilities such as progress logs and jeopardy and failure flags.

The closest approximation to 'job-management' software for managers comes with the PIMs systems. These offer a variety of facilities although the 'action lists' meet only a few of the requirements listed above. However, some are beginning to provide elementary linkage between the sub-units and they appear to provide the most relevant starting point for 'role-centred' systems.

With the 'problem-centred' perspective we identify an overall structure within which the various facilities matching the activities identified in Chapter 3 can be provided. This enables us to incorporate tools, techniques, facilities and those packages in Chapter 2 which can readily be assimilated such as COPE or PDS. Methods such as Checkland or Kepner-Tregoe could be offered but as peripheral options - not as the main drivers for problem-solving sequences. Thus the primary positioning is for flexibility with the facilities available as tools whilst Expert Systems suggest future capability to introduce a degree of route guidance. Nevertheless the system goes well beyond a simple tool-kit indicating areas where greater control of the process is enabled and where full or semi-automated linkage between the units is effected. We can see also the reconciliation between internally-driven packages such as Executive Information Systems and externally-promoted ones such as COPE. The main components are Input, Admin., Holding, Tools, Relating, Search, Data and Output. Subsequently a re-iteration of the Cardiff Control case is described which assesses the potential impact such a computer-based system might have had where it to have been available at the time.

SANDY'S PROBLEMS

We started the first chapter with Sandy's problems and the question how they might be solved. We can now reconsider what implications for his problem-solving there might be if Sandy had access to the sort of computing system described in the previous chapter.

Problem 1. Delayed train meaning he will miss an 8.30 meeting.

Sandy will have a lap-top computer mirroring the software on the office system and he can also link into the main system, if necessary, via a modem and telephone line. Sandy checks his ADMIN files which indicate who is attending. He sees from the agenda that items for which he is responsible are towards the end of the meeting. Sandy sends an electronic message to attendees apologising for the fact that he will be late, but confirming he will attend and requesting that any items relevant to him be held over until his arrival. Whilst logged-on he reads the minutes of the last meeting which have been sent to him on electronic mail, noting his action points. He sends a further message to one of his team asking him to assemble any relevant papers and files for the meeting (not held electronically).

Problem 2. Sandy has to cover for a senior colleague who is ill.

Sandy checks the diary system both for himself and his colleague, noting commitments and in particular where they clash. He sends messages to relevant subordinates requesting briefings on issues with which he is not familiar. He re-schedules appointments which are flexible. He also sends a broadcast message confirming that he is covering for the senior colleague and requesting any queries be referred to him.

Problem 3. A letter of complaint from a customer.

On the assumption that this is a regular customer, Sandy accesses the basic Transaction Processing system covering customer details. It provides details of the customer order, what was ordered and when and when it was delivered. There is also a log showing any history of previous complaints. Sandy notes the production batch number of the product ordered and cross-checks against the register of production problems. This confirms that the batch concerned did experience quality problems. Sandy drafts a letter of apology and sends a message to a subordinate to arrange for a replacement product to be delivered. He notes also that all customer recipients of orders from this batch should have been contacted and asked to return their products. He makes a note in his file containing minutes etc. of the 'quality' meeting (see Problem 1) to raise this as an issue. Finally, he logs details of the complaint and the action taken on the customer's records.

Problem 4. All managers wish to take holidays in August.

Sandy checks both the schedules of when leave has been booked and what commitments (meetings, reporting deadlines) exist for August. He establishes that as the managers are taking different sets of weeks in the month that there is less overlap (i.e. two or more managers off at the same time) than originally thought. Furthermore, during the potential problem weeks each manager on leave does have a key subordinate working who can cover for him and scheduled commitments are minimal. The Divisional monthly report is due during that week which will need close attention. He messages the managers on leave during the critical weeks to establish the nature of their leave. This confirms that in one case the manager will be at home decorating and will be available to come to work if a crisis emerges. Sandy summarises his findings which he sends to his boss with a recommendation that the leave be allowed but pointing out that a contingency plan is needed for production of the Divisional monthly report. He tables this as an agenda item for the next Divisional meeting.

Problem 5. Telephone bills for Sandy's section are twice as high as last year.

While the Problems 1-4 described so far could be considered as typical of Mintzberg's (1990) short duration, high volume problems, Problem 5 arguably offers more scope for the information-gathering and analysis activities covered in the early chapters. The problem could require the extensive use of a number of the facilities described in the previous chapter. Some possible examples follow:

-One might argue that Sandy should have known about this as his EIS would have flagged to him a significant variance either on trend or budget for possible action.

-In order to find out more about the calls, Sandy interrogates the MIS which records details of the calls logged by the office telephone switch. He transfers the data to a spreadsheet with graphics to identify patterns of use during the day and during the week or month, highest users of telephony by group and individual. He also compares the patterns with last year.

-He notes that he does now have more staff and that business is more buoyant but that at this rate he will end the year with a budget overspend. Some action needs to be taken.

-He messages his supervisors alerting them to the problem and inviting comment. He reports that some telephone numbers are repeated and asks for this to be examined in case there is duplication. He also asks for calls made after office hours to be checked as he suspects the cleaning contractor may be using the telephone.

-He reviews the office standard process flow-charts to identify when calls need to be made and considers whether any of these can be eliminated.

-He decides on notional supervisor-based budgets and arranges for these to be monitored via an Expert System and excesses to be reported to his EIS.

-He sends an interim electronic response to the Finance manager who raised the issue, diaries out for himself further checks to be made in the future and prepares an initial draft to his staff alerting them to the budget overspend and the need for economies.

Thus, there would appear to be scope for using the computer-based system increasingly extensively not only for complex problems but also for role-centred activities. In addition to the problems offered in the original article there are likely to be more involved projects over longer time periods which will afford the opportunity to exploit some of the more sophisticated facilities available. Clearly Sandy might choose not to use his computer system and one could expect differential levels of usage by

different managers, departments and organisations (cf. Chapter 4). Equally Sandy might choose to use a Checkland or Kepner- Tregoe approach, for example when considering the telephone bill problem and the implications for his unit's objectives. Ultimately usage is likely to be affected by the degree of usefulness of the system which this thesis has attempted to address and any pressure from peers, bosses or corporate culture to use the system.

FUTURE DEVELOPMENTS

The focus so far has been on the past and present. We can now briefly consider some potential future impacts on this area.

THE MANAGER OF THE FUTURE

The remainder of the 1990s are likely to see some significant changes to the role of the manager. For the future Dopson and Stewart (1990) see the manager as becoming more of a generalist with a wider range of tasks. Other characteristics are an increasing span of control coupled with responsibility for a wide mix of staff. Dopson and Stewart specifically note the greater visibility of performance that comes with the use of computers.

Kelly and Ibrahim (1991) refer to the coming of the 'existential executive' - an alternative to the analytic style which may have been appropriate for problem solving but not problem finding or solution implementation where lateral thinking becomes more relevant. Sims (1992) also notes that the job of a manager is to construct problems - suggesting that solving problems can be done cheaply by others. In this respect he uses:

Gossip

Walking about

Experiencing and imaging

Information systems

The latter constitute a varied and generally reliable, common bank of data, with information being constrained and less of a 'swamp'. But there are a number of disadvantages, e.g. systemic risk - the technical elements of software and hardware support - which is seen as the preserve of experts with its implication of dependency.

Moss-Jones's (1990) survey on the potential for automating managers identified a number of key issues. The numbers of managers were reducing whereas the proportion of professionals was increasing. Both the Information Management and Technical IT component was increasing. More use was being made of electronic data and messaging and managerial activities concerned with integration and boundary crossing were becoming more pronounced. Planning was on the increase whereas

controlling was on the decrease and managerial roles involved more team-work and less on a hierarchical basis. Organisational roles were less routinised and initiatives were taken more frequently. The activity rate was declining but reflective activities were expanding. Computer decision-support was on the increase although this was mostly at the operational and tactical level. Computer-produced print-outs and analyses were widely used. Identifying the principal changes to the managerial role Moss-Jones observes:

"Creativity, initiative-taking, non-routine, fluid communications and attention to the relevant and to the individual will be prime".

Most significantly Moss-Jones considers that centre stage will be taken by information management, expressed in terms which has close affinities with our Relational module:

"Dynamic computer models of sections of the business, and eventually the total business, updated in near-real time, with various formats and elements instantly re-analysable are still a long way off. But it is in that direction that management is moving".

COMPUTING DEVELOPMENTS

Developments in computing were extensively covered in Chapter 4. Continued convergence in hardware and integration of software can be expected with a corresponding shift of attention and expenditure from hardware to software. Major growth areas are likely to be on Executive Information Systems, Expert Systems, On-line information with some of the newer technologies like Multimedia also developing apace.

Oliff (1991) considers that there will be four main themes for the 1990s:

1. Leveraging technology architecture (changing the organisation to support the business direction)
2. Tailored workstations
3. Knowledge-based technology
4. Multi-media environment

These trends are consistent with the general direction of computer-based job-management and problem-solving proposed in this thesis.

PROBLEM-SOLVING DEVELOPMENT

One potential area for the development of problem-solving methods is the use of pictorial or symbolic representation. Buzan (1974) identifies the use of arrows, codes, geometrical shapes, artistic three dimensional drawings and colour in mapping but offers them as suggested mechanisms rather than defining appropriate applications. The benefits of symbolic representation have been quoted by writers such as Dreyfus (1972) who argued for the superiority of the symbol over the written word in terms of its ability to convey messages to the brain. Carney (1972) suggests the use of a variety of symbols which, although formulated in the context of Content Analysis, still have relevance to wider problem-solving. Thus there are symbols to represent:

- Ranking
- Questions
- Communications network
- Models
- Circular causation etc.

Palmer (1988) reports on the creation of an 'icon library' containing "recommended outlines for icons representing items such as telephones, calculators and waste baskets". Whilst this is specifically aimed at software designers it does indicate an attempt from within the business environment to standardise on the use of symbols to portray features relevant to managers and used by them, as we saw in Chapter 4. Keller (1983), Rosenhead (1989) and Friend (1989) all use simple symbolic notation to assist evaluation.

One issue when considering the wider application of problem-solving systems is the degree to which they are transferable. Obermeier and de Hilster (1985) note that "different domains require different sublanguages, where 'sublanguage' is defined as the particular language used in a body of texts dealing with a circumscribed subject area in which the authors share a common vocabulary and common habits of word usage" (cf. 'context-specific' methods, Chapter 3).

One way forward would be to develop a meta-communication capability or managerial and technical 'Esperanto'. Just as every Work Study practitioner recognises the notation of another practitioner because of standardisation, non-language problem-solving communication between managers could potentially be enhanced if there was a shared core of graphic symbols to denote problem components. A possibly relevant development area is that of Picteme-based languages which can either be used for expressing text or symbols. Thus Fuqua (1985) has addressed the problem of linguistic conversion by interposing a language like Interling between the natural language and the target notation system such as Lisp or Prolog. The original Apple desk-top metaphor and later systems which mimic this like Windows substitute simple icons for what were originally textual commands.

Kreis (1985) describes the PICOL system which is a picteme- oriented language. The elements can be represented hierarchially with pictemes being a combination of graphemes and sememes being combinations of pictemes. The claim is that the language is capable of representing in symbolic form the vast majority of textual requirements that might be needed.

Watts (1976) reports on what he refers to as the 'ideogram' in the context of discussing oriental writing suggesting that it:

"... gives one more information at a single glance and in less space than is given by the linear alphabetic form of writing which must also be pronounced to be understood".

He suggests it is particularly good for the representation of 'complex relationships or configurations' and is easily mastered by computers which may have especial relevance to the problem of 'information overload'.

Maruyama (1986) confirms that from an Information Theory viewpoint one page of detailed pictures, technical drawings or sophisticated cartoons contains several times more information than a page of text. He states that:

"A picture allows for simultaneous perception of all parts as well as a grasp of the interrelationships between the parts".

This enables the user to utilise the non-sequential and contextual capabilities in contrast to verbal information which can be processed only sequentially. He concludes that information coded into pictures or pictorial letters is more efficient and specifically cites the businessman as a potential beneficiary in terms of time saving. Even more pertinent is Maruyama's suggestion that recent developments have increased the prospects for computer- based pictorial representation, the three main elements being:

1. The Chinese invention of an input keyboard allowing the user to key in graphic parts of Chinese lettering directly.
2. The developments in computer graphics enabling the user to build his own pictorial vocabulary adapted to his profession or culture.

3. The development of new mind patterns by teenagers with computer games and high quality cartoonised teaching material.

To this we can add the acceptance of icons by managers when navigating software, the use of (paper-based) pictorial and diagrammatic representation seen in the final case study in Chapter 6 and the increasing use of symbolic labelling on products. Equally clearly, extensive research and development will be needed to design and introduce symbolic-based problem-solving systems and gaining managerial commitment to this level of complexity is likely to be as fraught as the introduction of computing as detailed in Chapter 4.

CONCLUSION

The job-management and problem-solving structure proposed here is evolutionary rather than revolutionary, reflecting a number of trends and themes emerging from the initial chapters but attempting to reconcile the disparate and partly self-contained tools and techniques within a unifying structure. This is primarily driven by the distinction between 'role-centred' and 'problem-centred' perspectives which marks a departure from existing literature. Whilst progress is likely to be inevitable there are still battles to be fought and the research has helped to identify some of the problems encountered by methods designers. Nevertheless and most significantly the enthusiasts are increasingly to be found in the ranks of practitioners.

Bird (1993a) reports how an EIS is even used to plan meetings, quoting an accountancy firm:

"In the old days, someone would have had to spend ages talking to secretaries or tracking down partners who may have gone out with their desk diaries. Now it takes seconds to identify the times when a group of people are free to meet and which rooms are available".

Bird (1993b) further notes a president and Chief Executive using portable and desktop PCs for a range of 'thinking and analysing' activities which include manipulating financial information, preparing minutes for meetings and dealing with electronic mail. Bird quotes him:

"The companies that survive in the 1990s and go forward strongly into the next millennium are those that have mastered the use of IT to improve the communications between all their people".

APPENDIX 1 - GOALS AND OBJECTIVES(Chapter 3)

Objective-setting clearly plays a major role in many businesses both when articulating the general business direction and when determining the targetry of individual business units and individuals. Drucker (1987) states:

"Businesses and non-profit organisations must have clear objectives and performance must be reviewed on a regular basis against these. Most problems arise because top management does not have a clear idea of what it seeks to be or the key achievements necessary."

Thackray (1984) gives the example of Texas Instruments having 11 distinct objectives followed by 50 strategies. These in turn were followed by several hundred tactical action plans or TAPs. In the case of the Severn Barrage project (Severn Barrage 1987) the Department of Energy specifies 5 overall objectives which the project team expands into 18 detailed objectives after discussions with the Department and the CEEB. Martin and Nicholls (1984) report the results of a survey aimed at identifying the success factors in the best-performing British companies. They conclude that there are five significant points to emerge, the first of which is the acute awareness by management of the overriding importance of company goals and the need for them to be established and achieved. Examples quoted of successful implementation include British Steel, Burtons and the manufacturer Hardy Spicer. In Turin Carlo de Benedetti (1983) ascribed his success in turning Olivetti from loss to profit partly to the setting of clear and ambitious objectives:

"Also, by not considering any achievement as a goal but as a starting point for further achievement".

This viewpoint is backed by O'Shaughnessy (1972) who suggests that goals themselves serve as a means to higher goals and are judged by their contribution to these ends. Clarifying direction is argued as making a specific contribution to business success. Philippe Stern, managing director of Swiss watch manufacturer Patek Philippe built a strategy round formal analysis using market research. He comments (Willatt 1984):

"If we have been doing better during the recession than some of our competitors, it may be because many manufacturers of medium and lower-priced watches have not known where to go. On the other hand we have known all along where we were going ... selling only through exclusive jewellery stores to people with money".

Faruqi (1987) gives examples both of the successful use of objectives - IBM's pursuit of Apple in Personal Computer market - and failure resulting from unclear objectives - Mobil's acquisition of

Mongomery Ward. Brown (1992) reports that the success of the manufacturing company, IMCO, was based on having a clear vision, in this case:

"To make the company recognised and respected worldwide as a brand of high quality giving total customer satisfaction".

From this, specific strategies emerged such as targeting the educated, mobile and high-earning professionals across Europe. Such is the importance attached to objectives that a self-contained body of theory and applications practice has been developed, commonly referred to as Management By Objectives (MBO).

MANAGEMENT BY OBJECTIVES

MBO can be viewed as a formal system for setting objectives and then measuring and rewarding management performance by relating it to the achievement of these objectives. A principal aim is to introduce coherence between the objectives, whatever the organisational level.

Belasco, Hampton and Price (1975) refer to MBO as 'one of the most popular innovations in planning and control in the past 10 or 20 years'. Examples of the successful application of MBO can be found in many references such as Meyer, Kay and French (1965), Wickens (1968), Raia (1974) and Carroll and Tosi (1973). Carroll and Tosi cite the following identified benefits in applied MBO:

- Activities become more directed towards goals
- Planning is helped
- Control standards are clarified
- Motivation is improved
- Resources are better used
- Role conflict and ambiguity are reduced
- Problems are identified better

the first National Productivity Award in 1986 was won by the Bristol-Myers Laboratories who claimed production improvements of between 150 and 350% by applying MBO with additional benefits in the shape of reduced accidents and materials losses. Increasingly it was applied to non-business examples such as the Police. 'Policing' by Objectives (PBO) operated in the Northamptonshire Constabulary and Marie Dickie, deputy chairman of the Police authority commented, (Caulkin 1985):

"Quite often police committees have foundered on there not being any kind of yardstick. The fact that we have a set of objectives and measurements of the way manpower is being used makes it much easier for us to do our job".

Attempts were also made to apply the principles to Government Departments. Norman Tebbit ('Aims' undated) itemises the aims of the newly created Department of Trade and Industry. The central aim is:

"to encourage, assist and ensure the proper regulation of British Trade, industry and commerce; to increase the growth of world trade and the national production of wealth".

This was surrounded by three segments, Climate, International Competitiveness and Innovation. These in turn are fragmented into a total of 16 sub-activities such:

Reduce regional disparities

and

Increase civil R and D in industry

Thus there was a framework for linkage between the overall objectives and detailed implementation plans. However, neat diagrams and coherent hierarchies do not guarantee an absence of problems and conflict between goals is a common feature in organisations.

GOAL CONFLICT

The assumption in early rational problem-solving models that there was always a single unitary objective or goal to which the solution search could be related was found to be wanting and a number of approaches were developed for reconciling multiple objectives. Roberts (1970) put forward a variety of tactics for dealing with multiple goals in systems models such as combining goals by assigning weights which reflect the rate of trade-off, treating the goals as constraints with fixed upper and lower levels, then optimise while holding the levels constant; searching for Pareto optimum then trying to improve the values of other goals without affecting the value of the first etc.

In the field of design Archer (1970) contrasts co-operating objectives (where two goals co-exist referring to the same property in the desired end result) and opposing objectives (where, say, an object needs to be both light [movable] and heavy [stable]). Dawson, Pointer and Stevens (1984) examined the conflicts caused by the pursuit of health and safety objectives in organisations. Firms might publish specific goals such as to 'achieve and maintain the highest standards of safety and health'. However, the managers responsible for its implementation had other, often conflicting, goals such as profit and loss, manning levels and productivity. Even supervisors are targeted to cost, time and quality objectives. In the survey conducted by the authors 58% of senior managers and 73% of junior

managers reported that considerations of health and safety conflicted with other aspects of work for which they were responsible.

One can broadly suggest that views on goal-contribution can be differentiated three ways. Firstly one can note the, albeit minority, view that consideration of goals is counter-productive. Eisner (Atkin 1967/8) comments:

"Consideration of goals has an unnecessary and often contaminating effect. I ... work on the alternative approach, simply the evaluation of actual effects".

In the second group goals may exist but they are internalised to the organisational leaders who would refute the suggestion that they have no goals but who, unless prompted, do not generally state or articulate the goals. Finally, there are those, typified by organisations who espouse MBO, who state their goals explicitly and attempt to integrate goal-achievement with overall performance of the organisation and its managers. Each of these views must have an effect on the problem-solving staged approach. In the first case reference to goals is specifically excluded. In the second case, identification of objectives may be problematic and complex. In the final case objectives are likely to be more evident and identifying relevance, whilst not always straightforward, becomes less of an issue.

APPENDIX 2 - PROBLEM-SOLVING CLASSIFICATION (Chapter 3)

When considering the issue of the scope for using 'method' to help problem-solving, two main viewpoints can be adopted. The first assumes that the method is applicable to the whole universe of problems, the second that relevance varies. The latter can be sub-divided into two principal categories. On the one hand there is an implication that a method may be applicable to a particular part of the problem-solving process with a further implication that this part is particularly critical or problematic. Thus PDS (chapter 2) concentrates on the evaluation and comparison of options. On the other hand one can argue that a method is relevant to a particular group or class of problems. Work Study (chapter 2) is considered as most relevant to problems of process. Whilst this can lead to a logical difficulty in that there is an assumed knowledge as to what the problem is before one can classify it, the principle of attempting to categorise problems remains a valid concern. This is supported by McKelvey (1975) who stresses that managers are in no position to take advantage of scientific findings unless they can discern which of them applies to his own situation. He states:

"The basic inductive/deductive process of science does not work without the phenomena under investigation being subdivided into sufficiently homogeneous classes".

He concludes that the increasing evidence for contingency approaches represents a 'grassroots response' to the existing absence of such classifications.

Whilst a number of writers have commented on aspects of problem classification, no unifying pattern has as yet emerged and this would seem a fruitful area for further research. Part of the problem would appear to be that the authors often offer only a couple of categories although this is hardly surprising as their intention is usually not to come up with a detailed classification schema.

Classification by the size or scale of a problem is commonly encountered. Savage (1954), for example, contrasts grand world problems such as 'How to live one's life' with small world problems such as 'What to eat for lunch'. Bandyopadhyay (1975) distinguishes between 'macro' and 'micro' problems where an example of the macro problem is a decision on the total number of branches a Bank might open and the micro problem would be the location of each branch. There is some evidence of users of methods employing a similar selection device. In Chapter 2 Carson (1971) quotes a user of the Kepner-Tregoe method as saying that he reserves it for the 'really big ones'.

A second major dimension is between problems which are repetitive and regularly encountered and those which are unusual or irregular. Simon (1969) cited 'programmed' and 'non-programmed' decisions and there is often an assumption that tools and techniques may more usefully be applied to the 'programmed' category. Chapter 2 refers to the distinction in the evolution of the Systems movement

between 'hard' and 'soft' with the implication that the former may be amenable to traditional, quantitative-based methods in contrast to the latter where the Checkland method is argued as more relevant.

A third dimension depends on the perspective of the analyst as to whether he is looking forwards or backwards in time. Ackoff (1978) refers to reactive problems where one walks into the future facing the past and proactive problem-solving where we specify where we want to go and try to get there. Within this framework he sees two types, the first negatively oriented where the concern is with the destruction, removal or containment of something present but not desired, the second positively oriented where the issue is the acquisition or attainment of something absent but desired. Thus the Kepner-Tregoe method is primarily reactive, depending on the identification of a gap in the performance of an existing system whereas Venture Analysis is future-directed with the emphasis on the evaluation of a forthcoming project.

De Bono (1977) identifies three main classes of problem all related to movement towards a goal:

1. In the first case we know where we want to get to but the way is blocked. Thus objectives are clear but constraints are in operation. Businesses may often perceive legal, union or financial factors to be restricting their options.

2. In the second case we 'run out of road', that is the future direction is unclear and more information is needed before we can proceed. Information gathering is central to the EIS/MIS developments discussed in Chapter 4.

3. Finally, we can be proceeding down a wide road but completely miss a relevant turning. This might be where a venture opportunity is missed or the firm fails to identify the need to change direction.

De Bono then offers thinking techniques to help come up with creative solutions to these problems. Raybould and Minter (1971) arrive at a five-fold classification:

1. The first type is referred to as the improvement problem where the object is to get from A to B. All De Bono's examples above are variations on this.

2. The next is the objective problem where A represents existing achievement but although there is dissatisfaction with it the nature and direction of B is unknown. Work Study addresses process problems in this category.

3. There are two variations to the third category. In the first, performance occasionally deteriorates from A to A1 and the problem is to maintain performance at A. Quality Control techniques address this in the production context. In the second sub-set there is an occasional improvement to A2 and the issue becomes how to obtain this regularly. Exception reporting in EIS/MIS can help to identify this.

4. The fourth is the potential problem with the planned level of performance having been determined but the penalty for not achieving it being ruinous. The Kepner-Tregoe method includes stages concerned with identifying this.

5. Finally, there is the evolution problem where there are several lines of action all improving on A but the difficulty relates to the choice. PDS, NIPPER, AIDA and Venture Analysis (Chapter 2) all focus on this area.

Missikoff (1985) identified seven classes of problem in the context of Expert Systems applications, as follows:

1. Information and data processing
2. Diagnosis and prospection
3. Story (text) understanding
4. Forecasting
5. Programming
6. Planning
7. Projection

Problems can also be classed by organisational unit, a 'manufacturing' as opposed to a 'marketing' problem. However, all these cases referred to above assume that the problem can have some independent existence whereas in practice the position may be clouded by perception. Swinth (Barron 1975) suggested that problems which appear to the outsider as ill-defined are seldom ill-defined from an insider's point of view. Ackoff (1978) noted that irrationality was usually in the mind of the beholder and Spencer (1983) quotes an executive bringing his wider experience to bear:

"I talked about the problem of machine-loading ... It's a very common problem and there are statistical devices if you need them. They never quite realised it was a common problem everywhere else".

These examples illustrate the bewildering choice that exists for classification schema and the lack of consensus on any standard. That such a standard is both desired and critical can be seen by the cases

cited in Chapter 4 which attempt to assess the relevance of tools and techniques to problem types or problem phases, (see Meador, Keen and Guyote 1984, Remenyi 1990 and Turban 1990).

Finally, one can suggest the essential components that might be considered necessary for the development of a more comprehensive schema.

1. Firstly, there is a need for categories to be determined which cover without redundancy as wide a range of problem situations as possible.

2. Next a methodology should be developed that allows the relevance of individual methods, tools and techniques to be measured for relevance against the problem categories.

3. Thirdly a body of research should be built up which assesses the methods for relevance using this methodology.

4. Finally, managers must be able to recognise that the problem under consideration falls to a particular category.

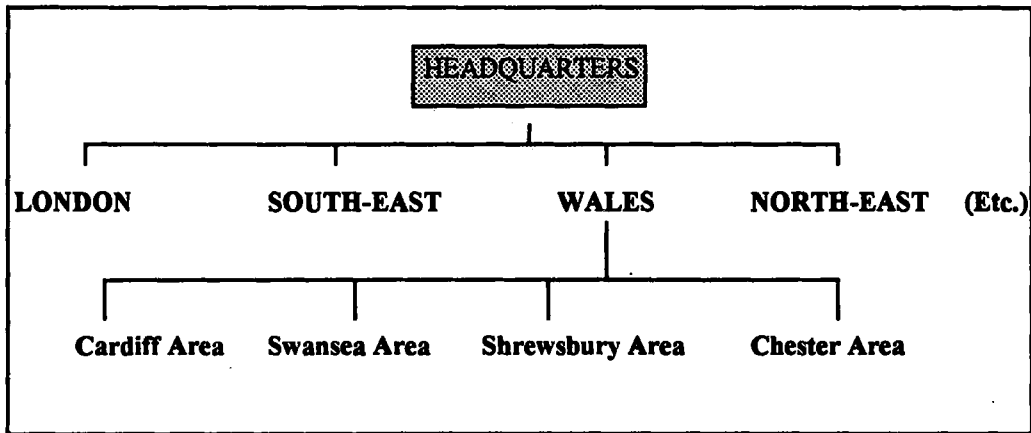
This would represent a significant advance on the present situation where appropriateness tables must be taken as they stand with little or no evidence that they represent anything other than the personal opinions of the author.

Appendix 3 - CARDIFF CONTROL CASE(Chapter 6)

CONTROL CASE BACKGROUND DATA

The diagram below shows the UK structure for BT which is based on geographical boundaries.

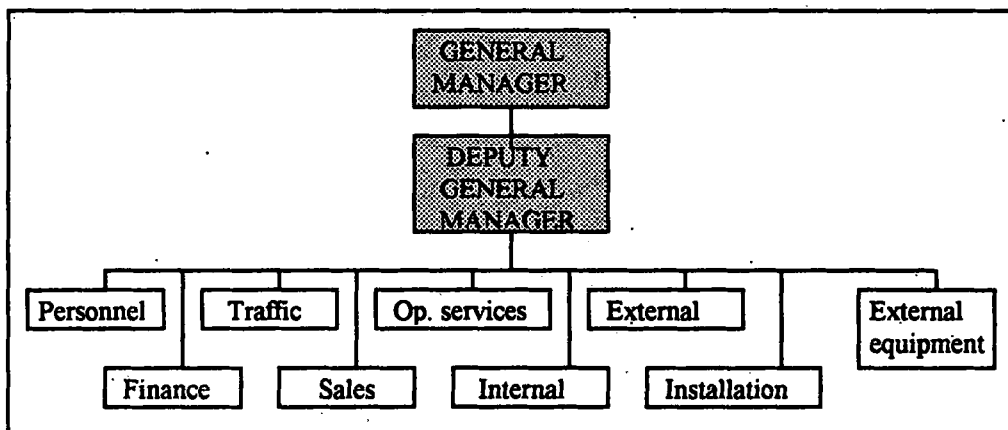
FIGURE 13



The Wales and the Marches Region was the second smallest, comprising four telephone areas, the biggest of which was Cardiff. Of the 61 Telephone Areas in the country Cardiff came 15th in terms of size and turnover, having in the previous few years witnessed an explosive period of growth as the substantial miners' pay settlements brought prosperity, and with it demand for telephone service particularly from the Valley towns whose economies were still heavily dependent on the mining industry. By 1982, however, the recession had commenced, pits were under threat and British Steel, another major local industry, also had a closure programme, all of which contributed to the bursting of the bubble and a dramatic lowering in growth rates.

The diagram below illustrates the organisational structure of the Cardiff Area with a General Manager (GM) ultimately responsible for 4,500 staff and a turnover of £100m.

FIGURE 14



In all a Telephone Area could have around 60 different grades, some of which, relevant to this study, are depicted in below.

TABLE 22

	EXECUTIVE	ENGINEERING	SALES	TRAFFIC
Middle Manager	HEO	Executive Engineer	Senior Sales Superintendent	Senior Telecomms Superintendent
Junior Manager	HCO EO	Assistant Exec. Engineer. Inspector	Sales Superintendent	Telecomms Traffic Superintendent
Basic Grades	CO CA	ST, TO, T1, T2A, T2B,-TTA	Comm.O, CO, CA	TTO

The Head of the Installation Division and Chairman of the Working Party (JT) provides the material for five of the in-depth interviews. Two of the middle managers feature as members of the Working Party, EC5 (KB) is in charge of the Installation Control and EC4 (SS) previously spent a short period in charge of the Control but now oversees specialist staff whose responsibilities can overlap with those of EC 5.

The work of the Installation Division is based around a system for providing telephone service. This has six distinct phases as follows:

Customer->Sales order->Routeing->Distribution->Execution-> Billing.

Orders for telephone service are received in the Sales Division which then issues an Advice Note of which there are several copies authorising different functions in the office to carry out the required engineering or administrative work. Two key functions in terms of the current study are those of Routeing and Records (R & R) and Distribution (DO).

The R and R staff are responsible for line-plant records. They keep them up-to-date from information provided by the field staff about which cable pairs have been taken into use or made spare etc. From these records they are able to provide a 'routeing' for a circuit from the Telephone Exchange through to the Distribution Point (DP). On receipt of their copy of the Advice Note the R & R staff check to see if a pair of wires exist from the Exchange to a point near the customer. These details are then recorded on the Advice Note before being passed on for execution of the work. Where the R & R is unable to route a circuit using office records a Survey Officer may be asked to carry out a 'field survey'. In

addition, surveys are required when poles need to be sited and wayleaves obtained. The Survey Officers play only a peripheral role in the study.

The Distribution staff are responsible for making the arrangements for the 'fluid' work (or 'work-in-progress') to be carried out in the most efficient manner. To do this they assemble the Advice Notes together for each installation taking into account appointments, type of work, location and urgency. In addition Distribution staff also regularly review all those Advice Notes that are not fluid in order to clear any potential difficulties and enable the work to be carried out.

Objectives listed in the Sales and Installation handbook (untitled, undated) are:

- "a) to provide an efficient customer liaison
- b) to provide service when and where it is required
- c) to maintain high standards of provision
- d) to keep costs as low as possible"

It adds:

"The broad aim of everyone employed in Post Office telecommunications is to give the customer the best service at as low a cost to the business as possible. Each individual duty will have its own specific objectives which should nevertheless be directed at maintaining or improving these broad objectives".

Note can also be taken of the Industrial Relations position with a number of Trades Unions representing different grades. The ones featured in the case study are:

A) The Society for Post Office Executives (SPOE). This is exclusive to the Post Office and covers all managerial grades from GM down to Inspector.

B) The Post Office Engineering Union (POEU). Again, this is exclusive to the Post Office and covers all rank and file grades in the Engineering hierarchy below that of Inspector. It is a powerful, well-organised Union with increasing national influence at TUC level.

C) The Civil and Public Servants Association (CPSA). A semi- autonomous branch of the national union covering clerical grades in the Civil Service. In the context of this study the grades represented are Clerical Officer, Clerical Assistant and the recently-introduced grade of Commercial Officer.

In the past the Unions would have convened at the Council of Post Office Unions (COPOU) which provided a forum for management/union discussions. However, COPOU had ceased to operate as such pending the introduction of a new forum. During the period of the study, industrial relations issues were resolved directly between individual unions and management.

References listed alphabetically

- Ablett, S. (1986) 'Clustering round the blackboard'. *Infomatics*. October. London, (32-34 Broadwick Street). VNU Business Publications.
- Ackoff, R.L. (1978) *The Art of Problem-solving*; New York/Chichester; John Wiley and sons.
- Ackoff, R.L. (1979 February) 'The Future of OR is Past'; *Journal of the OR Society*, Vol.30, no.2. pp. 93-104. London; Pergamon Press Ltd.
- Adams, J.L. (1974) *Conceptual Blockbusting - A guide to better ideas*, San Francisco; W.H.Freeman.
- Agor W.H. (1991) 'The Logic of intuition: How top executives make important decisions' from *Creative Management*, ed. J. Henry. Beverley Hills, California/London; Sage Publications.
- Aims* (undated). Produced by the Information Division, Department of Trade and Industry, REF: 1/84. London (1 Victoria Street); Department of Trade and Industry.
- Algie, J and Foster, W (1985) 'How to pick priorities', *Management Today*, March, pp 60-61, 123. London, Haymarket; Management Publications Ltd.
- Allio, R.J. (1972) 'The Corporate Road Map - planning at Babcock and Wilcox', *Long Range Planning*, December, vol.5, no.4. pp. 9-14. Journal of the Society for Long Range Planning, London; Pergamon Press.
- Apple Enterprise* (1992a) 'Management by Macintosh' Issue no.1, Spring. Apple Computer UK Ltd, Uxbridge (6 Roundwood Avenue); Apple Computers.
- Apple Enterprise* (1992b) 'Of Vital Importance' Issue no.2, Autumn, P.3. Apple Computer UK Ltd, Uxbridge (6 Roundwood Avenue); Apple Computers.
- Apple Enterprise* (1992c) 'The BP Culture Change' Issue no.2, Autumn, pp.11-14. Apple Computer UK Ltd, Uxbridge (6 Roundwood Avenue); Apple Computers.
- Archer, L.B. (1970) 'An overview of the structure of the design process', in *Emerging Methods in Environmental Design and Planning* ed. Moore. pp. 285-307 Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Argenti, J. (1976) 'Whatever happened to Management Techniques?', *Management Today*, April, pp. 78-79. London, Haymarket; Management Publications Ltd.
- Arnott, D (1983) 'When the co-operating faltered', *Management Today*, October, p.89. London, Haymarket; Management Publications Ltd.
- Atkin, J.M. (1967/8) 'Research styles in science education', *Journal of Research in Science Teaching*, Vol.5, Issue 4, December, pp. 338-345. New York/London/Sydney; John Wiley and Sons.
- Audio Visual Communications for Business* (1993) 'Decision Time', January, no.253, p.7.
- Bandyopadhyay, R. (1975) 'Use of taxonomies of information and decision - a case study'. In *The role and effectiveness of theories of decision in practice*, p.207-224. 1973 Conference Proceedings, edited by White, D.J. and Bowen, K.C. London; Hodder and Stoughton.
- Bannister, D and Fransella, F. (1971) *Inquiring Man*, Harmondsworth, (Middlesex); Penguin Books Ltd.

- Barron F.H. (1975) 'An information processing methodology for inquiring into decision processes'. In *The role and effectiveness of theories of decision in practice*, p.195-206. 1973 Conference Proceedings, edited by White, D.J. and Bowen, K.C. London; Hodder and Stoughton.
- Belasco, J.A., Hampton, D.R. and Price, K.F. (1975). *Management Today*, New York/London/Sydney; John Wiley and Sons.
- de Benedetti, C., (1983) 'Italy's Harlequin Economy', by N. Willatt. *Management Today*, September, p.84. London, Haymarket; Management Publications Ltd.
- Bennet, P., Cropper, S. and Huxham, C. (1989) 'Modelling Interactive Decisions: the Hypergame focus' from *Rational Analysis for a Problematic World*, ed. J Rosenhead, pp. 315-340, New York/London/Sydney; John Wiley and Sons.
- Berkin, J. (1986) 'Expert systems: organisational, business and strategic implications'. *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 151-158 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Birch, P. (1984) 'On the move' *Management Today*, May, p.16. London, Haymarket; Management Publications Ltd.
- Bird, J (1992a) 'Seeking a software solution' *Management Today*, September, pp. 97-102. London, Haymarket; Management Publications Ltd.
- Bird, J (1992b) 'An Open Minded Approach' *Management Today*, November, p. 122. London, Haymarket; Management Publications Ltd.
- Bird, J (1993a) 'A system for the perplexed'. *Management Today*, April, pp. 71,74. London, Haymarket; Management Publications Ltd.
- Bird, J (1993b) 'Self-help at the Top'. *Management Today*, July, pp.70-72. London, Haymarket; Management Publications Ltd.
- Bjorn-Andersen, N. (1986) 'Understanding the nature of the office for the design of third-wave office systems' from *People and Computers, Designing for Usability*. Cambridge/London/New York; Cambridge University Press,
- Blanchard K. and Johnson S., (1983) *One minute Manager* London; Fontana.
- de Bono E. (1977) *Lateral Thinking* Harmondsworth, (Middlesex); Penguin Books Ltd. (First published Ward Lock Education 1970).
- de Bono E. (1980) *Opportunities* Harmondsworth, (Middlesex);Penguin Books Ltd.
- Bowey A.M. (1983) *Myths and Theories of Organisation: the Impact of Organisational Interpretations*. Paper first presented to the fifth Colloquium of the European Group for Organisational Studies. Glasgow, 1981.
- Boxer P.J. (1978) *Reflective Analysis* London Graduate School of Business Studies, working paper. London (Sussex Place, Regents Park); London Graduate School of Business Studies.
- Boxer P.J. (1979) *Supporting Reflective Learning: Towards a Reflexive Theory of Form*. London Graduate School of Business Studies, working paper. London (Sussex Place, Regents Park); London Graduate School of Business Studies.
- Boyce D. (1986) Quoted in 'Convergence down the Line' by Scales I. *Communications Management*, September, p.29. London, (Priory Court, 30-32 Farringdon Lane, London, EC1R 3AU) EMAP Business and Computer Publications.

- Bridges G. (1984) 'BA's New Flight Path' by van de Vliet A. *Management Today*, July, p.45. London, Haymarket; Management Publications Ltd.
- Broadhead S. (1990) 'A new look for session management' *Network*, August, pp.28-32. London, (32-34 Broadwick Street); VNU Business Publications.
- Brown A. (1992) 'IMCO's Global Perspective'. *Management Today*, December, p.5. London, Haymarket; Management Publications Ltd.
- Brown M. (1981) 'How to tackle problems' *Management Today*, March, p.89. London, Haymarket; Management Publications Ltd.
- Brown M. and Rickards T. (1982) 'How to create creativity' *Management Today*, August, pp.38-41. London, Haymarket; Management Publications Ltd.
- Brown R.V. (1970) 'Do managers find decision theory useful?' *Harvard Business Review*, vol.48, May-June, pp 78-89. Cambridge, Massachusetts.
- Bucknall C. (1991) 'A manager's guide to Executive Information Systems' *Industrial Management and Data Systems*, no.3. pp. 6-8. Bradford; MCB University Press Ltd.
- Bullinger H. and Huber H. (1990) 'Which information systems do managers really need?' *European Management Journal* vol.8, no.2. June, Pp 186-191, Basil Blackwell Ltd.
- Business Information Review* (1986) 'Top 20 Business Books from BIM', October, vol.3, no.2.
- Butler A. (1986) 'Expert Systems for decision-making in Insurance' *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 15-26 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Buzan T. (1974) '*Use your head*' BBC Publications, British Broadcasting Corporation, 35 London. (Marylebone High Street); BBC publications.
- Caffrey J. (1991) 'It's all in the mind' *Connexion*, 6th February. London (32-34 Broadwick Street); VNU Business Publications.
- Campbell, J.P.; Dunnette, M.D.; Lawler, E.E. and Weick, K.E. (1970) '*Managerial Behaviour, Performance and Effectiveness*'. New York, McGraw Hill.
- Cane A. and Nakamoto M. (1992) 'Personal Communicator set for launch'. *Financial Times*, 1st October. London; The Financial Times Ltd.
- Carney T.F. (1972) '*Content Analysis - a technique for systematic inference from communications*' Pp. 312-321. London; BT Batsford Ltd.
- Carroll S.J. and Tosi H.L. (1973) '*Management by Objectives*' London/Basingstoke; McMillan Press Ltd.
- Carson I. (1971) 'How top men make up their minds' *International Management*, April. Sutton, (Surrey); Reed Business Publishing Group.
- Caulkin S. (1983) 'Wilkinson's Second Safety Match' *Management Today*, September, p.52. London, Haymarket; Management Publications Ltd.
- Caulkin S. (1985) 'The force's better beat' *Management Today*, March, pp.63-69, 109-111. London, Haymarket; Management Publications Ltd.

- Chambers (1981) *Chambers Family Dictionary*. Edinburgh; W & R Chambers Ltd.
- Checkland P.B. (1981) *'Systems Thinking, Systems Practice'* New York/London/Sydney; John Wiley and Sons.
- Churchman, C.W. (1971) *'The Design of Inquiring Systems'*. New York; Basic Books.
- Clifford, J (1976) *'Decision Making in Organisations'* London; Longmans.
- Clutterbuck, D. (1984) 'How to plant the seeds of productivity' *Management Today*, July, pp 80-93, 125, 128. London, (Haymarket); Management Publications Ltd.
- Cohen M.D., March J.G., Olson J.P. (1972) 'A garbage can model of organisational choice'. *Administrative Science Quarterly*, no.17. Ithaca, New York; Graduate School of Business and Public Administration, Cornell University.
- Communications Management* (1987) 'Facsimile's first steps into the PC world' and 'Orator gets applause', February. London, (Priory Court, 30-32 Farringdon Lane, London, EC1R 3AU) EMAP Business and Computer Publications.
- Communications News* (1993). 'Lack of strategy dogs Email users'. May, p. 3. Warwick House, Swanley, Kent.
- Computerworld* (1989) February 27. Framingham, Massachusetts.
- Comsell Interactive Video Training (1988) *'IT British Management training and 1992:the competitive gap'*. Pamphlet - London; Comsell.
- Conneighton C. (1991) 'Executive Information Systems' from Conference Proceedings *'The Desktop: Driving Information Technology Architectures'*. Gartner Group, 56 Top Gallant Road, Stanford CT 06902
- Cooke S. and Slack N. (1984/1991) *Making Management Decisions*. Englewood Cliffs, New Jersey 07632; Prentice Hall Inc.
- Cope User* - Issue 1. August 1988. Strathclyde University, Strathclyde; Strategic Decision Support Unit.
- Cope User* - Issue 2. November 1988. Strathclyde University, Strathclyde; Strategic Decision Support Unit.
- Cox, J. (1983) 'Support the British QC concept'. Correspondence in *Management Today*, June. pp32-34. London, Haymarket; Management Publications Ltd.
- Coxon, R. (1983) 'How strategy can make Major Projects Prosper'. *Management Today*, April. p.35. London, Haymarket; Management Publications Ltd.
- Crandall R.L. and Kerber L. (1985) *'What is an Executive Information System?'* Unpublished paper. 2nd Annual System W National Users Group Conference. Comshare, 32-34 Great Peter Street, London, SW1P 2DB; Comshare.
- Crandall R.L. (1987) *'COMMANDER Executive Information System'*. for internal use only. Comshare, 32-34 Great Peter Street, London, SW1P 2DB; Comshare
- Cross M. (1990) 'News World View' from *Which Computer*, December, p.24. 33-39 Bowling Green Lane, London.

- Cross M. (1991) 'Japan's quest for the brainy computer'. *New Scientist*, 26th January. New Science Publications, London; IPC Magazines Ltd.
- Cumbers M.B. and Tomes A.E. (1986) '*Computers and Decision Making*' Sheffield; Manpower Services Commission.
- Curnow R. (1986) 'Reallocating expertise: the structural impact of KBS'. *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 169-176 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Currie R.M. (1963) '*Work Study*'. Pitman Paperbacks, 2nd edition, London; (128 Long Acre), Pitman Publishing.
- D'Agapeyeff (1985) quoted in 'Expert Systems going for a song' by Johnston H. *Expert System User*, vol. 1, No. 6, October, p.20. London (Cromwell House, Bride Lane).
- Dale E. (1969) 'The Psychology of Decision Making' *Think Magazine*, January/February.
- Data Management* (1985) 'Rise and Fall of the PC'. December, pp. 6-7..
- Data Management* (1986) 'Electronic Postboxes'. June, pp. 23,29,32.
- Datapro (1991) 'Putting Expert Systems Technology to work' from *Managing Information Technology*, August. Datapro Information Services Group, 600 Delron Parkway, Delron, New Jersey 08075. New York/San Francisco/London; McGraw Hill Book Company.
- Datapro (1992a) 'Project Management Systems' from *Managing Information Technology*, July. Datapro Information Services Group, 600 Delron Parkway, Delron, New Jersey 08075. New York/San Francisco/London; McGraw Hill Book Company.
- Datapro (1992b) 'Expert Networks' from *Managing Information Technology*, January. Datapro Information Services Group, 600 Delron Parkway, Delron, New Jersey 08075. New York/San Francisco/London; McGraw Hill Book Company.
- Datapro (1992c) 'Computer Supported Co-operative Work, CSCW, from *Managing Information Technology*, May. Datapro Information Services Group, 600 Delron Parkway, Delron, New Jersey 08075. New York/San Francisco/London; McGraw Hill Book Company.
- Datapro (1992d) 'The Latest Technological Advances' from *Managing Information Technology*, February. Datapro Information Services Group, 600 Delron Parkway, Delron, New Jersey 08075. New York/San Francisco/London; McGraw Hill Book Company.
- Davis C.F. and Kennedy M.D. (1970) 'EPS: A computer programme for the evaluation of problem structure'; in '*Emerging Methods in Environmental Design and Planning*' ed. Moore. Pp. 121-125. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Dawson S, Pointer P and Stevens D (1984) 'Resolving the Health and Safety Conflict' *Management Today*, April, p.33. London, Haymarket; Management Publications Ltd.
- Dickey J.W. (1988) '*The Idea Machine (TIM), Innovation Support System*'. June. Virginia Polytechnic Institute and State University.
- Dill W.R. (1964) 'The Varieties of Administrative Decisions' in Leavitt H. and Pandey L. - *Readings in Managerial Psychology*, pp. 706-723. Chicago/London; University of Chicago Press.
- Dopson S. and Stewart R. (1990) 'What is happening to Middle Management?' *British Journal of Management*, vol.1, Issue No. 1, April, pp 3-16. Chichester; John Wiley and Sons.

- Dreyfus H.L. (1972) *'Symbol Sourcebook'*. New York; McGraw Hill.
- Drucker P.F. (1955) *'The Rational Manager'*. Oxford; (Halley Court, Jordan Hill,) William Heinemann Ltd.
- Drucker P.F. (1987) Talk entitled 'Managing and Evaluating the Strategic Performance of a Business' given to the Strategic Planning Society on June 17th. Reported in *The Strategic Planning Society News*, July/August p.1. London; (15 Belgrave Square) Strategic Planning Society.
- Duffy F and Torrey J. (1970) 'A progress report on the pattern language' in *'Emerging Methods in Environmental Design and Planning'* ed. Moore, pp. 261-277. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Du Pont Guide to Venture Analysis (1971) Education and Applied Technology Division, E.I. du Pont de Nemours and Co. (Inc.) Wilmington, (1007 Market Street, Wilmington, De., USA); Du Pont.
- Eastmen C. (1970) 'On the analysis of Intuitive Design Processes' in *Emerging Methods in Environmental Design and Planning'* ed Moore. pp. 21-37. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London: MIT Press.
- Eberhard J.P. (1970) 'We ought to know the difference' in *'Emerging Methods in Environmental Design and Planning'* ed. Moore. Pp. 363-368. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Eden, Sims and Jones (1979) *'Thinking in Organisations'*. London and Basingstoke; Macmillan Press Ltd.
- Eden and Sims (1984) 'Futures Research - working with management teams' *Long Range Planning*, August, vol.17, no.4. pp 51-59. Journal of the Society for Long Range Planning. London; Pergamon Press.
- Effem Management Services (1989) *'Acumen'* - system description. Shoppenhangers House, Shoppenhangers Road. Maidenhead, SL 6 2 PX. Slough; Effem.
- Elbing A.O. (1970) *'Behavioural Decisions in Organisations'*. Glenview (Illinois) Scott, Foresman and Co.
- Eosys Ltd (1986) *'Top Executives and Information Technology: disappointed expectations'*. Pamphlet - Slough.
- Etzioni, A. (1968) *'Mixed scanning: a "third" approach to decision-making'* in Faludi A., 'A Reader in Planning Theory' pp. 217-229. Oxford; Pergamon.
- Evered R. (1975) 'The Strategic Decision Process' in Hellriegel D. and Slocum J.W. - *Management in the World Today*. Reading/Menlo Park/London, Addison Wesley Publishing Co.
- Fanaeian-Nour A. and Kleiner B.H. (1992) 'The Computer Revolution in Organisational Management' *Industrial Management and Data Systems*, vol.92, no.6, pp. 8-12. . Bradford; MCB University Press Ltd.
- Faruqui A. (1987) 'Marketing Electricity - a military approach' *Long Range Planning* vol.20, no.4, pp 67-77. Journal of the Society for Long Range Planning, London; Pergamon Press.

- Feigenbaum E., McCorduch P. and Penny Nii H. (1988) *'The Rise of the Expert Company'* London and Basingstoke; Macmillan Press Ltd.
- Fenwick, I and Doyle. P. (1976) 'Extending the Application of Decision Analysis'. *Management Decision*, Vol.14, no.5. pp. 253-260. Bradford; MCB University Press.
- Finlay P.N. and Marples C. (1992) 'Strategic Group Decision Support Systems - A Guide for the Unwary' *Long Range Planning*, June, Vol.25, No.3, p.98-107. Journal of the Society for Long Range Planning, London; Pergamon Press.
- Fintech* (1986) 'Software Markets'. *Fintech* 5, 31/5. Financial Times Business Information. London, (1 Southwark Bridge); Financial Times Business Enterprises Ltd.
- Fischer M.T, Feder J and Gurney J. (1990) 'The electronic information industry and forecast in Europe, North America and Japan' from *'On-line information 90. 14th International Meeting Proceedings.'* Oxford; Learned Information Limited.
- Fleisher A. (1970) 'Comment: Is it possible to describe general problem-solving processes?'. In *'Emerging Methods in Environmental Design and Planning'* ed. Moore. Pp. 92-104. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Fondas N and Stewart R. (1990) *'Developing role theory for research on management jobs and behaviour'*. MRP 90/1. Oxford; Oxford Centre for Management Studies.
- Frazer F. (1985) 'Personal Computer Software'. *Fintech* 3, pp. 22-27 Financial Times Business Information. Financial Times Business Enterprises Ltd., 1 Southwark Bridge,.
- Friend J. (1989) 'The Strategic Choice Approach' from *'Rational Analysis for a Problematic World'* ed. J. Rosenhead, pp. 121-158. New York/London/Sydney; John Wiley and sons.
- Fuqua, K.C. (1985) 'The multilingual capabilities of the Lingua Natural Language Parsing System'. *Artificial Intelligence and Advanced Computer Technology - Conference Proceedings*. London; (18 Bedford Square); Europa.
- Gabor, P. (1976) 'Management Theory and rational Decision- making', *Management Decision*, vol.14, no.5, pp. 274-281. Bradford; MCB University Press.
- Gahmberg H. (1982) *'On underlying values and intuition in Strategic Decisions'*. Paper presented at First European Workshop on Organisational Symbolism. Exeter, (EX4 4RJ); University of Exeter.
- Gallupe R.B., Dennis A.R., Cooper W.H., Valacich J.S., Bastianutti L.M., Nunamaker J.F., (1992) 'Electronic Brainstorming and Group Size' *Academy of Management Journal*, vol.35, No.2, June, pp. 350-369. Ohio Northern University, (Ohio 45810); Academy of Management.
- Gamble P.R. (1988) 'Attitudes to computers of managers in the hospitality industry'. *Behaviour and Information Technology*. vol.7, no.3, pp.305-321.
- Garde, V.D. and Patel R.R. (1985) 'Technological Forecasting for Power Generation - A study using Delphi Technique'. *Long Range Planning*, August, Vol.18, no.4, pp.73-79. Journal of the Society for Long Range Planning, London; Pergamon Press.
- Gillingwater D. (1987) *'Attitudes to the use of computerised information systems for production management in manufacturing industry: a survey'*. Pamphlet - Loughborough University of Technology, Department of Transport. Published by Loughborough University, (Leics, LE11 3TU.)
- Glaser, B.G. and Strauss, A.L. (1967) *'The Discovery of Grounded Theory- strategies for qualitative research'*. London; Weidenfeld and Nicolson.

- Gordon W.J.J. (1961) '*Synerctics*'. New York (10 East, 53rd Street, NY 10022.); Harper and Row.
- Gummesson, E. (1991) '*Qualitative Methods in Management Research*'. Beverley Hills, California/London; Sage publications.
- Hague, J.T. and Watson H.J. (1983) 'Management's role in the approval and administration of Decision Support Systems' *MIS Quarterly*, June. MIS Research Centre, University of Minnesota, Carlson School of Management, (271 19th Avenue South, Minneapolis, MN 55455). Minneapolis; University of Minnesota.
- Hall A.D. (1962) '*A methodology for Systems Engineering*'. New York; Van Nostrand Reinhold.
- Hamilton D. and Parlett, M. (1977) 'Evaluation as Illumination: a new approach to the study of innovatory programmes', in *Beyond the Numbers Game*, ed, Hamilton D., et al. pp. 6-22. London; MacMillan.
- Harris N. (1993) "Management 'Flavours' of the month". *Professional Manager*, vol.2., No.6., p. 11. Institute of Management, London; Alloa Printing and Publishing Co. Ltd.
- Hart S.L. (1992) 'An integrative framework for strategy-making processes' *Academy of Management Review*, Vol. 17, no.2, 327-351. Ohio Northern University, Ohio 45810.
- Heath T.F. (1970) 'The Algorithmic Nature of the Design Process' in '*Emerging methods in environmental design and planning*' ed. Moore. pp. 57-68. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Hecht-Nielsen R. (1988) 'Neurocomputing: picking the human brain'. *IEEE Spectrum*, March. (IEEE log number 9037617)
- Heller F.A., Drenth P.J.D. and Koopman P.L. (1982) '*A contingency model of participative decision-making*'. First draft of article prepared by Koopman, P.L., Dept. of Industrial and Organizational Psychology, Free University, De Boelelaan 1081, HV Amsterdam, Netherlands; Free University.
- Hewett J. (1986) 'Commercial Expert Systems in the USA and Canada', *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 177-186 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Hickson D J, Butler R J, Cray D, Mallory G R and Wilson D C. (1986) '*Top Decisions*', Oxford; Blackwell.
- Hirsh W. and Bevan S. (1988) '*What makes a manager*' Institute of Manpower Studies, Mantell Building, University of Sussex, Falmer, Brighton, Sussex; University of Sussex.
- Hodgkinson C. (1978) '*Towards a philosophy of Administration*'. Oxford; Basil Blackwell.
- Hogarth R. (1980) '*Judgement and Choice, The Psychology of Decision*' New York/London/Sydney; John Wiley and Sons.
- Hollingham, J. (1990) '*Expert Systems - Commercial Exploitation of Artificial Intelligence*' PA Consulting, IFS Ltd.
- Holmes N. (1985) 'On-line information in Europe and the US'. *Financial Times Business Information Report*, January, pp. 4-5, 22-29. Financial Times Business Information. 1 Southwark Bridge, London; Financial Times Business Enterprises Ltd.

- Honey D. (1986) 'How to select the right equipment'. *Communications Management*, April, pp 37-44. London, (Priory Court, 30-32 Farringdon Lane, London, EC1R 3AU) EMAP Business and Computer Publications.
- Howard R.A. (1980) 'An assessment of Decision Analysis' *Operations Research*, January/February, vol.28, no.1, pp. 4 - 27. Baltimore, Maryland 21202; Operations Research Society of America.
- Huber G.P. (1980) *Managerial Decision Making*, London/Glenview, Illinois; Scott, Foresman and Co.
- Humphrey A S. (1986) 'Managing Creativity for Rapid Growth' BIM Report, *Management Today*, London, Haymarket; Management Publications Ltd.
- Hunt M M (1954) 'Bell Labs 230 Long Range Planners' *Fortune*, May.
- IDC (1991a) *Worldwide Information Technology Spending Patterns, 1990-1995.* 5 Speen Street, Framingham MA 01701; International Data Corporation.
- IDC (1991b) *Technology Assessment, European Software and Services.* No. L-191, June, pp. 15-17. 5 Speen Street, Framingham MA 01701; International Data Corporation.
- IDC (1991c) *The European Software Products and Applications Solutions.* No. L-491, December, p. 27. 5 Speen Street, Framingham MA 01701; International Data Corporation.
- IDC (1992), March. International Data Corporation, 5 Speen Street, Framingham MA 01701; International Data Corporation.
- Ilan, Y. and Shapira, Z. (1986) 'The Introduction and Use of Microcomputers by Professionals in an Industrial Corporation'. *Technological and Forecasting Social Change*, vol. 29 (2). New York; Elsevier Science Inc.
- Isenberg D.J. (1991) *'How Senior Managers Think'* from *Creative Management* ed. J. Henry, Beverley Hills, California/London; Sage Publications.
- Jenkins G.M. (1969) 'The Systems Approach - a Systems Study of a Petrochemical plant' *Journal of Systems Engineering*, 1 (1). (Reprinted in *Systems Behaviour*, pp. 56-82, ed. Beishon J. and Peters, G., Open University Press, London; Harper and Row.)
- Johnson T. (1984) *'The Commercial Application of Expert Systems Technology'*, 1 Mortimer Street, London, W1N 7RH; Ovum Ltd.
- Jones J.(1986) 'MacCadd, an Enabling Software Support Tool' from *People and Computers, Designing for usability*. Cambridge/London/New York; Cambridge University Press.
- Judson H.F. (1980) *'The Search for Solutions'* , pp. 184-191. New York; Holt, Rinehart and Winston.
- Kanter J. (1970) *'Management Guide to computer system selection and use'*. Englewood Cliffs, New Jersey 07632; Prentice Hall Inc.
- Kaplan A. (1973) *'The Conduct of Inquiry - methodology for Behavioural Science'*. Aylesbury; Intertext.
- Kast F.E. and Rosenzweig J.E. (1972) 'The Modern View: A systems approach' in *Systems Behaviour*, ed, Beishon J. and Peters, G, pp. 14-28. Open University Press. 28 Tavistock Street, London; Harper and Row.

- Kaufman (1968) *The Science of Decision-making; an introduction to Praxeology* London; Weidenfeld and Nicholson.
- Kaufman G. (1991) 'Problem-solving and creativity' from *Creative Management* ed J. Henry. Beverly Hills, California/London; Sage Publications.
- Kaye G.D. (1975) 'The Disappearing Decision'. In *The Role and Effectiveness of Theories of Decision in Practice*, p.106-112. 1973 Conference Proceedings, edited by White D.J. and Bowen K.C. London; Hodder and Stoughton.
- Keen M. and McBride S. (1986) 'Expert Systems in Clarifying Employment Law'. *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 37-48 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Keenan J. (1993) 'Combined Effort' *Marketing Business*, April; pp. 33-35. Chartered Institute of Marketing. London; HHL Contract Publishing.
- Keller R. (1983) *The Practice of Structured Analysis: Exploding Myths*. Englewood Cliffs, New Jersey 07632; Prentice Hall Inc.
- Kelly B.A. (1986) 'System Development Methodology: defining approaches' *Knowledge Based Systems*; Conference Proceedings held in London, July, Online, pp. 187-194 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Kelly G.A. (1955) *The Psychology of Personal Constructs*. New York; Norton.
- Kelly J. and Ibrahim A.B. (1991) 'Executive Behaviour: Its facts, fictions and paradigms' *Business Horizons*, March/April, vol.34, no. 2, pp. 27-36. Bloomington, Indiana 47405; Indiana University Graduate School of Business Studies.
- Kepner C.H. and Tregoe B.B. (1965, 1981) *The Rational Manager*. London; John Martin Publishing Ltd.
- Kepner C.H. and Tregoe B.B. (1980) *Top Management Strategy* London; John Martin Publishing Ltd.
- King C. (1985) 'How to program profits' *Management Today*, May. p. 81. London, Haymarket; Management Publications Ltd.
- Koberg D and Bagnall J (1972) *The Universal Traveller*. 1 First Street, Los Altos, California 94022; William Kaufmann Inc.
- Kraemer K.L. and King J.L. (1986) 'Computer-based models for Policy-making: Uses and Impacts in the US Federal Government'. *Operations Research*. Vol.34, no. 4, pp.501- 512. Baltimore, Maryland 21202; Operations Research Society of America.
- Kreis P and associates (1985) 'PICOL - A picteme oriented language'; *Artificial Intelligence and Advanced Computer Technology; Conference Proceedings*, pp. 9, 26-32. London, (18 Bedford Square); Europa.
- Kroeber, D.W. and Watson, H.W. (1988). *Computer-based Information Systems: A management approach*. New York; Macmillan.
- Lang J.R., Dittrick J.E. and White S.E. (1978) 'Managerial Problem-solving models: A review and a proposal'. *Academy of Management Review*. October, vol.3, no.4, pp. 854-866. Mississippi State, Mississippi 39762; Academy of Management.

- Latham, Terry and Taylor (1965) 'The PABLA system'. *Work Study and Management*, February, 9,(2).
- Leidecker J.K., and Bruno A.V. (1984) 'Identifying and Using Critical Success Factors' *Long Range Planning*, February, vol.17. no.1. pp.23-32. Journal of the Society for Long Range Planning, London, Pergamon Press.
- Levinson E. (1985) 'The implementation of Executive Support Systems' Centre for Information Systems Research. MIT Industrial Liaison Programme, MIT, Room E38-568, Cambridge, USA, MA 02139; MIT.
- Lin E. (1986) 'Expert Systems for Business Applications: Potentials and limitations' *Journal of Systems Management*. July, vol.37, no.301, pp. 18-21. 24587 Bagley Road, Cleveland, Ohio 44138. Association of Systems Management.
- Lindblom C.E. (1959) 'The Science of Muddling Through' *Public Administration Review*, vol.19, no. 2, pp.79-88. American Society for Public Administration. (Also in Leavitt H. and Pandey L - *Readings in Managerial Psychology*, pp. 92-109. Chicago/London; University of Chicago Press.)
- Lodge C. (1987) 'Traveller's check' Survey published by the *Market Research Society*, Summer, p.13. (15 Northborough Street. London, EC1V 0AH).
- Logcher R.D. (1970) 'An integrated approach to a computer system for Structural Engineering' in '*Emerging methods in Environmental Design and Planning*' ed. Moore. pp. 79-91. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Long,R.J. (1987) '*New Office Information Technology - Human and Managerial Implications*'. Croom Helm Information Technology Series, University of Cambridge. London/Sydney/Dover (New Hampshire); Croom Helm.
- Malpas-Sands C. and Bevington T. (1982) 'Bringing the overheads down to earth'. *Management Today*, November, pp.33-39. London, Haymarket; Management Publications Ltd.
- Manheim M.L. (1970) 'A design process model: Theory and application to Transportation Planning', in '*Emerging methods in Environmental Design and Planning*' ed. Moore. pp. 331-348. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Martin, C.J. and Clarke B.A. (1990) 'Executive Information Systems: Recent Developments and Research Imperatives' *British Journal of Management*, vol.1, Issue No. 1, April, pp. 27-34. New York/Chichester; John Wiley and Sons.
- Martin J. (1992) '*B882 Creative Management - Block 2 Techniques*', Open University. Huddersfield; H. Charlesworth and Co.Ltd.
- Martin P and Nicholls J. (1984) 'How to create commitment' *Management Today*, November, pp.94-98. London, Haymarket; Management Publications Ltd.
- Martschew, Pope and Witt (1985) 'The IKON Knowledge base at PCS GmbH', *Artificial Intelligence and Advanced Computer Technology; Conference Proceedings*, London, (18 Bedford Square);Europa.
- Maruyama M. (1986) 'Towards picture-coded information systems'. *Futures*, vol. 18, no.3, June, Pp. 450-452. Borough Green, Sevenoaks, Kent; Butterworth.

- Maver T. (1970) 'Appraisal in the Building Design Process' in *'Emerging Methods in Environmental Design and Planning'* ed. Moore. Pp. 195-202. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Mazur L (1983) 'Baker Perkins High Tech Take Up' *Management Today*, June, pp.74-81. London, Haymarket; Management Publications Ltd.
- McCall M.W. and Kaplan R.E. (1985) *'Whatever it takes - decision-makers at work'*. Englewood Cliffs, New Jersey 07632, Prentice Hall Inc.
- McDermott J. (1984) 'Building Expert Systems' in *'Artificial Intelligence Applications in Business'*, W. Reitman. New Jersey, USA (355 Chestnut Street, Norwood, New Jersey 07648); Ablex Publishing Corporation.
- McDonald M.H.B. and Wilson H.N. (1990) 'State of the Art Developments in Expert Systems and Strategic Marketing Planning' *British Journal of Management*, vol.1, Issue No.3, September, pp.159-170. Chichester; John Wiley and Sons.
- McFarlan F.W. and McKenney J.L. (1981) *'IS Perspectives'*. Notes prepared as the basis for class discussion. Cambridge, Massachusetts; Harvard Business School.
- McKelvey B. (1975) 'Guidelines for the empirical classification of organisations' *Administrative Science Quarterly*, December, vol.20, pp. 509-525. Graduate School of Business and Public Administration, Cornell University, Ithaca, New York.
- McPherson J.H. (undated) *'The Innovative Organisation'* handout accompanying lecture. Menlo Park, California; SRI International.
- Meador C.L., Keen P.G.W., Guyote M.J., (1984) 'Personal Computer and Distributed Decision Support' *Computerworld*, vol.18, no.19. Framingham, Massachusetts.
- Meindl J.R. (1982) 'The abundance of solutions: some thoughts for theoretical and practical solution seekers'. *Administrative Science Quarterly*, vol. 27, December, pp. 670-685. Graduate School of Business and Public Administration, Cornell University, Ithaca, New York.
- Meyer H.H., Kay E. and French J.R.P. (1965) 'Split roles in performance appraisal'. *Harvard Business Review*, no.43. Cambridge, Massachusetts.
- Mill R. (1987) Quoted in 'Copying and Facsimile - a joint venture'. *Communicate*, January, pp. 37-38. 15 Regent Street, London.
- Miller R.K. and Walker T.C. (1988) *'Artificial Intelligence Applications for Business Management'*, PO Box 590, Georgia. Fairmont Press Inc., Lilburn, Georgia; SEAI Technical Publications.
- Mintzberg H., Raisinghani D. and Theoret A. (1976) 'The structure of "unstructured" decision processes'. *Administrative Science Quarterly*, vol. 21, June, pp. 246-275. Graduate School of Business and Public Administration, Cornell University, Ithaca, New York.
- Mintzberg H. (1990) 'The Manager's Job: Folklore and Fact' *Harvard Business Review*, vol. 90, No.2, March/April, Pp. 163-176. Cambridge, Massachusetts.
- Mintzberg H. (1991) 'Planning on the left side and managing on the right' from *Creative Management* ed. J. Henry. Beverley Hills, California/London; Sage Publications.
- Missikoff M. (1985) 'Expert Systems Applications: A methodological approach for a classification'; (pp. 10, 11-17) *Artificial Intelligence and Advanced Computer Technology, Conference Proceedings*, September. London (18 Bedford Square); Europa.

- Moran T.P. (1970) 'A model of a multi-lingual designer'; in *'Emerging Methods in Environmental Design and Planning'* ed. Moore. pp. 69-78. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Moss-Jones, J. (1990) *'Automating Management'*. London; Pinter.
- Musashi M. (1974) *'A book of five rings'*; Translated by Victor Harris. London; Allison and Busby.
- Nadkarni A.R. and Kenny G.K. (1987) 'Expert systems and Organisational Decision-making'. *Journal of General Management*, vol.13. no.1, Autumn, pp. 60-68. Henley the Management College in conjunction with Basil Blackwell, Oxford; Basil Blackwell.
- Nadler G. (1970) 'Engineering Research and Design in Socio- economic systems'; in *'Emerging Methods in Environmental Design and Planning'* ed. Moore. pp. 322-330. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Naisbitt J. (1982) *'Megatrends'*. New York; Warner Books Inc.
- Naughton J. (1984) *'Soft Systems Analysis: an Introductory Guide'*. Block 4, The Soft Systems Approach. T301 Block 4 SSA: Guide. Open University Press, London; Harper and Row Ltd., 28 Tavistock Street.
- Neisser U. (1976) *'Cognition and Reality'*. New York; W.H. Freeman and Co.
- Norris G. (1986) 'A KBS for Investment Appraisal'. *Knowledge Based Systems, Conference Proceedings*, Online, pp. 27-36. Advanced Computing Series: 2. London/New York; Online International Ltd.
- Obermeier K.K. and de Hilster D. (1985) 'DIID - a context-driven Natural Language Interface'; *Artificial Intelligence and Advanced Computer Technology; Conference Proceedings*, September. London, (18 Bedford Square);Europa.
- Oliff M.D. (1991) 'Strategic Information Management in Global Manufacturing' *European Management Journal*, Vol. 9, No. 4, December, pp 361-371. European School of Management, Oxford and Cambridge (USA); Blackwells.
- Optner S.L. (1965) *'Systems Analysis for Business and Industrial Problem-Solving'* Englewood Cliffs, New Jersey 07632; Prentice Hall Inc.
- O'Shaughnessy J. (1972) *'Inquiry and Decision'* London/Boston/Sydney; J.Allen and Unwin.
- Ovum (1992a) *Software Europe*. October. Ovum Ltd. 1 Mortimer Street, London, W1N 7RH; Ovum.
- Ovum (1992b) *'Workflow Management Software'* February. Ovum Ltd. 1 Mortimer Street, London, W1N 7RH; Ovum.
- Ovum (1992c) *'Multimedia'* March. Ovum Ltd. 1 Mortimer Street, London, W1N 7RH; Ovum.
- Owen A.A. (1982) 'How to implement strategy' *Management Today*, July, p.51. London, Haymarket; Management Publications Ltd.
- PA Consulting Group (undated) *'How to take part in the Quality Revolution: A Management Guide'*. PA Group, London.

- Palframan D. (1991) 'Sony confidently walks to a different European beat'. *Management Today*, January, p.90. London, Haymarket; Management Publications Ltd.
- Palframan D. (1992) 'Technology race grows apart' *Management Today*, May, p.110. London, Haymarket; Management Publications Ltd.
- Palmer R. (1988) 'Doing things in style' *BT Information Technology Journal*, March/April, p.13. BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- Patterson Dr. R.F. (undated) *The University English Dictionary*. London (52 Gloucester Place), University Books.
- PDS Manual (1983) Work Science Associates. London; Brunel University.
- Peltu M. (1986) 'Playing the AI game' *Datamation*, December. (Reed Publishing, USA); Cahners Publishing.
- Peters T.J. and Waterman, Jr. R.H. (1982) *'In Search of Excellence'* 10 East, 53rd Street, New York NY 10022; Harper and Row,
- Pettit S. (1986) 'Browsing is ... decision support'. *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 285-300 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Phillips L.D. (1982) 'Requisite Decision Modelling: A Case Study', *Journal of the Operational Research Society*. April. vol. 33, no. 4, pp. 303-312. London; Pergamon Press Ltd.
- Pinfield L.T. (1986) 'A Field Evaluation of Perspectives on Organisational Decision Making' *Administrative Science Quarterly*, No.31, September, pp. 365-388. Graduate School of Business and Public Administration, Cornell University, Ithaca, New York.
- Pogson J.B. and Brown C.M. (1985) 'Savoir - current practical applications of an Expert System package', *Artificial Intelligence and Advanced Computer Technology, Conference Proceedings*, London, (18 Bedford Square); Europa.
- Porter W, Lloyd K and Fleisher A. (1970) 'Discourse: A language and system for Computer assisted City Design', in *'Emerging Methods in Environmental Design and Planning'*, ed. Moore. Pp. 92-104. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge. Massachusetts/London; MIT Press.
- Post Office (undated) *'The Process of Problem-solving'* course handout. Post Office, 148 Old Street, London, EC1V 9 HQ.
- Poulet R. (1986) 'How Businesses bust themselves' *Management Today*, July, pp.68-71. London, Haymarket; Management Publications Ltd.
- Pounds W. (1969) 'The Process of Problem Finding' *Industrial Management Review*. Vol. 11, pp. 1-19. Industrial Management Review Association. (Also in Leavitt H. and Pandy L - *Readings in Managerial Psychology*, pp. 110-132. Chicago/London; University of Chicago Press).
- Prescott B.D. (1980) *'Effective Decision Making - a self-development programme'*. Aldershot/Vermont (USA); Gower Publishing Co. Ltd.
- Professional Manager* (1993a) Institute of Management, Vol.2, no.3, May, p 29, article by Murdock, A. Institute of Management, London; Alloo Printing and Publishing Co. Ltd.
- Professional Manager* (1993b) 'Are Managers getting the message?', Institute of Management, July, Vol. 2, no.4, pp.4, 32. Institute of Management, London; Alloo Printing and Publishing Co. Ltd.

- Project Management Handbook* (1992) BT Programme Office, TPU 1159, Issue 5 (08/92) BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- Quade E.S. and Boucher W.I. (1968) *'Systems Analysis and Policy Planning Applications in Defence'*. New York; Elsevier Publishing Co.
- Quillard, J.A.; Rockart, J.F.; Wilde, E.; Vernon, M.; and Mock, G. (1983) *'A Study of the Corporate Use of PCs'*. Mass.; Massachusetts Institute of Technology.
- Raia A.P. (1974) *'Managing by Objectives'*. Brighton/Glenview, Illinois; Scott, Foresman and Co.
- Rajan, A. (1988) *'Information Technology and Managers: Some Good Practices'*. Institute of Manpower Studies, Mantell Building, University of Sussex, Falmer, Brighton, Sussex; University of Sussex.
- Raiffa, H. and Schlaifer, R. (1961) *'Applied Statistical Decision Theory'* Graduate School of Business Administration, Boston; Harvard University.
- Raybould E.B. and Minter A.L. (1971) *'Problem solving for management - a new look at Method Study'*. Management publications for the Institute of Work Study Practitioners. London; Management Publications Ltd.
- Raymond L. (1988) 'The impact of computer training on the attitudes and usage behaviour of small business managers'. *Journal of Small Business Management*, July, vol.26, no.3, pp. 8-13.
- Remenyi D.S.J. (1990) *'Strategic Information Systems - Development Implementation case studies'*. NCC Blackwell, 108 Cowley Road, Oxford; Blackwell Publishers.
- Remenyi D and Money A. (1991) *'A holistic approach to effectiveness management'* Working Paper, HWP 6/91. Henley Management College, Greenlands, Henley-on Thames, Oxon - Brunel, University of West London.
- Report and Accounts, British Telecom, (1982). BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- Revans R.W. (1982) *'The origins and growth of action learning'*. Bromley (Old Orchard, Kent) Chartwell-Bratt.
- Reynolds F.D. and Darden W.R. (1974) *'Construing Life Style and Psychographics'* from *Life Style and Psychographics*, ed. William D Wells. Chicago; American Marketing Association.
- RIBA Handbook of Architectural Practice and Management* (1963) Royal Institute of British Architects. London, (The Finsbury Mission, Moreland Street) RIBA Publications Ltd.
- Rich E (1983) *'Artificial Intelligence'* New York/San Francisco/London; McGraw Hill Book Company.
- Richman L.S. (1987) 'Software Catches the Team Spirit'. *Fortune International*, June 8th, no.12, p.93. Times Inc. Magazines. New York; James B. Hayes.
- Roberts P.O. (1970) 'The Treatment of multiple goals in Systems Models', in *'Emerging Methods in Environmental Design and Planning'* ed. Moore. pp. 190-194. Proceedings of the First International Conference, Design Methods Group, Massachusetts Institute of Technology. Cambridge, Massachusetts/London; MIT Press.
- Roberts D. (1985) *'Delivering Executive Information Systems'*, unpublished, 2nd Annual System W National Users Group Conference. Comshare, 32-34 Great Peter Street, London, SW1P 2DB.

- Robertson E. (1987) 'Birth of a survey' *Survey*, Market Research Society, Spring. London, (15 Northborough Street, EC1V 0AH), Market Research Society.
- Rockart J.F. (1979) 'Chief Executives define their own data needs'. *Harvard Business Review*, vol. 57, No.2, March/April, pp.81-92. Cambridge, Massachusetts.
- Rockart J.F. and Treacy M.E. (1982) 'The CEO goes on-line'. *Harvard Business Review*, vol. 60, No. 1, January/February, Pp. 82-88. Cambridge, Massachusetts.
- Roe A. (1952) 'A psychologist examines 64 eminent scientists'. *Scientific American*, 187. (Also 'A psychological study of eminent psychologists and anthropologists and a comparison with biological and physical scientists' *Psychological monographs*, 1953, 67., no. 2).
- Rosenhead J. (1989) 'Robustness Analysis: Keeping your options open' from '*Rational Analysis for a Problematic World*' ed. J Rosenhead, pp. 193-218. New York/London/Sydney; John Wiley and Sons.
- Rowe C.J. (1988) 'Computer awareness among functional managers' *Industrial Management and Data Systems*, Sept/Oct, pp.14-18. Bradford; MCB University Press Ltd.
- Rowe C and Herbert B. (1990) 'IT in the Boardroom: the growth of computer awareness among chief executives' *Journal of General Management*, Summer, vol.15, no.4, pp. 32-44. Henley, the Management College, in conjunction with Basil Blackwell, Oxford.
- Sales and Installation Handbook*, internal publication by BT. Untitled and undated. BT PLC, 81 Newgate Street, London. EC1A 7AZ.
- Sackman, H. (1975) '*Delphi critique: expert opinion, forecasting and group process*' Mass., USA; Lexington Books.
- Saunders C and William Jones J. (1990) 'Temporal sequences in information acquisition for Decision Making: A focus on source and medium'. *The Academy of Management Review*, vol. 15, no.1, pp. 29-46. Mississippi State, Mississippi 39762; Academy of Management.
- Savage (1954) '*Foundations of statistics*' New York/London/Sydney; John Wiley and sons.
- Schnelle, E. (undated) '*The Metaplan method*' Metaplan Series no.7., by Metaplan GmbH, 2085 Quickborn, Goethestrasse 6.
- Schon D.A. (1971) '*Beyond the stable state*' London; Temple Smith.
- Schon D.A. (1983) '*The Reflective Practitioner: How Professionals Think in Action*' London; Temple Smith.
- Schwoerer J and Frappa J. (1986) '*Artificial Intelligence and Expert Systems: Any applications for Marketing and Marketing Research?*' ESOMAR Congress proceedings, pp. 10-24. European Society for Opinion and Marketing Research. Amsterdam; Elsevier Science BV.
- Scott-Morton, M.S. (1983) '*State of the Art of Research in Management Support Systems*'. Boston; MIT.
- Segev E (1976) 'Triggering the strategic-decision process' *Management Decision*, vol. 14., no.5, pp. 229-238. Bradford; MCB University Press.
- Severn Barrage Development Project (1987) *Consultation Document no.1*. Severn Tidal Power Group, Balfour Beatty Ltd. February. London, (1 Angel Square, Torrens Street, EC1V 1SX), Balfour Beatty.

- Shenhar A (1990) 'What is a manager?' *European Management Journal*, vol.8, no.2, June pp. 198-202. European School of Management, Oxford/Cambridge (USA); Basil Blackwell Ltd.
- Sibbett D. (1981) '*Georgia Advocacy Office Developmental Workshop*' Session notes, unpublished, August 31st, Atlanta.
- Simon H.A. (1969/1981) '*The Sciences of the Artificial*' Cambridge, Mass; MIT Press.
- Simon H.A. (1977) '*The New Science of Management Decision-making*', (2nd edition,) Englewood Cliffs, New Jersey 07632; Prentice Hall Inc.
- Sims D. (1992) 'Information Systems and Constructing Problems'. *Management Decision*, vol.30, no.5, pp. 21-27. Bradford; MCB University Press.
- Sinnott E.W. (1959) 'The Creativeness of life' in H.H. Anderson (ed.) '*Creativity and its cultivation*', New York (10 East, 53rd Street, NY 10022.); Harper and Row.
- Sixsmith, Major General E.K.G. (1970) '*British Generalship in the Twentieth Century*' . p. 27. London/Melbourne/Cape Town; Arms and Armour Press.
- Spencer, A. (1983) 'Non-executive realities' *Management Today*, May, p.64. Haymarket, London; Management Publications Ltd.
- Spender, Stephen (1952) 'The making of a poem' in B Ghiselin (ed) '*The Creative Process: A symposium*' University of California Press.
- Stainton R.S. (1982) 'Simulation: a means of grappling with the future' *Journal of General Management*, vol. 7, no.4, p. 19. Henley, the Management College, in conjunction with Basil Blackwell, Oxford.
- Stake R.E. (1972a) 'Comments and Conjectures: the seeds of doubt' *Educational Forum*, January, vol. 36, pp. 271-272. Kappa Delta Pi, USA. (Also quoted in *Beyond the Numbers Game*, ed, Hamilton D., et al. pp. 158-159. London; MacMillan.)
- Stake R.E. (1972b) 'The 7 Principal cardinals of educational evaluation'. Handout for presentation by Robert Stake at AERA Annual Meeting, Chicago. (Also quoted in *Beyond the Numbers Game*, ed, Hamilton D., et al. p. 160. London; MacMillan.)
- Stewart R. (1963) '*The Reality of Management*', Oxford (Halley Court, Jordan Hill); Heinemann.
- Talbot, E.G.; Savage, T.R. and Borko, H. (1982). '*Office Automation research at TRW using a Local Area Network*'. Unpublished, quoted by Long (1987) - see above.
- Taylor A.J.P. (1979) '*How Wars Begin*' London; Hamish Hamilton.
- Taylor J. (1986) 'Expert Systems: where do we go from here?' *Knowledge Based Systems*, Conference Proceedings held in London, July, Online, pp. 313-324 - Advanced Computing Series: 2. London/New York; Online International Ltd.
- Thakray J. (1984) 'TI's Profitable Paradox' *Management Today*, September, p.68. Haymarket, London; Management Publications Ltd.
- Tools and Techniques Handbook* (1988, January) BT internal publication - section 6. BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- Torrington D. and Weightman J. (1987) 'Middle management work'. *Journal of General Management*, vol.13, no.2, Winter, Pp. 74-89. Braybrooke Press.

- Trendelenburg, Zeller, Krautter and Schmitt, (1985), 'Pro.M.D. - an Expert System for Medical Diagnosis written in Prolog', *Artificial Intelligence and Advanced Computer Technology, Conference Proceedings*. London, (18 Bedford Square);Europa.
- Turban, E. (1990) *'Decision Support and Expert Systems'*. London/Basingstoke; McMillan Press Ltd.
- Turner C. (1983) in *'Companies' Management Today*, November, p.65. London, Haymarket; Management Publications Ltd.
- UKC Quality Directorate, (1988) *'Meeting Customer Requirements, Tools and Techniques for Continuous Improvement'*. BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- Van Gundy, Jr., A.B. (1988) *'Techniques of Structured Problem- Solving'*, (second edition), New York; Van Nostrand Reinhold.
- Vickers G. (1965) *'The Art of Judgement'* London; Chapman and Hall.
- Virkkala V. (1984) 'Creativity in management training: developments in Finland'; *Creativity and Innovation Network*, April/June. Manchester, M13 9 PL; Manchester Business School.
- Vliet V. (1984) 'How Remploy made whole' *Management Today*, September, p.60. London, Haymarket; Management Publications Ltd.
- Vliet V. (1986) 'Where Lucas sees the Light' *Management Today*, June, p.42. London, Haymarket; Management Publications Ltd.
- Waddington C.H. (1977) *'Tools for Thought'*. London; Jonathan Cape.
- Warfield J.N. (1982) 'Interpretative Structural Modelling (ISM)' from *Group Planning and Problem-solving methods in Engineering Management* ed. Olsen, S.A., pp.155-202. New York/London/Sydney; John Wiley and sons,
- Warlock D.R. (1990) 'Restructuring the European Information Industry' from *'On-line Information 90. 14th International Meeting Proceedings.'* Abingdon (Oxfordshire); Learned Information Limited.
- Watts, A. (1976) 'TAO. the Watercourse Way'. London; Jonathan Cape.
- Welbank M. (1983) *'A review of Knowledge Acquisition Techniques for Expert Systems'* Memorandum no. R19/022/83. BT publication. BT PLC, 81 Newgate Street, London, EC1A 7AZ.
- White D.J. (1975) 'Discussion' in *'The role and effectiveness of theories of decision in practice'* p.207. 1973 Conference proceedings edited by White D.J. and Bowen K.C. London; Hodder and Stoughton.
- Wickens J.D. (1968) 'Management by Objectives: an Appraisal'. *Journal of Management Studies*, no.5, Pp. 365-379. Oxford; Basil Blackwell.
- Wiig K. (1986) 'Expert Systems: impacts and potentials', *Knowledge Based Systems, Conference Proceedings held in London, July, Online*, pp. 1-10 - *Advanced Computing Series: 2*. London/New York; Online International Ltd.
- Willatt N. (1984) 'Patek Philippe's Better Time' *Management Today*, February, p.78. London, Haymarket; Management Publications Ltd.
- Willis C. (1986) 'On-line business databases: an investigation into their users and uses' *Business Information Review*, October, vol.3, no.2.

- Wilson B. (1984) *'Systems concepts, methodologies and applications'* New York/London/Sydney; John Wiley and Sons.
- Wilson B. (1986) BIM report. *Management Today*, March, p.89. London, Haymarket; Management Publications Ltd.
- Wind and Claycamp (1976) 'Planning Product Line Strategy: a matrix approach' *Journal of Marketing*, January, vol.40, no.1, Pp. 2-9. Chicago; American Marketing Association.
- Yankee Group (1987) *'IBM distributed systems: A Tactical review'*, February, Boston, Massachusetts; The Yankee Group.
- Yin R.K. (1984) *'Case Study Research - Design and Method'*. Beverley Hills, California/London; Sage Publications.
- Yong Yeong Wee, Kau Ah Keng and Tan Leng Leng (1989) 'A Delphi Forecast for the Singapore Tourism Industry: Future scenario and marketing implications'. *International Marketing Review*, vol.6, no.3, pp. 35-46. Bradford; MCB University Press.
- Young B and Linstone H.A. (1982) 'Delphi method' from *'Group planning and problem-solving methods in engineering management'* ed. Shirley Olsen. New York/London/Sydney; John Wiley and Sons.
- Young R.M. and Harris J.E. (1986) 'A Viewdata-structure Editor designed around task/Action mapping' from *People and Computers, designing for usability*. Cambridge; Cambridge University Press.
- Young S. (1968) *'Management: a decision-making approach'*. Belmont, California; Dickenson Publishing Company Inc.
- Zmud R.W. (1982) *'DSS enhancement of Informal Organisational Information Systems'*. Unpublished, Carroll Hall, Chapel Hill; University of North Carolina. (Paper also presented to 2nd International DSS Conference, San Francisco, June 1982).
- Zugback R. von, and Wilson J. (1989) 'Choosing an IT system by numbers', *Industrial Management and Data Systems*, no.3 pp.12-16. Bradford; MCB University Press Ltd.
- Zwicky F (1962) *'Morphology of propulsive power'*, Society for morphological research.