Manager–computer interaction: a study of a task–tool relationship

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MANAGER - COMPUTER INTERACTION:
A STUDY OF A TASK-TOOL RELATIONSHIP

by

K.D. EASON

A Doctoral Thesis
Submitted in partial fulfilment of the requirements
for the award of
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Manager-Computer Interaction: A Study of a Task-Tool Relationship  
K.D. Eason

Computer systems are playing an increasing role in management. This thesis presents three related field investigations of the benefits and problems of manager-computer interaction. An initial literature search shows that computers have considerable potential in the management process but that this potential is rarely realised. The first field investigation was an interview study of 82 managers who used three different kinds of systems; batch processed standard output systems, data base systems with interrogative facilities and management modelling systems. The results showed serious mis-matches between user task needs and the provisions of the system ('task fit' problems) especially for standard output systems. The more interactive systems had the potential to overcome 'task fit' problems but created 'ease of use' problems for the managers because of the more complex facilities they had to know and to operate.

After a theoretical analysis of the 'ease of use' issue a second field study is reported which examined the use made by 125 bank staff of a data base system with retrieval facilities. This study examined a strategy by which managers cope with 'ease of use' difficulties, making partial use of the available facilities. This study found considerable evidence for partial use. A model is offered to explain the phenomenon which is based upon the idea that the manager seeking a means of completing his task makes an often implicit choice between known facilities he can 'bend' to his purpose and a search for an ideal facility which may not exist.

The last field study examined the impact of computer systems upon the manager's conception of his task. It was a multi-national study of managers using eight systems in five countries. The findings show that tasks are perceived as more standardised and more complex. A causal framework is offered to explain this apparent paradox.

The final chapter examines the future of manager-computer interaction. The need is for a pre-programmed tool which can interact closely with a human being and enable him to remain self-programming so that he may cope with his open-ended tasks. A variety of promising developments are examined; flexible systems, evolutionary systems and adaptive systems.
The three investigations reported in this thesis were undertaken with the author as principal investigator but in association with other researchers. The exact responsibility of the author for the work reported in each of these studies is described below:

Study 1 of 82 U.K. Managers (chapter 3) was part of a larger study partially completed under an SSRC grant to the author. The full study of 254 users was planned with two colleagues, Leela Damodaran and Tom Stewart, and the field data was collected by all three investigators. The analysis of the data reported herein and the discussion is entirely the author's responsibility.

Study 2 of 125 bank staff (chapter 5) was planned by the author but pilotted and slightly modified by bank staff who thereafter administered the questionnaire. The analysis of the data and the discussion is the author's responsibility.

Study 3 of 8 management systems (chapter 6) was conducted under an SSRC grant which enabled the author to take part in an international study. The methodology of the study was developed in association with four research groups in other countries. The U.K. cases were conducted by the author and his collaborators Leela Damodaran and Tom Stewart. Each member of the international team took responsibility for analysing and reporting part of the international data. The material analysed and discussed in chapter 6 was the responsibility of the author.
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CHAPTER 1: THE STUDY IN PROSPECT

1.1 Man and his Machines

"The stories of man and his machines are inseparably woven together" (Weizenbaum, 1976, p.17). The tools man creates liberate him from the limitations of body and mind. Simultaneously they shape or channel the way he conceives of the world and the actions he considers possible. We are currently about 30 years into a revolution associated with one of the most significant machines man has produced, namely the computer, and we have yet to witness its full impact. It is the first flexible, general purpose, information processing device man has created and hence may liberate (or shape) man's thought processes more directly than any other machine. This thesis is dedicated to the study of how the use of computer technology is affecting the thought processes and actions of its human user.

The particular vehicle chosen for this investigation is manager-computer interaction. The manager was chosen as a suitable example of a user because his job embodies within it elements which make a computer a natural tool for him to use and, at the same time, elements for which it is singularly ill-suited. The manager deals in information for decision making purposes and should be able to make good use of a device which purports to monitor, search, store, retrieve and process information. However, management involves a range of ill-defined roles (cf. Minzberg, 1973) and the job is characterised by a need to cope with uncertainty and change. A manager may need to formulate goals, identify priorities, make value judgements, resolve conflicts, and take decisions in the face of uncertainty and ambiguity. Each of these functions would represent a severe challenge to the computer programmer. In the managers job is focussed much that is truly human in task performance and much that appears to relate to computer use. If we can achieve an understanding of what happens when computer technology is applied in this environment we may have learnt something of considerable significance for the future development of the latest of man's machines.
1.2 Theoretical Underpinnings

As Chapter 2 will reveal, the impact of computer technology upon management has received considerable research attention. It is however attention largely focussed upon the organisational ramifications of the technology. The research to be reported herein takes a different point of departure. It is an approach which derives from the experimental study of man as an information processor and its application in the discipline of ergonomics. In particular it is concerned with task performance at the individual level of analysis in which man and machine work together to achieve their task purpose.

Readers familiar with the literature on man-machine systems may assume that the emphasis in the study will be upon some fragment of man-machine interaction, for example controls or displays. The emphasis however is upon the system rather than its parts. In this instance the system is taken to be the man and machine working together to achieve a desired level of task performance, and the question to be examined is how the machine influences the man and influences task performance.

The approach used is to study three variables and the interplay between them: the man, the machine and the task. The framework this produces is summarised in Figure 1.1. The task is taken to be a requirement to transform a set of inputs to a desired set of outputs (goal achievement). The instruments for effecting these transformations are the man and the machine. (This approach to the concept of task is explored further in Harker and Eason (1979)).
The nature of task performance is a product of the characteristics of the task, the machine and the man and the interaction that takes place between them. The three variables can be conceived as the independent variables of this study, the impact upon task performance being one of the dependent variables. It is a mute point, to be examined more thoroughly subsequently, whether the task is to be treated as a wholly independent variable because, to some extent, the task as treated is that conceived by the man and implicitly modelled by the machine. However, inasmuch as task performance involves interaction with the real world, the task is likely to prove something more than the initial conceptions of man and machine. We will, for the present therefore, treat the task as an independent variable.

Task performance is not the only dependent variable under scrutiny because, as a result of the interplay of task, man and machine, there may very well be an impact on man and machine, for example, man may change his conception of the nature of his task as a result of a task engagement and some of the facilities of the machine may become unused.
It is then the purpose of this study to examine the impact of interaction between these variables upon each of the variables. In the study the task in question is the information processing task of management, the man is a manager and the machine is a computer.

1.3 Methods

All scientists, and especially those concerned with human behaviour, face the dilemma of whether to deal directly with the 'real' phenomena and risk the dangers of not achieving the control necessary to make reliable causal inferences, or whether to establish adequate control in a laboratory setting and risk creating artificial phenomena which bear little resemblance to the real thing. The only reliable way of dealing with this dilemma appears to be conduct studies which move through a field/experimental cycle. Once 'grounded concepts' (Glaser and Strauss, 1967) have emerged from relatively uncontrolled field studies, they can be tested in more closely controlled laboratory (or perhaps field) experiments. The results from these studies can then be put to the acid test of reality once again, perhaps in an action research paradigm in which they are used to make a contribution to a practical problem and the results evaluated.

When a field of study is in its infancy and there does not exist a body of tried and tested theory relevant to the subject matter, the investigator is well advised to go directly to the phenomena in reality and try as best he may to put some conceptual handles on it. Despite the research already conducted into the impact of computers, it was my conclusion that I had to start in a field setting and accept any lack of control that this entailed. As a consequence, this thesis reports three empirical studies each conducted in a field setting. They will not please the experimental design purist or those who hold statistical methods in high esteem. They are studies given what shape and control could be given while minimising contamination of the phenomena
and studies in which simple statistical techniques are used to aid the interrogation of somewhat messy data. Some might claim that a piece of research should lead to a theory both formulated and tested; I shall be happy if this research is considered to have brought into the scientific fold phenomena which have hitherto escaped close investigation.

The theoretical frameworks provided in the closing chapters of this thesis are to be regarded as an attempt to provide a relatively parsimonious explanation for the phenomena investigated. The propositions about cause and effect embodied within these frameworks have not been thoroughly tested although it is to be hoped that many of them are now expressed in such a way as to lend themselves to test. Indeed some of the propositions expressed at the end of Chapter 5 have already been the subject of experimental study and there are plans for further experiments.

1.4 The Structure of the Thesis

The work reported herein spans a period of 8 years (1972 to 1980) and is a series of studies each developed from the conclusions of the previous work. The work began with a literature review of research on manager-computer interaction which is reported in Chapter 2. This review showed that there appeared to be a considerable gap between the potential impact of the computer and the impact in practice and that many of the reasons were associated with the problems managers faced when trying to use the technology.

Guided by the conclusions of the literature review, a survey of managers using computers was conducted which focussed on the different types of systems in use and the problems of using them. The results of this survey are presented in Chapter 3. This study clarified many of the problems of manager-computer interaction and suggested some of the consequences for the way the system was employed, i.e. faced with difficulties the users 'coped' by using or not using the system in particular ways.
Following the survey results, Chapter 4 is a return to the literature, this time the psychological literature, to seek explanations for the phenomena observed. In particular, there was a need to seek a better understanding of concepts like 'ease of use' and 'least effort' which appeared to account for much of the user's behaviour. Armed with alternative explanations of this phenomena a further field investigation was conducted which is reported in Chapter 5. This study examined one aspect of system usage of one system in order to focus on a specific, critical issue and the study comes close to being a field experiment in which specific hypotheses are tested.

By following the major conclusions of the initial survey, the investigations up to this point had concentrated on difficulties in the relationship between the man and the computer. As a result the third element in the triad of variables, the task, had not received systematic study. To redress this balance, Chapter 6 presents a study focussed on the impact of the computer upon the task and in particular on the user’s conception of his task.

The concluding chapter (Chapter 7) brings together the findings of the three empirical studies to present a hypothetical causal framework which identifies the consequences of the three independent variables having certain characteristics. In conclusion it goes beyond this to suggest some of the characteristics that it will be necessary for the computer system to have if it is to have the liberating effect upon man's thought processes that has been predicted.

1.5 Acknowledgements

Any study that covers a span of eight years and involves field studies brings the researcher into contact with many people and depends for its success upon their willingness to offer assistance. I have been very fortunate in finding that whenever I needed help, it was readily offered.
The Human Sciences and Advanced Technology (HUSAT) Research Group, under the directorship of Professor Brian Shackel, provided a stimulating environment for the research. My colleagues in the group, Leela Damodaran and Tom Stewart, were my collaborators in the survey reported in Chapter 3. The survey we conducted together took a wider brief than the material reported herein and was partially supported by the S.S.R.C. The conclusions reported with respect to the management user are, however, my sole responsibility.

The three field studies reported involved the active cooperation of managers and computer systems staff in many organisations and, given the conclusions this thesis reaches about the value people place on their time and energy, I am extremely grateful to everybody who helped me. They are too numerous to mention and I am, in many instances, bound by agreements to confidentiality. I would like to offer my special thanks to the staff of the bank that was the setting for the case study reported in Chapter 5 because the structure and administration of this study was very much a case of joint collaboration.

The study reported in Chapter 6 is part of an international comparative study and in addition to my British colleagues, Leela Damodaran and Tom Stewart, I am indebted to the following who contributed to the research design and data collection: H. Lippold and E. Reindl (West Germany), N. Bjørn-Andersen and P. Pedersen (Denmark), G. Weiser (Austria) and D. Robey (U.S.A.). The project was supported by the S.S.R.C. Once again, the responsibility for the analysis and conclusions reported in Chapter 6 rests entirely with me.

I was assisted in the handling of the data by Marie Wagner and I was very fortunate that the early typing was in the lightning and accurate hands of Carol Hunt. The trauma and anxieties of finalising the thesis were greatly eased by the competent typing and unflappable charm of Sue Sher. The theoretical formulations in Chapters 4 and 7, especially inasmuch as they are concerned with task-tool relationships, owe more than she would accept
to many mind clarifying discussions with my colleague Susan Harker.

Due to my many other commitments, this thesis has been a long time in gestation and I must finally express my gratitude to my family; to Judy who gave professional help with many of the figures and mental support by never losing confidence that it would one day be complete, and to Claire and Michael for trying to understand their distant and irritable father. During the course of this research they learnt a great deal more about the world than I learnt about managers and computers.
CHAPTER 2: MANAGEMENT AND COMPUTERS; PROSPECTS AND REALITY

2.1 The Focus of the Investigation

This investigation concerns the degree to which the computer is providing a valuable aid to the manager in the performance of his work. The focus is therefore upon the computer as a tool supporting, and hopefully enhancing, the ability of the human being to perform his task. This initial chapter constitutes a survey of the literature to ask the following questions:

1. what are the predicted effects of management use of the computer, i.e. the advantages and disadvantages, and
2. are these effects found in practice and, if not, why not?

The literature on management and computers is vast and growing rapidly. Fortunately much of it is irrelevant to the purposes of this study and can therefore be ignored. A great many books and articles have been written, for example, which aim to inform the manager about the advantages of computerization, how to select a computer, and how to implement a system in his organization, etc. (e.g. Mumford and Ward, 1968; Engers, 1969). The existence of this literature illustrates the double role managers have to play with respect to computers. They are of necessity concerned in any major development that takes place in their organization and if clerical procedures are computerized they will have an important role to play. However, such a process has no direct effect upon how they manage. The second role arises when the application of the computer is directly to help them with their management function. It is to this latter role that this investigation is directed and hence any literature for management concerned with the former role will be disregarded.

2.2 The Prospects for Manager-Computer Interaction

The effects computers may have upon management have been widely discussed. Not unnaturally the backgrounds, disciplines and experience of authors clearly influences the kinds of predictions they make. These factors also influence the degree to which writers see the effects of the computer as purely beneficial, a mixed blessing or a force to be opposed. Other
authors attempt only to describe possible effects and make no explicit evaluation of the effects.

We can organise the many predictions into four categories which are derived from the two dimensions illustrated in figure 2.1.

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Level of Effect</th>
<th>Management Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normative</td>
<td>Individual Manager</td>
<td>1.2.1 Practitioners</td>
</tr>
<tr>
<td>Descriptive</td>
<td>Individual Manager</td>
<td>1.2.2 Decision-Making Theorists</td>
</tr>
</tbody>
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Figure 2.1: Predictors of the Effects of Computers upon Managers

The first dimension discriminates between two levels of effect the computer may have. It is anticipated that it will have an effect upon the individual manager but it may also have an effect upon the entire management structure of the organization. The second dimension concerns the orientation of the author; whether he adopts a normative or prescriptive orientation in specifying what should happen or whether he adopts a descriptive orientation, seeking only to describe what may happen leaving the assessment of whether this is beneficial or detrimental to others. We can identify authors with these orientations who comment upon each level of computer effects. At the level of the individual manager, I have termed the normative thinkers 'practitioners' because they are computer scientists, management scientists etc. concerned to specify the practical advantages of computer aid to managers. At the same level there exists a group of descriptive theorists who have analysed the management decision-making process as it is rather than as it should be and who attempt to predict what may happen when a computer system is used to assist this process.
At the level of the management structure there are a group of O.R., management science and cybernetics specialists who have derived theories of the structure organisations should take and the process by which they should function and they see the computer as a powerful tool in the achievement of these ideals. At this level too there is a group of industrial sociologists and organizational theorists extrapolating from their knowledge of organizations to predict what will happen when computerization takes effect.

The views of each group are presented below and, later in the chapter, the evidence is considered for and against the various prophecies that are made.

This review was first conducted in 1972 and its conclusions were instrumental in shaping the empirical studies conducted. No attempt has been made to update the review because it would disturb the logical presentation of the research. While I am aware of many more recent pieces of work I am not aware of any that would cause me now to change the conclusions I reach at the end of this review.

2.2.1 Practitioner Views of Computer Effects on Individual Managers

Computer system designers first became involved in organizational problems with the development of systems to undertake routine clerical operations, e.g. payroll, invoicing etc. Once an organization has these functions computerized, a good deal of company information is held in data banks. Managers are decision-makers and to make informed decisions they need information. In an organization of any size the acquisition of management information is nearly always a problem and most managers complain of having to make decisions on the basis of inadequate or out-of-date information. What could be a more natural progression for computer systems development therefore, than to use the speed and accuracy of the computer and the data already held, to provide management information? Thus the concept of computer-based management information systems was born.
As Hedberg (1970) points out, computers can have two different kinds of effects upon individual managers. One kind of effect is upon the quality of information inputs. The second relates to the managers' decision-making procedures. In general, systems designer advocates of management information systems have concentrated upon the effects on the quality of information inputs. Carroll (1967) summarises the conclusions of many in suggesting that computer-based systems may lead to higher quality information inputs as a result of improved:

a) currency (age) of data;
b) scope (globalness) of data;
c) accuracy of data.

In other words, by introducing a computer-based information system, managers may expect an up-to-date, relevant, complete, and accurate service.

The first variable, currency, has also become the centre of a controversy which has a direct bearing on whether management systems should be on-line and in real-time. An on-line system is one in which the user has direct access to the computer via a remote terminal and can therefore access its data banks whenever he wishes. A real-time system is one in which the data bank is up-dated as soon as data becomes available, e.g. as soon as a bank customer cashes a cheque his account balance on the data bank is amended. An on-line, real-time system therefore permits its user immediate access to the latest information. This possibility has been one of the selling points of management information systems and is based on the premise that managers who complain of out-of-date information actually need real-time information. Dearden (1966) has been a particularly outspoken critic of this assumption, considering that the very last thing a manager who is dealing with the long term policy of his organisation should need is immediate notification of every
change. It is a direct encouragement to engage in short term tactical decision-making rather than more difficult strategic planning.

Systems designers have concentrated upon the effects on information inputs presumably upon the assumption that man is a rational decision-maker and that better information means better decisions. Others have looked more closely at the likely effects upon the decision process itself and have adopted two rather opposite stances.

Operations Research and Management Science theorists who specialise in developing techniques to 'rationalise' the manner in which decisions are taken, see the computer as an opportunity to extend and develop these techniques. In some cases, although it is rarely stated explicitly, the target is complete automation of decision process because the availability of the right information plus formalised decision procedures can lead to an optimum decision being taken without reference to man.

The alternative approach, exemplified by Licklider (1960, 1965) foresees a future of "man-computer symbiosis" in which the decision process will be a joint endeavour with man and computer each undertaking the functions most appropriate to his/its abilities and working closely together in an on-line system to achieve better decisions than either could alone. In this approach the techniques of the management scientist, e.g. linear programming, network analysis, etc., are functions the computer can perform to aid the man who controls the decision-making process.
2.2.2 Descriptive Approaches to Computer Effects on Individual Manager

The opposing views of the practitioners on the decision-making process can best be assessed by examining in some detail what is known about the process by which managers actually take decisions. A number of theorists have sought to describe this process by producing models of the phases the decision-maker goes through.

There are many such models, e.g. Jones (1957), Gore (1964) and Pounds (1969), but a simple and widely used model is the three stage paradigm of Simon (1960). This model has the added advantage for the present purpose that it has been extensively used in two of the major investigations of the impact of computers upon management (Morton, 1967; Hedberg, 1970). This paradigm and the possible contribution of the computer to each phase of the process, is as follows:-

1. The Intelligence Phase

Intelligence is used here in its military sense to mean the gathering of information. In this phase therefore the manager is scanning the environment, both inside the organisation and outside, to identify problems he must tackle or opportunities he might exploit. It is the process of problem detection and it is over when the manager moves on to formulate a means of attacking the problem.

The computer can aid this phase of the process by providing a monitoring service, i.e. reporting to the manager the current state of the many information variables in which he may have an interest, e.g. sales, production, stock levels, the stock market prices, etc. There is also the possibility of the system going beyond the passive presentation of information and highlighting potential problems. For example, in 'management by exception' systems the computer compares predicted values with actual values and outputs only those which are in some way unusual or out-of-order and therefore require
management action. Computer systems that operate in this way, are in effect, performing part of the problem detection phase for the manager.

2. The Design Phase

The design phase involves, as Hedberg (1970) puts it "a search for understanding". At the end of the intelligence phase the manager knows a problem exists but he does not know its extent, its nature and, above all, its causes. He has to seek information to develop his internal 'model' of the problem. It is in the nature of people that at the same time as developing an understanding of a problem, they are also evolving different ways of resolving it and hence the output from this phase is one or more possible solutions to the problem.

This phase of the process tends to be very much more detailed and involved if the decision is 'non-programmed' as opposed to 'programmed' (March and Simon, 1958). A non-programmed decision is one which is unfamiliar to the decision-maker and therefore involves working from first principles to 'model' the situation before taking action. A considerable amount of information might be required to create and validate the model. When the decision is 'programmed', i.e. when the decision-maker has encountered the situation before and has a fully developed 'model' for handling it, only very specific pieces of information are sought before action is taken.

In both cases the computer can be of service. In the non-programmed situation, it can act as an information resource which the manager can interrogate to build up his model of the situation. In the programmed situation, the computer can, in effect, hold the 'model' in store and will therefore be able to collect and process the limited amount of information necessary to assess the situation and specify the available options. In these circumstances there is virtually no design phase and hence virtually no role for man in this phase of the decision-making process.
3. The Choice Phase

The choice phase is the phase in which the alternatives generated in the design phase are evaluated, perhaps compared, and a decision taken and implemented. Once again the nature of this process varies if the decision is 'programmed' or 'non-programmed'. If it is programmed it is often possible to provide a standard, objective, set of goal criteria against which alternatives may be compared and an optimal solution selected. If the decision is non-programmed it is usually not possible to specify all of the goal criteria for a comparison to be made. At the same time as the decision-maker is modelling the nature of the problem, he is also likely to be modelling the goals and values relevant to the situation, and it is most probable that this process is still taking place as alternatives are evaluated, so that the process is actually one of matching 'means' and 'ends' while at the same time making modifications to both the 'means' and the 'ends'.

In the case of fully programmed decisions there is no reason why the computer should not make the evaluation by comparing all alternatives against the goal criteria and should thereby take the decision. Many of the Operations Research techniques, e.g. linear programming, may be used to establish the optimal solution in these circumstances. In some situations, e.g. stock control and re-ordering, production control and scheduling, this is in fact what occurs. Where automation of the decision process cannot be fully implemented, the computer can still play an important role in the decision-making process by assisting the manager to evaluate the consequences of a possible solution. In the majority of 'non-programmed' situations, no matter how unique the situation, it is usually possible to compute some of the possible consequences of action. For example, whatever the issue, an organisational policy change usually results in an analysis of what it will cost the organisation and what financial benefits will result.
The computer can help by using a model of company operations to compute these values and so provide a 'what happens if?' tool for the manager who may try many solutions in a short time to see what effects they may have.

It is an important feature of the Simon model, and of more dynamic versions of it such as that proposed by Alexis and Wilson (1967), that iteration should occur between these three phases before a decision is made. Man has a tendency to conduct only a superficial examination of his problem before generating a trial solution and if this does not measure up to his 'level of aspiration' (Lewin et al., 1944), he may look more deeply at the nature of the problem to seek further solutions. In terms of the model this means re-cycling occurs, the decision-maker moving from the choice phase back to the design phase and may be even back into the intelligence phase in search of a wider understanding of the problem he faces. The more re-cycling that occurs the deeper the understanding is likely to be and the more likely the decision-maker is to come up with the optimum solution rather than one which 'satisfices', i.e. meets the minimum criteria for an acceptable solution (Simon, 1957).

One of the factors which can limit a decision-makers opportunities for re-cycling is the availability of information. Re-cycling usually means collecting, examining or processing more information and, if this takes time, it may delay the decision process which may be an important factor leading the decision-maker to 'make do' with the information he has. Morton (1967) argues that an on-line computer system provides a flexible source of information and processing aids and will therefore encourage more re-cycling to take place.

It is evident therefore that, whatever phase of the decision process we examine, there is a potential computer contribution. It is also evident that the computer can adopt a passive, supporting role vis à vis the manager, providing a flexible information service, or it can play a dominant role to all intents and purposes replacing the manager as a decision-maker.
2.2.3 The Normative Approach to Computer Effects on Management Structures

Shortly after computer specialists began to appreciate the value of their data bases as sources of management information, they also began to appreciate the extent to which information is the life-blood of organisations and that the computer had the ability to integrate the many different information systems of an organisation to facilitate the integrated management of the enterprise. As a result the literature contains many references to the creation of 'total' or 'integrated' management information systems, (e.g. Kanter, 1972). These are systems which gather together all of the formalised information flows within an organisation and are hence powerful repositories of information for management.

To a large extent the exponents of integrated management information systems are concerned with the improvement in the quality of information inputs to management. They are not explicitly concerned with the impact upon decision processes and still less are they concerned with possible changes in the organisation and functioning of the management structures. There are many theorists who, given the kind of system described above, have tried to predict what kind of changes may occur at the organisational level of analysis and these are discussed in section 2.2.4 below. However, another group of theorists see the possibility of systems of this kind as a golden opportunity to create 'rational' management structures and hence achieve 'rational' management of organisations.

The theorists who have derived concepts of 'rational' management structures are people who have backgrounds in management science and operations research. These are the disciplines which began by developing quantitative methods by which management decisions should be made, i.e. to encourage rational decision-making. The development of systems concepts, control theory and cybernetics has led some of
these theorists to broaden their base and to propose control systems for the management of organisations.

One of the leading figures in this movement is Stafford Beer (1966, 1967) who makes extensive use of an analogy between the organisation and the human nervous system. Beer argues that management, like the brain, needs a system for sending and receiving information from every part of the system it controls. However, there must be filters and controls to ensure that, whilst important information gets through, the majority of information is rejected, stored or summarised to protect the control centre from overload. Beer therefore proposes a hierarchy of control systems and specifies feedback mechanisms, filters, etc., to ensure that the central control obtains the information it needs. The computer, of course, provides an ideal vehicle by which an integrated set of control systems can operate.

As a result of this thinking several authors have proposed utopian views of the organisation of the future. Beer (1968), for example, describes a factory in which "machines control machines", i.e. computer systems command planning and control systems which control the activities of automatic machines operating on numerical control principles. Crawford (1967) provides a view of the "Brave New Business" in which the organisation is divided into three kinds of departments:

1. Sensory Departments (for detecting changes relevant to the organisation).
2. Operational Departments (for effecting action), and
3. Planning and Goal Changing Departments (for management).
The management functions under this arrangement are conducted by relatively fewer people who would make collective decisions in an 'operations control room' reminiscent of the 'war room' control centres, in which they would have access to all the information and decision aids the computer could supply.

Thus the computer system becomes the nerve system of a highly centralised organisation and the concept of integrated management information systems has powerful repercussions for the organisation of management structures.

2.2.4 Descriptive Approaches to Computer Effects on Management Structures

Section 1.2.2 was devoted to decision theorists who describe in detail how decisions are actually taken and predict the effects of computers upon individual decision-makers. In the same way there are theorists who describe in detail how organisations actually function rather than should function and they too comment upon the likely effects of computer systems upon management structures. The disciplines that these workers profess are organisational theory, management studies and industrial sociology, each with an emphasis upon behavioural aspects as opposed to the quantification approach of management science.

Amongst the many prophets from this background probably the earliest and most influential were Leavitt and Whisler (1958) who attempted to predict how the computer would affect management in the 1980s. They suggested that the possibility of a central control system would lead to a centralisation of decision-making because top managers would have access to all the information in the organisation which had previously been the property of geographically and organisationally scattered middle managers, ownership of information being one of the techniques by which they preserved their autonomy.
As a result of such a major shift in power and responsibility, it might be anticipated that the content of managers' jobs might change. Leavitt and Whisler believed this would be particularly true for middle management and described two ways in which they might be affected by the computer. First, they suggest that the ranks of middle management would be reduced as many of their functions would be centralised or taken over by the computer, and second they suggested that many middle management functions would be routinized or formalised so that many managers would, in effect, be demoted to supervisors. The overall effect of these changes would be that the management structure would be 'flattened' with fewer steps in the hierarchy and with most long-term decision-making centrally controlled.

The most important general effect which has been predicted and debated concerns the possibility of computers actually running the organisation and displacing managers from management functions altogether. On the whole these suggestions are made mostly by technologists and are not supported by organisational theorists. Dearden (1966) for example, feels that the work of senior managers in strategic planning is largely a matter of unstructured working with other people; of agreeing objectives and resolving conflicts, and is not an activity the computer could undertake. He considers the computer only has a place where decisions are repetitive, where the speed and accuracy of the computer can be beneficial. This view is echoed by Simon (1965) who sees automation of programmed decisions and therefore of junior management as a real possibility before 1990. He differs from Dearden however, in suggesting that the middle management function (management control) may also be fully automated in this period, leaving a few senior executives in sole charge of the organisation.
Thus, although their contact with the reality of organisations makes these theorists a little more cautious than their normative colleagues, the organisational theorists are still predicting fairly radical changes in management structures as a result of the application of computer technology.

2.2.5 Summary and Conclusions
This review reveals a diversity of speculation about the possible impact of computers upon management. One point on which everyone is agreed is that there will be radical changes in management or as Burck (1964) says "management will never be the same again". Beyond this however there is little agreement. There are considerable variations between those who are stating what they would like to see occur and those who are simply trying to predict what will occur. There is also a divergence between two alternative views of the man-computer relationship; in one view we are headed towards automated management, as the computer gradually takes over more and more of the management function, and in the other every manager is going to be given a tool so revolutionary in its potential that it will transform his decision-making capabilities. This somewhat confused picture can be interpreted in two ways; either we are not very good at predicting, and our values and ideologies confuse wishes and predictions, or the computer may have a range of effects and there is flexibility for those who design systems to select the particular effects of each application.

2.3 The Reality of Manager-Computer Interaction
We have now seen something like 20 to 25 years of computer applications in industry and commerce and this provides some opportunity to assess whether the hopes, fears and predictions are right. This section summarises literature reports of the reality of computer impact upon management concentrating upon empirical studies that have been conducted. The evidence for each of the predictions described in section 2.2 is considered but this time in reverse order, i.e. first the level of management structures and then the level of the individual manager.
2.3.1 Normative Predictions for Management Structures

There is very little evidence to suggest that we are any nearer automatic factories with computer based management control systems than we were 10 years ago. With the advent of the micro-processor the introduction of robotics on the shop floor is becoming more common but the cybernetic structures proposed by Beer and his followers have yet to have a major direct impact upon the design of organisations. It is not that these ideas have been tried and found wanting, it is more that they have not been tried. The one well known example was Beer's attempts to organise control systems for important sectors of the Chilean economy under the Allende regime which ended suddenly when the regime was overthrown and hence could not be evaluated.

Several reasons can be offered to explain the lack of use of these concepts. One reason frequently mentioned by advocates of this approach is that the managers who must make the decision to introduce these concepts, do not understand them (Ward, 1974; Kanter, 1972). To combat this ignorance widespread training and education programmes are advocated. Another reason often suggested is that managers are showing a 'resistance to change' syndrome because the role of the manager in the future organisation is not at all clear and it could be, for many managers, that there is no role at all.

An alternative formulation is that the 'rational' approaches of theoreticians under-estimate the complexity of organisations. There is very little room in these approaches for issues of a political nature in organisations; for the problems of goal formulation, goal conflict, the distribution of power and influence and the complex processes by which organisations handle these issues. Attempts to describe the management process in large organisations emphasise the importance of these issues (e.g. Cyert and March, 1963; Thompson, 1967) and any approach which largely ignores them must therefore be of limited value to an organisation.
Nevertheless there is some evidence to suggest that 'rationalist' approaches may be having an indirect effect on the design of organisational control systems. These approaches are very attractive to the computer programmers and systems analysts who are largely responsible for the creation of these systems. These specialists are trained in the use of quantified and formalised methods and many find it difficult to accept the ill-defined, ambiguous, conflict ridden field of management processes. When they design management information systems they are using their accurate, formal methods to create something which is to serve a large, fluid, uncertain, unknowable muddle. Anything that presents a formal, well ordered, view of this process is therefore welcome.

The problem is, of course, that this is the process as some theoreticians feel it should be rather than as it is. The system designers have little direct control over the process and they cannot force the process to become 'as it should be'. It is possible to predict that, where designers have been influenced by normative concepts, systems may be better at serving managers with what they should want rather than what they consider they want. This problem will be considered further in section 2.3.3. below.

2.3.2 Descriptive Predictions for Management Structures

There have been a number of studies by organisational theorists and industrial sociologists seeking to establish the consequences of computer use for management structures and management processes. One of the earliest was a study by Whisler and Meyer (1967) of the impact of the computer upon 19 American Life Insurance Companies. Whisler (1970) summarises the impact upon decision-making found in this study as follows:-
"Decision systems or areas are consolidated, decision-making moves to a higher level in the organisation, decision-making is increasingly quantified and rationalised. Also the study indicates that the primary impact on decision-making is at the middle-management level, that top management decision-making is little affected by the technology and that substantial new problems of inflexibility in decision-making have resulted from computer use. Finally, the effect on decision flexibility has been self-contradictory; use of computers in decision-making stimulates ideas for change but greatly increases the costs of adopting these changes".

There is therefore some evidence for the hypothesis that computer systems centralise decision-making and decreases the power of the middle manager. In claiming that decisions are made more rationally using quantified methods there is also support for the normative views of O.R. and Cybernetic theorists.

These findings have been supported by other studies by Hoos (1960), and Vergin (1967).

However, a study by Blau and Schoenherr (1971) of 54 employment security agencies in the U.S.A. came to the opposite conclusion, namely that computerisation promotes decentralisation of responsibility. This finding has been supported by other studies by Adams (1965), Shaul (1964) and Klatzky (1970), who each found middle managers who claimed they had more responsibility than hitherto. Klatzky explains this finding by postulating a "cascade effect". In her study of 50 U.S.A. labour offices she found that senior executives were happy to shed some of their decision-making responsibilities to their juniors in order that they could concentrate upon more strategic planning. The computer facilitated this process by taking over some of the more routine tasks of the junior managers thus giving them more time for accepting new responsibilities.
We thus have directly contradictory results from different studies. The same confused pattern emerges with respect to the job content and status of middle managers. Whisler and Meyer found that the function of middle managers had only marginally changed in their life offices; they had not been reduced to supervisors as Leavitt and Whisler had predicted. However, Burck (1964) considers the effects are more dramatic, and that many middle management jobs are being lost or re-organised because of the impact of the computer. Vergin (1967) investigated the status issue in 11 organisations and concludes that in no case was a middle manager relieved of his job. He did find, however, that functions of motivation and co-ordination had been reduced amongst the most affected managers with subsequent feelings of reduced status. Shaul (1964) in a study of 53 companies, concluded that middle managers devoted more time to planning, staffing and guidance of personnel and less to direct supervision, and that status had therefore been increased.

Contradictory results appear to be a characteristic of studies of the impact of computers upon management and several reasons for this state of affairs can be offered. First, as Pedersen (1974) argues, there are considerable methodological problems. One researcher's measure of centralisation is quite different from that used by another and where there is little agreement upon the nature of critical variables, little agreement in results is to be expected.

Another possibility, as Rosemary Stewart (1971) concluded from her case studies of 10 British Companies, is that the effects of most systems on middle and senior managers is quite marginal. Vanlommel (1972) considers that a methodological issue has contributed to many investigators obtaining more dramatic views of the impact of computers than is warranted. He claims that most investigators ask
directly about the impact of the computer whereas in his study of Belgian organisations he employed indirect methods and was led to the same conclusion as Stewart; that effects that could be directly attributable to the computer are minimal.

A third possibility is that the computer creates a potential for change but it depends upon the management climate of the organisation how this opportunity is used. In other words, computer systems are not deterministic and there is flexibility in the impact they can have; if you want to centralise you can create a system that enables this, if you want to de-centralise the computer can also facilitate this process.

If this range of possibilities exists it is hardly surprising that results are conflicting and it would appear necessary for future investigators to examine the dynamics of the systems design process to ascertain the influences that might lead to the effects found subsequently. Mumford and Hedberg (1975) in their international study have demonstrated that choice exists in the development of computer based clerical systems and there is little reason to doubt that the same or more choice exists if a system is being developed to serve a less routine function.

Finally, there are two possibilities which have been virtually ignored by all investigators of the organisational level of impact. One is that the different kinds of computer technology may have different consequences for management. There are considerable differences between, for example, batch processed systems and on-line systems, but very few of the investigations cited above have taken systematic account of these variations. The other possibility is that the success or failure of the system may have consequences for its effects upon management. If a system is regarded as extremely valuable by management one might
anticipate that its effects would be greater than if it were regarded as an abject failure. However, few of the investigators have attempted the, admittedly difficult, task of evaluating system success.

2.3.3. Practitioner Reports

If the effects upon management structures has not been quite as radical as predicted perhaps there has been a more immediate effect upon the individual manager. It will be recalled that two kinds of effect have been predicted; first a change in the information input to the manager and second a change in the decision process. In this section we review the reports of managers and of system designers on the success of the systems thus far introduced.

With respect to information input we can ask whether we are now in an age where managers make decisions on an informed basis supplied by the computer with relevant, accurate and timely information? A glance at the titles of books and articles reporting the scene tells its own story; "the computer disillusion" (Stewart, 1967), "the unhelpful computer" (Cloot, 1970), "management misinformation systems" (Ackoff, 1968), and "the myth of real-time management information systems" (Dearden, 1966). Hardly a month goes by without some group of computer specialists gathering together to hold a post-mortem about the ineffectiveness of computer based management information systems.

It appears to be universally accepted now that the potential attributed to computer aid for managers is not being realised in practice, a conclusion supported by a number of surveys of management opinion. In the U.S.A. McKinsey and Co. (1969) conducted a survey of 36 companies and found that the majority were disappointed with the profitability of their computer installations. As a 'super-clerk' the computer was regarded as successful but employed as an aid to management its success had been minimal. Barnett (1969)
reports a survey by Case and Co. of 865 executives from 655 U.S.A. companies which found widespread dissatisfaction with computer aid and a lack of knowledge of the potential of the computer. In Britain a survey of 102 firms by Rothwell (1968) found 40% of companies unhappy with computer profitability and 55% claiming their computer was under-employed. In a more recent survey of 2000 Canadian middle managers, Guthrie (1974) also found a considerable measure of negative attitudes to computers, more so amongst people who had had relatively little experience of computer aid.

A general conclusion to be drawn from these reports is that when the computer aids clerical procedures it is successful, but when it seeks to aid the more complex tasks of the manager it usually fails. The problems of individual managers receiving information from computers are now very well known. They may be listed as follows:

1. Timeliness - although it is fast, the computer often produces information after the vital decision has been taken when the information is of historical interest only.
2. Relevance - the popular stereotype of a manager is fast becoming one of a man surrounded by piles of printout which he is desperately searching for the one item of significance to him.
3. Comprehensiveness - despite the volume of information generated, the vital information may still be missing.
4. Accuracy - many errors are found which automatically renders the remaining information suspect.
5. Breakdowns - the reliability of computer systems is such that managers are frequently cut off from their information source.
If managers are not being well supplied by their information service it may be the computer is being more successful in directly supporting their decision processes, i.e. by providing mathematical techniques for the computation of optimal decisions or enabling the manager to evaluate the consequences of alternatives he may be considering. The story is, unfortunately, a rather similar one. Managers too often find computer based techniques such as linear programming, network analysis, exponential smoothing etc., too complex to understand and too difficult to use. They are faced with the uncomfortable choice of using the computer aid and accepting its advice without question, (because they do not know how to assess it) or rejecting the system in its entirety and proceeding by manual means. The experiences reported by Bluck and Taylor (1968) provide a salutary lesson. They developed a complex production planning system which optimised stock levels over a 12 month period. Unfortunately planners found it impractical and impossible to use. Thereafter the model underwent several modifications until it had become much simpler and had lost all of its mathematically sophisticated techniques. In its final form the planner could use it to test out the consequences of his decisions as he made them and, as a result, it became an acceptable and useful tool.

Faced on all fronts with the rejection by management of computer aid, attention has turned to where in the system design process, designers were going wrong. There has been widespread condemnation of the practise of not involving users fully in the design process because, amongst other things, it encourages designers to proceed on the basis of assumptions about management which may be untenable. Ackoff (1968), in a very influential article, identifies five assumptions which he believes are not justified:-
1. The critical deficiency under which most managers operate is the lack of relevant information.
2. The manager needs the information he wants.
3. If a manager has the information he needs, his decision-making will improve.
5. A manager does not have to understand how his information system works.

In addition to these assumptions another which has already been mentioned is that managers need up-to-date information. Dearden (1966) and others consider that management should be concerned with long term trends and the provision of up-to-date information is an encouragement to deal only with short term issues.

2.3.4 Systematic Studies of the Process of Manager-Computer Interaction

The studies reported above have been anecdotal or, at best, field reports of the reactions of managers to computer aid. They constitute 'black box' studies in which the input (the computer aid) and the output (the manager's reaction) are known but the process of engagement which leads to the output can only be surmised. There are a few studies which have directly studied this process and the results are of considerable significance.

Morton (1971) conducted a study in the Laundry Division of the Westinghouse Electric Corporation in the U.S.A. He developed a system based on visual display terminals which provided managers with decision aids for marketing and production decisions. The system provided an information base for these decisions and facilities for the manipulation of the information to explore future possibilities. He also made a detailed evaluation of the effects of this system in operational use employing Simon's intelligence, design, choice paradigm as his analytical framework. Whilst he concludes there can be no certain way of showing that the decisions made were 'better', he reports many changes
in the process of decision-making which are assumed to lead to improved decision-making. These may be summarised as follows:

1. **Impact Upon Time.** There was a sharp reduction in the amount of time the managers spent working on the problem and in the elapsed time, in one case from 22 days to 1 day.

2. **Problem Finding.** The system helped pattern recognition by enabling managers to detect trends, see relationships and generally appreciate the information they requested.

3. **Problem Solving.** The managers developed several solutions and frequently implemented solutions they did not, at first, foresee as possibilities.

4. **Communications and Learning.** The managers reported that their ability to manipulate information gave them a much better insight into the nature of their task and enabled them to demonstrate points to their colleagues effectively.

This generally very positive evaluation of the impact of computer aid stands in stark contrast to most of the studies reported which imply that the computer does not have its predicted positive effect. Morton (1971) considers that the main factor is the use of interactive visual display terminals. He feels in particular that batch processed systems are only appropriate to support structured types of decisions; the more flexible, interactive data base technology underlying the use of visual display terminals is necessary to deal with unstructured, ill-formed problems.
Corroborative evidence for this view comes from a study by Hedberg (1970) which investigated the use of a management game in which participants took roles in 4 competing banks. The participants in the game were given three types of computer aid: a hard copy (HCR) system in which some reports were automatically provided whilst others were available on request, a Cathode Ray Tube (CRT) system in which the same information base could be interrogated on-line, and a second CRT system with the same information base but with additional manipulative options for forecasting. These systems were used by bank executives and by students of business administration.

Hedberg also used the Intelligence-Design-Choice paradigm to analyse the resultant decision-making process. He noted marginal changes in the directions indicated by Morton (more information search, greater intensity of decision-making activity etc.) but he did not detect evidence for recycling between the three phases. His results are therefore supportive of Morton's conclusions but he is much more cautious about proclaiming changes in the decision-making process.

With respect to Morton's conclusions about the advantages of using visual display terminals, Hedberg offers interesting comparisons between the hard copy and the CRT versions of his system, in particular he notes greater activity in the intelligence phase with the CRT versions. He also found many differences between students and bank executives. Students tended to use more reports, to search for more information and to use other decision aids much more frequently than bank executives. Hedberg analysed taped protocols of decision-making sessions and came to the conclusion that Bank Executives were making much more frequent use of 'standard operating procedures' (SOP's) than students. These are rules for search and monitoring and action etc. developed for use with other forms of information technology, and they continued to dominate the bank executive's behaviour and
possibly inhibited their ability to make effective use of the new tools at their disposal.

Hedberg identifies one other reason why the impact upon the decision-making process may not have been as far-reaching as expected. He reports that the man-computer interface used with the CRT versions of the systems was slow and frustrating to use and this may have inhibited users. A similar conclusion was reached by Eason and Corney (1970) in a comparative study of managers using a manual planning aid and an interactive aid used with a teletype. The problems of using the latter system were such that 48.6% of elapsed time in each session was classified as non-productive with respect to the decisions to be taken. As a result there is very little evidence for a change in the decision process; managers continued to implement the first viable alternative they formulated.

The evidence of these process studies suggests that the batch processed method of giving decisional support to managers is much less effective than support given by interactive terminals. An alternative explanation for the more positive results of these process studies is that they are studies in which the managers were either subjects or under very close scrutiny by the investigator. The systems they were using had also been very carefully constructed to serve the task environment. These 'spotlight' features may be contrasted to the lack of attention paid to individual managers in the design of large-scale management information systems and may have contributed to their success. A comparison of the impact of batch processed systems and interactive systems in the field is needed to resolve which explanation is appropriate. If it is the interactive nature of the aid which is important a second conclusion may be reached which is that, even when an interactive system is employed, success is by no means guaranteed because factors relating to the ease of use of the man-computer dialogue may well become crucial.
2.4 Summary and Conclusions

This review reveals that, at all levels, the history of manager-computer relations is a story of glittering prophecy not borne out in practice. At the organisational level automatic factories are not yet in being nor is there conclusive evidence that computer systems dramatically influence the power structure of the organisation. At the individual level the manager has neither been displaced nor has his decision making ability been revolutionised by the powerful new tool at his disposal. For most managers the story is one of disillusionment with the information support provided by their computer system.

Explaining the disappointing progress of the computer in the managerial environment is difficult because most of the studies are fairly global and give few clues as to what happens when managers use computer aid. Two kinds of conclusion seem justified and worthy of future research. One is that the process of systems design tends to adopt a view of the organisation which is normative and 'rational' with the result that the system produced is not sufficiently well matched to organisational reality to lead to any real impact. This view is currently receiving much attention from authors concerned with 'user involvement in systems design' or 'participative design' (Mumford and Henshall, 1978).

The other conclusion is that the batch processed basis of computer technology which was the operating mode of most systems studied by investigators is not capable of meeting the varied and uncertain needs of managers. The evidence from Morton and Hedberg suggests that the use of interactive terminals may avoid these limitations.

Whilst not disputing the importance of the former conclusion, this research is designed to examine the second conclusion which has received much less attention. As a first step towards examining the nature of manager-computer interaction in more detail, this research programme began by examining the different effects of batch and on-line systems in use by managers.
CHAPTER 3: A SURVEY OF MANAGER-COMPUTER INTERACTION

3.1 Introduction
As a result of the literature review presented in Chapter 2 the first objective established for this research was to clarify the nature of the impact of computer systems on different types upon managers. Specifically, the intention was to examine whether the impact of batch processed systems has been as disappointing as the literature suggests and whether more interactive systems meet with any greater success. The survey reported in this chapter seeks to build a general framework for understanding the response of the manager to computer aid and to answer these specific questions about the impact of different kinds of systems.

3.2 Research Design
The principle independent variable in this study was the type of computer system used by the manager. As a supplementary study an analysis was also conducted of the effects of the level of the manager in the organisational hierarchy. The dependent variable was an assessment by the manager of the impact of the computer system upon his task and more widely upon his role within the organisation. The principle hypothesis under examination was that the more interactive systems would be evaluated as giving a better service and having a more positive impact than batch processed systems. The variables were operationalised as follows:-

3.2.1 Types of Computer System
Closer examination of the kinds of computer systems used by managers revealed that a simple division between interactive and non-interactive systems would be inadequate. In suggesting that terminal based systems were superior to batch processed systems authors such as Morton (1967) refer to two properties of these systems. First they refer to instant access whereby terminal users can get answer to questions within seconds and can therefore complete their decision-making in 'one sitting'. Secondly, they refer
to the facility for interrogation of the system. Many batch processed systems provide only a standard set of outputs for their users and do not have facilities for special purpose analyses. Interactive terminals permit the user some choice over the information he obtains. Analysis of a few systems suggested that the property of interrogation was not confined to terminal based systems although the property of instant access is only associated with terminal systems. In order to discriminate whether any differences in impact are attributable to one or the other of these two properties it is necessary to adopt the classification of forms of manager-computer interaction given in figure 3.1.

<table>
<thead>
<tr>
<th>Mode of Interaction</th>
<th>Mode of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch Processed</td>
<td>Non-terminal</td>
</tr>
<tr>
<td>Standard Output</td>
<td>✓</td>
</tr>
<tr>
<td>Data Base Systems with Retrieval Facilities</td>
<td>✓</td>
</tr>
<tr>
<td>Computer Models for Decision Evaluation</td>
<td>✓</td>
</tr>
</tbody>
</table>

Figure 3.1: Forms of Manager-Computer Interaction

In this classification we have adopted the terms Mode and Medium of interaction to describe the two properties of systems in which we are interested.

The Medium of Interaction refers to the availability to the user, of a device which provides the user with instant access to the facilities of the computer. In this classification we have not attempted anything more than a simple dichotomy but clearly the terminal category could be subdivided into
coding sheets, printouts or perhaps contact with the computer only through another human being. We shall make references to distinctions in the medium of interaction at this level as necessary in the text.

The Mode of Interaction refers to the choices the computer system permits the user in the outputs he receives. At the simplest level the user has no immediate choice. The system generates a set of standard outputs and some of these are sent automatically to the user. There is often no provision within these systems for special purpose analysis to be performed at the users instigation. Such requests could only be met by additional programming effort. The user therefore has no power to interrogate the system. At a more sophisticated level, data is held on a data base and the user is provided with retrieval and search facilities which enable him to explore the data base and extract the information he requires. In this mode the user is unable to change the data base or ask for the information to be processed in particular ways. He is like the reader of a book who can turn the pages but not change the words. The power to process information comes when the manager makes use of evaluation models for decision evaluation. In these systems the user has control over some of the parameters by which the system processes information and can obtain answers to questions such as 'what happens to profits if we phase out product x and introduce y'? It is possible to identify other modes of interaction and to discriminate more finely between the three presented here but for the purposes of this study a classification into these three modes was adequate. (For a more detailed classification see Eason et al. 1975).

It will be noted that as the mode of interaction becomes more sophisticated so the user has more power to interrogate the system. It is most unlikely that any user would employ a terminal with the standard output mode because he has no need to interact with the system. It is quite possible
however to use both of the more sophisticated modes with and without a terminal. It is not necessary to have instant access to interrogate a data base or operate an evaluation model. We may thus expect to find forms of interaction in use between managers and computers in five of the six cells of the matrix in figure 3.1.

There is one further consequence of adopting a view of a system which focusses on the facilities offered to users: the system can appear in very different forms to different members of the user population. In this survey therefore managers will be classified by the form of interaction they employ and any system may appear in several cells of the matrix.

3.2.2 Job Level
To examine whether the impact of computer systems varied with management level, the managers in the sample were classified into three levels: Senior managers, who were company directors or divisional managers in large organisations, Middle managers, who were departmental or branch managers, and Junior managers, who were section heads, supervisors or management assistants.

3.2.3 The Assessment of Computer Impact
Chapter 2 indicated that computer systems could have many different kinds of effects upon managers, from the creation of symbiotic partnerships which open up the possibilities of enhanced performance in decision making to the loss of important job functions. In assessing the impact of the computer system in this survey there were two aims. The first was to attempt a comprehensive evaluation so that a profile of impact could be identified. The second was to focus upon the perceived adequacy of the service provided by the computer system. This focus was adopted because much of the literature which is critical of the progress of MIS identifies the inadequacy of the service as the major reason for failure. It is also based on the belief that
positive impacts of the system upon managerial life will arise where the service is regarded as good and a poor service will lead either to negative wider impacts or no impact at all.

Following this overall rationale the assessment of impact was constructed to cover the following four factors:

1. **Task Fit.** This is an assessment by the manager of the degree to which the service provided by the computer meets the requirements of the tasks he undertakes. It is an assessment in which the manager is asked to judge whether there is any serious discrepancy between what he finds he needs and what the service provides on six dimensions of an information service: **accuracy**, **relevance**, **completeness**, **recency**, the extra work required to translate output into useable form, and **reliability** in the sense of frequency of breakdowns.

2. **Ease of Use.** Taking note of indications by, for example, Hedberg (1970) and Eason and Corney (1970) that the ease with which a system may be used is likely to be an important factor governing usage, an assessment of 'ease of use' was included. Some of the questions were relevant to all systems (legibility, ease of analysis, extra work and operating procedures), whilst others were specifically related to terminal usage (reading from a vdu screen, workspace and environment, response time and terminal operation).

3. **User Support.** This was an assessment of the help available to the manager in using the system. It covered questions of two kinds: those relating to help in using the system (assistance after breakdowns, with interpretation and with operating difficulties) and past and future user involvement in systems design.
4. **Indirect Consequences.** The other assessments are concerned with an assessment by the manager of the system: this assessment is of the impact of the system upon himself, his work and his job. It is closer to being an assessment of the impact of the system. It covered questions relating to impact upon the work itself (*degree of routine, procedures, and workload*), the manager’s attitudes to his work (*satisfaction, new ideas, skills and methods*), and broader implications upon *job scope and communications with others*.

These questions were presented to the manager in a semi-structured interview which lasted between 1 and 2 hours. The survey was of an exploratory nature and it was deemed inappropriate to structure responses according to pre-established scales. The policy adopted was that for each question the manager would be asked if there was a problem or an issue and if there was, it would be followed up according to a prescribed checklist. The full questionnaire is presented in Appendix 1.

### 3.2.4 The Management Sample

This study was conducted as a part of a larger survey which included other types of user. The full survey is reported in Eason et al. (1974). In the entire study 26 different computer systems were examined which were deliberately heterogeneous in functions, organisation and type and size of user populations. The philosophy was to seek similarities and differences in user responses in a cross-section of commercial computer applications. One of the advantages of being part of a larger study is that the sample of 82 managers is taken from 17 different systems and hence the common response characteristics to be reported are unlikely to be functions of specific systems or of specific organisations. The structure of the sample is given in figure 3.2.
The intention in constructing the sample of managers was to seek equivalent numbers of managers for the various forms of interaction identified in Figure 3.1 and for the three levels of management. Figure 3.2 indicates that these objectives could not be achieved. It proved very difficult (a) to locate managers who themselves used computer terminals, and (b) senior managers who made direct use of the computer in any way. It will be noted that just over half of the managers used batch processed standard output systems. This is despite considerable efforts to locate managers using more interactive modes of interaction and is probably an underestimate of the proportion of managers using the standard output type of system at the time of the survey (1972/73). The sub-totals of systems sum to more than 17 because some systems are used by managers in more than one category of the sample matrix.

**Figure 3.2: The Management User Sample**

<table>
<thead>
<tr>
<th>Form of Interaction</th>
<th>Management Level</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Junior Users</td>
<td>Middle Users</td>
</tr>
<tr>
<td><strong>Mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Standard Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td>Terminal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td>2. Database with Retrieval Facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Terminal</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Indirect</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Terminal</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>43</td>
<td>13</td>
</tr>
<tr>
<td>Terminal</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>14</td>
</tr>
</tbody>
</table>
The nature of the sample is instructive with respect to the kinds of systems in use by managers during the period of the survey and the level of management most affected. It does however mean that care has to be taken in the examination of the results to avoid unwarranted assumptions.

3.4 Treatment of Results
The main aim of the analysis of data from managers is to examine how they respond to different forms of interaction with the computer. However, the reasons for their responses are likely to be a product, among other things, of the tasks they undertake and the conditions under which they work. It is useful therefore to begin the analysis by trying to build up a view of the manager as a computer user in general before looking at his response to particular forms of computer aid. It is possible to do this by comparing managerial responses to the responses of other users in the survey as a whole.* Further indications of the nature of the manager's world and how it affects his use of the computer can then be gleaned from an examination of variations in response with job level. Lastly, the data is presented to permit examination of variations due to the form of interaction employed.

3.5 The Manager and Other Computer Users
The main survey included two other types of user: Clerks (n = 103 from 15 systems) and Specialists, i.e. designers, O.R. specialists, economists etc. (n = 69 from 10 systems). Many of these users were making use of the same systems as the management users. For an exposition of the nature of the specialist user and his problems see Stewart (1976).

* The data relating to clerical and specialist users is presented here by courtesy of my co-workers in the main survey, Leela Damodaran and Tom Stewart.
3.5.1 Task Fit

A comparison of the results of the three groups of users on the component questions of the task fit is given in figure 3.3. Also included is an overall score, a 'task fit index' composed of all questions (given equal weighting) and representing the percentage of responses indicating users were free of problems. A high score therefore indicates a good fit.

<table>
<thead>
<tr>
<th>Problems With:</th>
<th>Managers %</th>
<th>Clerks %</th>
<th>Specialists %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>26</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Relevance</td>
<td>33</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td><strong>Completeness</strong></td>
<td>59</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>Recency</td>
<td>33</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Extra Work</td>
<td>38</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>Reliability</td>
<td>69</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>*Overall Task Fit Index</td>
<td>57</td>
<td>63</td>
<td>70</td>
</tr>
</tbody>
</table>

*Figure 3.3: A Comparison of Task Fit Results for Three User Types*

** p < 0.01 (x^2)  
* p < 0.05 (x^2)

Viewed overall the management users obtained a significantly poorer service than did other users. On many of the component questions more managers than other users expressed the view that there were shortcomings in the service and in the case of the completeness of the service this was a significantly greater number. The question about the reliability of the system yielded the greatest proportion of negative comments but other users were equally concerned about this issue. Most users it would seem, are concerned about their dependence on the service they get from the computer and are in difficulties when it is not available.
These results confirm the impression given by the literature that the management user is not generally well served by his computer systems. The nature of his complaints suggest that he had most difficulty getting a reliable service which covers the breadth of his information needs: this could be an indication that one of the problems is the variability of the managers information needs as a result of his open-ended tasks and his high discretion in dealing with them.

3.5.2 Ease of Use

A similar comparative table of results is presented in figure 3.4 for the individual questions relating to ease of use and an overall 'ease of use' index is reported which has been constructed in a similar manner to the 'task fit' index. It should be noted that only 26 managers responded to the questions directed at terminal users (14 regular users and 12 occasional users).

<table>
<thead>
<tr>
<th>Problems With:</th>
<th>Managers %</th>
<th>Clerks %</th>
<th>Specialists %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Users</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legibility of Outputs</td>
<td>10</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>* Output Analysis</td>
<td>36</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Extra Work</td>
<td>38</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>* Operating Procedures</td>
<td>37</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td><strong>Terminal Users</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal Workstation</td>
<td>60</td>
<td>62</td>
<td>57</td>
</tr>
<tr>
<td>Terminal Operation</td>
<td>35</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>System Response Time</td>
<td>42</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>* Overall 'Ease of Use' Index</td>
<td>66</td>
<td>69</td>
<td>70</td>
</tr>
</tbody>
</table>

* p < 0.05
The overall 'ease of use' index confirms the pattern of the 'task fit' index: it is the managers who found their systems significantly more difficult to use than other users. The managers had significantly more problems on two of the component questions, one relating to the analysing of output and one relating to the procedures necessary to operate the system. There was also a greater proportion of management users reporting difficulties with two aspects of terminal usage, the operation of the terminal itself and the system response time which many of them experienced as too long.

These results suggest that the manager is not only a difficult customer to serve because of his variable task needs. He is also the most likely to complain about difficulties in using the service. In seeking reasons for the particular awkwardness of this kind of user, we may identify three contributions:

1. The manager's task variability is likely to mean that his needs of the system will vary from one occasion to another. This may mean that he will be using a different procedure each time which he will not know and he will be analysing outputs for different purposes each time. Compared with the repetitive character of the work of, for example, the clerical user, the manager will find himself led quite frequently into new situations which must be more difficult to handle than familiar ones.

2. The manager will be an infrequent user of the computer because of his many other duties and he is unlikely to become really familiar with the procedures and outputs he uses.

3. The manager is likely to be under continual pressure to spend his time on other matters and is therefore more likely than other users to resent time consuming aspects of computer use.
3.5.3 User Support

Overall management users enjoyed a high standard of support, comparable with that of specialists and significantly greater than received by clerical users.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Managers %</th>
<th>Clerks %</th>
<th>Specialists %</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Help in breakdowns</td>
<td>77</td>
<td>60</td>
<td>97</td>
</tr>
<tr>
<td>Help in general</td>
<td>90</td>
<td>92</td>
<td>93</td>
</tr>
<tr>
<td>Learning about the System</td>
<td>31</td>
<td>58</td>
<td>38</td>
</tr>
<tr>
<td>* Know More</td>
<td>54</td>
<td>76</td>
<td>72</td>
</tr>
<tr>
<td>User Involvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past Involvement</td>
<td>45</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Future Opportunity</td>
<td>71</td>
<td>31</td>
<td>72</td>
</tr>
<tr>
<td>Overall 'User Support' Index</td>
<td>68</td>
<td>47</td>
<td>68</td>
</tr>
</tbody>
</table>

Figure 3.5: User Support Results for Three Types of Users

** p < 0.01
* p < 0.05

As evidenced by figure 3.5, the managers experienced fewer user support problems on most questions than their colleagues. The status of managers within an organisation seems to mean that when they feel a need for help, they can easily obtain it. This has a corollary in the views of those who provide the assistance who feel that managers do not ask for help sufficiently frequently which means that the limiting factor in user support is often non-use by the manager. The question listed as 'know more' in figure 3.5 is of interest in this context. Only 54% of managers wished to extend their knowledge of the system compared with 76% of clerks and 72% of specialists (p < 0.05), the reason being that managers did not feel it appropriate to spend their time studying the system unless there was a specific purpose for so doing.
A similar pattern emerges for user involvement. Managers more than other users had the opportunity to contribute to systems design in the past and more of them felt they would have further opportunities in the future. The limiting factor on the degree of their involvement they felt was the time they would be able to give to it rather than the lack of opportunity.

3.5.4 Task and Organisational Consequences
Managers were asked to evaluate the kinds of effects the computer system had upon their work and their organisational life and, where they identified an effect, to judge whether this was to be regarded as positive or negative. The average number of positively regarded effects for manager users was 2.67 which was comparable with other types of user. The average number of negative effects identified by the managers was only 0.4 with as many as 68% of managers perceiving no negative effects. This is considerably less than the negative experiences of clerical users.

Although the general levels of positive evaluations was the same for all three groups, the effects to which each group referred were markedly different. As figure 3.6 indicates, more managers than clerks felt that computer use had helped them develop new skills, ideas and methods. The other positive aspects for managers were the impact upon the scope of the job and a favourable effect on job satisfaction. Managers and specialists also commented favourably upon decreases in routine which is a markedly different response from clerical users who did not welcome increases in routine. The other positive aspects for managers were that their new skills in their view made their promotion prospects brighter and they found themselves involved in communications with a wider range of people.
### Figure 3.6: Task and Organisational Impact for Three Types of User

<table>
<thead>
<tr>
<th>Questions</th>
<th>Managers (%)</th>
<th></th>
<th>Clerks (%)</th>
<th></th>
<th>Specialists (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>+'ve '-ve</td>
<td>N</td>
<td>+'ve '-ve</td>
<td>N</td>
<td>+'ve '-ve</td>
</tr>
<tr>
<td>New Ideas and Skills</td>
<td>72</td>
<td>100 0</td>
<td>57</td>
<td>100 0</td>
<td>74</td>
<td>100 0</td>
</tr>
<tr>
<td>Routine Work - more</td>
<td>17 (21)</td>
<td>37 17</td>
<td>61 (0)</td>
<td>28 33</td>
<td>9 (54)</td>
<td>50 5</td>
</tr>
<tr>
<td>- less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope of Job - more</td>
<td>40 (2)</td>
<td>81 3</td>
<td>42 (9)</td>
<td>73 12</td>
<td>30 (3)</td>
<td>93 7</td>
</tr>
<tr>
<td>- less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Satisfaction</td>
<td>62</td>
<td>90 10</td>
<td>67</td>
<td>67 33</td>
<td>67</td>
<td>91 9</td>
</tr>
<tr>
<td>Promotion Prospects</td>
<td>24</td>
<td>67 10</td>
<td>31</td>
<td>44 13</td>
<td>22</td>
<td>70 0</td>
</tr>
<tr>
<td>Workload Change</td>
<td>47</td>
<td></td>
<td>68</td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>35 (12)</td>
<td>41 44</td>
<td>34 (34)</td>
<td>64 15</td>
<td>40 (14)</td>
<td>67 21</td>
</tr>
<tr>
<td>Decrease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>53</td>
<td></td>
<td>48</td>
<td></td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>30 (23)</td>
<td>79 21</td>
<td>28 (20)</td>
<td>84 16</td>
<td>38 (5)</td>
<td>85 15</td>
</tr>
<tr>
<td>Decrease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average No. +'ve Evaluations</td>
<td>2.6</td>
<td></td>
<td>2.2</td>
<td></td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Average No. -'ve Evaluations</td>
<td>0.4</td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

The few negative comments by managers related to increases in workload, associated with the effort to use and learn to use the computer system. There were also small groups of managers who found the level of routine had increased and who regarded the changes in communications as unwanted.
3.5.5 Discussion: The Characteristics of the Management User

From a comparison with other types of user the manager emerges as peculiarly difficult to satisfy. He obtains a rather poorer service than other users, particularly with respect to the completeness of the service. He complains more than other users about the 'ease of use' of the computer system particularly with respect to operating procedures and the analysis of outputs. He has no difficulty in obtaining support or involvement but does have problems finding the time to take advantage of these opportunities. However, despite his problems, the end product is that he has far more positive effects to indicate than negative effects. Overall the generally positive view of computer use is supported by the final question of the interview: 96% of managers stated that they would not wish to work without the computer system and 77% said they could think of useful ways in which it could be extended to help them.

With these results, and the unstructured comments made by managers in support of their responses, we can begin to isolate the variables that influence a manager's response to computer aid with the objective of subsequently developing a hypothetical causal framework. For the present we may list the contributing variables as:

1. Task Openness and Variability. A lot of the problems in providing managers with an effective information service seem to arise from the developing and changing needs of a job which is essentially one of resolving new problems and grasping new opportunities. The problems of completeness and of irrelevance seem to be two sides of the difficulty of not knowing quite what will be needed.
2. High Discretion. As compared with most users managers have considerable discretion both with respect to their tasks (they may, within limits, define them and conduct them as they deem appropriate) and with respect to their use of computer systems (they have considerable control over the extent to which they use them). One reason for the overall positive results despite the criticisms of the service is probably that managers have the discretion to take advantage of the best features and to avoid the consequences of the worst features of the system. Not so the poor clerical user.

3. Time Pressures and Infrequent Use. The ease of use problems appear to be less to do with the complexity of the system and more to do with the other demands on the manager's time. These are likely to mean that he never devotes time to simply exploring what the system can achieve but relies on learning as he uses. He is also likely to be, at best, an intermittent user and he will probably forget what he has learned on one occasion before he uses the system again.

In summary the verdict thus far must be that here is a user who needs a flexible and sophisticated service but will object if its complexity becomes apparent to him. He will tend to select a strategy for using the computer which minimises the time he spends and maximises the positive effects commensurate with the time he is prepared to give.

3.6 Job Level

The framework of variables we have begun to assemble may be further elaborated and explored by examining how managers' responses varied according to the seniority of the position they occupy.

A full analysis of the effect of job level is made difficult because it was not possible to obtain more than seven level 3 (senior) managers in the sample. However, this very fact indicates that computer use is more widespread amongst more junior levels of management. This conclusion is substantiated by one of the supplementary questions asked in the interview which requested
managers to make a rough estimate of the amount of their time that was devoted to computer use. Figure 3.7 summarises the results.

<table>
<thead>
<tr>
<th>% Time Devoted to System</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
</tr>
<tr>
<td>0-5</td>
<td>10 20</td>
<td>12 48</td>
<td>5 71</td>
</tr>
<tr>
<td>6-25</td>
<td>25 50</td>
<td>11 44</td>
<td>1 14</td>
</tr>
<tr>
<td>26-50</td>
<td>7 14</td>
<td>2 8</td>
<td>- -</td>
</tr>
<tr>
<td>51-75</td>
<td>4 8</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>76-100</td>
<td>1 2</td>
<td>- -</td>
<td>1 14</td>
</tr>
<tr>
<td>Unanswered</td>
<td>3 6</td>
<td>- -</td>
<td>- -</td>
</tr>
</tbody>
</table>

Figure 3.7: Time Devoted by Managers to the Use of Computer Systems

It will be noted from figure 3.7 that the modal time for junior (level 1) managers is 6-25% whereas other levels of manager are in the 0-5% group. Very few managers in the sample could be said to be more than intermittent users of the computer and the amount of time involved seems to vary systematically with seniority so that only a limited number of very senior executives have any direct contact with the systems in their organisations.

The evaluations of the managers of different levels of the computer systems they use are summarised below. In order to focus attention upon significant issues only results that discriminate between the levels are presented.
3.6.1 Task Fit

No significant differences between the levels were found on the overall task fit. The level 2 managers achieved the highest fit (64%) followed by the level 3 managers (57%) and the level 1 managers (54%). This trend is interesting because it contradicts expectations. If task variability and discretion are the main contributors to a poor task fit, the more senior the manager, the poorer should be his task fit.

A consideration of the component questions shows why this result was obtained. Level 1 managers complained more frequently than other managers about irrelevant information and, compared with level 2 managers, they were more concerned about extra work and with information recency. However, on these two latter questions it was the small group of level 3 managers who were least satisfied. The senior managers were also more vocal on the subject of completeness of service.

Given the weaknesses in the sample, the main feature of the data requiring explanation is the poor service obtained by the junior managers. In theory they should be more easily served because their jobs are more structured than their colleagues and their relative satisfaction with the completeness of their service may bear this out. The problems they experienced appear to be due to two factors: first, they work to tighter and shorter deadlines and they consequently need up-to-date information, and secondly, the problems of irrelevance and extra work suggest that they have less ability to protect themselves from these system features or leverage in the organisation to get them changed.

3.6.2 Ease of Use

The overall ease of use results, although not significant, show a trend similar to task fit. The best result was obtained for the level 2 managers (75%) who were this time followed by the level 1 managers (64%) with the small group of level 3 managers experiencing the most problems (56%). The main differences between the levels on the component questions were on output analysis and operating procedures.
Senior managers complained most frequently about output analysis and this appeared to be linked to their problems with extra work. The unstructured nature of their work always seemed to mean that outputs required translation into another form before they could be useful. The level 2 managers experienced fewer problems than their colleagues with operating procedures although the reasons given by level 1 and level 3 managers for their problems were different. Senior managers complained, no matter how simple the procedures they operated, because of the very intermittent nature of their usage and the pressures for them not to waste time on irrelevancies. The junior managers tended to use the more complex modes of interaction (22 of the 25 managers using instructional modes were level 1) and consequently they were using more complex procedures (see the analysis of systems differences in 3.7 below).

3.6.3 User Support
The senior managers obtained the best result for user support (74% compared with 63% for level 2 and 65% for level 1), a result which appears to be a direct function of power. As one senior manager expressed it "They respond too quickly - I snap my fingers and they come running". The results for level 2 and level 1 managers are interesting because they are bi-modal: most managers obtained results of over 75% on the overall rating but the averages were depressed for both levels by a group of 6 managers in each case who gave scores of less than 25%. The reasons for this will be discussed with reference to the component questions.

In general the availability of assistance was considered very good except in the specific instances of users whose companies did not themselves operate the systems or users who were geographically distant from the centre of the system. A majority of the senior managers (67%) did not wish to learn more about the system as compared with 55% of level 2 and 39% of level 1 managers. The more senior the manager it would seem the stronger the view that you only learn about computer systems when you have a very specific need. The
problems of access to information preoccupied 43% of level 3 managers, who had difficulty finding time for it, and 36% of level 1 managers who did not have access to appropriate resources (especially those managers who were organisationally or geographically distant from the base of the system).

As many as 95% of level 2 and 86% of level 3 managers anticipated being involved in future systems design and their main doubt was whether they would be able to allocate the necessary time to design issues. Only 68% of level 1 managers felt they would get the opportunity and it was again those organisationally and geographically distant who expected to be overlooked.

In summary therefore there are two sources of difficulty in an otherwise very rosy picture. The first, associated with senior managers, is a matter of finding time amongst competing pressures to make use of the available facilities. Secondly, a substantial minority of junior managers, particularly those organisationally and geographically distant from the base of the system, felt they did not have access to the relevant resources. The best position to be in was to be a level 2 manager close to the system base because you then have both access to the resources and the time to make use of them.

3.6.4 Task and Organisational Consequences

Computer systems had in general rather limited indirect consequences for the tasks and jobs of the managers and very few questions discriminated between the three levels. There was no difference in positive effects except for the question which concerned promotion prospects where 32% of level 1 managers felt their prospects had been enhanced by use of the computer system compared with 12% of the level 2 managers and none of the senior managers.
It is easier to discriminate between the levels on the negative factors. A greater percentage of level 1 managers (24% as compared with 8% and 0% respectively for level 2 and 3) claimed the system now meant more routine. Approximately 40% of all levels thought there had been a change in workload but a majority of the level 1 respondents saw it as an increase and rated this as a negative consequence whereas their colleagues were split on the nature of the change and were more neutral in their evaluations.

In summary the differences are small but seem to show that it is junior managers, who in any case make more use of the system, who are more inclined to experience the negative aspects of the system which reinforces the view that they are in too weak a position to protect themselves whereas their colleagues appear more able to reap the benefits of computer use and avoid the negative aspects.

3.6.5 Discussion: The Effects of Job Level

The results show a surprising correspondence in response from senior and junior managers, the middle managers in general receiving the most satisfactory service. However, the similarity in responses is misleading because they appear to be attributable to different factors in each case.

Junior managers make more use of computer systems than their colleagues and their problems in getting a reasonable service are to do with irrelevance, extra work and recency. Underlying these results are the need to work to shorter timescales than their colleagues and the problems of obtaining a tailor-made service from a relatively weak position in the hierarchy. The ease of use difficulties of these managers are also related to their inability to change the system or to protect themselves from its worst features but they are also the result of these managers using more complex systems than their colleagues. Most junior managers have few support problems but there were a group, organisationally and
geographically distant from the base of the system, who did not feel they could command the support they required. As greater users of the system than their seniors, these managers also experienced slightly more task and organisational consequences, particularly negative consequences which may again be indicative of a lack of power to protect themselves from these changes.

The problems of the senior managers are difficult to assess on the basis of a sample of 7 but appear to relate to the difficulties of obtaining a flexible, easy-to-use system capable of meeting rapidly changing needs. Even the most simple to use systems tend to be criticised on 'ease-of-use' grounds by people who are constantly under pressure to engage in other activities. Even where excellent support facilities exist they do not appear to have the time to make effective use of them. However, the effects of the system upon them are either inconsequential or positive and the question for later discussion is not so much what the effect is upon them but rather more what the effects of their responses are for the effective use of the potential of the computer system.

3.7 A Comparative Analysis of Systems

Having developed some understanding of the problems posed by the manager as a user of computer systems we can now turn to an examination of how effective different kinds of systems may be in supplying the manager. Again the results will be presented for the different types of responses and attitudes examined.

3.7.1 Task Fit

The main proposition under examination in this survey is that managers will obtain a better service from those systems which permit them to interact and thereby define the service they obtain. In figure 3.8 comparative data on task fit issues is presented for three modes of interaction and for two media of interaction.
<table>
<thead>
<tr>
<th>Problems</th>
<th>Mode</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Output %</td>
<td>Data Base Systems %</td>
</tr>
<tr>
<td>Accuracy</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>Relevance</td>
<td>*39</td>
<td>7</td>
</tr>
<tr>
<td>Completeness</td>
<td>59</td>
<td>55</td>
</tr>
<tr>
<td>Recency</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>Extra Work</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Reliability</td>
<td>82</td>
<td>53</td>
</tr>
<tr>
<td>Overall Task Fit</td>
<td>57</td>
<td>66</td>
</tr>
</tbody>
</table>

**Figure 3.8: A Comparison of Task Fit Data for Different Forms of Interaction**

* * p < 0.05
** ** p < 0.01

The hypothesis derived from chapter 1 suggests that the task fit will increase as the mode of interaction becomes more interactive and more powerful. It also suggests that the task fit will increase with the move from a non-terminal medium of interaction to a terminal based system. The data for the mode of interaction confirms the hypothesis inasmuch as the users of data base systems achieve a significantly better service than users of standard output systems but the trend is not continued with evaluation models where there is a drop in service to below the level experienced by standard output users.

Seeking the reasons for this in the component questions allows us to discount the issues of completeness and recency because they show no variation across the three modes. This is somewhat surprising because it might have been supposed that the use of a large data base would practically eliminate the problem of incompleteness of service. The fact that it does not may simply be because the data base does not hold the relevant information but there are also factors associated with the way managers use these systems which will be considered at the end of the chapter.
The most significant change in a component question is on relevance where in fact the move to a system with retrieval facilities does virtually eliminate the problem of obtaining irrelevant information. Unfortunately this gain is lost when the more sophisticated evaluation model mode is used. The unstructured responses of the managers using this mode indicates that they are referring to a kind of irrelevance caused by the way these models process information. The managers are defining as irrelevant those parts of the output which are based on false or unrealistic premises used by the model to process information and the managers feel this is often the case with this kind of system. The same issue underscores the results for accuracy. As the mode becomes more powerful so the users complain of more inaccuracies in the output. Usually inaccuracy is a product of inadequate data input but, in the case of evaluation models, the users were reporting that the use of over-simple or false assumptions in the model rendered much of the output inaccurate.

The variation in the amount of extra work follows the trend for the overall task fit. This result reflects the problem of relevance: a data base system enables the user to formulate the output as he requires it and, if he is successful, the output should require no extra work before he can use it. A standard output may well need extra work because it was not designed for the manager's specific task, and, when using evaluation models, users report having to work on outputs to compensate for over-simple or false assumptions built into the system.

A considerable and at first sight unexpected variation is found for system reliability. It might have been expected that users of the more interactive systems would have been more concerned about reliability than standard output users but the reverse is the case. The reason appears to be that the managers with interactive facilities can initiate computer use when they wish and are less tied to a timetable associated
with the arrival of printouts. In the latter case a
delay may be a matter of days and could be a period when
critical decisions have to be taken. The system supporting
the more interactive modes usually only involve down time
for the users in periods of minutes or, at most, hours.
These are not welcomed but they are in general less
critical.

Few conclusions can be drawn about the effects of different
media of interaction because of the small sample of
terminal users and, in fact, there were no significant
differences between terminal and non-terminal users on
overall task fit or on the component questions. In general
terminal users obtain a better service than non-terminal
users but this appears to be more related to the presence of
interactive facilities that permit choice (i.e. to the mode
of interaction) than to the presence of the terminal itself
although, of course, the terminal shortens the period
between request and reply. One surprise was that terminal
users did not receive a better service in terms of recency
of information. Many of the terminal based systems did
not operate in real time and thus the information held is
not necessarily any more current than that held by non-
terminal based systems.

In summary, the task fit data follows the expected trend
but only to a limited degree. The expected improvement as
systems become more interactive and offer more choice to
their users is seen in the move from standard output to data
base systems but is reversed as the more complex evaluation
models are introduced. It is seen too in the move from
non-terminal to terminal based systems although it is not a
significant improvement. The improvement from standard
output to data base systems is largely in relevance, due
directly to the user being able to construct his own output,
and to some extent to a decrease in extra work and dependence
upon system reliability. The task fit however remains
relatively low in comparison with other types of user and there remain problems untouched by the change, namely completeness, accuracy and recency of information.

The problems associated with evaluation models are of a different order created by the more active role taken by these systems in the processing of information. By virtue of the parameters and rules governing information processing these systems embody a model of the task world and the problems expressed by managers relate in the main to their doubts about the validity of this model which leads them to query the accuracy and relevance of the outputs produced.

3.7.2 Ease of Use

The act of giving the user more choice in the way he employs the potential of the computer of necessity means he has to understand and to operate the system in a more complex way than hitherto. We may therefore expect more comments about ease of use issues as modes of interaction become more sophisticated and the medium shifts from non-terminal to terminal. Figure 3.9 presents the comparative data for the different forms of interaction on the 'ease of use' issues.

The overall results for the mode of interaction follow the same pattern as the overall results for task fit and therefore only partially confirm the expected trend. There is the expected rise in 'ease of use' problems between standard outputs and evaluation models but unexpectedly, the data base systems are rated as easier to use than the standard output systems.
The surprising feature here is that standard output systems should be rated as difficult to use because they automatically provide a service to the manager. The results from the component questions show that the 'ease of use' problems of these systems are all at the output end: the problems of analysing the output and conducting the extra work to turn them into a useful form.

<table>
<thead>
<tr>
<th>Problems with</th>
<th>Mode</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Output %</td>
<td>Data Base %</td>
</tr>
<tr>
<td>Legibility of Output</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Output Analysis</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Extra Work</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Operating Procedures</td>
<td>**13</td>
<td>36</td>
</tr>
<tr>
<td>Overall 'Ease of Use'</td>
<td>*69</td>
<td>74</td>
</tr>
</tbody>
</table>

Figure 3.9: A Comparison of Ease of Use Data for Different Forms of Interaction

* p < 0.01
** p < 0.05

Note. Terminal only questions were omitted because of insufficient data.

The main problems with data base systems with retrieval facilities lies not at the output end but at the input end where the problems of operating the system to obtain the required service was considered serious by 36% of managers. This question yielded the most significant difference between the systems because the proportion of complaints rises to 64% for users of evaluation models. It is this factor, plus the problems of understanding and assessing the output and the extra work necessary to convert the output into a useful
form that makes the evaluation models the most difficult form of interaction for managers to use. On both the input and output side these systems would appear to be ill-suited to the life style of the manager.

The limited number of managers using terminals reported a greater proportion of 'ease of use' problems than their non-terminal using colleagues. This result is the product of two factors. The first is that the presence of the terminal adds a number of new procedures which the manager has to master and users react to these as strongly as they do to other kinds of operating procedures. The other factor is that terminal users are, in general, using more complex and interactive modes of interaction than the sample of non-terminal users and this tends to depress their results. A comparison of terminal as against non-terminal users in the two modes (data base systems and evaluation models) that have both mediums yields little because the sample of terminal users is too small but the indications are that it is the mode rather than the medium that is the prime cause of 'ease of use' problems.

The 'ease of use' data therefore confirms expectations that as systems become more sophisticated managers become more resistant to the complexity they encounter. However, this is not the complete story because in using data base systems managers have fewer problems than with the simpler to operate standard output systems. This is because the simpler systems cause problems of analysis and extra work at the output end which, in our simple method of adding components to give an 'ease of use' rating, outweighs the benefit of not having a complex input procedure to operate.
The shift from the standard output mode to the more sophisticated levels and from non-terminals to terminals appears to be very much like moving from public transport to private transport. Public transport can be frustrating because it is not tailored to the specific needs of the individual: you have to go to where it operates, fit yourself to its timetable and it may not take you to exactly where you wish to go. The standard output user has all the same problems of fitting the existing timetable and accepting the output as given and having to work on it to get what he needs. The switch to private transport frees one of the constraints of public transport: depending on the type of vehicle, you can now go where you want when you wish to. But it brings in its wake a set of responsibilities and requirements that are not present in the use of public transport. If you buy a car you have to learn to drive, the car has to be maintained, each time you travel you have to work yourself rather than have someone do it for you and, if the worst happens, you may need the services of the A.A. or the R.A.C. The computer user moving to more interactive forms of interaction is in exactly the same position and managers in particular seem to find the operating load associated with such systems quite onerous.

We may usefully extend the transport analogy one stage further. The computer can take many forms and it can be to information processing tasks what the bicycle, the car and the aeroplane are to transport. It would seem that our managers are relatively tolerant of having to 'drive' the equivalent of a car (depending on their seniority) but they draw the line at being asked to 'fly' the computer equivalent of an aeroplane.
It is important to note that the increase in management complaints about 'ease of use' is not simply a product of an objectively measurable increase in system complexity. Specialist users also make use of these systems and only 26% had problems with the procedures for using data base systems and 14% with the procedures for evaluation models. The steep rise in managerial complaints is therefore also a response specific to managers indicating something of a problem of using such systems in a managerial environment.

There is one sense in which the results presented here, particularly for the more complex forms of interaction, may be misleading. The procedures necessary for operating a system may be far more important determinants of computer usage than problems of analysing outputs simply because they are the first stage of any task episode. Faced with a complex procedure the manager may find another way of tackling his task and may never discover how easy the output would have been to use. It may well be that the 'ease of use' problems discussed here have serious implications for the way systems are used and these implications will be discussed at the end of the chapter. Suffice it to say here, that, in considering the systems in answer to our questions, they may well have been considering only those parts of the system they have used. They may already have rejected the more complex facilities of the system and hence our data probably underestimates the 'ease of use' problems managers would have with their systems if they made full use of them.

3.7.3 User Support and Indirect Consequences
The overall results for user support and indirect consequences for the different forms of interaction are given in figure 3.10.
<table>
<thead>
<tr>
<th></th>
<th>Mode</th>
<th>Medium</th>
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<tbody>
<tr>
<td></td>
<td>Standard Output %</td>
<td>Data Base %</td>
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<tr>
<td>User Support</td>
<td>64</td>
<td>72</td>
</tr>
<tr>
<td>Indirect Consequences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Positive</td>
<td>3.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Figure 3.10: A Comparison of User Support and Indirect Consequences for Different Forms of Interaction

The differences in values for overall user support are not significant across modes or mediums, all managers claiming a relatively high level of support. There is some evidence that the support is better for the more sophisticated modes and for terminal users. This may be because they tend to be relatively small-scale systems but an alternative explanation may be that, as the service becomes more sophisticated, so it becomes much more apparent to users and designers alike that deliberate efforts must be made to provide support. The component questions reflect this pattern. Only 40% of the non-terminal users had been involved in systems design as compared with 69% of terminal users (p < 0.05). With respect to the modes of interaction the greatest variation in response came from the question which asked whether users needed to know more about the system. 71% of the users of evaluation models thought this was necessary compared with 48% of standard output users and 40% of data base users. This may reflect the 'ease of use' problem of trying to understand and assess the validity of the system.
Consideration of the indirect consequences data enables an examination of another proposition derived from the literature, i.e. the greatest positive impact will result from the use of the more interactive system. The results in figure 3.10 do not offer much support for this proposition: there is no significant difference in the number of managers reporting positive effects for the different modes. On the contrary the users of the more sophisticated modes report more negative effects than the users of standard output systems.

The area where we might have expected positive effects would have been in job scope and job satisfaction but in neither case is there very much evidence of change for any mode. The main reasons given for the negative effects for the higher modes and for terminal users were increases in routine and in workload caused by the requirements to use the procedures of the system.

Altogether these results show a relatively small amount of impact upon managers by any form of interaction and the only conclusion that can be drawn is that none of these systems is having a revolutionary effect upon the way the manager works or the job he finds himself doing. However the questions were fairly general and may not have been sufficiently sensitive to detect subtle but important changes which have taken place. Taking these results together with some questions which were not included in the assessment of indirect consequences it is possible to discern two general issues:

First, there was a suggestion that the higher modes of interaction and the use of on-line terminals had the potential for making a more profound impact upon the manager's task and job than did the simpler systems. Overall, more effects were noted by users of advanced
systems than by their non-terminal, standard output using colleagues. In many cases the impression given by standard output users was that the system was a relatively unimportant aspect of their working lives. This was not the case for the users of more complex systems: they saw the possibilities of getting a valuable service that would have ramifications for the way they worked. The effects they reported however were likely to be a mixture of the good and the bad, the bad effects being largely to do with the time and effort and the adaptation they had to make to successfully use the system. One indication of the unrealised potential users could envisage came from a question which asked users whether they thought the systems could usefully be extended: 64% of standard output users felt this was the case but 88% and 90% of data base and evaluation model users respectively gave this response.

The second issue was that, in one important respect, standard output users experienced more ramifications from system use than their colleagues. A greater percentage of standard output users experienced an increase in the routine of their work (although many welcomed it as bringing order out of chaos). A related finding was that these users experienced more difficulties than their colleagues when there was a system breakdown. The general point here was brought into focus by a question that asked the degree to which users felt their work was under computer control. 78% of the standard output users claimed there was a considerable element of computer control over their work whereas only 20% of the data base users and 42% of the evaluation model users felt this was the case (p<0.01).

A possible explanation for these findings is that the one-way direction of communications in the use of standard output systems combined with the lack of control users have over content and format etc., engenders feelings of dependency and of being under external control. In contrast, interactive systems increase the users control over many aspects
of computer use and permit the user to view the computer system as a tool rather than as a control mechanism. We have discussed this aspect of the survey results elsewhere (Damodaran et al. 1974).

3.7.4 A Summary of the Survey Results

Before proceeding to the presentation of an explanatory framework for these survey results it is appropriate to summarise the main findings:

1. The survey results show that compared with other computer users the manager:

   (a) Is difficult to serve in terms of completeness and to a lesser extent accuracy, reliability, relevance and recency. Overall he is more critical of the service he receives than are other users.

   (b) Makes greater demands of the 'ease of use' of the system than do other users especially with regard to operating procedures and analysing outputs.

   (c) Receives good support when using the system but often finds it difficult to give the necessary time to use support facilities.

   (d) Identifies very few task, job and organisational consequences of system use as compared with other users. The consequences he does note tend to be positive rather than negative.

2. A comparison of the results for three levels of managers reveals that:

   (a) Middle managers are less critical of the service they receive than either junior or senior managers. Junior managers complain of out-of-date information, irrelevance and extra work. Senior managers complain about incompleteness and extra work.
(b) Middle managers also make less frequent complaints about the ease of use of systems than do their colleagues. Both junior and senior managers complain about analysis of outputs and of operating procedures.

(c) A small group of junior and middle managers who were organisationally and/or geographically distant from the base of the system complained that they were not getting adequate user support but all other managers were satisfied with the support they received. Senior managers were concerned that their commitments did not give them sufficient time to make use of the available resources.

(d) The majority of the indirect consequences, both positive and negative, were felt by junior managers who made more use of computer systems than their more senior colleagues. They felt usage might enhance their promotion prospects but were concerned about the increase in routine and the increase in work load often created by the system.

3. A comparison of results for managers using different forms of interaction showed that:

(a) Users of pre-structured, batch processed forms of interaction complained most of irrelevance and reliability. They were most critical, overall, of the quality of the service they received. They also obtained low ease of use scores because of problems in analysing outputs and extra work. They had few user support problems although they were the group least likely to have been involved in systems design. Although they identified few indirect consequences, possibly because many of this kind of user were rather
indirect and infrequent users, they were more preoccupied than other users with the degree of control and routine associated with the computer system.

(b) Users of database systems with retrieval facilities were least critical of both task fit and ease of use aspects. The problems of irrelevance disappeared but difficulties with completeness and accuracy remained. Problems of output analysis were reduced but the focus for ease of use difficulties was switched to problems with operating procedures. User support was regarded as good and there were very few indirect consequences.

(c) The users of computer models for decision evaluation complained more than other users about the quality of the service they received and the ease of use of their systems. They complained of inaccuracy and irrelevance and were very concerned about output analysis, extra work, and especially with operating procedures. They were happy with user support and reported few indirect consequences.

(d) There were very few terminal users in the sample and a comparison of medium of interaction can only provide indicators. Terminal users appear to obtain better task fits than non-terminal users in terms of a more relevant and reliable service although it remains incomplete and no more up-to-date. 'Ease-of-use' was worse for terminal users because of more complex operating procedures but user support was better and there were fewer indirect consequences.
3.7.5 An Explanatory Framework for Manager-Computer Interaction

The above summary is a relatively uninterpreted statement of the main findings of the survey and the aim now is to seek a tentative framework capable of explaining these findings. In discussing each set of findings separately, a number of possible causal variables have already been advanced and the aim is now to draw these variables into a single framework to suggest the relations they have one with another.

Whilst the survey results have been concerned with the experiences of managers over the period in which they have been using their systems, the basic unit of these experiences is a task episode i.e. the manager dealing with a specific task for which the computer system may provide a service. The overall response of the manager appears to be built upon his experiences through a number of such episodes. The framework that is offered below is therefore based upon the task episode.

Figure 3.11 provides a framework for a task episode based upon the three variables of concern in this research: the manager, the task and the computer system. In this framework the initial conditions of each of the elements defines their interaction and the outcome, i.e. the form of task execution. In addition one of the elements, the manager, has adaptive capabilities and may therefore change as a result of the interaction providing a new starting point for the next interaction even if the task is the same.

1. The Task Stimulus. The process begins with a stimulus which indicates to the manager that a task requires his attention. It may be profitable at this point to consider briefly the meaning of the concept 'task' because it is a very widely used term which can be very diffuse in its meaning. It is used here in line with the following definition offered by Hackman (1969):
Figure 3.11: A Framework for A Task Episode in Manager-Computer Interaction
A task consists "of a stimulus complex and a set of instructions which specify what is to be done vis a vis the stimuli. The instructions indicate what operations are to be performed by the subject(s) with respect to the stimuli and/or what goal is to be achieved". Furthermore the task "may be assigned to a person (or group) by an external agent or may be self-generated" (p.113).

The task therefore can be conceived as a requirement for action which will lead to a movement from state A (the current state) to state B (the desired goal state) with a human 'actor' as the transformation agent. To the extent that the manager (as the 'actor' in question) has discretion he may determine the nature of state A, the desired state B and the mechanisms by which he will move between them. To the extent that the manager has discretion over his task, the task cannot be said to have an objective existence outside the formulation held by the manager. There are however two ways in which elements of the task can be said to exist independently of the 'actor':

(a) The task stimulus indicates the nature of state A that exists in the task environment (and may include the manager as an element in the task environment). The nature of the world is independent of the manager's conception of it although the actions the manager takes to change this state will be a product of this conception. One of the important features of the task stimulus in a managerial environment is the task variability. One way of defining the managerial role is as a 'boundary controller' between the system he manages and related systems and in this role he functions as an exception handler. Almost by definition therefore his job is to handle variable task stimuli.
(b) The task goals and instructions for their achievement come to a greater or lesser extent from sources external to the manager: from superiors, colleagues, government etc. They provide a fabric within which the manager is expected to operate, a structure which indicates what is and is not possible or desirable. These goals and instructions may be said to exist independently of the manager. They may be formally set down in 'standing orders' or they may exist in the minds of others with whom the manager will interact in the conduct of the task. Again however this independence has no direct effect upon task execution because it is mediated by the manager who decides how to transform state A to state B. Task execution is therefore dependent upon the manager's understanding and acceptance of these external goals and instructions.

The general conclusion is therefore that, whilst the task stimulus and the task context have an independent existence which will ultimately affect the success of the manager in moving from state A to state B, his initial actions in task execution will depend upon his own representation of these factors.

2. The Manager. Having identified a task stimulus, the next stage is an interpretative one by the manager who must investigate the nature of the task and decide how to set about its execution. On the basis of the survey data three factors about the manager are likely to shape his response:

(a) The Task Model. As a result of previous efforts to respond to similar or related task stimuli, the manager will have a set of concepts which permit him to represent for himself the nature of his current task, the appropriate goals and possible routes to goal achievement. As a result of the research work of Simon (1960), March and Simon (1958) etc. there is a considerable body of knowledge about the nature of this 'task model' and the way it relates to management
decision making. Aspects of this knowledge will be introduced as necessary later in this text but for the present one characteristic of the task model is important. When a task stimulus occurs frequently the manager will develop a detailed model appropriate to the task which will include a detailed set of rules for how to respond. March and Simon have likened this to a 'programmed' response. When the task stimulus has novel features the manager will not have a detailed model available and, by definition, neither will he have a ready made 'action program'. The task model will in this case be much more general and may have to be developed to cope with this particular task episode. Similarly action may be guided by generally useful strategies which may facilitate the development of a task specific action program.

(b) Discretion. By virtue of his status in the organisation, the manager, as compared to other computer users, has considerable discretion with respect to his task. There are thus two factors which contribute to the variability of the task response; the variable nature of the task stimulus and the variation due to the manager's discretion. Thus, two managers may experience the same task stimulus but respond to it in different ways.

(c) Tool Using Preparedness. At any point in time the manager will have a set of more or less well organised knowledge and skills relating to the information sources and processing techniques external to himself that he may use to execute his task. On the basis of the survey we can make the following statements about the 'tool using preparedness' of the manager:
i. He will not by virtue of his background be familiar with the disciplines associated with computer technology unless he has previous experience of computer use.

ii. He is unlikely to receive very much formal training in the use of specific computer systems and is therefore likely to learn by use.

iii. He will be an intermittent user of the computer and will forget detailed procedures from one occasion to another.

iv. He will view his time as precious and will not engage in purposeless exploration of system capabilities and may resist ways of using the system which demand a lot of his time.

Taken together these factors are likely to mean that the manager is in a relatively unprepared state to use the computer system and he is unlikely to learn very rapidly.

3. Information Needs. Primarily as a result of the interaction of the task stimulus and the manager's task model, the manager arrives at a requirement for information needs or processing needs for which he might turn to the computer system.

4. The Computer System. As a result of the survey three features of the computer system influence the manager's response to it.

(a) The task model. By virtue of providing information or information processing capabilities and also the ways it presents information, the system can be said to embody a model of the task it is designed to serve.
(b) **Flexibility and Power.** To the extent that there is flexibility in the system which gives the user the power to structure outputs, process information and perhaps enter and change data, the system permits the user to develop the task model held by the system to the form he requires.

(c) **'Ease of Use' and User Support.** On the basis of the survey, it is not sufficient to offer the user the flexibility and power of the system. It is necessary to offer these facilities in an "easy to use" manner with readily available "user support" if the user is to make effective use of the facilities.

5. **Task Fit.** As a result of the interaction of specific task needs (arising from the managers perception of the task stimulus) and the provisions of the system a degree of 'task fit' may be said to exist. The degree of mismatch may be the result of the inability of the system to meet the needs of the manager or it may be the inability or unwillingness of the manager to use the flexibility of the system to meet his needs.

One aspect of the survey data that has not been discussed is the consequences of a poor task fit being obtained. Data on this issue was not obtained in a quantitative form but the unstructured questions used to follow up problem areas revealed that managers had a number of ways of coping with mis-matches. The coping strategies can be classified according to the three variable framework employed in this research, i.e. the outcome may affect (6) the perception and execution of the task, (7) the usage of the system and/or (8) the task model of the manager. The particular effects are dependent upon the type of mismatch as indicated in the sections below.
6. Task Execution. The manner in which a specific task is executed appears to be affected by the quality of task fit the manager can obtain (or has obtained previously) in the following way:

(a) If the task fit is good, i.e. if the manager judges that the service he receives is what he requires, the consequence is that the task is completed on the basis of good information and information processing support. It may well approach the improved form of 'rational' decision making described by Simon (1965) and Licklider (1965).

(b) If the fit is poor in some important respect but the manager has to use the service, i.e. he has little discretion with respect to computer use, or he gets a better service than he can get by other means, the consequence may be a tailoring of the task to meet the provisions of the system. The survey gave many explicit examples of this occurring but there are indications that it can be an insidious process of which users are often unaware.

Examples of explicit task 'shaping' by system provisions were most evident in the timetabling of decision making to fit the availability of output from batch processed systems. Many managers said they were forced to take decisions by these pressures rather than take them at the most opportune moment. Another example is the focus on some information variables rather than others as a result of what the system provides. These led, in the opinion of many managers, to pressure to give greater weight to the quantitative aspects of the task, e.g. costs, units produced or sold etc., and less to qualitative aspects that cannot easily be represented in the computer e.g. quality, ethics, safety, etc.
It seems most likely that the process frequently goes much further than this and that the task model of the manager is influenced and shaped by the task model embodied by the system. Sackman (1974) has referred to this process as 'computer tunnel vision' and, as a result of studies of specialist computer users, Stewart (1976) has given examples of it occurring in the problem solving behaviour of design engineers.

7. **System Usage.**

(a) If there is a good fit the result for system usage will be that, whenever a task of this kind is identified in the future, there will be a strengthening of the tendency to use the system once again in the way that proved successful. The 'preparedness' of the manager is thus reinforced in this particular way.

(b) **Disuse.** If there is a poor fit in terms of available service from an inflexible system (or one rendered inflexible by difficulties in use) and the manager has the discretion to employ (or even to develop) an alternative method which may be more successful, the result may be system disuse, at least for this particular task. We were frequently told of disuse but, by virtue of selecting a sample of computer users, it was difficult to measure the extent of this phenomena. Managers, by and large, have the discretion to respond in this way and it is probable that many systems have failed because of it.

(c) **Partial Use.** If there is a possibility of achieving a relatively good fit from one of the known facilities of a flexible system, it will tend to be used rather than a facility, as yet unused by the manager, which could give a better fit. This phenomena was extremely widespread in the use of flexible systems and systems designers as a result found that many potentially useful facilities were not being used. It appeared to be
based on 'ease of use' criteria; it is easier to use a known facility even if the result is not quite what you want, rather than to search for a better fit which may not exist. This strategy can be used in conjunction with the task modification strategy so that the known facility can be used on a task slightly modified to match its provisions. This particular strategy also works to limit the user to less than the full potential of the system. In the survey managers frequently reported poor task fits whilst systems designers claimed the system was capable of meeting their needs if managers were to use the full potential of the system.

(d) Distant Use. When a manager considers that a flexible system has the capability to meet his needs but considers it would require too much personal effort he sometimes has the discretion to ask another person to use the system on his behalf. The strategy of using a 'human interface' in this way to put distance between the user and the system seems to be a favourite strategy of senior managers who were to be terminal users. Martin (1973) documents a case of a system used by IBM that was intended for direct manager-computer interaction but, in time, was operated by information analysts on behalf of the managers. Such a strategy has considerable benefits for the busy manager and may become the standard method of senior managers using complex systems. Elsewhere the author (Eason, 1981) has enumerated the advantages and disadvantages of adopting this strategy as a conscious design policy.

8. Task and Tool Model Modification. As a result of a specific task episode, the manager, as an adaptive, learning, human being is likely to change his models in two important respects:
(a) **Task Model.** If the episode has been successful and use of the computer system sheds new light on the nature of the task and the way it could be conducted, then the task model will be elaborated as a result.

However, this view needs to be tempered by a reminder that the task model may also be shaped or channelled by the nature of the service that has been offered.

(b) **The Tool Model.** In addition to the task model we may also view the manager as possessing a model of the tool; of its contents and facilities and how it relates to his task. A successful episode will reinforce the particular task-tool connections employed and will cause them to be used again in future similar episodes. An unsuccessful episode will lessen the chances of the system being used in a similar context. The distant use and the partial use strategy both tend to reinforce what is known already rather than expanding the manager's knowledge and, as a result, the 'tool model' may not develop very quickly.

### 3.8 Research Directions

This survey set out to seek differences in managerial responses to different types of computer aids. A number of differences were found and the tentative model of the task episode constructed as a result suggests a number of questions which may usefully become the focus for the further progression of this research.

1. **Ease of Use.** A dominant concept as systems become more complex is the user's judgement of the 'ease of use' of the system. We know that managers regard this as important but we cannot, as yet, claim to have clarified the nature of this concept or to have good evidence about the way it affects behaviour towards a system.
2. Task Behaviour. In the data from the survey there is evidence to suggest that computer systems encourage managers to develop a new and deeper understanding of their tasks and there is also evidence that systems channel, shape and control task behaviour. There are many questions to examine in this apparent contradiction between liberation and control.

There are, of course, many other issues that could be pursued. We could, for example, make finer distinctions between computer systems and investigate their effects, or we could move to an organisational plane and ask whether systems evaluated as good in terms of task fit have greater organisational impact than those less highly valued. The central theme of this research is however the psychological characteristics of the manager which will determine his individual reaction to computer aid. We will therefore pursue this research by first of all examining the 'ease of use' issue which appears to mediate between the potential value of a system and the actual use made of it, and subsequently to look again at the effects upon task behaviour. To this end chapter 4 is a theoretical examination of the 'ease of use' concept followed, in chapter 5, by an empirical study of this issue. We turn again to task behaviour in chapter 6.
CHAPTER 4: EASE OF USE AND MENTAL EFFORT

4.1 Introduction

The most general conclusions from the survey reported in the previous chapter were that:

1. Managers are not well served by inflexible, standardised information systems probably because of the variable and changing nature of their information needs.

2. When managers are served by flexible, sophisticated information systems they respond negatively to the complexity of the system and find ways of minimising their direct involvement with it (by disuse, partial use or distant use). As a result they probably do not get as much value from their systems as they could.

The purpose of this chapter is to examine in greater depth the reasons for the second response. One possible explanation is that managers are not capable of mastering the flexible systems provided for their use. Since there are no grounds for assuming managers as a group are any less intelligent than other groups of computer users this explanation can be discounted. An alternative, which is closer to the situation as the managers describe it, is that the systems require more time and effort to use than the managers consider appropriate given the other pressures on their time. This raises questions of the nature of 'effort' and 'ease of use' and the form a complex system could take which would be acceptable to managers. To account for the manager's response therefore it may be appropriate to examine the theoretical basis of concepts relating to 'effort' and 'ease of use' with the intention of formulating an empirical study which would focus on these questions.
4.2 The Concept of 'Ease of Use'

The idea that a tool should be 'easy to use' is all pervasive in the literature on man-machine relationships but it is not a concept that is given systematic treatment. An examination of standard human factors design text books, e.g. McCormick (1970) and Van Cott and Kinkade (1972), reveals no definitions of the concept or techniques for measuring it. For most authors it appears to offer sufficient explanation in itself and it is self-explanatory to offer 'ease of use' or 'ease of operation' as a design criterion. Looking deeper into the context of such design discussions there appear to be a number of components to the concept. Whether a tool is easy to use can for example be judged by subjective report or by objective measures of performance such as speed and error rates. As we shall see later, the subjective and the objective measures unfortunately do not give the same results. Implicit in comments on 'ease of use' is the demand for the behaviour patterns of man required to use the tool to be 'natural', i.e. to be part of his normal repertoire of behaviour or, at least, compatible with them. Unfortunately the concept of 'natural' behaviour is also difficult to pin down. It would seem likely that, whilst there may be some behavioural predispositions built into man, the majority of 'natural' behaviour patterns are acquired in a general sense through cultural norms, e.g. the hands on the clock-face travel clockwise and our expectation is that all dials will increase in a clockwise direction, or through the acquisition of specific skills, e.g. the novice typist will find an alphabetic keyboard easier to use than a QWERTY keyboard whilst the reverse is true for the typist, trained on the QWERTY keyboard.

Another assumption that is common in considerations of 'ease of use' is that something that is easy to use minimises the amount of effort expended by the human operator. The concept of effort has received a little more systematic treatment than 'ease of use' and may therefore be more useful for our purpose.
4.3 The Concept of Effort

To say that we seek to minimise effort begs the question of what kind of effort. We could be concerned with physical effort or with mental effort or indeed with the length of time taken. In the context of information processing tasks it would seem appropriate to consider the mental effort embodied in information processing.

A widespread conclusion in information processing theory is that man has limited channel capacity (Broadbent, 1958) and that the mental load felt by the individual at any point in time is a measure of the degree to which this capacity is full. Kahneman (1973) has equated this loading with mental effort and, in his view, capacity, and therefore effort, expands up to its limit according to task difficulty. Following an effort minimisation model we would anticipate from this that people would seek to minimise capacity loading and therefore task difficulty. This is a difficult argument to sustain because the research on curiosity behaviour, on sensory deprivation, on arousal etc. all suggests man abhors situations in which he is not engaged in information processing and, indeed, in many circumstances will seek tasks which test his competence and load his information processing capacities. He could, in many circumstances, be said to be maximising his effort. How can we resolve this seeming contradiction?

One possible route is via the formulation offered by Zipf (1965) in his 'Principle of Least Effort' which states that "the organism takes a path that will minimise its probable average rate of work". This is the most developed of a series of similar formulations including Tolman's (1932) law of least effort and Wheeler's (1940) law of least action. Each states that, whilst man is a goal seeking organism, he will seek his goal by a route which will minimise his expenditure of effort.
This formulation can be used to explain the contradiction between least effort and stimulus seeking if we allow the organism a variety of reasons for establishing goals, i.e. everything from meeting basic needs for survival through to self-actualisation. The domain in which least effort will then apply is activities in the pursuit of the selected goal. In effect Zipf is claiming that man has two purposes (1) to achieve a desired end, (2) by a route involving minimum effort. It is not clear which has priority or how they inter-relate but presumably the selected goal is usually dominant, i.e. we are more likely to choose a goal and then worry about the effort entailed than we are to select a goal with the effort involved as a prime consideration. However, probably everybody has had the experience of changing the goal when the effort implications become apparent. It is frequently called 'cutting ones losses'.

This analysis may become clearer if we now put the issues of goals and effort into a task-tool framework. Following Kahneman, the task gives rise to the main source of effort, i.e. the organism finds it necessary to expend effort in the pursuit of the task and seeks to focus and minimise the use of his limited capacity on the task. This will mean that he will seek methods and tools which speed him towards his task goal and will resist tool related activities that cause deviation from the goal. The purpose of the tool is to facilitate the pursuit of the task but, if it requires effort to master the tool, it is in itself an obstacle to the main task.

Unfortunately this approach leads to further questions. Why, for example, are we prepared at times to spend considerable time learning how to operate a tool? And why can we observe ourselves and others spending considerable time engaged in laborious methods of achieving our goals when, in retrospect, we can see much more direct routes we could have taken?

Zipf suggests answers to both of these questions by setting as the criterion the pursuit of goals to minimise the probable average rate of work. The implication of probable is that it is
the expectation of how much effort will be expended which is the determinant of choice rather than the actual amount of effort used. The implication of average is that the task performer may look beyond the task he is performing at the time towards the probable frequency with which he will be repeating it. A new tool which takes some effort to master may receive effort from someone who expects to use it many times in the future but not from someone who expects to use it once only.

Having relied so heavily upon Zipf's formulation it is important to ask what empirical evidence there is for it. In support of the concept of average effort we may cite the survey reported in the previous chapter in which clerks and specialists were much more willing to expend effort developing competence with computer systems than were management users. Clerks and specialists are users who see many repeat applications for their acquired knowledge whereas managers are casual users; if they return to the computer system it will probably be with a rather different need.

In support of the concept of expected effort we may cite a number of studies of information gathering behaviour. Rosenberg (1967) investigated the information seeking behaviour of 108 research and non-research industrial personnel. He concluded that the most preferred methods were least effort methods like consulting a personal library or somebody nearby. Hodges and Angalet (1968) similarly concluded that the prime technical information source of 1,500 members of the U.S. Department of Defense was their local work environment. Gerstberger and Allen (1968) asked 19 engineers to keep diaries of information seeking activities and concluded that the criteria which most determined choice of information channel were quality (likelihood of success) and accessibility. They furthermore concluded that it was Zipf's 'principle of least effort' which best explained the results obtained. Finally, Longton (1977) working under the supervision of the author and using the Repertory Grid technique to allow managers to generate criteria for selecting between information sources, identified personal, local environment and ease of use as important factors. In all cases these studies depend upon
self-report by users and therefore report expectations. None of the studies, unfortunately, examines what actually happens in practice.

4.4 Least Effort and Conscious Choice

One feature of the Zipf approach is that it appears to assume that a person makes a conscious choice between available methods before establishing the route to a desirable goal. Everyday experience suggests this is an unwarranted assumption because much of our behaviour appears to be governed by habit rather than conscious choice. It is no doubt true that, on occasions, we make choices but we must explain the other occasions also and, perhaps, should have as our goal an understanding of the conditions that lead to conscious choice.

We need an approach that leads to the behaviour described by Zipf's principle but without the implication that selection is a conscious process. In other words, is there a formulation which leads man to seek to expend minimum effort without demanding that he continually monitor and select his actions with this goal in mind?

One approach which has these qualities is Simon's (1957) concept (reported in chapter 2) of man the decision maker as a man of 'bounded rationality' who seeks to 'satisfice' in his decision making. Simon claims that, rather than generate all the alternatives in a choice situation and examine them all to determine the optimal solution, man tends to select an alternative, evaluate it and, if it 'satisfices' as a solution, to look no further. This strategy obviously results in the individual minimising the time he spends upon decision making. By proceeding sequentially through the available options until he finds one 'that will do' man is minimising his effort without making an explicit attempt to do so.
This conception of the determinants of man's behaviour should mean that we frequently find him pursuing courses of action which are less than optimal with respect to his task goals. There is a great deal of evidence to this effect in classical psychological studies of problem solving and decision making. Under the headings of 'rigidity', 'conceptual and perceptual set', 'functional fixedness', 'mechanisation of behaviour' and 'Einstellung' many authors have reported evidence of man failing to pursue the objectively most rational course open to him. Although there are differences amongst the phenomena described under these headings, the general characteristics are similar. These are that a person in a choice situation selects a path or a way of behaving which is already familiar to him either because he has recently been exposed a number of times to situations where this response is appropriate or because he has over many years, learned to respond to these situations in this way.

The best known and most extensive study of this subject has been made by Luchins and Luchins (1959) who conducted numerous experiments over a period of 20 years, to investigate the factors which influence the development or disruption of conceptual set. Their classic experiment involves water jar problems in which the subject is given a series of 6 problems which can all be solved by the same method. Thereafter there are 5 more problems 4 of which can be solved by the same method but also by another, much more direct, method. The remaining problem, number 9 in the series, can only be solved by the direct method. As a result of many replications of this experiment Luchins and Luchins have found that 60 to 85% of school children and 70 to 85% of college groups use the indirect method to solve problems 7 and 8 (the first two 'criticials') and that 55 to 85% of school children and 50 to 70% of college groups failed the criterion for problem 9 (the 'extinction problem') by not finding the direct solution in 2½ minutes.
Similar results have been obtained by other authors and for many different tasks. The search for an explanation and for ways of preventing the set from forming has not been particularly fruitful. Explanations advanced here involved habit formation, psychological stress, personality, intelligence and other individual differences, psychoanalytic interpretations based on unconscious processes, and explanations which suggest that the information processing technique taught in school led to a predisposition for 'blindness'. Most of these explanations have proved inadequate when experimentally tested and the reader is referred to Luchins and Luchins (1959) for a full explanation of why they are inadequate. As an example, individual difference explanations are not adequate alone, because in some situations all individuals display conceptual set behaviour.

The explanations favoured by Luchins and Luchins refers to the way in which we are trained to process information. In their studies, they have been most successful in disrupting the formation of set when they instructed the subjects to look for alternatives or, by virtue of the way the problems are presented, forced them to look beyond their existing methods. They feel that teaching methods that require the student to concentrate upon method or process rather than end product could alleviate the tendency to behavioural rigidity.

4.5 Mental Effort: Productive and Re-productive

In formulating their explanations in terms of 'conceptual set' Luchins et al. and other workers on problem solving make no direct contribution to the issue of mental effort. However, we can draw two conclusions from this work. First, the act of selecting a 'set' method involves minimum mental effort (if it occurs as a conscious process at all), and secondly, the method chosen is likely to be familiar to the person and will therefore not require a great deal of new information to implement. One way of explaining these results is therefore to say that what man is trying to minimise is 'thinking effort', i.e. having to think
about what you are doing step by step, locate sources of information about your options, decide between them etc. Luchins and Luchins comment upon this by distinguishing between genuine and false problem solving. By genuine problem solving they mean a situation in which the subject has to search for a method to fit his problem rather than in false problem solving which is the direct application of a known method. In many respects this distinction is very similar to Wertheimer's (1959) distinction between 'productive' and 'reproductive' thinking. Wertheimer considers that most thinking is largely reproductive, an act of repeating psychological processes that have been successfully used previously. Occasionally a person may meet a novel situation for which he is obliged to use productive thinking to generate a new method. An apt, though no doubt exaggerated, analogy is the distinction between loading and running a computer program on the one hand and writing and testing a new program on the other.

It may be, therefore that a viable hypothesis is that man seeks to minimise mental effort devoted to productive thinking rather than all effort. This should lead to testable propositions because it implies we should find people following paths which involve considerable time and effort rather than expend productive energy developing a novel approach. One of the studies conducted by Luchins and Luchins sought to test this proposition.

They created a situation in which their indirect method of solving problems involved considerably more effort than the direct method. This was accomplished by asking subjects to trace mazes. Each maze consisted of three paths, a direct path, a moderately direct path (always blocked) and a very circuitous path. Subjects traced 11 mazes, and in the first six the direct path was always blocked. In four of the last five mazes both the direct and indirect paths were open and in the extinction problem (number 9) only the direct path was open. To increase the amount of effort involved in drawing the circuitous path, half of the subjects traced the mazed while viewing it through a mirror.
If the principle of least effort applied, Luchins and Luchins predicted that subjects in the mirror maze condition would use the direct route more frequently than subjects viewing the mazes normally. In fact they found that the subjects tracing the mirror mazes showed significantly more use of the indirect route in one problem (number 8) than did the non-mirror maze group (86% to 56%) and significantly more of mirror maze subjects failed to find the direct route to solution in 2½ minutes in the extinction problem (68% to 32%). As Luchins and Luchins remark, a hypothesis that subjects seek to maximize effort would have been a better predictor of these results.

The authors note that subjects using the mirrors seemed to be under considerable stress because of the difficulties and effort involved and they feel that this may have accounted for the higher percentage using the indirect method, i.e. the stress led to a concentration of their attention on the problem of successfully following the indirect path and this concentration led them to ignore the other parts entirely. Luchins and Luchins are careful to point out that this does not necessarily discount the principle of least effort but does throw doubt upon its applicability in these circumstances.

This study supports the notion that it is the use of productive effort that is being minimized rather than effort per se. It suggests that objective studies which measure, for example, time to task completion are unlikely to give support to a principle of least effort. It also suggests that, when people complain about the amount of effort required to do something or the difficulty of using something, they are talking about the amount of conscious attention they have to give it in order to productively cope with a novel situation. 'Ease of use' in this formulation means the person has available a ready made (whether by nature or training) sequence of behaviour which matches the demands being made on him. It is perhaps that it does not in its use demand conscious attention that renders it 'natural'.
One feature of this analysis however still requires questioning. Is man truly seeking to minimise the use of his productive thinking capacity? This returns to an earlier theme where it was argued that self-actualisation, curiosity and exploratory behaviour cannot be reconciled with this concept. The solution offered previously was that man is a goal seeking organism and he tries to minimise his path to his goal. We may now perhaps try to rephrase this a little more explicitly by saying that man seeks to use his productive thinking capacity in the pursuit of his goals with the greatest economy, i.e. he is going to seek to apply existing concepts, procedures, methods etc. to the achievement of new ends and any productive effort to be devoted to these tool-oriented activities represents a diversion of these efforts away from more desirable utilisation. Indirect support for this conjecture comes from the observation of Luchins and Luchins that their mirror-maze subjects were focussing their energies on their very difficult task and were less likely to identify the fact that the direct route was open than subjects who viewed the maze directly. We may interpret this as meaning that where the central task pursuit is difficult, it soaks up all available productive capacity making it unlikely that any effort is directed to more peripheral activities.

The interpretation of effort we have now developed implies a limited capacity for productive effort and this is in line with modern conceptions of the characteristics of man's information processing capacities. Whilst there are many controversies still to be resolved, a consensus seems to be emerging which sees man as possessing a limited information processing capacity which is slow but very flexible and which is the main vehicle for man's adaptive behaviour. In some formulations it is the seat of man's consciousness. This view recognises that man also has other information processing capacities which, in fact, permit a certain amount of parallel processing to take place. The other capacities appear to be capable of handling greater volumes of information but they do so according to pre-established procedures, i.e. they are
chunks of information processing ability dedicated to specific informational transformations. Hence man is deemed to have a slow, limited capacity, productive processing capability with a large number of specific, reproductive processing capacities. The productive capacity also appears to function as the executive controller, monitoring and scheduling the activities throughout the cognitive system. Broadbent (1971) in an exhaustive survey of experimental evidence about the nature of man as an information processor sheds further light on the concept of least effort. He identifies three strategies ("filtering", "categorising" and "pigeon-holing") which serve to protect the central processing capability from information overload and to ensure its limited capability is used on relevant and important processing. Legge and Barber (1976) provide a short but clear account of man's information processing faculties which invites comparison with a distributed system of micro-processors which has a self-programming executive controlling the activities of a network of dedicated processors which are relatively difficult to re-program.

It would be in the long term interests of an organism of this kind to protect the productive capacity and use it to maximum advantage. This would mean using it to develop dedicated capabilities that could then run virtually autonomously and using these capabilities wherever there are regularities in the demands on the organism. The initial response of the organism to any situation which looks similar to one encountered previously would therefore be to switch in the 'program' prepared for that eventuality, only referring to the productive executive in the event of a failure of the 'program' to achieve the desired end product.

This exploration of the basis of 'ease of use' and 'mental effort' considerations has led us to some tentative conclusions which may be of assistance when considering how managers respond to computer systems. We have concluded that the most likely basis for man's inclination to provide least effort in the pursuit of
his goals is that he has a limited and slow productive thinking capacity and this is his only means of making adaptive responses to his environment. He also has available a wide array of specific information processing capabilities (also conceived of as a repertoire of habits, and skills) which allow him to process information rapidly but in predefined ways. We have further hypothesised (i) that the productive capacity will be used on what are perceived to be central goal pursuits rather than activities perceived as peripheral, and (ii) that more effort will be made available when the behaviour patterns so created may be expected to be used regularly in the future. In effect the argument is that man operates according to a cost-benefit judgement of the utilization of his productive capacities, where cost is the amount of effort and benefit is the furtherance of goals now or in the future. It should not be assumed that the judgement is a conscious one; it is more likely that a familiar path (which involves limited productive effort) is embarked upon automatically and conscious questions of effort are only raised when this proves unproductive.

4.6 Mental Effort in Computer Use

The formulation of mental effort presented in the previous section is sufficiently promising to make use of it in an analysis of the effort required to use a computer system. In this analysis we are concerned with the type of mental effort required to tackle the task. We make this distinction in the belief that performers will prefer to use available productive thinking capacity on the latter with the result that the former will receive little attention. This supposition is untested and a future research project might, for example, test the assertion that, where the task is more demanding of productive mental effort, less attention will be paid to the tools being used.

Our prime concern in this analysis is to distinguish between those activities involving reproductive effort and those involving productive effort. Figure 4.1 lists ten kinds of activities which may occur in computer use and apportions them to the reproductive and productive categories.
4.6.1 Reproductive Effort

This kind of effort will be utilised when the user is employing the computer system upon a type of task he has encountered previously. In these circumstances he is likely to have available to him knowledge and skills which will carry him from problem interpretation, through system operation to perception of results and their translation in terms of the problem without conscious examination of alternative methods of tackling these activities. The methods he uses will be those he has used previously, i.e. they may include operating keyboards etc. but they
may be restricted to telling another person what is required. In this mode of operation the user is essentially loading already developed internal 'programs' and running them with the current set of data. Whilst this analogy is apt as a contrast to the productive mode of operation, it may not be carried too far because man in the reproductive mode behaves rather differently than the average computer program; for example, he is flexible in the choice of sub-routines and tends to use heuristics rather than algorithms.

The first four operations in figure 4.1 may not be performed separately and there may be iterations especially between system operation and perception of output. However, these are the operations which have been examined in most human factor studies of man-computer systems with the aim of minimising the time and effort required.

4.6.2 Productive Effort

Although the bulk of man-computer interaction probably only involves the four kinds of operations presented above, all naive users must occasionally be placed in situations where they are not entirely sure how to proceed. In these situations they will be required to expend productive effort. Three kinds of operation can be identified:

1. Problem Diagnosis. If the user is faced with a task which is novel in some aspect and he does not know how to proceed (Luchins and Luchins 'genuine problem') then he cannot embark directly upon interpretation of the task for system use. Prior to this the nature of the task has to be diagnosed to ascertain whether and how the system may be used to answer the need.

2. Method Selection. If the problem diagnosis yields the general strategy to be followed to answer the task need, there will then be a need to translate the strategy into a series of tactics which may be followed to fulfil the need.
3. Errors and System Malfunctions. Even if the user is performing a task familiar to him he can still be faced with a need to expend productive effort. He may make an error in operating the system and have to find a way of recovering from his mistake. Alternatively the system may malfunction and force the user into an unfamiliar situation. If the user meets the same error or system malfunction situation on a number of occasions, he will learn how to respond and hence will be expending reproductive effort to recover from the situation. However, all too often, the error/system malfunction creates a novel situation for the naive user.

4.6.3 Search Effort

In many cases when the individual has to expend productive effort to determine how to proceed with his problem, he needs only to refer to the general knowledge he has of this kind of problem and the system facility which he knows to be available. He does not need to look further than his own mental resources. However, it is characteristic of the naive user that his knowledge of the system is not the result of extensive training but is the product of his use of the system. This means that his mental resources are usually thin and soon exhausted with the result that he has to look elsewhere for the knowledge he requires. He may therefore engage in search tasks and we can identify three kinds which correspond with the three kinds of productive effort described above.

1. Diagnostic Help. The user may need external help to diagnose the kind of problem with which he is faced. The source of help may be another person, a technical document of some kind or the computer system itself may provide help. Whatever the source the user must expend effort locating the right source, formulating his problem and assimilating the response received.
2. Procedural Help. When trying to translate the problem into a set of procedures the user may need to study the various procedures the system offers. Many systems provide a procedures manual for just such an eventuality but users may still prefer to consult people more familiar with the system.

3. Rescue. When an error or system malfunction leads to a situation from which the user alone cannot escape, he may have to seek the help of systems personnel in the same way the motorist may summon the RAC or the AA.

Whilst there are many issues that may be debated with respect to this classification, e.g. is not the user in productive mode simply switching to higher order search 'programs', there is one point that is essential to the thesis of this chapter. The proposition being presented is that the productive mode operations require the conscious attention of the user upon questions relating to the use of the system. This diverts the use of this limited resource away from primary goal pursuits and, because of this, effort devoted to these activities will be minimised.

4.7 Coping Strategies of the User

With these points in mind we can now look again at the strategies by which management users in the survey seemed to come to terms with the operational characteristics of their computer systems. The evidence is somewhat circumstantial because these strategies were a discovery of the survey rather than a topic systematically examined. However, they may serve as evidence for and against the proposition and assist in the process of deciding how best to progress this research. It may be remembered that there were three strategies:
1. **Disuse of the system.** Even where the system provided a potentially useful service, there were suggestions that some possible users made no use of it. Whilst no systematic data was collected it seems that these users are likely to be (a) those with high discretion with respect to the system (i.e. they cannot be forced to use it), and (b) those with ready made alternatives (or with the capability of creating an alternative). It seems likely that the alternatives do (or will) require relatively little adaptation by the manager whereas the computer system may be quite foreign to his normal information seeking behaviour. The former may therefore be construed as a method of minimising the productive effort the manager has to expend on information seeking tools.

2. **Distant Use.** A strategy characteristically used by managers confronted by on-line terminals or systems which offer them a wide range of choice, is to use another human being to operate the system on their behalf. They are then able to continue to use the familiar skills of communication with another person as their methods of seeking information and they do not have to provide the productive effort necessary to establish the skills necessary to communicate directly with the computer. It is interesting to note that, once these skills are established, much of the effort required to use the computer system passes into the realm of reproductive effort. We may surmise, however, that it is the effort required to establish the skills that provides the barrier.

3. **Partial Use.** Another strategy employed when a system offers a range of facilities, and seemingly a very common strategy, is to limit the use of the system to a small sub-set of the facilities and to ignore the rest. In the terms used in this chapter we can say that these users have been prepared to provide a certain amount of productive effort, sufficient to master a limited number of facilities, but they then use these as the reproductive effort base for their future computer use rather than continue to provide the productive effort necessary to extend their repertoire of facilities.
No doubt other factors also contribute to the development of these strategies. They do, however, provide some basis for believing that there is justification for exploring further the concepts of mental effort developed in this chapter. It would be possible to do this by conducting an empirical examination of the development of any of these strategies in order to seek an explanation for their development. By this means we could hope to demonstrate the role of mental effort in this process. It is in the nature of research that it is not possible to follow all potentially interesting lines of inquiry and one strategy only can be examined. The one selected was the partial use strategy because (a) it was very common, (b) because it is concerned with the range of facilities employed, it yields quantitative data, and (c) it is a graded strategy whilst the others tend to be all-or-nothing. Finally, it is of tremendous importance to the designers of computer systems. Faced with uncertainty about the information needs of the user, designers are utilizing modern technology to increase the range of facilities from which users can select. If the partial use strategy is widespread, the result is that many of the facilities they provide are wasted although, in theory, they may be of value to the users. A solution to this problem would therefore be of considerable practical value.

4.8 Examples of Partial Use

To conclude this chapter, and as a prelude to formulating a study of the partial use strategy, the data from the survey and from other studies of systems has been reviewed for evidence of the circumstances in which partial use occurs and the way it manifests itself.

4.8.1 An On-line Management Information System

This system provided senior managers with visual display terminals in their offices. The system had a simple search and enquiry language which enabled the user to examine a data base of information about company operations. He could examine a particular subject, e.g. sales, at a
macro level or a micro level, e.g. sales of a particular product to a particular customer. He could examine the present position, past trends or future predictions. In interview some of the users said they only used some of these facilities although they were, in theory, all useful. One manager went so far as to say that he did not look at the historical data because he had forgotten the relevant commands. Facilities for learning the relevant commands were readily available but users found it difficult to find the time to use them.

4.8.2 An Inquiry System for Customer Accounts
This on-line system provided the branch staff of a major bank with a variety of methods of extracting information about a customer's account. At one stage there were 28 options each obtained by keying a customer code number and a short digital code for the inquiry. Each of the inquiries was designed to meet a particular kind of task need. Since some tasks are more frequent than others it was anticipated that some options would be used more than others. However, it was not anticipated that three options would account for 77% of the usage and that many of the options would be virtually ignored.

4.8.3 A Simulation System for Managers
Hedberg (1970) reports a system used to simulate banking problems which permitted users to select a variety of outputs and a variety of analysis techniques, e.g. trend analysis. In his experimental work he found that students made wide use of these facilities but experienced bankers when they used the system made sparing use of most of the facilities, concentrating upon a limited number of options. Hedberg accounts for this by reference to the 'standard operating procedures' familiar to bankers from their banking experience, which cause them to see some facilities as more relevant than others.
4.8.4 An On-Line System for Customer Enquiries

This on-line system contained a sophisticated enquiry language which enabled unique output requests to be composed in order that users could obtain a specific reply to their enquiry. The system also had a facility whereby the composed requests could be stored for later use. After a short while the majority of the use of the system was the result of the re-use of existing requests. It rapidly became unusual for management users to use the request construction facilities and even full time clerical users found their existing library of coded enquiries more useful than the construction facilities.

4.8.5 A Network Analysis System

This system was operated in batch mode but permitted considerable flexibility in (a) the form of data input, (b) the kind of processing undertaken, and (c) the construction of outputs. As a result a very large number of outputs were possible. The system served users who controlled the execution of large scale projects and there was a tendency for users to establish the types of output required at the beginning of the project and to use these throughout its life. This tendency persisted despite the different phases of projects and led to many complaints of poor service from the system, particularly towards the end of each project.

4.8.6 A Personnel Records System

This large scale system contained the personnel records of a large organisation. It contained a sophisticated retrieval language which enabled details of personnel to be sorted, classified and output on a wide variety of variables, e.g. all employees with Ph.D's under 25 years of age and living in Scotland. Originally it was planned that this system would be operated from terminals located in the offices of personnel managers. In practice, the sophistication of the retrieval language meant that the personnel managers showed no inclination to use it directly and the system was operated from a central location by a group of system specialists responding to requests from personnel managers.
4.8.7 A Hospital System for Clinical Test Requests

Doctors in a large teaching hospital were provided with on-line terminals which they could use to examine their waiting lists, investigate the bed state of the hospital and to order clinical tests to be performed on their patients. Some doctors, particularly junior doctors, used all of these facilities but many senior doctors used the information display facilities but did not use the test ordering facilities. They found them too complex to learn and too strict to operate and preferred to continue using the manual ordering procedure.

4.9 Discussion of Cases

These systems are different in type and application and involve different degrees of flexibility. They range from systems in which users select from a standard set of preformatted outputs to systems which have facilities for the construction of unique outputs. They also range from systems which only permit outputs from a data base to systems which give the user the opportunity to input data, and to define processing and outputs.

In some of the cases there is evidence of a 'honeymoon' period in which users explore the facilities on offer and then an equilibrium phase appears to be entered in which the repertoire of known and used facilities is not increased.

The evidence given is too scant to be more than suggestive of possible explanations for this phenomenon. The most obvious explanation is that users have identified the facilities that are needed for the tasks in which they engage and have no need of the other facilities. When a facility is not used by any user it would therefore be assumed that it does not meet the needs of any particular user whatever assumptions were made during systems design.
There are also indications that users go beyond task need considerations to make their judgements on the basis of cost-benefit evaluations in which costs are in terms of personal effort and time. It is this form of explanation which most directly focuses upon 'ease of use' aspects of computer systems.

Finally, particularly from Hedberg's analysis, the explanation may lie in the formation of habitual responses which are applied more or less without reference to specific unique qualities of the task stimulus.

With respect to relevant literature, the explanation relating to task need warrants further investigation. It is no doubt part of the explanation and may be the whole explanation. Any empirical study must allow for this as an explanation and seek to test whether other forms of explanation are also necessary.

The other forms of explanation direct attention to the nature of 'ease of use' and evidence as to its effects upon choice behaviour in the use of tools, and to the nature of habitual responses and their relevance to the use of tools. In the next chapter a study is reported which assesses the extent of partial use in a specific case and attempts to discriminate between these explanations.
CHAPTER 5 : A STUDY OF THE USE OF A FLEXIBLE INFORMATION SYSTEM

5.1 Introduction

This chapter reports a study of one case in which the phenomenon of partial use of computing facilities had been noted and is an attempt to assess the extent of this effect and to seek explanations for it.

The chapter begins by discriminating between the various explanations that have been offered before presenting the methodology for the study. This is followed by a presentation of the results and a discussion which models the phenomenon in terms of cost-benefit judgements.

5.2 Explanations of the Phenomenon

To focus this investigation upon critical aspects of this phenomenon it is necessary to seek possible explanations for it. We may then find that we can utilize these explanations to generate hypotheses that may be tested in the investigation.

5.2.1 The Rational Choice Hypothesis

The simplest explanation is that users are responding entirely rationally and are selecting the best option for the task they have to undertake. If they do this and the result is that a large number of options are not used, these options are simply unnecessary.

It seems unlikely that this explanation represents the whole truth although it raises the critical question of what range of options a person with a given variety of tasks should require. It is too great an assumption to claim that each user will make equal use of all the facilities offered by a system. His task needs will inevitably lead to differential use of facilities. The essential question is the degree to which the 'profile' of use generated purely from task needs differs from the actual 'profile' of use. Before it is possible to establish whether there are other contributory causes, it will be necessary to find a methodology to deal with the problem of usage profiles derived from task needs alone.
5.2.2 The Conscious Choice Hypothesis

If the 'rational choice' hypothesis is regarded as insufficient explanation in itself, the consequence must be that the user is, in some instances, selecting an option which is not the most suited to his task needs. Why should a user behave in this way? One possible explanation is that, after due consideration of the options, he has decided that, for him, the theoretically best solution is not the most suitable. We may call this the conscious choice hypothesis because it requires a conscious comparison of options by the user.

This explanation has some appeal because it fits the comments made by many users. This is to the effect that the best task solution was not ideal because of some constraining influence on them, i.e. they did not have sufficient time to implement the best solution, it would have meant an unacceptable delay, or it demanded an amount of effort out of proportion with the importance of the task.

One of the most frequent comments made about computer systems is that they are difficult for the non-specialist to use, i.e. outputs are difficult to interpret, manuals are difficult to understand, terminals are difficult to operate, man-computer dialogues are difficult to follow, etc. If users do experience problems of this kind it could well be that they take account of the difficulties in deciding which course to take whenever they have a choice of action. The user may therefore conclude that a manual alternative is preferable to a computer alternative although the latter may offer greater benefits. Similarly, if one computer alternative is easier to implement than another it may be preferred regardless of the relative merits of the two alternatives as solutions to the task need.
5.2.3 The Reproductive Response Hypothesis
The 'conscious choice' hypothesis assumes that the user is aware of the options available to him and deliberately selects the option appropriate to his needs. This hypothesis makes assumptions of a similar nature to those that pervade the theory of economic man, i.e. that man is in possession of complete information when he makes his decisions (Edwards and Tvesky, 1954), and that he consciously evaluates the merits of all alternatives before arriving at a decision. An alternative hypothesis is that the individual faced with a familiar stimulus produces a habitual response (a reproductive response) and is not conscious of having made a choice.

5.2.4 Summary
It is possible to hypothesise that the limited use of options in a flexible computer system is the result of a rational choice based upon task needs, a conscious choice that goes beyond task needs to consider other factors such as personal effort or a reproductive response based on previous experience. It will be apparent that these explanations lead to different conclusions for systems design. Briefly the rational choice hypothesis suggests that unused flexibility may be unnecessary and the conscious choice hypothesis suggests attention must be paid to factors which prevent users from simply considering task needs, e.g. 'the ease of use' of the system may need to be improved. The reproductive response hypothesis poses more problems because, if the response is inappropriate, ways by which the system could encourage users to 'break set' have to be explored (Stewart, 1976).
5.3 Methodology

5.3.1 Selection of System

As a first stage in the exploration of this phenomenon a field examination of its extent and defining characteristics was considered appropriate. This may be sufficient to establish which of the explanations (or which combination of explanations) is most likely.

The first step therefore was to seek a suitable operational system. Computer based systems which provide flexibility in information service come in many forms and vary between those that simply enable users to select between a fixed number of outputs and those which enable users to select a form of processing to be under-taken on a given set of data and to select appropriate output forms. If a very sophisticated system were chosen for analysis there would be the danger that any conclusions reached would be limited to this kind of system, i.e. no conclusions could be drawn for the simpler systems. Whilst the reverse is not absolutely true, it does appear that any regularities found in human behaviour with simple systems may also be found, perhaps to a greater degree, with more complex systems.

For these reasons an approach was made to the Bank which operated the inquiry system for customer accounts described in 4.8.2. This organisation was very large and had the added advantage of a very large number of system users distributed in branches around the country. The system provided 36 alternative ways by which information could be printed on a special purpose teletypewriter computer terminal about a customer's account. The user entered the customer's account number and a three digit inquiry code number and received the information immediately. The investigation would therefore be into the processes by which users selected an inquiry code from the list of
options. The Bank agreed to the study and provided considerable resources of manpower and time to ensure its success.

5.3.2 'Right' and 'Wrong' Responses
In order to test the three hypotheses the unit of study had to be the option selected by a user for a specific task; in particular to differentiate between the hypotheses it had to be possible to discriminate between the option that should have been selected and the one that was selected. The study was therefore composed of a set of tasks in which users selected options which were subsequently analysed as being 'right' or 'wrong' responses. This immediately raises the question of who is to judge what is right. This was resolved by asking staff personnel of the organisation responsible for or associated with the running of the system to make these judgements. They were effectively assessing which option was designed for use in each circumstance which is probably as near as one can approach to the 'right' answer in this setting.

5.3.3 Observation, Diary or Questionnaire?
The two most popular techniques for investigating task behaviour in field settings are observation and self-completion diaries. Both techniques mean the investigator collects information about whichever tasks occur, i.e. he has no control over the tasks with which the subject is confronted. It would be very wasteful of resources to conduct the study on this basis. It was known from the organisation's log of options used that 45% of requests were for the option giving a Customer's balance of account. This was a case of an oft repeated task and an option designed to serve it. It was doubtful whether much would be learned by the collection of data about this option. What was of concern to the organisation was that many options which were thought to be of considerable value were very rarely used. It was decided that the investigation should
focus upon these options. This would have meant that an observer would have had to wait for long periods for the right kinds of task to occur before he could collect useful data and this approach was rejected as wasteful. A diary could have been produced which asked for information about particular kinds of task but apart from problems of task definition, this approach would have drawn undue attention to the tasks under study and was also abandoned.

The alternative was to design a standard set of tasks and offer them to all subjects. This has the disadvantage of being artificial and leaves open the question of whether response to them is the same as to 'real' tasks of the same type. Neither the investigator nor the members of the organisation consulted could give any good reason for believing the response would be different apart from the act of recording which seemed more likely to trigger a conscious response than a real, familiar task may do. It seemed therefore that any method that involved the subject recording his actions may operate against the reproductive response hypothesis. Since there was no way of avoiding the effect, the only recourse was to view results with this bias in mind.

The advantages of this method were considerable. Not only did it make good use of resources but it enabled the selection of tasks most suitable for testing the hypotheses. It also meant all subjects undertook identical tasks making it possible for comparisons across subjects to be made. For these reasons this course of action was adopted and the 'panel of experts' within the organisation were asked to design a set of tasks which would be familiar to most users of the system but which, in the opinion of the experts, should involve the use of a not very frequently used option. In the event the panel had no difficulty in designing eight tasks with these characteristics.
5.3.4 The Structure of the Questionnaire

The eight tasks were embodied within a questionnaire, a synopsis of which is included in Appendix 2. For each task the user was asked how he would respond to the task request (not necessarily employing the computer system), and whether there were any alternatives he might have employed. If alternatives were listed the user was asked to explain the reason for his preference. If the user was unsure how to proceed he was asked what he would do to find out, e.g. ask someone, consult the manual, guess, etc. Finally, the user was asked how frequently he encountered a task of this nature.

The list of eight tasks comprised Part II of the questionnaire. Part I sought information about the user which might account for any variation in responses obtained. It asked for information about the branch of the user, his position and grade, length of experience, previous positions and training with respect to the system. In each case it is possible to produce a rationale for an effect upon system usage. In the case of previous positions, for example, the user may have had responsibility for operating the system within the branch. A further question asked who the user would turn to for help in the branch if he was in difficulty with the system.

If users made direct use of the system without recourse to any aids they would obviously be relying on their memories. In completing the tasks they were asked not to make reference to any documents or other people. If they were in doubt they were asked to indicate this by saying how they would resolve it. In administering the questionnaire it was emphasised that it was not a test of individual knowledge and ability but a device to help system designers. Respondents remained anonymous to reinforce this point and to encourage users not to bias responses.
In order to ascertain knowledge of the system directly Part I also included an invitation to list all inquiry codes used regularly, used occasionally or known but never used. In the event of users demonstrating that they rarely sought information from external sources, these listings would form the repertoire of possibilities for the user to consider and would be powerful determinants of response.

5.3.5 Alternative Classes of Response
At the same time as designing the tasks, the panel of experts also (a) determined the correct response or responses, and (b) identified other responses which might lead to success but would be regarded as incorrect because they were not as appropriate as the correct response, e.g. they were less likely to yield the right answer, less efficient in computer time, less efficient in user time, etc. With this data available the 12 classes of response listed in figure 5.1 were identified. As data became available, the panel of experts, classified each task response into one of these categories.

Correct
No alternative given 1
Alternatives given and rejected 2
Incorrect but Successful
Correct solution listed and rejected 3
Correct solution amongst known options 4
Correct solution unknown 5
Incorrect and Unsuccessful
Correct solution listed and rejected 6
Correct solution amongst known options 7
Correct solution unknown 8
Search
Inquiry Code List 9
Inquiry Code/Other Manual 10
Refer to another person 11
No Response 12

Figure 5.1: Possible Responses to Task Questions
5.3.6 Predictions of Response from Hypotheses

The three rival hypotheses lead to different predictions of the profile of responses to be anticipated:

(i) Predictions based on the rational choice hypothesis.
This hypothesis claims that people will select the course of action best fitted to their task needs and no other considerations will affect the decision. In the present tasks this means correct responses (1 and 2) plus the search responses (9, 10 and 11) in cases where the correct response is not immediately known. This hypothesis makes the strong assumption that, in the event of a new task, the user will compare all options before taking a decision. If he does not know all of the options he must engage in a search response.

(ii) Prediction based on conscious choice hypothesis.
This hypothesis suggests that factors apart from immediate task needs may affect the decision and alternatives will be consciously evaluated in terms of all the factors involved, e.g. 'ease of use'. If this is the case one would expect to see correct responses (1 and 2) but also successful responses that are assessed as correct but which the user judges, from his vantage point, to be more appropriate than the ideal, i.e. he may list the ideal among alternatives and give reasons for rejecting it (3).

(iii) Prediction based on the reproductive response hypothesis.
This hypothesis suggests that no conscious evaluation of alternatives will take place and that the user will simply implement the option he habitually uses in these or similar circumstances. This strategy puts the emphasis upon immediate action rather than search and is a non-learning approach, i.e. if there is no seeking for new options and no conscious evaluation of alternatives, the users knowledge of the scope of the
system and how to use it will not develop. This strategy would therefore lead to a minimum knowledge of known codes. In terms of response categories it would lead to some correct answers with no alternatives given (1) but, because alternatives are rarely considered, there would be few correct answers with alternatives listed (2). There would be few search responses (9, 10 and 11) but many incorrect responses both successful and unsuccessful. Incorrect responses would tend to be those where the correct solution is unknown (5 and 8) rather than known and rejected (3 and 6).

Thus, whilst it is not possible to predict precisely the allocation of responses to categories there is sufficient diversity of prediction to assess the validity of the three explanations.

5.3.7 The Sample and Survey Administration
The questionnaire was first administered in one branch as a pilot study. It was given to a sample of branch staff by staff of the Department concerned with the system and other procedures within the branch. Each member of staff completed it without supervision but comments upon areas of ambiguity etc. were gleaned when questionnaires were returned. As a result of the pilot study a few minor alterations in wording were made, e.g. the scale for assessing experience of a task was changed from an abstract frequency rating (Never, Rarely, Often, Frequently) to a time based rating (Daily, Weekly, Monthly, etc.).

The criteria for selecting the full sample were simply that a cross section of staff should be included and a cross section of branches. To this end 15 branches were selected which differed in size and location. The questionnaire was given to a sample of staff in each branch
ranging from junior clerks to management. This enabled a comparison to be made between the response of clerical and management staff. In total there were 125 respondents.

The administration of the questionnaires was conducted throughout by the staff of the organisation who also made the initial analysis by classifying responses.

5.4 Results

5.4.1 Overall Responses to Tasks

The overall pattern of responses to the eight tasks is given in figure 5.2. In summary just over half of the responses were correct and 35% were assessed as incorrect (9% also likely to be unsuccessful). The search responses were very low (3%) and there was a 9% no response rate. The latter was largely a result of inexperienced staff reporting no experience of the tasks in question. Rather than identify a search response they preferred to make no response at all.

Considering the results in terms of the alternative predictions the following is evident.

(i) The Rational Choice Hypothesis. This explanation could be used to account for the correct responses (52.9%), the search responses (3.0%) and possibly the no responses (8.6, Total = 64.5%). It cannot be used to explain the 35.5% incorrect responses. The rational choice model only allows for the selection of an option on the basis of task needs and therefore does not predict incorrect responses. It is possible that the user will misinterpret the task but this is likely to yield an incorrect, unsuccessful response. There is no reason in this model to anticipate a 26.0% incorrect but successful response.
(ii) The Conscious Choice Hypothesis. By virtue of bringing factors other than task issues into the decision, the conscious choice model does predict a level of incorrect but successful responses, i.e. the user rejects the 'officially' correct solution for reasons of his own and chooses another alternative which is also successful. The hypothesis also requires awareness of ones actions and there should
also be evidence that users following this course know of the correct option and dismiss it. This is the explanation most observers seem to favour. In explaining the limited use of some options people often say, for example, 'I know 'x' is correct but it takes too long to print' or 'the manager does not like you using it because it prevents the terminal being used for data input' or 'x' may answer this task but if I get 'y' I am covered if the customer asks further questions'. Valid as these arguments may be, they would suggest that a user giving an incorrect successful answer would know the correct solution. In only 6.4% of cases was this true (category 3 plus category 4); we still have to account for 19.6% of responses where the correct solution was not listed and rejected as an alternative or was not listed amongst known options. In these cases the option has been selected seemingly without a conscious choice between it and the 'correct' response.

(iii) The Reproductive Response Hypothesis. A model which sees man blindly applying a known alternative which has some probability of success without considering or seeking other alternatives predicts a range of responses. It predicts a degree of correct success and it also predicts a degree of incorrect success and failure. What it does not predict is a high level of search because its a 'try something and see if it works' philosophy. It also does not predict responses in which other alternatives are listed and rejected. In these respects it provides the best 'fit' with the data obtained, it is the only hypothesis which can explain the 27.9% incorrect responses where the correct option was unknown (categories 5 and 8) and only 3% search responses.
(iv) Conclusions. No single hypothesis provides an adequate explanation for these results. This may be interpreted in a number of ways. Perhaps the methodology is at fault and spurious data has been obtained. Perhaps each subject is capable of behaving according to two or more of the models proposed depending on the task in question. Finally perhaps some subjects respond according to one model and some according to another. The specific analyses reported below seek to discriminate between these interpretations.

5.4.2 Knowledge and Choice

The low level of search responses means that subjects were relying upon their memory of the inquiry codes when making their selection. In the first part of the questionnaire subjects were asked to list the codes (or describe their functions) and we therefore have a report of this memory which should be a good predictor of success in the tasks. Figure 5.3 gives the distribution of knowledge about inquiry codes.

\[
\text{Mean} = 10.8 \\
\text{Standard Deviation} = 4.15
\]

Figure 5.3: No. of Inquiry Codes Reported
The average number of codes reported was 10.8 with a maximum of 30 (out of 36) and a minimum of 2. The standard deviation was ± 4.15. The distribution was slightly skewed with only 12% scoring above 15.

If this is a good representation of users' knowledge, few respondents can hope to effectively employ the rational choice method without recourse to external search, i.e., they do not have recourse to all available options in their memories in order to make the necessary exhaustive comparison of options.

Figure 5.4 gives the distribution of the inquiry codes reported by respondents.

<table>
<thead>
<tr>
<th>Inquiry Code Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>95-99</td>
</tr>
<tr>
<td>90-94</td>
</tr>
<tr>
<td>85-89</td>
</tr>
<tr>
<td>80-84</td>
</tr>
<tr>
<td>75-79</td>
</tr>
<tr>
<td>70-74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Respondents</th>
<th>Knowing Code</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69</td>
<td>60-64</td>
<td>836*</td>
</tr>
<tr>
<td>60-64</td>
<td>55-59</td>
<td>401*</td>
</tr>
<tr>
<td>55-59</td>
<td>50-54</td>
<td>816</td>
</tr>
<tr>
<td>50-54</td>
<td>45-49</td>
<td>812, 402</td>
</tr>
<tr>
<td>45-49</td>
<td>40-44</td>
<td>827, 501, 824, 826</td>
</tr>
<tr>
<td>40-44</td>
<td>35-39</td>
<td>101*</td>
</tr>
<tr>
<td>35-39</td>
<td>30-34</td>
<td>502*, 838</td>
</tr>
<tr>
<td>30-34</td>
<td>25-29</td>
<td>503*, 831</td>
</tr>
<tr>
<td>25-29</td>
<td>20-24</td>
<td>811</td>
</tr>
<tr>
<td>20-24</td>
<td>15-19</td>
<td>823*</td>
</tr>
<tr>
<td>15-19</td>
<td>11-14</td>
<td>801, 102*, 818, 835, 839*</td>
</tr>
<tr>
<td>11-14</td>
<td>6-10</td>
<td>802, 815, 829, 837</td>
</tr>
<tr>
<td>6-10</td>
<td>0-5</td>
<td>803, 805, 807, 813, 819, 820, 822, 832</td>
</tr>
</tbody>
</table>

Figure 5.4: Knowledge of Specific Inquiry Codes

* Codes needed for Correct Solution to Tasks
There are a group of 4 codes known to over 65% of respondents and 19 codes which are known to less than 25% of respondents. The four well known codes consist of two methods of getting the balance of an account (808 and 809), a listing of the last 16 items on the account (825) and a profile of the account which gives peaks and troughs over an extended period (836). These four inquiry codes accounted for 75% of the usage of the inquiry code system in an analysis made in 1975 and this suggests a close correspondence between a code being known and being used. This was confirmed by correlating usage data with knowledge data which gave a correlation of 0.73 (Kendall’s tau; significant beyond 0.05 probability).

The relationship between knowledge of codes and success in selecting an appropriate code can be examined from the data. One crude measure is the relationship between the number of codes known and success in tasks A-H. In general, the more codes you know, the more likely it is that you know the one that is needed for a specific task. An analysis of the relationship between these variables gave a correlation of 0.56, a significant (p < 0.01) positive correlation. This is an encouragement to believe knowledge is a pre-requisite to finding the right solution but is it sufficient? To examine this we need a finer measure which relates knowledge of the specific codes needed in the tasks to the response rates for the tasks.

The inquiry codes which are asterisked in figure 5.4 are those which were needed to obtain the correct solutions to the tasks in the second part of the questionnaire. It will be noted that they are widely distributed in the scatter diagram some being much more widely known than others. If prior knowledge of the inquiry code is important in selecting the right code we may expect a correlation between the degree to which a code is known and the incidence of correct responses to the tasks. Figure 5.5 is a plot of this relationship.
The correlation between the frequency with which a code was known and the incidence of a correct solution was 0.66. Although high this is not a significant correlation because of the small sample size \( (p = 0.1) \). The fact that it is not a perfect correction suggests that whilst knowing a code is important it is not sufficient to yield a correct response in all cases. Therefore there are also other variables at work.

There are two further questions we may ask of this data to illuminate the relationship between knowledge of codes and their use:

1. Is there any evidence that people know of codes they have not reported, and
2. How frequently do people know the right code but not make use of it?
The first question is posed for methodological reasons to ascertain the degree to which the record of known codes is reliable. The second question is central to the investigation because, if there are a large number of incorrect responses where the correct code was known, it implies either a 'wrong connection', i.e. the respondent did not associate the code with the task, or that a deliberate selection of another code was made. To answer the second question we know from the general analysis that in only 4.0% of cases (combining category 4 and 7 responses) were correct options listed and not used. To answer the first question we can ascertain the number of instances in which codes were mentioned in the task which were not present in the list of known codes. A full analysis was therefore made of responses in the following categories:

1. Correct solution with known code.
2. Incorrect solution with known code.
3. Correct solution with 'unknown' code.
4. Incorrect solution with 'unknown' code.

The results are given in figure 5.6:

<table>
<thead>
<tr>
<th>Response on Tasks A-H</th>
<th>Known (%)</th>
<th>Unknown (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct Codes:</td>
<td>35.6</td>
<td>17.1</td>
<td>52.7</td>
</tr>
<tr>
<td>Used (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Used (%)</td>
<td>9.4</td>
<td>37.9</td>
<td>47.3</td>
</tr>
<tr>
<td>Total (%)</td>
<td>45.0</td>
<td>55.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 5.6: Comparison of codes Known and Currently Used
The 'Used' category is the correct response categories (1 and 2) from figure 5.1 separated into those responses where the code was given in Part A (35.6%) and those where it was not listed (17.1%). The level of used but not listed responses throws some doubt on the validity of the code listing in Part A of the questionnaire. It is evident that when posed with a specific requirement for a particular code many subjects were able to recall it whereas they were not able to do so under the general requirement to recall the full list. The data giving the extent of knowledge of codes must therefore be assumed to be an under-estimate of true knowledge.

The 'Not used' category includes responses where subjects did not claim knowledge of the code (37.9%) and where it was listed (9.4%). This latter figure includes situations in which the subjects chose other options both successful and unsuccessful and where they adopted a search response or made no response at all. It reveals the degree to which the code is not linked into the model of the task. For the most part this is because another response is favoured.

5.4.3 Analysis by Task

The responses for the eight tasks are summarised in figure 5.7. It is immediately apparent that there are wide differences in response patterns, e.g. the correct response for task C is 76.8% compared with 25.8% for task F. For the same two tasks the successful but incorrect response ranges from 4.0% for task C to 62.1% for task F.
### Table 5.7: Responses to Tasks A–H

<table>
<thead>
<tr>
<th>Responses</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>(%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct (1&amp;2*)</td>
<td>71.2</td>
<td>62.9</td>
<td>76.8</td>
<td>45.6</td>
<td>53.6</td>
<td>25.8</td>
<td>16.9</td>
<td>68.0</td>
</tr>
<tr>
<td>Successful (3,4&amp;5)</td>
<td>21.6</td>
<td>3.2</td>
<td>4.0</td>
<td>44.7</td>
<td>26.4</td>
<td>62.1</td>
<td>33.1</td>
<td>14.4</td>
</tr>
<tr>
<td>Unsuccessful (6,7&amp;8)</td>
<td>4.0</td>
<td>16.9</td>
<td>6.4</td>
<td>6.5</td>
<td>14.4</td>
<td>6.5</td>
<td>21.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Search (9,10&amp;11)</td>
<td>2.4</td>
<td>7.3</td>
<td>3.2</td>
<td>1.6</td>
<td>3.2</td>
<td>1.6</td>
<td>4.8</td>
<td>0.8</td>
</tr>
<tr>
<td>No Response (12)</td>
<td>0.8</td>
<td>9.7</td>
<td>9.6</td>
<td>1.6</td>
<td>2.4</td>
<td>4.0</td>
<td>24.2</td>
<td>15.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 5.7: Responses to Tasks A–H

* Category numbers from figure 5.1.

In order to explore the variation in response each task is described below and the inquiry codes employed are presented and discussed.

(1) Task A. In this task the respondent was asked to check whether the processing of a specific debit from an account had been completed. The data and amount of the transaction was given but no reference number.

The appropriate inquiry in this case was one in which the user lists the specific debit of interest (401) and the majority of respondents cited this inquiry (71%). This inquiry was listed in Part A by 66% of respondents. Of the 27 (21.6%) who chose different responses which would also have been successful 12 chose a method which listed the last 16 items on the account (825) known to 87.8% of respondents and 5 a method which gave all debits since the last full statement (826) known to 43.4% of respondents. Both of these approaches give more information than is required and run the risk of
not including the required item. Nine respondents gave an inquiry which listed all debits since a specific date. This approach avoids the risk of omitting the relevant inquiry but still includes much more information than is actually required. In 5 instances of successful but incorrect solutions the respondents listed and rejected the correct solution. The unsuccessful respondents confused credits with debits.

(ii) Task B. In this task the respondent was asked to identify the balance of an account at a certain date for the auditors. The correct response is an inquiry designed to give the balance at a specified date (503). This code was listed by only 27% of respondents although, when this task which directly related to it was presented, 63% of respondents remembered it. This task caused difficulty for some respondents because there are very few alternatives which will work. A successful inquiry would have been to order a full statement for the period in question, (used by 2 respondents) a technique which is slow because it is not received over the terminal and which yields more information than required. Most of the unsuccessful responses obtained a balance (but a current one) (4 respondents) or obtained information about the date in question (but not the balance) (4 respondents). Presumably failure would have led, in time, to a search response but it is of interest that this was not the first reaction.

(iii) Task C. The customer, on this occasion asked for details of the charges made against his account for a period some months previously. The inquiry system does not provide an assured means of obtaining data
about this period and the correct procedure is to order the relevant statement. This is a multi-purpose response and a response used frequently by staff. The majority of respondents recognised its value in this instance although it is not an immediate answer. For this task, rating the use of inquiry codes as successful or unsuccessful is an uncertain process. The use of the general purpose inquiry which lists the last 16 items on the account (825 - 3 respondents) or all items since the last statement (826 - 3 respondents) were rated as successful but this is only the case if the relevant item is in the list. If the period in question was some time previously this can only be true if the account is slow moving. Other inquiry codes, such as those that give interest information, could never have answered the query and were rated as unsuccessful.

(iv) Task D. In this case the respondent was asked to establish whether a particular credit had been paid to the account which was usually paid on a regular basis. The appropriate inquiry was one which lists all credits from a specifiable data, (502; reported as known by 33% of respondents). In practice, the task stimulated 45.5% respondents to recall the code. This is an example of an inquiry that was not very well known and for which there were alternatives which were better known. An important point to consider is whether the relevant inquiry is little known because of the existence of the better known alternative. In this case two inquiries accounted for all the successful alternatives. 28 people employed the inquiry which gave the last 16 items on the account (825; known to 88% of respondents). This code is almost certain to give the required information albeit embedded in other information.
27 people asked for all credits since the last statement, (827; known to 46.7% of respondents). This inquiry was also likely to give rather more information than was necessary. Seven of the respondents who used successful but incorrect responses (13%) listed the correct option and rejected it giving as their reason the need for extra information in case it was required. The small number (8) of unsuccessful responses were largely due to junior staff confusing debits and credits.

(v) Task E. In this task a customer knows there has been a withdrawal from his account and he knows its date and reference number. The respondent is asked to find the amount withdrawn. The inquiry specifically designed for this eventuality is one which traces the withdrawal by its reference number (101; reported as known by 39% of respondents). In the event it was remembered by 54% of respondents although there were a considerable number (26%) who found an acceptable alternative. The most frequently used alternative was the 825 code which gives the last 16 items in the account (12 respondents). This will probably be successful if there has been little movement on the account since the withdrawal but it does give excess information. An alternative is the 826 code which gives withdrawals since the last full statement (7 respondents). This is certain to be successful but gives excess information. A similar statement may be made about the 501 code used by 7 respondents which gives all withdrawals from a specified date. It may be noted that these three inquiries are known to 87.3%, 43.4% and 27% of respondents respectively. Particularly in the case of the 825 code, it may well have been a case of when in doubt turn to the general purpose inquiry which may be successful. This interpretation is supported by the fact that only 2 respondents listed the correct code and rejected it. Of the unsuccessful responses, 11 respondents used
the 102 code which gives the reference numbers of a range of withdrawals. The other frequent but unsuccessful response was the 401 code (6 respondents) which checks whether a specific amount has been withdrawn.

(vi) Task F. In this task a customer has reported the loss of his cheque-book and asks whether it has been used for unauthorised withdrawals from his account. He knows the range of reference numbers. The correct solution is to use the 102 code which checks whether a range of reference numbers have been presented for payment. This is a little known inquiry code (reported by 11% of respondents) and only 25.8% of respondents gave it as a solution.

As many as 62.1% of respondents gave successful but incorrect solutions. A considerable range of alternatives were given all of which give details of recent withdrawals. The most popular alternative was, once again, the 825 inquiry which gives the last 16 items on account (31 respondents). In two more instances this inquiry was used in conjunction with inquiries which gave more recent information in case withdrawals had taken place in the preceding day. Other popular alternatives were the 826 code which gives all withdrawals since the last statement (23 respondents) and the 501 code which gives all withdrawals since a specified date (20 respondents). In each of these cases, the inquiry is likely to reveal evidence about whether there have been unauthorised withdrawals, although possibly not complete evidence, and the information will be embedded within other information. The correct response is the only way of limiting output to the information required. These three codes were the same three widely known codes that were used incorrectly in Task E. Only 6
respondents (8%) listed the 102 code as an option and then rejected it. Of the 6.5% unsuccessful responses, 5 were caused by the use of the 101 code which gives information about one withdrawal only and 2 by the 401 code which checks a specific withdrawal amount.

(vii) Task G. The last two tasks are specifically management tasks. In Task G the 'management by exception' system reports an account 'out of order' on the previous day and the task is to investigate in order to determine appropriate action. The inquiry codes designed for this purpose are the 823 (last working day entries on a specific account) and the 839 (a limited profile of the account). These inquiries are likely to reveal the changes that have occurred recently in the account and the general state of the account. These codes were used by only 16.9% of respondents.

One reason for this low 'correct' response is that there are a number of other codes which may be regarded as nearly as successful and they accounted for 33.1% of responses. They are the familiar much used codes; the last 16 items (825; 16 respondents), all debits since last statement (826; 3 respondents) and items debited since a date (801; 13 respondents). Ten respondents by-passed the system and went directly to the paperwork of the previous days work which would have entailed a laborious search. The other alternatives will usually be successful but again many give more information than is necessary.

Unsuccessful responses accounted for 21% of responses and no responses 24%. The latter were the result of junior staff being confronted by a management task of which they had no experience. The main responses defined as unsuccessful were 824 (15 responses) (details of overnight entries) and 836 (5 responses) (the full account profile).
(viii) Task H. This was another task at the management level in which a customer requires an urgent interview and the task is to obtain appropriate information about the working of the account. The two codes designed to summarise the movements of an account over a period of time are 836 (the account profile) and the 839 (a short account profile). The 836 code is a well known general purpose account and these two codes were used by 68% of respondents. Many other codes provide useful information if not in such a clear summarised form and these were used by 14.4% of respondents. Three of the alternatives used gave balance information (808, 809 and 838; 10 respondents in total). The other alternative used by two respondents was the last 16 items (825). In all cases the information obtained was much more limited than the correct solutions although it would have been useful to the task. It was difficult to define any responses as unsuccessful but 15.2% of junior respondents who had no experience of the task made no response.

(ix) Conclusions. The analysis by task makes explicit the rationale behind some of the choices made by respondents. The following points may be noted:

1. The success rate varies a great deal from 76.8% (C) to 16.9% (G) and a number of factors contribute to this variation. One factor is the degree to which there is one right answer; in Task G, for example, there are a number of responses which may be regarded as adequate although there are responses specifically designed for the task in question. Another factor is the degree to which the inquiry code is known perhaps for other purposes.
2. Where a successful but incorrect solution is chosen it may be inappropriate for a number of reasons. First there is uncertainty; it may not give the information required. Secondly, and perhaps most commonly, the information may be embedded in a considerable amount of irrelevant material and a search may be required. Thirdly, the information may be presented in a form unsuited for the task in question and lastly, it may be necessary to seek two or more codes and combine the information necessary for the task. In some instances the information required had to be inferred from the information given which may have led to errors being made. From the user's viewpoint his choice may (a) lead to more effort than an appropriate selection would require, (b) may not yield the appropriate information, or (c) may cause him to make inferences which are not valid.

Except for (c) the consequences are largely uneconomic use of time. From the computer specialists viewpoint there may also be economic issues because the substitute inquiry codes tend to involve more processing and output time than the specialist codes that were the correct responses.

3. An analysis of the codes used as successful substitutes for correct responses shows that only a limited number were used in this way. Ten codes account for 95% of this category of response and three account for 86%. These are 825 (the last 16 items; 43%), 826 (items since last statement; 26%) and 501 (debts since a date; 17%). The characteristics that these codes have in common are that they are well known and give a considerable amount of recent information about the account. They are, in effect, general purpose codes whereas the correct codes have more specialist functions.
4. The conclusions this analysis leads to concerning the dynamics of the choice process will be left until the analysis is completed. Suffice it to say that the general rule is that if something you already know is likely to work, albeit uneconomically, use it rather than engage in a search for a more specialist code which may not exist.

5.4.4 User Variation

The overall analysis (given in figure 5.2) showed that 35.5% of responses were incorrect, (26.0% successful and 9.5% unsuccessful). The next question to ask is whether these responses were evenly distributed amongst respondents or whether some respondents are more prone to make some responses than others.

The distributions of successful and unsuccessful responses are given in figures 5.8 and 5.9 respectively.

![Figure 5.8: Distribution of Successful, Incorrect Responses](image)

![Figure 5.9: Distribution of Unsuccessful, Incorrect Responses](image)
The distribution of successful, incorrect responses shows that the majority of respondents (64%) made between 1 and 3 successful, incorrect responses. There is not, therefore, a large group of users who either made no such responses or were responsible for most of them. The distribution of unsuccessful responses shows a different pattern 50% (61 respondents) made all of the errors and 57% of the errors were made by a group of 23 respondents who made two or more unsuccessful responses each. In seeking the reasons for successful, incorrect responses we are examining the majority of respondents whilst in examining the unsuccessful responses the investigation focusses upon a small group.

We have already examined one variable which makes a large contribution to user success; knowledge of codes both generally and the specific ones needed to conduct the task. We know that knowledge of codes correlates significantly with the selection of a correct response. It is not a perfect correlation and therefore there are other variables of importance. In addition there is the important question of how the knowledge of codes is acquired. If the knowledge of codes is an important intervening variable in the successful use of codes, then attention should be devoted to finding correlates of this knowledge. A number of variables may be identified as important in this context and are examined below:-

(i) Experience of Task. Are incorrect responses the province of respondents with little or no experience or is there more to it than that?
(ii) Seniority. Does success vary with the position held within the organisation?
(iii) Computer System Oriented Posts. Do individuals who occupy or have occupied positions in which they were responsible for operating the computer system do better than other members of staff?
(iv) Branch variations. The respondents to this survey are distributed in a number of branches with little contact with one another. Have some branches found ways of using the inquiry code system more successfully than others?
Experience of Task. Each task included a four point rating scale of the experience of the respondent of the task in question (4 = daily, 3 = weekly, 2 = monthly, 1 = infrequently or never). It is therefore possible to correlate the experience of the respondent with the responses he makes. On the basis of the rational choice model one would presume that respondents with little or no experience of a task would resort to a search response more frequently than respondents with considerable experience of the task. The reproductive response model would suggest that once a person has found any solution that works he will tend to continue using it. Therefore greater experience is unlikely to affect the likelihood of a correct response being found.

A comparison of response categories and experience of tasks is given in figure 5.10.

A high percentage (45.5%) of responses were made by people with very little or no experience of the task. There was a significant difference between their responses and the responses of those with experience of the task, (X² = 194, for 16 df, p < 0.01). This result is obtained because there is a higher rate of search responses and no responses amongst staff who have not encountered the task and amongst those who did not give an experience rating. There is very little difference in the correct or incorrect responses across the four categories of task. An analysis which omitted the 'no response' categories gave a X² of 16.1 which, for 16 df was not significant at p = 0.05. Most of the variance in this data was attributable to the larger number of 'search' responses amongst respondents with no experience of the task. We conclude therefore, that whilst those who have experienced a task are more likely to respond directly to the task they are no more likely to obtain the correct response.
<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Infrequent</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Daily</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Correct (1/2)</td>
<td>238</td>
<td>52.3</td>
<td>111</td>
<td>57.2</td>
<td>88</td>
</tr>
<tr>
<td>Incorrect/Successful (3/4/5)</td>
<td>111</td>
<td>24.4</td>
<td>59</td>
<td>30.4</td>
<td>39</td>
</tr>
<tr>
<td>Incorrect/Unsuccessful (6/7/8)</td>
<td>47</td>
<td>10.3</td>
<td>20</td>
<td>10.4</td>
<td>15</td>
</tr>
<tr>
<td>Search (9/10/11)</td>
<td>21</td>
<td>4.6</td>
<td>2</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>No Response (12)</td>
<td>38</td>
<td>8.4</td>
<td>2</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>455</td>
<td>100.0</td>
<td>194</td>
<td>100.0</td>
<td>142</td>
</tr>
<tr>
<td>% of Responses</td>
<td>45.5%</td>
<td>19.4%</td>
<td>14.2%</td>
<td>9.4%</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

Figure 5.10: Response Categories by Experience of Task
We therefore have the surprising conclusion that there is no evidence of learning of the 'officially correct' response in these results. It does not matter how much experience one has of the tasks in question, it is not likely to lead to improved performance.

This is a particularly important finding with respect to the three hypotheses advanced to explain this data. The Rational Choice and the Conscious Choice hypotheses both predict that learning will occur. They postulate that the subject, confronted by a choice, will work out an appropriate response or will search for one. On the next occasion this particular choice is required an appropriate solution is already available. The Reproductive Response hypothesis is on the other hand a non-learning hypothesis; it is based on the philosophy 'try something you already know' and unless the subject actually finds it unsuccessful he will not engage in any activity which will increase his repertoire of available codes or perceived code-task relationships. This data is therefore strong evidence for the Reproductive Response hypothesis.

(ii) Seniority. The sample was a cross-section of staff from a branch and included the following five grades:

Grade 1: Trainee grades and machine room operatives (including the computer terminal for data entry) (n = 21).

Grade 2: Clerks who deal with routine matters for customers (n = 50).

Grade 3: Senior clerks who handle complex documentation.

Grade 4: and support management (n = 17 +12).

Management Grades - Three management grades are to be found in a branch (known as 'appointed staff') (n = 25).
It might be anticipated that experience of the tasks would be correlated with the position of the respondent. Figure 5.11 summarises the relationship between staff grades and average task experience.

There is therefore a relationship which suggests that junior staff have a limited experience of the tasks. The same is also true for management because many of the tasks they do not undertake directly. Senior clerks are most likely to be familiar with the range of tasks either because they undertake them in their present position or because they used the inquiry system to undertake them when they were in more junior positions. Managers who remember conducting tasks of this kind probably did so before the computer system was introduced.

A comparison of the response categories obtained for the different grades of staff is given in figure 5.12.
### Response Categories of Grades of Staff

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>App.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Correct (1/2)</td>
<td>65</td>
<td>38.6</td>
<td>215</td>
<td>54.2</td>
<td>76</td>
<td>56.3</td>
</tr>
<tr>
<td>Successful/Incorrect (3/4/5)</td>
<td>44</td>
<td>26.2</td>
<td>97</td>
<td>24.4</td>
<td>37</td>
<td>27.4</td>
</tr>
<tr>
<td>Unsuccessful/Incorrect (6/7/8)</td>
<td>23</td>
<td>13.7</td>
<td>30</td>
<td>7.6</td>
<td>18</td>
<td>13.3</td>
</tr>
<tr>
<td>Search (9/10/11)</td>
<td>3</td>
<td>1.8</td>
<td>7</td>
<td>1.8</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>No Response</td>
<td>33</td>
<td>19.7</td>
<td>48</td>
<td>12.0</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>168</td>
<td>100.0</td>
<td>397</td>
<td>100.0</td>
<td>135</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 5.12: Response Categories of Grades of Staff
The distribution in figure 5.12 shows significant differences between grades ($\chi^2 = 93$ for 16 df; $p < 0.01$). Examined in detail, the table reveals a number of reasons for this result. The poorest response by a significant amount is obtained, not surprisingly, from grade 1 staff for whom many of the tasks were unfamiliar. This is also the grade with the highest proportion of no responses. It is noticeable that, whilst it also has the highest proportion of unsuccessful and incorrect responses it does not have the highest proportion of successful but incorrect responses. This is spread relatively evenly across all grades ranging from 22.9% for grade 4 staff to 30.5% for appointed staff (management). This reinforces the conclusion that at least part of this behaviour is the result of non-adaptive behaviour; these kinds of 'errors' are not corrected by experience.

The most successful grades were grades 3 and 4. This may be because (a) they have experienced all of the tasks and used the computer system to conduct them, or (b) many of them have been or are responsible for the computer system in the branch. This latter explanation is examined in greater detail below. Appointed staff may well have not performed the task themselves since the implementation of the computer system.

One final point to note is the distribution of search responses. The generally low level of search responses means data is not conclusive but it is noteworthy that it is the senior grades (grade 4 and appointed staff) who exhibit most use of search categories. This suggests that senior staff know how to use the search mechanisms available and feel they have the right to use them, e.g. asking someone to assist them, whereas new staff may be reticent to ask.
The general conclusion must be that the experience and status afforded by seniority is of some assistance in reducing unsuccessful, incorrect responses but it is not as significant a variable as might be expected. The dominant feature of the data is that there is a uniform level of what is in design terms, inappropriate responses and this pervades the entire sample.

(iii) The Effect of Supervising the Computer System. One of the reasons why grades 3 and 4 may perform better than other grades is that it is usually these grades (or possibly grade 2) that include the staff who are or have been running the machine room of the branch (including the computer system). One of the duties associated with this role is apparently advising staff who need help with the computer system. As figure 5.13 illustrates 50% of staff when asked who they would turn to for help, cited the supervisor of the machine room. This percentage is larger if one removes the supervisors themselves who generally sought aid from Appointed Staff or from the Installation Staff at the Computer Centre who implemented the system.

If you ask someone for help who is it likely to be?

<table>
<thead>
<tr>
<th></th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine Room Supervisor</td>
<td>59</td>
<td>50.0</td>
</tr>
<tr>
<td>Appointed Staff</td>
<td>28</td>
<td>23.7</td>
</tr>
<tr>
<td>A Machinist</td>
<td>16</td>
<td>13.6</td>
</tr>
<tr>
<td>Installation Staff</td>
<td>7</td>
<td>5.9</td>
</tr>
<tr>
<td>Other staff</td>
<td>6</td>
<td>5.1</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>118</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 5.13: Staff giving assistance in Use of Computer Systems
If these staff are used in this role it is reasonable to suppose that they might have a more extensive knowledge of the computer system than other staff and that they may achieve a better performance level on tasks A-H than other staff. In figure 5.14 the response profile of Machine Room Supervisors and those who have previously occupied this role, are compared with other members of staff.

The distribution of results in figure 5.14 is also significant ($\chi^2 = 25.9$ for 8 df, $p < 0.01$). The proportion of correct responses for the machine room supervisors is considerably greater (17.2%) than for staff without experience of this role and ex-machine room supervisors are not far behind the current holders of the post. The current supervisors still show a high percentage of successful/incorrect responses (18.8%) but considerably less than other members of staff.

We have thus identified one high scoring group in the sample but even they show some tendency towards making successful but incorrect responses. A detailed examination of the records of the eight supervisors shows surprising variation (from 1 correct response to 8). It was found that low scoring individuals had relatively little experience of the branch (1 to 1½ years) whereas the average for this group was 3½ years. Experience before entering this role would seem to be essential if it is to be successfully performed.
<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Machine Room Supervisors</th>
<th>Ex-Machine Room Supervisors</th>
<th>Other staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct (1/2)</td>
<td>42 65.6</td>
<td>178 58.7</td>
<td>306 48.4</td>
</tr>
<tr>
<td>Successful/Incorrect (3/4/5)</td>
<td>12 18.8</td>
<td>86 28.2</td>
<td>168 26.6</td>
</tr>
<tr>
<td>Unsuccessful/Incorrect (6/7/8)</td>
<td>5 7.8</td>
<td>23 7.6</td>
<td>65 10.3</td>
</tr>
<tr>
<td>Search (9/10/11)</td>
<td>0 0</td>
<td>5 1.6</td>
<td>27 4.3</td>
</tr>
<tr>
<td>No Response (12)</td>
<td>5 7.8</td>
<td>12 3.9</td>
<td>66 10.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>64</td>
<td>304</td>
<td>632</td>
</tr>
</tbody>
</table>

Figure 5.14: Response Categories Comparing Machine Room Supervisors with Other Staff
(iv) Branch Variation. The range of correct answers across the branches as illustrated in figure 5.15 is considerable, from 79.1% to 36.7%. The range of incorrect but successful responses is not so large (8.3% to 39.3%) and has only three scores less than 20%. This suggests that the incidence of the successful, incorrect response is fairly constant across branches. The three exceptions to this rule prompted a search for branch correlates with the incidence of this response but none were found. The success of the three branches which displayed less than 20% incorrect, successful responses was not attributable to the length of on-line service of the branch, or the sample of staff questioned. Neither did an analysis of the sources of training offered in each branch supply the answer. In all branches the training was provided either by the installation staff, in-branch training or reading the instruction book, a small number of staff identifying 'trial and error' as a significant 'training' method. None of these methods appears to be associated with success in using the system.

It is likely therefore that the reasons for some branches making more successful use of the inquiry system than others has not been measured in this study. It may, for example, relate to the size of the branch, its location, or the pattern of business (which will affect the range and frequency of tasks for which the system may be used). Another possible explanation is that in some branches staff are better supported in their use of the system than they are in others. If the analysis presented here is correct, an influential factor in determining the pattern of response may be the kind of help the user can turn to when he has a problem. It is likely he will ask one of his colleagues and will follow his guidance. If that
<table>
<thead>
<tr>
<th>Branch</th>
<th>Sample</th>
<th>Correct (1/2)</th>
<th>Incorrect/ Successful (3/4/5)</th>
<th>Incorrect/ Unsuccessful (6/7/8)</th>
<th>Search (9/10/11)</th>
<th>No Responses (12)</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>19</td>
<td>79.1</td>
<td>3</td>
<td>12.5</td>
<td>1</td>
<td>4.2</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>92</td>
<td>76.7</td>
<td>10</td>
<td>8.3</td>
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<td>7.5</td>
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<td>C</td>
<td>14</td>
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<td>59.8</td>
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<td>24.1</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>23</td>
<td>57.5</td>
<td>12</td>
<td>30.0</td>
<td>4</td>
<td>10.0</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>32</td>
<td>57.1</td>
<td>16</td>
<td>28.6</td>
<td>5</td>
<td>8.9</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>17</td>
<td>53.1</td>
<td>11</td>
<td>34.4</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>G</td>
<td>11</td>
<td>46</td>
<td>52.3</td>
<td>26</td>
<td>29.5</td>
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<td>8.0</td>
</tr>
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<td>16.0</td>
<td>6</td>
<td>8.0</td>
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<tr>
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<td>5</td>
<td>20</td>
<td>50.0</td>
<td>13</td>
<td>32.5</td>
<td>4</td>
<td>10.0</td>
</tr>
<tr>
<td>J</td>
<td>7</td>
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<td>15</td>
<td>26.8</td>
<td>11</td>
<td>19.6</td>
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<td>K</td>
<td>3</td>
<td>11</td>
<td>45.8</td>
<td>8</td>
<td>33.3</td>
<td>4</td>
<td>16.7</td>
</tr>
<tr>
<td>L</td>
<td>5</td>
<td>18</td>
<td>45.0</td>
<td>14</td>
<td>35.0</td>
<td>6</td>
<td>15.0</td>
</tr>
<tr>
<td>M</td>
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<td>19</td>
<td>33.9</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>N</td>
<td>14</td>
<td>43</td>
<td>38.3</td>
<td>44</td>
<td>39.3</td>
<td>6</td>
<td>5.4</td>
</tr>
<tr>
<td>O</td>
<td>16</td>
<td>47</td>
<td>36.7</td>
<td>36</td>
<td>28.1</td>
<td>23</td>
<td>18.0</td>
</tr>
</tbody>
</table>

Figure 5.15: Response Categories Across Branches (ordered by percentage correct responses)
5.5 DISCUSSION

5.5.1 Summary of Findings

Before discussing possible explanations for the results obtained it is useful to summarise the main findings.

(i) Overall Response Patterns. There were 1,000 responses to task questions of which 52.9% were correct (33.9% giving alternatives) and 35.5% were incorrect (although 26.0% would probably have been successful). There was a very low level of search response (3.0%) and an 8.6% no response.

(ii) Knowledge of Codes. The average number of codes reported was 10.8 out of a maximum of 36. This must be regarded as an under-estimate of the extent of knowledge however because there were 171 instances in which a specific task led to the recall of codes not listed in Part A of the questionnaire. There was a group of 4 codes which were known to over 65% respondents and, in an analysis conducted in 1975, these four codes accounted for 75% of the usage of the inquiry system.
There was a good correlation between knowledge of a code and its correct use but there were 94 instances in which it was known but not used.

(iii) Tasks. Response patterns to the different tasks varied widely. The highest proportion of correct responses was for task C (76.8%) and the lowest for task G (16.9%). The highest proportion of successful but incorrect responses was for task F (62.1%) and the lowest for task B (3.2%). The incidence of successful, incorrect responses appeared to depend upon whether one of the four best known codes could be used as an adequate substitute. An analysis showed that three well known codes accounted for 86% of the alternatives used. The consequences of employing a successful but technically incorrect response were either that there was a risk of not obtaining the required information or of making uneconomic use of time or information, i.e. too much information was obtained which may have been costly to generate and to search in order to locate the required information.

(iv) Experience of Tasks. 45.5% of responses were made by people with very little or no experience of the tasks presented. There was a significant difference between the pattern obtained from this group and that obtained from those with experience of the tasks. This difference was largely due to the inexperienced group making more search responses and no responses. There was no significant difference between the number of experienced and inexperienced staff who made correct and incorrect responses. Therefore, whilst those with experience of the task are more likely to make a direct response to it, they are no more likely to make the correct response, as defined by experts on the system. There is, therefore, no evidence that technically correct solutions are identified with experience of tasks.
(v) **Position.** A significant difference was found in the pattern of responses between grades. Again this was largely due to junior staff giving the largest proportion of 'no responses'. Grades 3 or 4 were the most successful although the level of successful but incorrect responses is fairly constant across all grades (from 22.9% for Grade 4 to 30.5% for appointed staff (management)). An analysis of the results of staff who supervise the use of the computer system showed that they made significantly less incorrect but successful responses than their colleagues.

(vi) **Branch Variation.** There was a considerable variation in the response patterns between branches ranging from 79.1% to 36.7% in correct answers. The range of incorrect but successful responses was not so large (8.3% to 39.3%). No factors were identified which correlated with branch variation, i.e. size, length of time on-line, sample and training were not related to this distribution.

5.5.2 **The Alternative Hypotheses Revisited**

1. **The Rational Choice Model.** According to this model, if a person has experienced a task previously, he will know the correct response because on a previous occasion he will have compared all options against the needs of the task and will have made the correct identification. Thus, this model does not predict the level of incorrect (successful, or unsuccessful) responses obtained. It also predicts that, if a person is inexperienced with respect to the task, he will engage in a search of all available options to identify the best one. If the person has not memorised all available options this research must be carried out externally. Since the average level of knowledge is about 30% of the options, external search should be the dominant response. Again the model is not in
accord with the level of search responses obtained. There is, therefore, little support from the data for this model.

(ii) The Conscious Choice Model. This model differs from the rational choice model in two important respects. First it suggests that the person takes more than task issues into consideration in making his choice. He may, for example, consider the time it will take to obtain a solution. Secondly, this model does not demand a comparison of all options but only those thought to be related to the task. It is a model derived from the comments of staff who, when asked why they do not use option 'x', say that they are aware of the alternative and dismiss it for reasons of convenience etc. If this is the case we should expect to find both correct responses and incorrect but successful responses in which the correct option was also listed. Unfortunately for this model the majority of incorrect but successful responses are given by individuals who give no evidence of knowing the correct response.

(iii) The Reproductive Response Model. This model assumes that, once an option is known, it will be used automatically in any circumstances in which it may be relevant and no conscious choosing between alternatives takes place. There is a great deal of evidence to suggest this is an accurate account of the process. It would appear that many respondents rely on their knowledge of a few general purpose options which they use in all circumstances. It is these codes which are the basis of the successful but incorrect responses. There is also the evidence of task experience. Both the rational choice and the conscious choice models assume that, whenever a new task is identified, a comparative evaluation of options will be made. When known codes prove inadequate this should involve an
examination of unknown codes. The user will thus acquire more knowledge of codes and their uses. The reproductive response model assumes that, whenever a new task is identified, the user will apply the most likely of his known codes without conscious reference to other codes. If this code serves the purpose, albeit inefficiently and riskily, it will be used to complete the task. Following this procedure the user is unlikely to add to his knowledge of codes as a result of his experience; he is only likely to add to his knowledge of how to 'bend' the use of a few codes to fit the widest possible range of tasks. This model therefore predicts no decrease in the number of successful but incorrect solutions with experience and this is the result obtained.

Although this model provides a good fit with some of the results it is, like the other models, an inadequate explanation for all the results. Given that staff do not start using the system with a comprehensive understanding of the codes and the tasks for which they are to be used, we have to explain how some members of staff come to know and use nearly all of the codes. If the reproductive response model is the only mechanism at work, knowledge will be limited to a few well known codes. An adequate explanation would need to embrace both the non-learning reproductive response approach and the learning approach of the rational or conscious choice models.
5.5.3 An Integration of Models

(i) The 'Open Decision' Model. As an aid to integrating the models, the literature on decision-making was again examined for any approach which embodied within it learning and non-learning responses. The general approach of the researchers at Carnegie-Mellon University (Simon (1957), March and Simon (1958)) appeared to have these elements and the summary provided by Alexis and Wilson (1967) of the 'open decision process' gives a framework which may be pertinent to the data obtained in this investigation. This framework is reproduced in figure 5.16.

In the Alexis and Wilson model the decision process begins with a problematic stimulus which causes the individual to make a cursory examination of the goals he seeks (set approximate aspiration level). His first action thereafter is to select a small number of alternatives and to try one, i.e. to check what outcome would be (or is) obtained from the alternative. If the outcome meets the minimum requirements of the aspiration level, it is accepted and implemented. In the term used by Simon (1957), the decision maker 'satisfices' and selects the first alternative that 'will do' rather than 'optimising' and seeking the best solution from all available alternatives. In the Alexis and Wilson model there are two other possible results of the comparison of outcome with aspiration level. One possibility is that the outcome exceeds aspiration level. In this case the decision maker will still implement the alternative but, for future reference, he may increase his expectations or level of aspiration with regard to this decision task and the alternative selected will be reinforced as the first one to try on the next occasion. The more likely event is that the outcome will be less than the level of aspiration. In this case the decision maker
Problematic Stimulus

START

Approximate Aspiration Level (L)

Take initial action

Derive subjective value of outcome U (O)

Invoke alternative and obtain outcome

Select limited number of alternatives

Derive subjective value of outcome U (O)

Compare value of outcome U (O) with aspiration level (L)

OK

If outcome less than aspiration

If outcome more than aspiration

Increase level of aspiration

Decrease level of aspiration

Decrease range of alternatives

Increase range of alternatives

Repeat

Wait for further stimulus

Period 1

Period 2

Period 3

Figure 5.16: The Open Decision Model

can either seek other alternatives or decrease his level of aspiration to make it fit the outcome obtained. It is most probable that he will seek further alternatives, select one and compare the outcome obtained with the aspiration level. If this also fails the test, a further alternative may be tried. This process continues with other alternatives until a 'satisficing' solution is found or until the decision maker decides that he is unlikely to find a solution and that he must decrease his aspiration level. The alternatives selected are those which the decision maker has successfully used previously in similar circumstances. When these are exhausted the decision maker has to search more widely to try alternatives previously used in different circumstances or to generate entirely new alternatives.

It will be noted that this model display both non-adaptive and adaptive behaviour. If the first alternative evaluated meets the requirements of the solution and is implemented no learning takes place; the decision maker has simply reproduced past behaviour which fits the existing circumstances. March and Simon (1958) refer to this as 'programmed' behaviour because it is analogous to a computer running through a previously specified set of instructions. At the end of the decision process, the decision makers' model of the world in which he is operating remains the same except that it has been slightly reinforced by the successful implementation of the alternative. If, on the other hand, the evaluation of the first alternative is not successful (or is more successful than expected) the decision makers' 'model' of the world is likely to have undergone some change by the time his decision is made. He may, for example, have discovered new uses for existing alternatives or have created new alternatives. He may also have changed his aspiration level so that the goals he seeks on the next occasion may be different.

To apply the open decision model to the results obtained for the use of the inquiry code system we start with the premise that the reproductive response approach is synonymous with selecting and implementing the first solution to 'satisfice'. Each process involves the implementation of an established 'program'. A revised open decision model based on this principle is presented in figure 5.17. This model begins with a task that has some information requirements for which the inquiry code system could be used. The performer's first action is to check whether he has previously encountered a task of this kind and, if so, which code he used. He is thus seeking a task-code connection from his store of such connections. We may make some assumptions about the structure of this memory. First, it consists of a series of connections in which some codes are linked to many tasks (the general purpose codes) and that the more frequently used the connection the stronger it will be. Since frequent tasks usually make use of general purpose codes, there are two reasons why most task stimuli will initially lead to the selection of a general purpose code. In entering this store of information the decision maker is not seeking to make a comparative assessment of alternatives but only to extract the strongest connection that will 'satisfice' the task demands. If the first one identified seems likely to do this it is immediately implemented and if it is successful in providing the required information the process ends at this point. As a result of its further use, the task-code connection is reinforced in the memory and is thus even more likely to be used for future tasks. More detailed consideration will be given below to the judgements of what will suffice and what is successful.
Figure 5.17: Revised Open Decision Model for Task-Code Connections (TCC's)
If the nature of the task is unfamiliar the decision maker will not find a task-code connection that will suffice. He need not, however, immediately resort to external aid. He can search his knowledge of codes and seek one that could be put to use in this novel situation. As before this phase of the process is characterised not by comparisons of alternatives but by sequential evaluation of alternatives. In this phase the decision maker may also check his knowledge of sources of information other than the inquiry system. If this process fails the decision maker will have to try and enlarge his repertoire of options by seeking outside assistance. This may mean another person or a formalised statement of the options available. Should this search fail the decision maker will have to conclude that the inquiry system cannot be of assistance and may have to reformulate the information requirements of the task to make them fit the information available.

The guiding principle of this decision process is that it begins as a reproductive process and involves progressively more search and conscious evaluation of new possibilities as successive alternatives fail to meet the task requirements. It effectively involves a gradual shift from the reproductive response model to the conscious decision model although the latter does not include comparative evaluation of all alternatives. The process appears to be an attempt by the individual to minimise the amount of effort required to find an acceptable solution. This process has echoes of Zipf's (1965) 'Principle of Least Effort' although the effort being minimised is 'productive thinking'. It is the mental effort required to identify and evaluate new possibilities. The accent is upon finding ready made responses that can be implemented 'without thought'. An apt analogy is with a computer being used to run programs from a library rather than being used to create new programs.
This proposal may seem to support arguments about man's nature that suggest he is fundamentally lazy and to refute theories that he is naturally active, creative and 'self-actualising', (Maslow, 1954). There is, however, an interpretation which leaves the possibility of 'self-actualising' man. The popular view of man as an information processor is that he has limited capacity and, he must be selective if he is to make good use of it. The decisions involved in using the inquiry system are, at best, peripheral decisions, i.e. they are not central to any creative activities demanded to do the job. If, for example, the decision maker has a task in which he has to make a difficult loan decision, he may wish to devote his 'productive thinking' capacity to considering this issue rather than be diverted into considering which inquiry system code he should use to get the information. In other words, the decision maker may be 'lazy' with respect to peripheral decisions because he is devoting his creative energies to what he considers to be central decisions. If this interpretation is correct there should be a correlation between what the decision maker perceives as his central goal and that to which he applies his creative energies. Further examination of this model should include a test of this hypothesis.

5.5.4 Criteria for Selecting Solutions: A Cost-Benefit Evaluation

The hypothetical model presented in figure 5.17 gives the general processes by which an individual may select a code in the inquiry system but we may hypothesise further about the criteria used in selecting a given code. Bringing together many of the findings reported herein we may hypothesise that the process is dictated by a form of cost-benefit evaluation, probably of an implicit nature.
The cost in this equation is relative rather than absolute and relates to mental effort rather than money. It is relative in the sense that the individual may compare the cost of the first alternative he identifies with the cost of searching for any further alternatives. The first alternative is likely to be of low cost because it is well known and involves 'programmed' responses.

The benefit in the equation is the ability of the solution to provide the information required at a 'satisficing' level, i.e. it is sufficient for it to provide a minimal answer only. In the context of the tasks in the survey acceptable shortfalls in the provision of the information were:

(i) too much information so that identifying the appropriate information requires visual search,
(ii) fragmented information so that the answer has to be compiled from separate items,
(iii) the possibility of the information not being obtained, and
(iv) the need to infer the answer from the information, i.e. to conclude that a debit had not been paid by its absence from a listing.

These shortfalls may mean that in implementing a solution the individual may find (a) that he has to engage in extra effort to obtain an answer, or (b) that he does not obtain a satisfactory answer. In the latter case he will have to continue his search. In the former case it appears that he prefers to risk effort following the implementation of a solution rather than engage in additional search effort to find a solution that meets the requirements directly.
It will be noted that this evaluation involves a number of comparisons. If these are not to overload the individual they need to be made in sequence. Figure 5.18 provides a representation of a possible sequence and constitutes an elaboration of part of the model expressed in figure 5.17.

![Diagram of a Two Stage Cost-Benefit Evaluation](image)

**Figure 5.18: A Two Stage Cost-Benefit Evaluation**
In this sequence the first consideration in selecting an option is mental effort. As a result known options will always be examined first. To select from the unknown options the user will have to engage in search effort and also runs the risk of not finding a suitable solution. His choice may well be between a known option which will give an answer albeit inefficiently (i.e. involving subsequent work to obtain the desired outcome), and an unknown option which will involve a search with no guarantee of finding an acceptable alternative. Stated in this way it can be argued that the rational response is to choose the known option.

This analysis lays progressively greater emphasis upon cost considerations and it may be useful to speculate why this should be so. We have, to date, identified two possibilities and we can add a third. In summary these are:-

(i) Expenditure of effort not directly towards the main goal is wasteful; all the time the individual is searching for a solution to a peripheral issue he is not progressing with central issues. If time is important this may be critical.

(ii) Search is necessary to extend one's repertoire of options but there is no guarantee that it will be successful.

(iii) Search involves learning which can be conceptually uncomfortable. If one 'opens up' mentally to admit new possibilities, the new knowledge may undermine established practices. In the long term this may be fruitful but in the short term the need to re-evaluate established practices may be regarded as a threat if action is required urgently.
5.5.5 Accounting for Individual Differences

The data reported in the results section shows considerable variation between respondents both in terms of the number of tasks correctly undertaken and the number of codes reported. Since there is no formal training in the use of the codes, it is reasonable to assume that most users began using the inquiry system with relatively little idea of its potential. We have therefore to explain how the individual variation results from the use of the system.

One conclusion we have drawn from the data is that the variation is not simply a product of experience of the system. The likelihood of obtaining correct responses does not increase with experience. In seeking other explanations for the variation we may speculate about four possibilities:-

(i) The Nature of the Task. The only way in which the model presented in figure 5.17 permits the repertoire of codes to be increased is when the task presented cannot be answered by known options. In this case the user must search for other options. The presence of the general purpose codes appears to mean that this is a relatively rare occurrence but staff in the higher clerical grades may well experience a diversity of tasks which demand a wider knowledge of codes.

(ii) The Nature of the Job. Some positions involve more diversity of tasks and should involve greater knowledge of codes but there are also positions which make different kinds of demands. A number of positions seem to be at the centre of an advice giving network in each branch. The supervisor of the machine room is most often in this role but it can also apply to the machine room operatives and to the junior management of the branch. Being cast in this role can extend ones
knowledge of the inquiry system in two ways. First, one encounters a diversity of tasks in the problems which are raised. Secondly, if this role is accepted as a valid part of the job, one may regard obtaining a good working knowledge of the system as a central rather than a peripheral aspect of one's work. It may therefore be accorded more 'mental effort' than other members of staff may give it. To some extent the situation is dynamic: if one accepts the advisory role as valid and seeks to become proficient at it, branch staff will learn you have this expertise and will make more use of it thereby bringing more problems to your attention and causing your knowledge to increase.

(iii) Support Services. The differences between respondents may largely be accounted for by the quality of support they receive in using the system. The formal documentation of the system is the same for all but the extent and nature of initial training may vary as also will the expertise available within the branch. Since in some branches all respondents perform well whilst in others there is a uniformly poor response, the quality of the support in each branch may be a key variable.

(iv) Individual Differences. The variations may also be, in part, attributable to personality differences between respondents. Some may, for example, be more inclined to 'satisfice' than others; some may have a more 'tool' oriented disposition than others and may be more prepared to experiment with the system than others. Since we have no information about the personality characteristics of respondents the contribution of these characteristics must remain a matter of conjecture.
5.6 **RECOMMENDATIONS**

This study was undertaken as a research exercise rather than one with the specific intention of providing advice on improving the usage of the system. Nevertheless the model evolved can be used to suggest mechanisms which might be used to improve usage. They are presented here as ideas that might be useful but, because the frame of reference was research rather than application, there can be no guarantee of their validity.

The aim of the changes considered below would be to increase the range of options used by staff in order that the percentage of technically correct solutions could be increased. Operationally this would result in a drop in the percentage usage of the general purpose codes and an increase in those at present rarely used which are more task specific.

One avenue of change would be to change the system so that the general purpose codes were withdrawn and only task specific codes remained. If this were possible it would force individuals to make a search for each new task they encountered. It is, however, doubtful whether this is a practical proposition since individuals have a remarkable aptitude for 'bending' known options to fit new circumstances.

If the system is to remain unchanged any changes must occur in the support facilities provided for its use. Since respondents rely heavily upon their knowledge of the system one approach might be to improve initial training. If it were possible to give each member of staff a comprehensive knowledge of the codes available and the tasks for which each should be used, the problem would vanish. However, it is doubtful whether seeking to achieve such an end would be cost-effective; it would involve teaching a lot of staff about tasks they may never encounter or which they may not encounter for several years by which time they will probably have forgotten the details. This approach also tends to overlook the changing nature of the system: it is quite likely that codes will be changed and the training given will become out-of-date.
An alternative is to concentrate on point-of-need support, i.e. the facilities within the branch which the individual can turn to if he needs help. If these can be improved individuals may be more inclined to search than to try an ill-fitting but known option. The model as presented suggests that all known options with any chance of success must be tried before search commences but we may hypothesise that, if the cost of search can be reduced, the pattern may be changed. This hypothesis could also be tested in any future development of the model.

The cost of search could be reduced by changing the formal documentation of the system or by changing the human support given within the branch. The individual engaged in search is seeking an answer to a specific task need and what he needs is a form of documentation which classifies task needs and links each category to appropriate inquiry codes. The documentation in use at the time of the investigation was organised by code number and did not make use of a classification of tasks. A classification of the type suggested could take the form of a printed tree structure or algorithm or it could be included as an additional inquiry code in the system.

If changes of this kind were made it would have consequences for the kind of training undertaken. Instead of seeking to achieve comprehensive coverage, training could concentrate on teaching a task classification and the methods of using the search facilities. This is in line with the conclusions of Luchins and Luchins (1959) who advocate, as a means of avoiding conceptual set, a system of training based on finding alternative solutions rather than the right solution. The accent is upon teaching the process of identifying and evaluating alternatives rather than teaching the solution itself. In this way the trainee becomes acquainted not with the codes but with the search processes necessary to identify the codes.
It may well be, however, that the best results could be achieved by strengthening the human support systems within branches. There is some evidence that, when they experience difficulty, people prefer to seek advice from other people in preference to formal documentation. It is possible that the considerable variation in responses between branches is attributable to the quality of their human support systems. At present it would appear that the quality of support is almost accidental. Although the focus for advice is the supervisor of the machine room there is no evidence that these duties are officially recognised as an important part of this position. In consequence there is no training for these duties and certainly no attempt to use this role as a medium for encouraging correct usage of the system within the branches. This could be done by (i) training staff taking on these supervisory duties in the manner described above, i.e. training them to examine alternative options, and (ii) establishing good contacts between these staff and the implementation team so that when they have a 'point of need' problem they too have a readily accessible source of aid.

5.7 CONCLUSIONS

As with most research studies this investigation raises more questions than it answers. It has shed light on the reasons why users of the inquiry system make excessive use of a small number of codes to the virtual exclusion of many others. Indeed the analysis makes it difficult to conceive of circumstances where this will not occur. The model developed to explain the results is the source of the many further questions for research and two of these seem particularly pertinent to our understanding of why man responds to choice in this way and what kind of action could be taken:

(i) Is man more likely to engage in active search for a solution if he regards the search as a central goal than when it is a peripheral activity necessary to achieve another goal? 
(ii) Would search activities become more common if the search process was made easier in terms of mental effort?
The model has been stated in a manner which makes it applicable to all circumstances in which a decision maker seeks information. It is to be hoped that it will be of predictive value in studying the use of other forms of flexible information system. The system was deliberately chosen because it involves simple, discrete, options and was therefore easy to investigate. On the basis of the model, however, it should (given statements of relevant task experience), be possible to predict the usage patterns associated with more complex systems.

Although this has been an exercise for research purposes it is appropriate to end by repeating the importance of the ultimate practical goal of this work. Flexible information systems are emerging because it is difficult to predict information needs and they, in theory, permit users to match the information to his needs. We have, however, created a situation in which users do not make use of the range of choices at their disposal. The long term aim is to devise ways in which people can be helped to make better use of the resources to which technology now gives them access.
CHAPTER 6: THE IMPACT OF COMPUTER SYSTEMS UPON MANAGERIAL INTERPRETATIONS OF TASKS

6.1 Introduction

In the introduction to this thesis the underlying framework (figure 1.1, p.3) identified three independent variables (manager, task and computer system) which interacted to have an impact on all three variables. Previous chapters have examined various impacts upon the manager and the usage of the computer system but task impact has not been systematically examined. This chapter seeks to examine the impact of computer systems upon a manager's interpretation of his task; how he conceives of his task and its execution and what role he feels the computer plays in his task performance.

The chapter is organised as follows. It begins by examining the predicted effects of computer systems on managers' tasks and the evidence for these predictions to be found in the initial survey. The methodology for this study is then presented, followed by the overall results for task impact. A further stage of analysis is then attempted which seeks to isolate the variables accounting for variation in impact before a causal model is presented in the final discussion.

6.2 The Role of the Computer in the Managerial Task

Computer information systems may be regarded as playing two roles in the tasks of individual managers one of which is due to their treatment as individual tools of the managers and the other due to their treatment as tools of the organisation which means they act as control and coordination mechanisms at the individual level.

6.2.1 Computer Systems as Individual Tools

A management task is typically an information handling task in which to move from the stimulus state to the goal state requires a diagnosis of the detailed nature of the stimulus state, and an elaboration and evaluation
of alternative methods of moving to the goal state. There is therefore a need to collect information and to process it and in both respects the computer may play a part. Speculation and empirical research has emphasised the role computer systems can play in providing a better information support for the diagnosis of problems and information processing support for the evaluation of decision alternatives. The visionaries, e.g. Licklider (1965), see this as the dawning of a new age in which 'man-computer symbiosis' will enable the manager to optimise his decision making behaviour. More soberly Simon (1965) refers to decision making becoming a 'science' as, with the help of computer systems, a process dominated by intuition, guesswork and judgement becomes more 'rational' and dominated by information and analysis. In looking for the impact of computer systems from this perspective we are therefore looking for evidence that the manager has an improved understanding of his task and is better able to take the necessary decisions. We may seek changes in the manager's understanding of the intrinsic aspects of the task and, consequently, how he undertakes it.

6.2.2 Computer Systems as Mechanisms for Co-ordination and Control

The tasks of an individual manager are, to a greater or lesser degree, interdependent with the tasks of others in the organisation, and organisational effectiveness demands that the efforts of interrelated individuals are co-ordinated. This in turn means some kind of control must be exerted over individual task behaviour. Hackman (1969) refers to a task as "a stimulus complex and a set of instructions which specify what is to be done vis a vis the stimuli" (p.113). The instructions can be regarded as a mechanism for control, and a computer information system can be conceived as having a similar role. It may perform this role in a number of ways. First, by virtue of providing the information support for the manager, the system may define some aspects of the 'how and when' framework within which the task will be undertaken. Secondly, to the
extent that the system, directly or indirectly, captures the results of the manager's decisional activities, it is open for more senior executives to use this information to monitor and control the manager's activities. Thus, either directly through the implicit 'instructions' embodied within the system, or indirectly by virtue of information made available to other managers, an individual manager may experience the computer system as tightening the framework within which he conducts his tasks.

These two views appear to offer two distinctly different possibilities for computer impact, one emphasising a possible enrichment of the manager's task understanding and the other a diminution of his possibilities because of a tighter instructional framework.

6.2.3 Evidence from the Initial Survey

Some evidence relating to these predictions has already been collected in the initial survey and was reported in Chapter 3. Managers were almost unanimous that the system they used led them to develop new ideas and skills relating to their skills and nearly 50% felt the scope of their jobs had been enlarged, (Figure 3.6, p.49). There appears to be some evidence therefore for the intrinsic aspects change. Figure 3.6 also indicates that a substantial minority of managers experienced greater workloads and greater routine which may also be indicative of a constraining effect. A more specific finding (p.68) came from the question about feeling under the control of the computer, where 78% of standard output users felt there was considerable control over their work compared with 20% of data base users and 42% of the evaluation model users.

It may be therefore that there are a minority of managers who experience tighter control and more routine whilst the majority experience an enlargement of their view of the task. There are, however, disturbing signs that a two directional theory may be inadequate because a number of
managers reported new ideas and skills and more control and more routine. Many of them also commented favourably on the greater degree of routine. It may be necessary therefore to produce an explanation for the simultaneous occurrence of enlargement and tighter constraint.

The aim of the study reported in this chapter is to examine the occurrence of these two effects more thoroughly and to ascertain whether they occur separately or simultaneously. Furthermore the aim is to seek variables which determine the direction and degree of the impact.

6.3 An International Survey

Between 1975 and 1977 the author and his colleagues had the opportunity of taking part in an international comparative study of the impact of computer information systems upon management. Research teams from Denmark, West Germany, Great Britain, Austria and the U.S.A. took part. This study examined the impact of computers at many levels, (individual, interpersonal and organisational). It will be reported in full Andersen and Eason, 1981) and many papers exist already (Eason, Stewart and Damodaran, 1977; Eason, 1981; Andersen and Eason 1980; Robey, 1979). The study involved in-depth case studies in each country. Eight systems were examined in total, two in Great Britain under my supervision. The research team in each country conducted their own case studies according to an agreed methodology and different members of the international team undertook to examine the data on specific issues across all cases. One of my responsibilities was the data on task impact which is reported in this chapter. I readily acknowledge therefore the active co-operation of my international colleagues although the analysis and interpretation of the data presented here are my own responsibility.
Since this chapter focuses upon a limited sub-set of the total data base for this study it would be inappropriate to describe the methodology in detail. Suffice it to say therefore that relevant aspects of the methodology and of the cases will be introduced in the text where they are necessary. Two general points need to be made at the outset:-

(a) The methodology for defining systems and assessing task fit etc. were heavily influenced by the survey reported in chapter 3. This means a similar conceptual framework underpins the work to be reported in this chapter.

(b) The eight cases involve a mixture of organisations but the systems are dominantly what we have described as data base systems with retrieval systems. The aim was to seek information systems that transcended departmental boundaries. This excluded most evaluation model systems which tend to be relatively small-scale. The study was conducted up to 4 years after the earlier survey and in that time the design of systems had progressed so that more systems were of a data-base character, i.e. fewer were simply standard output systems although all of them had regular, standard outputs as part of their service. In comparing the results for these systems with those of the earlier study therefore the most appropriate category of system is the data-base system.

6.3.1 Assessment of Task Impact
As part of extensive semi-structured interviews, the management users of the eight systems investigated were asked the nine questions about the impact of the systems upon their tasks which are given in Appendix 3. One methodological difference between this study and the earlier survey was that they were asked to specifically relate the impact to two managerial tasks they undertake. This approach was adopted to tighten the cause and effect
framework and to permit some examination of the impact upon different kinds of tasks. The managers were asked to say whether there had been a perceivable effect upon their tasks (a five point scale from major decrease to major increase) and, where there was an effect, to evaluate it on a 5 point scale.

The nine questions are listed in figure 6.1. They fall into three categories. The first category corresponds to intrinsic task aspects which will permit us to examine the enlargement of scope and understanding hypothesis. The second and third categories reflect different aspects of the hypothesis that the system will tighten the task framework by adding more structure and more load.

**Intrinsic Factors**
- Degree of complexity in the task.
- Number of problems recognised within the task.
- Possibility of developing new ideas or methods.
- Feedback on decisions.

**Structural Factors**
- Degree of routine of the task.
- Standardisation of codes or terminology in the task.

**Load Factors**
- Work pace in the task.
- Variations in work pace in the task.
- Work load within the task.

Figure 6.1: Categories of Task Impact
6.4 Results for Task Impact

A total of 85 managers completed the task impact questionnaire and the results are summarised in figure 6.2. The results give the percentage of change reports and their direction (increase or decrease). The results were compiled by calculating an average for each case and the figures present the means of these case averages. This was necessary because of the wide variations in numbers of managers interviewed in the cases. It ensures that each case is given an equal weighting in the results.

<table>
<thead>
<tr>
<th>Task Aspects</th>
<th>% Change Responses</th>
<th>% Decrease</th>
<th>% Increase</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Factors</td>
<td></td>
<td>40 30 20 10</td>
<td>10 20 30 40</td>
<td>50 60 70</td>
</tr>
<tr>
<td>1. Complexity</td>
<td>11.5</td>
<td>63.4</td>
<td>74.9</td>
<td></td>
</tr>
<tr>
<td>2. No. of Sub-Problems</td>
<td>7.9</td>
<td>60.9</td>
<td>68.8</td>
<td></td>
</tr>
<tr>
<td>3. Feedback</td>
<td>3.6</td>
<td>64.4</td>
<td>68.2</td>
<td></td>
</tr>
<tr>
<td>4. New Ideas &amp; Methods</td>
<td>2.3</td>
<td>63.5</td>
<td>65.8</td>
<td></td>
</tr>
<tr>
<td>Structural Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Standardisation of Codes</td>
<td>1.0</td>
<td></td>
<td>48.4</td>
<td>49.4</td>
</tr>
<tr>
<td>2. Degree of Routine</td>
<td>6.5</td>
<td></td>
<td>40.5</td>
<td>47.0</td>
</tr>
<tr>
<td>Load Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Variations in Work Pace</td>
<td>9.3</td>
<td></td>
<td>49.0</td>
<td>58.3</td>
</tr>
<tr>
<td>2. Work Pace</td>
<td>5.8</td>
<td></td>
<td>46.6</td>
<td>52.4</td>
</tr>
<tr>
<td>3. Work Load</td>
<td>12.9</td>
<td></td>
<td>35.0</td>
<td>47.9</td>
</tr>
</tbody>
</table>

Figure 6.2: Direct Task Impact
There are two features of this data which are immediately striking. First there is a high level of change responses for all questions from which we can infer that we are dealing with systems that do make a major impact upon their managerial targets. Second there is a high proportion of 'increase' responses compared with 'decrease' responses. No general conclusion can be drawn from this because it is in part a product of the way questions were formulated and relations between increase and decrease responses will be considered for component questions.

The task aspects are listed according to the incidence of change responses within the three categories. The first 4 questions evoked over 65% change responses which represent some of the most general forms of computer impact found in the survey. Managers who report an increase in these aspects are reporting that they now experience their tasks as being more complex and as containing more sub-problems. They are also reporting that, through their computer systems, they are receiving better feedback on the consequences of their decisions and that, as a result of using the system, they had developed new ideas and methods of tackling their tasks. The questions relating to complexity and the number of sub-problems could be taken to mean that the computer systems had actually made tasks more difficult, i.e. that operating the system or handling outputs actually made it a more difficult task to undertake. There is some evidence for this interpretation but, on the basis of unstructured comment by respondents, the more general interpretation is that it is the manager's perception of the task that has changed rather than the task itself. The managers' report, for example, that the improved information base provided by the system enables them to better diagnose their problems, to see more clearly how variables inter-relate and how variables they had hitherto not considered influence the outcomes they are trying to achieve. In summary the effect appears to be that the computer system enables the manager to develop and refine his internal representation of the tasks he undertakes.
To illustrate this phenomena an example may be taken from the hospital case. When deciding which patients to admit doctors reported that hitherto they had considered only medical criteria. Following the introduction of the system they were better able to appreciate the administrative consequences of their decisions particularly for nursing staff. This did not change the need to use medical criteria as the primary considerations but the doctors did find themselves attempting to arrange admissions to minimise administrative inconvenience and to make better use of resources. As a result their decisions had a new dimension and their tasks were more complex.

The inter-correlation analysis presented in Figure 6.3 reveals these four task aspects to be significantly inter-related. The most significant correlations are between the perceived number of sub-problems and feedback (0.74) and the development of new ideas and methods (0.62). Complexity is not highly correlated with these factors which may be further evidence that a number of respondents who reported increases in task complexity were reporting increased task difficulties as opposed to an enrichment of task appreciation. The number of sub-problems perceived within the task may therefore be a better guide to changes in perceived task complexity.
### Table: Inter-correlations of Dimensions of Task Impact

<table>
<thead>
<tr>
<th></th>
<th>Complexity</th>
<th>No. of Sub-problems</th>
<th>New Ideas &amp; Methods</th>
<th>Feedback</th>
<th>Work Pace</th>
<th>Work Pace Variations</th>
<th>Work Load</th>
<th>Routine</th>
<th>Standardisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>.51*</td>
<td>-.01</td>
<td>.42*</td>
<td>.21</td>
<td>.28</td>
<td>.21</td>
<td>.65</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>No. of Sub-problems</td>
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<td>.74**</td>
<td>.46*</td>
<td>.70**</td>
<td>.27</td>
<td>.28</td>
<td>.44*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Ideas &amp; Methods</td>
<td>.26</td>
<td>.46*</td>
<td>.61*</td>
<td>.31</td>
<td>.68**</td>
<td>.56*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>.53*</td>
<td>.66**</td>
<td>.62**</td>
<td>.69**</td>
<td>.67**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Pace</td>
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<td></td>
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<td>.80**</td>
<td>.76**</td>
<td>.38</td>
<td></td>
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<tr>
<td>Work Pace Variations</td>
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<td>.67**</td>
<td>.51*</td>
<td></td>
<td></td>
<td></td>
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<td>.60*</td>
<td>.68**</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All correlations are Spearman Rank Correlation Coefficients ($r_s$).

* $p < 0.05$

** $p < 0.01$

**Figure 6.3: Inter-correlations of Dimensions of Task Impact**

Whilst the overall incidence of change on the other factors is not as high as for the intrinsic factors, there are still approximately 53% of responses indicating changes in load factors and 48% changes in structural factors. Thus approximately half of the responses show that computer systems influence when a task is conducted particularly by influencing variations in work pace, i.e., computer systems create conditions demanding task performance by, for example, giving recent information which indicates a need for action, establishing deadlines by which time the results of tasks have to be entered into the system and by providing data at a particular time which is necessary for the completion of a task. The majority of respondents who said there had been a
a change in their work load claimed it had been increased because, for example, they now had to consider more information, but this was the question which obtained the greatest proportion of 'decrease' responses where, for example, the improved data base rendered some aspects of previous task performance redundant. Finally on structure the way in which the task was conducted also tended to be more formalised with increases in the level of routine and in the degree to which codes and procedures were standardised.

The inter-correlation analysis reveals that the five factors highly inter-related: seven of the ten correlations are significant beyond the 0.01 level. It would appear therefore that a change in any one form of constraint is likely to be accompanied by changes in all of the others, and there is little reason in the correlations to separate these factors into two groups.

The survey has thus produced evidence for both the 'enrichment' and the 'constraining' view of the nature of task impact. Since it does not appear easy to reconcile these two views the next question is whether these two forms of impact occur in different cases or in the same cases? The inter-correlation analysis shows that the level of correlation between intrinsic and structure/load factors is not as high as it is within each group but there are a number of significant correlations. In particular increases in the level of routine and of variations in work pace are correlated with improvements in feedback. The conclusion is therefore that task constraint and task enrichment are to a considerable degree concurrent changes and deeper analysis shows that they actually occur for the same manager. The managers are reporting that they are more tightly controlled in the performance of their tasks but that they develop a more enriched view of their tasks nonetheless.
Additional evidence can be gleaned from the managers' evaluation of the changes they experienced. Figure 6.4 summarises this data for each group of factors. (The data for each question is reported in Robey (1979).) It will be noted that, where there was an increase in intrinsic factors, managers' reported an improvement. This may be interpreted as a positive evaluation of an enhancement of their tasks. More surprisingly, the dominant interpretation of increases in structure and in load was also positive. Manager do not, it seems necessarily regard tightening constraints as important infringements of their task autonomy.

<table>
<thead>
<tr>
<th>Managers' Evaluation</th>
<th>Deterioration</th>
<th>Makes No Difference</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td><strong>Intrinsic Factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>2.0</td>
<td>4.2</td>
<td>51.0</td>
</tr>
<tr>
<td>No Change</td>
<td></td>
<td>31.2*</td>
<td></td>
</tr>
<tr>
<td>Decrease</td>
<td>1.8</td>
<td>0</td>
<td>8.9</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>6.1</td>
<td>12.1</td>
<td>34.5</td>
</tr>
<tr>
<td>No Change</td>
<td></td>
<td>41.3*</td>
<td></td>
</tr>
<tr>
<td>Decrease</td>
<td>1.2</td>
<td>1.8</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Load</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>15.0</td>
<td>8.1</td>
<td>24.4</td>
</tr>
<tr>
<td>No Change</td>
<td></td>
<td>37.9*</td>
<td></td>
</tr>
<tr>
<td>Decrease</td>
<td>1.6</td>
<td>0.8</td>
<td>12.2</td>
</tr>
</tbody>
</table>

* All 'no change' responses evaluated as 'makes no difference'.

Figure 6.4: Managers' Evaluation of Task Changes
One way of explaining these findings is to regard the manager's task as essentially open-ended: as a task in which the manager is continually striving to improve his grasp of variables in the task environment and his ability to predict the consequences of possible actions. The manager therefore always has the possibility of 'upwards development' and he can, in one sense, increase his task discretion by being able to conceive of and to examine options not hitherto considered.

If a task is closed and these opportunities for development are not present, it may be that any additional constraint will be seen to diminish the task. However, if the task is open, a new factor which is a constraint and also an opportunity to improve insight may not be regarded in this way. Thus, in this survey, many managers welcome the constraining features which serve to structure and order the task (for example the standardisation of codes), because previous disorder or absence of information was hampering the development of an understanding of task dynamics.

6.5 Task Impact in Each Case

Notwithstanding the high overall level of task impact there were still considerable variations in impact from case to case and in this section data is presented and discussed for each case.

The search for reasons for variance in task impact between cases will be guided by a simple proposition: that the more technically powerful the system, the more will be the impact upon users' tasks. This is a major reason why more powerful and more interactive systems are being implemented and it is important to ask whether this obvious statement is justified.

In order to examine the proposition it will be divided into two sub-propositions and the variables relating to these arguments considered. The sub-propositions are as follows:

(a) The more powerful and interactive the system, the greater the improvement in the information base of the managerial task.

(b) The greater the improvement in the information base, the greater the impact upon the task.
The first proposition focusses attention upon the ability of the system to support the task, the second on the translation of this potential into impact upon the task. To examine these propositions we must operationalise two sets of variables in addition to task impact which we have already described. The two sets of variables are as follows:

(a) **System Potential.** The term 'system potential' is not here intended as a technical assessment related to memory capacity etc. but to be a judgement of the capability of the system to serve its users. It is usual to consider this a matter of system design in which attempts are made to specify user requirements (and where user involvement may be all important). However, another view could be that the important factors are the flexibility and the interrogative capacities of the system because these place before the user the opportunity to tailor the service to his perceived needs at the time of the need and to receive the service in a suitable time frame, i.e. they give the user greater potential to direct the system as he sees fit.

In this analysis we examine the potential of the system in terms of the flexibility and interrogative capacity it places at the disposal of its users. Following chapter three, the interrogative capacity is termed the medium of interaction indicating the time base of interactions between man and computer. In this case three levels are differentiated: on-line, real-time systems in which information is captured at source and is immediately available to users via computer terminals, on-line systems in which information held by the computer may be instantly accessed and interrogated by users but it will not necessarily be the most recent data, and batch processed systems in which users may experience a delay of hours or days between request and response.
The mode of interaction is an indication of the flexibility of the system and assesses the degree of choice available to the user to organise and structure his own service. In this survey we utilised the full six modes developed in Eason et al. (1974). These form an ascending scale of flexibility from standard data input and standard, pre-structured outputs, through various possibilities for selecting amongst outputs and searching data bases to making use of a high level programming language.

Not all users of a system employ the same mode and medium of interaction and we shall later examine variations within cases. However the first part of the analysis is a case by case analysis and for this we have identified a typical mode and medium for each case.

We may now re-state that part of the proposition which relates to system potential. The argument may now be stated as the more interrogative and flexible the system the greater will be the improvement in the perceived information base of the user because he has more opportunity to control the service he obtains.

(b) The Information Base of the Managerial Task. In the earlier survey user assessments of systems were in terms of a 'needs-provisions fit' model, i.e. what are the users current needs and how well is the system meeting them? The task impact data considered here is based upon a 'before and after' model and to make comparisons we need to make system assessments in the same terms. This was accomplished by asking users to make a 'before and after' assessment of changes in 'task fit' using the nine components of task fit listed in figure 6.5.
Relevance  
Comprehensiveness  
Availability  
Recency  
Precision  

Validity  
Reliability  
Privacy  
Safety

Figure 6.5: Components of Revised Task Fit

This is a measure of 'task fit' developed by the international team as a revision of the measure used in the survey presented in Chapter 3. The questions relating to Relevance, Reliability and Completeness have been retained. Accuracy has been sub-divided into Precision and Validity and Recency into both Recency and Availability. Finally, the dimensions of Privacy and Safety have been added. As a result no direct comparison with the previous data can be made. In addition, in the present context we are discussing a 'before and after' version of the measure in which managers were asked to indicate the quality of the service compared with a time before the system was introduced using a 5 point scale from 'major deterioration' to 'major improvement'.

A high change in task fit in a positive direction therefore implies that the user perceives that he now has a much better information base upon which to conduct his managerial task. Since this is a question about the user's perception of a change for his own tasks it is a judgement which will embody any limitations on the realisation of system potential because of problems with system 'ease of use' and user support.
The data for the eight cases on these system variables and for summarised task impact variables are given in figure 6.6. The systems are presented in order of system potential, the medium of interaction being used as the prime indicator. The medium is divided into three discrete categories (on-line, real-time; on-line; batch processed) and each case has been assigned to one category. The mode may be treated as an interval scale and a value has been calculated for each system which is the average of the modes employed by the sample of users. On this scale the value 2 indicates use of standard outputs and the value 3 indicates selection from a list of outputs or some degree of choice in the construction of outputs. It will be noted that the range is 1.94 to 3.04, i.e. the users of these systems are, by and large, making use of some degree of choice, more so than the average user in the previous survey.

Since the proposition under examination involves two hypothetical causal links, the change in task fit acting as intervening variable, the two causal links may be examined separately.

The data on task impact for each case are presented for two tasks; task A which is conducted in a relatively certain environment and task B which is conducted in a relatively uncertain environment. In the majority of cases the change in task fit does appear to be correlated with system potential (0.69) (see figure 6.7). Three of the on-line, real-time systems have task fit scores in excess of 4.0 where 5.0 indicates a 'major improvement' and 3.0 'no change'. Two of the batch processed systems, the Restaurant Supplier and the Glass Maker, have values close to the 'no change' level. It appears from this data that a system of limited potential is unlikely to make a big change in the task fit. There is however no guarantee that a powerful system will lead to a major change in task fit. The Hospital is the major indication that this does not always occur since it is a powerful system that has virtually no impact upon task fit.
Figure 6.6: Direct Task Impact in Each Case
The second part of the proposition, that change in task fit will lead to task impact, is only partly supported by the correlational analysis given in figure 6.7. A significant correlation of 0.56 is obtained for the relation between task fit change and constraint factors (combined load and structure factors) but the correlation between task fit change and intrinsic factors is only 0.24. This result is however, rather misleading (as is the correlation of -0.10 between system potential and intrinsic factors) because the distribution of intrinsic scores is unusual. There is a cluster of 10 values above 70%, none between 60 and 70 and 6 below 60%. Given this bi-modal distribution a simple allocation of the scores into two categories (as in figure 6.8) may be less misleading.
The distribution of values predicted by the proposition is indicated by the arrow and it shows that 12 of the 16 intrinsic values are as predicted by the task fit change, i.e. high task fit change leads to high intrinsic change, low task fit change leads to moderate intrinsic change. There are three exceptions to this rule in which low task fit change leads to high intrinsic change; the tasks in the Glass Maker and one of the tasks at the Restaurant Supplier. In only one task (in the Bank) does high task fit change lead to only moderate intrinsic factor change. The predicted distribution is also found between system potential and intrinsic factor values although the Hospital tasks are now to be added to the list of exceptions because this high potential system creates very little change in task fit and relatively little change in the intrinsic factors in the task.

The conclusion to be drawn from this analysis is that there is good evidence to support the proposition that change in task fit is related to the incidence of changes in intrinsic factors although there are a number of exceptions which require explanation.
The constraint values display a similar distribution to the intrinsic values and there is in fact a 0.61 correlation between them. The task fit score predicts the distribution of 9 of the 16 constraint values the exceptions being two cases in which low task fit change is associated with high constraint (the Wholesaler tasks) and three examples of high task fit change associated with low levels of constraint (both Bank tasks and one Mail Order task). System potential does not appear to be a good predictor of the incidence of constraint responses.

In order to explain these findings, and in particular to explain the exceptions to the propositions, a closer examination of the data is necessary to examine the plausibility of alternative explanations. Once again this examination will consider the two parts of the proposed causal chain separately.

6.6 The System and the Information Base of the Task

6.6.1 Analysis by Case

Although the correlation between system potential and perceived improvement in the information base is significant there are examples in which the power of the system is not transformed into task fit change. The Hospital is the best example. A number of explanations may be advanced:

(a) The Previous Task Fit. The judgement of change in task fit is based upon a before and after comparison which raises the question of the quality of information service before the system was implemented. Where this was widely considered by users to be adequate, it is unlikely that the system, no matter how powerful, will make very much difference. In most cases systems were introduced with the specific intention of improving the information base in particular ways, i.e. providing more recent or more comprehensive information. A notable feature of the Hospital system was that it was
initiated primarily with the wider organisational aim of better utilisation of resources and not because individual doctors and nurses etc., were demanding an improved information service. It is perhaps not surprising therefore that individual users do not see the system as a vital improvement in the service to them.

(b) 'Ease of Use' Problems. In earlier chapters we have discussed the way in which system potential can be lost because users find the system too difficult to use in other than routine ways. Thus the wider flexibility of the more powerful systems is often wasted because users do not avail themselves of the opportunities they present. To some extent problems of this kind may be mitigated by the provision of user support facilities. Data reported in Andersen and Eason (1980) shows that the Hospital case ranks sixth in terms of difficulty of use and fifth in the quality of user support. The case also revealed considerable evidence that many facilities were not being used, particularly by medical staff, and as a result the potential of the system was not being effectively utilised (Eason, Damodaran and Stewart, 1977).

(c) The Components of the Information Base. A final possibility is that the change in task fit, derived as it is from assessments of change on nine dimensions, does not adequately reflect changes in the information base. It is possible, for example, that averaging across these dimensions causes gains on some to be hidden by deteriorations in other aspects of the service.

In figure 6.9 the changes for each dimension are listed in order of magnitude and figure 6.10 gives the inter-correlations between the dimensions.
Recency

Availability

Comprehensiveness

Validity

Precision

Reliability

Relevance

Safety

Privacy

Figure 6.9: Changes in Dimensions of the Information Base

<table>
<thead>
<tr>
<th></th>
<th>Recency</th>
<th>Availability</th>
<th>Precision</th>
<th>Reliability</th>
<th>Comprehensiveness</th>
<th>Validity</th>
<th>Relevance</th>
<th>Privacy</th>
<th>Safety</th>
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<td>.89**</td>
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<td>.11</td>
<td>.25</td>
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<td>.76**</td>
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<td>.64*</td>
<td>.17</td>
<td>.16</td>
<td>-.03</td>
<td>.42*</td>
</tr>
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<td>.62**</td>
<td>.77**</td>
<td>.48*</td>
<td>.57*</td>
<td>.42*</td>
<td>.39</td>
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<td>.70**</td>
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<td>.53*</td>
<td>.53*</td>
<td>.47*</td>
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<td>.40*</td>
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</table>

Figure 6.10: Correlations between Dimensions of Task Fit Change
The inter-correlations analysis suggests that six of the factors belong in one cluster and three in another. The three factors that form a separate group are also the three which appear at the bottom of figure 6.10 because they display least change. The group of six factors contains the three factors for which there was greatest change (recency, availability and comprehensiveness) and which were frequently the target of system introduction. For example, an improvement in the recency of information was a target for the four on-line, real-time systems and was achieved in all four cases. Comprehensiveness was the major gain for the batch processed systems. For example, in the Glass Maker system the information base was considered to be more comprehensive and more available because cost data was now incorporated into forecasts and outputs were widely available within the organisation. The three factors, validity, precision and reliability were not given as reasons for system implementation but important gains were made in them wherever gains in recency, availability and comprehensiveness were made.

By contrast the three factors, relevance, safety and privacy, were regarded by many managers as issues which became serious as a result of improvements on the other dimensions. For example, improvements in recency and availability were often considered to mean a wider range of people had better access to information, making it more difficult to maintain information privacy where it was necessary. This was considered a major issue in those cases in which the data base contained personal information about members of the public, i.e. the Hospital and the Bank. Similarly, problems of irrelevance were often linked with improvements in comprehensiveness.
This analysis suggests that whilst the task fit change measure gives a comprehensive view of changes in the information base it can serve to hide important gains on components. It may be that omission of the three factors that provide a separate cluster will provide a better measure of change in the factors which are most actively sought when a system is introduced. Figure 6.7 (page 186) includes correlations for a revised task fit change measure in which relevance, privacy and safety are omitted. This has the effect of improving the correlation with system potential to 0.73.

### 6.6.2 Analysis by User

Thus far the question of system potential has been examined case by case. The nature of the impact as experienced by users varies within as well as between systems because, for example, not all users of a system make use of on-line terminals. It is possible therefore to examine whether there is support for the proposition at an individual user level by examining the system as used by each individual and comparing it with change in task fit of the individual. Figure 6.11 summarises the results of this analysis.

<table>
<thead>
<tr>
<th>Mode of Interaction</th>
<th>Medium of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Interactive</td>
<td>Non-Terminal</td>
</tr>
<tr>
<td>Interactive</td>
<td>Terminal</td>
</tr>
</tbody>
</table>

**Average Task Fit Change**

- **All Cases**
  - Non-Interactive: 3.79
  - Interactive: 3.84
  - Non-Terminal: 3.70
  - Terminal: 4.10
- **Comparable Cases**
  - Non-Interactive: 3.92
  - Interactive: 3.83
  - Non-Terminal: 3.80
  - Terminal: 4.10

**Figure 6.11:** Task Fit Changes for Mode and Medium of Interaction
In this analysis it is possible to separate the two components of system potential and examine their effects independently. Users have been divided into two groups on the mode of interaction (those making regular use of facilities for construction or selecting their service being classed as interactive and the remainder as non-interactive) and two groups on the medium of interaction (those who regularly use terminals and those who do not). The values given are the means of case averages in order that the different numbers of users in each case do not influence the data. The 'All Cases' averages compare all non-interactive users with all interactive users. They show that interactive users achieve a marginally better average task fit change whilst terminal users achieve a considerably better change than their non-terminal using colleagues. This analysis however includes some cases where there are no interactive and no terminal users and a better comparison is one which includes only cases where both modes and both media are in use. This analysis removes the difference between the two modes of interaction but the difference between the media remains.

On this evidence the ability of systems of greater potential to provide better information bases is primarily a function of the provision of on-line terminals, and the benefits of being able to select and construct the information service are not realised. This is in accord with the conclusions of Eason et al. (1975) that the benefits of on-line terminals are realised by users who do manage to obtain more up-to-date information and to access a wider range of information, whilst the benefits of flexible facilities are often not realised because users find the software procedures involved difficult to use.
6.6.3 Summary

In summary it would appear that the following points can be made about the relationship between system potential and the information base of managerial tasks:

1. There is strong evidence that systems with greater potential for users lead to a greater improvement in the perceived information base of users.

2. The improvement is more closely related to the provision of on-line terminals than it is to the provision of facilities whereby users can select or construct their own outputs.

3. Whilst low potential systems do not yield major improvements in the information base, there can be cases where high potential systems also fail to have this effect. Possible reasons for this failure are as follows:

   (a) The previous information base may have been adequate for the tasks.

   (b) The users may be unable or unwilling to use the full potential of the system and may therefore not attain the improvement in the information base that is possible.

   (c) There may be a specific rather than a general improvement in the information base. For example, there may be an improvement in information recency or availability but this may not spread to other properties of the information base. Indeed it may, in the eyes of the users, cause a deterioration in such factors as information relevance, privacy and safety. Whether these are considered major issues is dependent upon case specific factors such as the nature of the data held within the system.
6.7 The Information Base of the Task and Task Impact

The general finding about this relationship was that an improvement in the information base is usually associated with a considerable degree of task impact. However, there was a high level of task impact throughout the survey and this means that in some cases high degrees of task impact were achieved with minimal change in the information base.

In seeking explanations for these findings two kinds of factors will be considered, the nature of the change in the information base and the nature of the task. These factors will be considered first with respect to impact upon intrinsic factors and secondly with regard to constraint impact.

6.7.1 Impact upon Intrinsic Factors

It is tempting to attribute impact upon intrinsic factors to important changes in the quality of the information base serving the task but from figure 6.6 (page 185) it is clear that there are three tasks where considerable change occurs when the task fit change is minimal and 4 other tasks where change is moderate despite little change in the information base. A possible explanation for this is that, whilst the change in the information base has not been large, there has been sufficient improvement on some components to stimulate a changed perception of the intrinsic character of the task.

In figure 6.12 the tasks with overall task fit changes of less than 3.7 are listed with the components for which scores in excess of 3.7 were achieved. This analysis shows that every task has one or more components with a score of this level and it may be that these components are responsible for the changes in intrinsic factors that occurred. It will be noted that the components vary from case to case and there is no indication that one component is more responsible for this change than another. An inter-correlation analysis of intrinsic task factors and information base components showed that no single factor
exhibits a correlation which would suggest it was a prime cause of changes in intrinsic task factors. It appears that the trigger for these changes is task specific, i.e. it may be more recent information in one instance and more comprehensive information in another.

<table>
<thead>
<tr>
<th>Case</th>
<th>Overall Task Fit Change</th>
<th>Components Over 3.6</th>
<th>Value of Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesaler</td>
<td>Task A ) 3.6</td>
<td>Recency</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>Task B ) 3.6</td>
<td>Availability</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comprehensiveness</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Validity</td>
<td>3.8</td>
</tr>
<tr>
<td>Glass Maker</td>
<td>Task A ) 3.5</td>
<td>Comprehensiveness</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>Task B ) 3.5</td>
<td>Availability</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recency</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>3.7</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Task A 3.2</td>
<td>Relevance</td>
<td>3.8</td>
</tr>
<tr>
<td>Supplier</td>
<td>Task B 3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>Task A ) 3.1</td>
<td>Availability</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Task B ) 3.1</td>
<td>Recency</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Figure 6.12: Component Task Fit Change Scores in Cases with Low Overall Change

It appears that, in order to identify the degree to which these changes occur, it is necessary to examine the nature of the task itself. Earlier in this chapter it was argued that intrinsic task change is mostly likely to occur when a task is open-ended because in these tasks the task performer is continually seeking a better understanding of task dynamics. It was argued that most managerial tasks
are of this nature but it is of course possible to place managerial tasks on a dimension ranging from the more open to the more closed. In this study each research team classified the tasks they investigated as more or less open-by differentiating between tasks conducted in a relatively stable environment and those conducted in a relatively uncertain environment. It might be anticipated therefore that the tasks conducted in a relatively uncertain environment would be more susceptible to changes in intrinsic factors.

<table>
<thead>
<tr>
<th>Average Incidence of Intrinsic Task Changes</th>
<th>Tasks in a Stable Environment</th>
<th>Tasks in an Uncertain Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative</td>
<td>65.7</td>
<td>72.2</td>
</tr>
<tr>
<td>Absolute</td>
<td>61.6</td>
<td>74.7</td>
</tr>
<tr>
<td>Correlation with Task Fit Change</td>
<td>0.44</td>
<td>0.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distribution</th>
<th>30-60%</th>
<th>70-100%</th>
<th>30-60%</th>
<th>70-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Fit</td>
<td>3.7 - 5.0</td>
<td>-</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Change</td>
<td>3.0 - 3.6</td>
<td>4</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 6.13: Task Differences and Intrinsic Task Changes
Investigators classified tasks in both relative and absolute terms, i.e. in each case a judgement was made of which of the two tasks involved the greatest degree of uncertainty and an absolute judgement was made of whether each task was conducted in a stable or uncertain environment. Figure 6.13 gives the average incidence of intrinsic task changes using both relative and absolute classifications. The incidence of intrinsic task changes is highest in the absolute assessment for tasks in uncertain environments. However, this analysis does not take account of differences between cases and the relative assessment is a more reliable finding. It also shows a greater incidence of intrinsic task changes in the tasks in an uncertain environment although not to such a marked extent.

This task distinction can be examined still further by analysis of the relation between task fit change and intrinsic task change for the two kinds of task. Figure 6.13 shows this correlation to be 0.44 for the tasks in stable environments but only 0.08 for those in uncertain environments. These correlations are however of limited value because of the bi-modal distribution of the intrinsic task change scores and the 2x2 distribution matrix in figure 6.13 may be more informative. This shows that the proposition that high task fit change is associated with high intrinsic task change is confirmed exactly for tasks in a stable environment whereas for tasks in an uncertain environment the relationship is upset by tasks with low task fit scores giving rise to high intrinsic task change. In other words all of the exceptional cases indicated previously are tasks in uncertain environments.
This analysis is based on relatively few tasks but it seems to indicate that tasks in uncertain environments are more sensitive to changes in their information bases than are tasks in relatively stable environments. We might therefore hypothesise that it takes a smaller change in the information base of the task in an uncertain environment to create the conditions for change in intrinsic factors than it does for a task in stable environment.

As in the analysis of system potential, it is possible to seek corroborative evidence for these conclusions by reference to variations within cases. In the survey each research team classified the level of each manager interviewed and his job type. It may be hypothesised that the more senior the manager the more uncertain the environment of his tasks and also, after Thompson (1967), that managers who have jobs which deal with the boundary between their organisations and others will deal with greater uncertainty than those whose jobs lie within the 'technical core' of the organisation.

We may therefore predict that, for a given level of task fit change, managers with higher positions and who have boundary management jobs will exhibit a greater incidence of intrinsic task change than their colleagues. An analysis based on this prediction is presented in figure 6.14.

There is very little difference between the scores for intrinsic task changes for the three levels of management to give any support to the prediction but there is some variation for job type. The two job types most associated with boundary management are marketing/sales and buying and, whilst the task fit change level is similar for all job types, the level of intrinsic task change for those job types is greater than for the two job types most concerned with internal affairs (production and logistics). We have therefore partial support for the argument presented.
The impact of improvements in the information base upon intrinsic task factors may therefore be summarised as follows:

1. High intrinsic task change does occur with high task fit change but it can also occur when there is little change in the information base.

2. In cases where low task fit change leads to moderate or high intrinsic task change there are gains in one or more components of the information base which could account for the change. The components tend to vary from task to task.

3. Tasks which exhibit low task fit change and high intrinsic task change may all be classified as involving high environmental uncertainty. Analysis of the incidence of intrinsic task change between task types and between job types suggests that the more the task is conducted in an uncertain environment, the more sensitive it is to changes
in its information base, i.e. a small change can create the conditions for considerable intrinsic task change.

6.7.2 **Constraint Impact**

The general finding about the occurrence of constraint impact is that it is correlated with change in task fit and also with the potential of the system. It is inevitable that it therefore also occurs with impact upon intrinsic task factors.

The most obvious explanation for this phenomena is that using a computer aid inevitably means you are constrained to work within the rules by which the system operates. The more useful the system is to you, the more use you make of it, the more the constraints affect your behaviour. That managers, by and large, do not take a negative view of these constraints is probably an indication that they are seen as the necessary costs of being able to use a valued service.

However, as before, there are exceptions to the rule that system potential and task fit change are correlated with high incidence of constraint. There are cases where low task fit change is associated with high constraint, e.g. the Glass Maker and the Restaurant Supplier. In these cases there is a high degree of impact upon intrinsic task factors and it is possible that the explanation is that the same components of the information base that have been improved, and probably give rise to this change, also give rise to constraint impact. There are no cases in which there is very little intrinsic task impact but a high degree of constraint. This would amount to impersonal control of how the task is undertaken with no perceived benefit to the user. This may be a feature of clerical use of computer systems but it is doubtful whether it would be acceptable within a managerial environment.
Conversely, there are tasks in which there is high task fit change and high impact upon intrinsic task factors but relatively little constraint, e.g. the Bank and the Mail Order company. This is more difficult to explain using system variables and it is necessary to examine the nature of the task.

<table>
<thead>
<tr>
<th></th>
<th>Tasks in a Stable Environment</th>
<th>Tasks in an Uncertain Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative</td>
<td>47.1</td>
<td>54.5</td>
</tr>
<tr>
<td>Absolute</td>
<td>45.1</td>
<td>57.7</td>
</tr>
<tr>
<td>Correlation with Task Fit Change</td>
<td>0.37</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Figure 6.15: Task Differences and Task Constraint

The examination of the occurrence of constraint impact in the tasks conducted in stable and uncertain environments presented in figure 6.15 shows that, on both relative and absolute assessments, the result is the same as for intrinsic task factors; there is more impact on the tasks conducted in an uncertain environment. Since there is no difference in the task fit scores for the two types of task on the relative assessment, the explanation for this does not lie with the improvement in the information base. A possible explanation, akin to the one used to explain the greater intrinsic task impact, is that there is more possibility of introducing constraint into the tasks in uncertain environments because they have hitherto been very unconstrained. This will not have been the case
for the tasks in a stable environment which may well have been fairly well constrained and the computer system may simply fit into the existing constraint pattern. This, for example, may be the explanation for the low constraint impact score for the book-keeping task in the Bank.

This explanation cannot however be used to explain why in some of the tasks in an uncertain environment there is high task intrinsic impact but relatively little constraint, e.g. the Sales Monitoring task in the Glass Maker and Currency Dealing in the Bank. A possible explanation for these tasks is that the managers engaged in the tasks work relatively independently of one another whereas in other tasks there is tight task interdependency. When a computer system serves users with inter-dependent tasks it not only introduces constraint due to its operational characteristics but it can also act as a co-ordinating and standardising agent between users. If users, for example are to share the same information or indeed if one person is to use information supplied to the system by another, it is necessary, within the systems we have examined, that users adhere to rules about how and when the information is supplied. This is not the case where users work relatively independently of one another which is true of the two tasks cited above.

It is possible to examine this explanation a little more by reference to the data about the incidence of task constraint for different job types and levels of management.
<table>
<thead>
<tr>
<th>Job Type</th>
<th>No. of Cases</th>
<th>Task Fit Change</th>
<th>Incidence of Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Marketing/Sales</td>
<td>2</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>2. Administration</td>
<td>5</td>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td>3. Buying</td>
<td>4</td>
<td>3.8</td>
<td>3.2</td>
</tr>
<tr>
<td>4. Logistics</td>
<td>5</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>5. Production</td>
<td>2</td>
<td>3.6</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>No. of Cases</th>
<th>Task Fit Change</th>
<th>Incidence of Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Senior</td>
<td>4</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>2. Middle</td>
<td>8</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>3. Junior</td>
<td>6</td>
<td>3.7</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Figure 6.16: Task Fit Change and Constraint for Job Type and Level

Once again, as figure 6.16 indicates, there is relatively little variance in the task fit change scores across job types and levels and hence a direct comparison of the incidence of constraint is possible. In this case we can argue that boundary roles and senior roles, according to Thompson, tend to involve relatively weak inter-dependency with other members of the organisation and we would expect them to exhibit relatively low levels of task constraint which is indeed the case. The highest levels are associated with the logistics function, i.e. with planning and scheduling tasks, and for middle management. In both cases it can be argued that these are functions which are primarily concerned with co-ordinating and controlling the activities of others and as such involve tight task inter-dependencies.

In summary therefore the following points may be made about the incidence of constraint impact:

1. High degrees of constraint are associated with improvements in the information base and tend to occur with changes in intrinsic task factors.
2. In circumstances in which low task fit changes occur with high degrees of constraint there is also high intrinsic task impact and the explanation may be that critical aspects of the information base have been improved.

3. Greater degrees of constraint impact are associated with tasks in uncertain environments possibly because tasks in stable environments are already heavily constrained.

4. Tasks in uncertain environments which exhibit high intrinsic task impact but low constraint tend to involve users who have relatively weak task inter-dependencies with their colleagues.

6.8 Conclusions

This analysis leads to a number of conclusions that are well substantiated by the data and a number of much more tentative explanations which require further investigation.

The principle conclusions are as follows:

1. The systems examined in this survey, representing a cross-section of different types of systems in use by managers, all exhibited a high degree of impact upon their users and can thus be claimed to be reaching their target. They appear to cause managers to revise their ideas of the tasks in which they engage.

2. Simultaneously with changes in intrinsic task factors, managers are likely to experience an increase in constraint in 'when' and 'how' they conduct their tasks.
3. The more powerful the system, in the sense that it offers more possibilities for interacting with and manipulating data, the more the task impact.

These conclusions paint a much more satisfactory picture of management information systems than Ackoff (1968) presented a decade ago and which was found in the survey reported in chapter 3. It may be that current systems have solved many of the problems that were then causing difficulties. There is however one feature of this data which should sound a cautionary note. The benefit that managers derive is accompanied by greater degrees of constraint. It is true that this is welcomed by many managers as bringing 'order out of chaos' but it is necessary to question whether this order is always an appropriate order. Weizenbaum (1976) has sounded a warning that the use of computer systems can shape the way problems are perceived and tackled and that they encourage 'instrumental reasoning' in which qualitative aspects of tasks (goals that are difficult to operationalise, areas of uncertainty, etc.) tend to be ignored in favour of those aspects of the task the computer can handle. The constraints that have been discussed here, particularly those relating to routine and standardisation, may well have this kind of effect. Sackman (1974) has stated the problem another way. He refers to 'computer tunnel vision' as a phenomenon in which tasks are modified to suit the characteristics of computer tools. The managers in the survey imply that their computer tools provide them with a clearer 'window' on their tasks but it is possible that the shaping of the thought processes is an insidious process and the managers themselves are unable to detect whether they are looking into a 'window' or a 'tunnel'. A study that relies on the user's perception of change is therefore not likely to ascertain the extent of this phenomenon which would require task observation before and after system implementation.
Whilst the three general conclusions are widely applicable to the systems investigated, the analysis also suggests that a variety of task and organisational factors serve to shape the degree and type of task impact. Figure 6.17 is a representation of a causal model which may be offered as an explanation for the occurrence of task impact.

Inhibitors:
1. Ability and Willingness to use the System.
2. Adequacy of Previous (alternative) Information Base.

Figure 6.17: Hypothetical Causal Model for the Incidence of Task Impact

In this model the main causal route is shown in terms of the proposition advanced at the beginning of the chapter: the more potential possessed by the system, the more impact it has upon the information base of the managerial tasks and the more impact it has in terms of both intrinsic factors and constraints.
This is likely to be the outcome unless certain inhibiting factors are present in the organisation which reduce the task impact. The potential of the system, for example, may not be translated into an improvement in the information base as perceived by the user if (a) he regarded the previous information base as adequate or has access to an alternative source of information which he regards as adequate, or (b) he is unable or unwilling to develop the expertise necessary to use the facilities of the system to improve his information base. If either of these conditions prevails task impact will be less than predicted by the power of the system. If the information base has been improved, the impact will be found in terms of change in intrinsic factors and task constraint to the extent that the task is open-ended and there is therefore an opportunity for change in intrinsic factors and for greater constraint. Where the task is relatively closed, which is likely to be the case if the task environment is stable, there may not be much opportunity for impact of either variety. This conclusion incidentally supports Ackoff's (1980) suggestion that the pay-off in developing computer systems is much higher for systems to support senior management engaged in tasks dealing with uncertainty than it is for systems which seek better control over tasks which are already heavily constrained and controlled.

The final form of inhibitor affects the occurrence of task constraint. Where the system serves a number of users who are interdependent, considerable task constraint may be expected but if there is little interdependency change in intrinsic factors may occur without constraint.
CHAPTER 7 : THE FUTURE OF MANAGER-COMPUTER INTERACTION

7.1 Introduction

The aim of this chapter is twofold; to review the present achievements and problems of manager-computer interaction and to examine its possible futures. The research studies reported in previous chapters have been conducted over a period of years in which manager-computer interaction has undergone rapid change. There is therefore an opportunity to examine its evolution to date and to use any trends that are found to project into the future.

The focus of this chapter, as in the rest of the thesis, is upon the computer as a tool in the service of the individual manager. However, an alternative focus is upon the computer as a tool in the service of the organisation. In this formulation the computer can be seen as a vehicle for the control and coordination of individual managers. A number of references have been made to the potential conflict of these formulations and it is possible that a future which optimises manager-computer interaction may be in conflict with a future which optimises the use of the computer as a mechanism of control. We will return to this issue after we have considered the future of manager-computer interaction.

7.2 The Reality of Managerial Tasks

Before turning to an evaluation of the impact of manager-computer interaction upon the performance of managerial tasks it is relevant to review what we have learned about the nature of managerial tasks. Chapter 2 made some efforts to define the nature of these tasks as information processing activities primarily making use of the Simon intelligence-design-choice paradigm. Whilst this has provided a useful perspective, one of the lessons to emerge from the field work conducted in this study, is that there are other perspectives that must also be taken into account if the reality of the managerial task is to be appreciated. Little attempt was made in the research
studies to formally classify these issues and therefore what follows is a somewhat impressionistic listing of the dominate themes that it became difficult not to notice in the course of conducting this research. Whilst this listing emerged in an unsystematic way, it is comforting to note that, as a picture of the reality of management, it has a lot in common with the views expressed by Stewart (1963) and Minzberg (1973).

The dominate feature of the managerial task to emerge is that it is an open-ended task, subject to the variability present in the environment and therefore requiring a capacity to cope with this variability. This portrayal of the managerial task is therefore cast in terms of the open systems view of tasks developed by Harker and Eason (1979) and summarised in figure 7.1.

![Figure 7.1: An Open Systems View of the Managerial Task](after Harker & Eason, 1979)
In this view any task is regarded as an attempt by an active agent (usually man) to induce a transformation in the state of some feature of the world (the inputs) so that an alternative state can be achieved (the outputs) which conforms to the goals of the agent. It may however, be that the Universe in question is not in a steady state, i.e. is already undergoing a transformation, in which case the task becomes one of guiding it towards the required goal state.

Given this general view of a task, what can we say specifically about the managerial task? Notwithstanding the tremendous variety of such tasks the following general points may be made:

(a) It is a decision-making task in which the goal is to determine the path to be taken by the operational systems that are being 'managed'.

(b) It is an information processing task because of the need to gather and process information about relevant circumstances and to evaluate alternative courses of action (hence the intelligence-design-choice phases).

(c) It is an open-ended task in that the inputs can take a wide variety of forms. Indeed the lack of regularity in the inputs is one of the defining attitudes of such tasks. If a manager is not dealing in short term 'trouble shooting', i.e. coping with a newly emerged problem for which there are no ready made solutions, he is formulating longer term policies where the uncertainties of the future render the inputs variable.

(d) The goals to be achieved may be more or less variable and the task performing system must be capable of re-
formulating task goals or at least of resolving trade-offs. For example there are continuing needs to trade off quantity vs. quality, risk vs. pay-off, the short term vs. the long term etc.

(e) The information required to effect the transformation may be available in a wide variety of forms and the outputs may be required in a variety of forms; for example, the system that undertakes managerial tasks has to be capable of interpreting accounts sheets and of enquiring into the motivational make-up of a subordinate. The output may need to be in a form on the one hand, to satisfy the formal examination of the auditor, and, on the other hand, to satisfy potential investors of the integrity and trustworthiness of the proposers.

(f) The transformation may need to be effected using data which lends itself to quantitative processing but may also rely upon ambiguous data, missing data, and data which is qualitative, value laden and judgemental.

(g) The environment in which the managerial task is conducted makes it unlikely that a task will be completed in one episode. The managerial environment is often described as a series of interruptions. Certainly management is characterised by its short episodes and by its never ending 'in-tray'. Any responsibility for managing the short and long term viability of an operating system, carries the consequence of a task never complete because there will always be issues outstanding.

7.3 Allocation of Function in Managerial Tasks

The conduct of a managerial task has hitherto lain with a human being; with a 'manager'. The subject of this thesis
suggests that another and increasingly important agent in the conduct of the task is going to be the computer. Some authors do not consider it too fanciful to foresee a day when a computer system is the sole 'manager' of a system. This may not have been seriously proposed for management tasks but it is certainly a goal of those concerned with the automation of production systems. Where there are two parties to the conduct of a task, it is possible to consider the appropriate 'allocation of function'. In the original Fitt's formulation (1951) this was regarded as a matter of identifying the strengths and weaknesses of the alternative agents. In later approaches (e.g. Jordan, 1963) this approach has been challenged in favour of a joint optimisation concept in which the effect of interaction between the contributors is fully considered. In the analysis that follows we will begin by identifying relative strengths and weaknesses and subsequently consider the various ways in which the partners may work together.

Since managerial tasks have been seen as the province of the manager, the first requirement is to demonstrate that there are functions which can be better performed by the computer. The argument has been extensively covered elsewhere in the thesis. In summary it is that the computer is a powerful device for the processing, storage and communication of data in large volumes, very quickly and very accurately. In the managerial environment it is often necessary (a) to monitor a wide array of data sources to determine where action is necessary, (b) to explore information sources in depth to build up a model of the problem, and (c) to process information about alternative courses of action in order to select the most appropriate action. The many management aids examined in this research demonstrate that it is possible to use computer systems to serve these functions.
What then are the functions best left with the human 'manager'? Compared with a computer system, a human being is a slow and inaccurate information processor who has a large data store but has difficulty ensuring accurate retrieval. However, if we examine again some of the realities of the managerial task we find that man has properties which are essential and which are not found in present day computer systems:

(a) Input/Output capabilities. Computer systems can only work with information presented and coded in forms they can recognise which is a severe limitation. Similarly they have a limited range of output modalities. A task performing system interacting directly with the external environment must be able to cope with inputs in many modalities and give outputs in appropriate forms. A human being has the ability for example to read handwriting of many types, to understand graphs and tables, to understand speech, to perceive patterns in pictures, to appreciate emotions and attitudes through non-verbal cues etc. He can also give information in the same variety of modes. Most managerial tasks, and many others, require this array of modalities. Indeed one of the dangers in man-computer interaction is that man can be reduced to a general purpose input/output transformation device, preparing data in a form that can be processed by a computer.

(b) Values and Goals. Many managerial tasks require an in situ appraisal of goal priorities, an assessment of values to be sought or protected and a judgement of trade-offs. These judgements rely upon systems of ethics and morals which are a human prerogative. Whilst it may be possible to build the goals and values into a computer system, it is difficult to see how such programs could
directly handle in situ changes in the goal structure.

An apt analogy may be the statute book and our continuing need for judges to rule on interpretation and legislatives to modify and create new statutes. Maybe future managers will operate in similar roles.

(c) Variability, Ambiguity and Uncertainty. The openness of managerial tasks means that frequently the task inputs present a configuration never previously encountered. It may also mean a new variable has to be considered. The task performing system has to be capable of recognising the novel features of the task inputs and of adaptively responding to produce the required transformation. The computer systems examined in this research were non-adaptive and could only respond to configurations on inputs which their designers had predicted. Change and variability were therefore the province of the human being. Similarly, computer systems cannot cope with partial information or ambiguous information and such conditions are very common in managerial tasks. To make judgements where there is ambiguity and to produce 'best guesses' where there is little information is also the province of the human being.

(d) Development and Learning. Managerial tasks are often characterised by rapid change and complexity. The task performing system has to model this complex and changing world if it is to cope effectively. It may be claimed that many of the computer systems examined contained models of their task environment. However, they were essentially static models. It would appear that if we wish there to be a development of the knowledge about a task within a task performing system, we have to rely on the learning capabilities of the human being.
To summarise, where a task includes a need for the rapid, and accurate processing, storage or communication of pre-determined types of information then the computer can be of service. Where the task requires an ability to detect information in a variety of modalities in order to determine a possibly unique task input configuration which will require an adaptive response, possibly including a re-appraisal of the goals to be achieved, a human being is essential.

It seems likely that every management task considered in this thesis has a mixture of these attributes. For these reasons a suitable way of handling these tasks is to employ a form of man-computer interaction. We may state the goal of such interaction as being to seek effective task performance by facilitating the performance of both kinds of function by the two partners, i.e. it should be possible for the computer to enlarge the range of accurate, relevant and timely information considered in the task performance and for the human being to find adaptive ways of recognising and responding to the unusual, ambiguous, and uncertain elements and to the need to resolve value dilemmas. Having enunciated this as a target for manager-computer task performance, we may examine the performance attained by different forms of manager-computer interaction.

7.4 Task Performance Using Batch Processed Management Information Systems

Much of the literature referred to in chapter 2 and many of the systems in the survey reported in chapter 3 were of a particular type which constituted the first kind of manager-computer interaction to have a powerful effect upon management. This kind of system involved the collection of data from many different parts of the organisation, often as the
result of operational routines, and the batch processing of this data to provide a variety of management printouts. Typically these printouts were pre-determined in terms of content and tabulation. They were also likely to be standardised across management functions. In many cases the development of these systems was part of a grand philosophy to build integrated management information systems to rationalise and streamline the flow of information in the management structure of the enterprise.

The conclusions of chapter 2 and the results of the survey in chapter 3 leave little doubt about the effectiveness of these systems. In the terms used to make our evaluation, these systems failed on the following grounds:

(a) irrelevant and not sufficiently comprehensive, i.e. they produced a lot of data that was not needed and frequently failed to produce what was needed.

(b) inaccurate and untimely, i.e. the data that was relevant was often not sufficiently accurate and was too out-of-date to be useful.

(c) reliability, i.e. printouts failed to arrive at the appointed time.

Some of these failures were caused by the inadequacies of hardware at that time e.g. breakdowns, but the fundamental problem lay in the conception of the management task underlying the systems design philosophy. This was that there was a degree of structure, standardisation and regularity in the management tasks commensurate with providing routine, standardised information. In practice such systems often gave managers a starting point for their tasks but were of very limited help when it came to investigating in depth the nature of problems or deciding what to do about them. The systems failed to recognise differences between management functions,
the rate of change of management tasks or the autonomy of managers and hence their different ways of working. In essence they provided a very coarse form of management information and for specific tasks usually fulfilled neither the functions to be attributed to the computer nor the support necessary for the manager to fulfill his functions. They left the manager with little help in establishing the specific requirements of a task and no help in responding adaptively to its demands. There may well have been a tendency for the manager to accept the standardised view of the task being projected by the system. Often, however, the response of the manager was either to reject the outputs of the system (disuse) or to accommodate only those features which were of immediate use (partial use).

7.5 Task Performance Using Interactive Decision Support Systems

Whether as a result of developments in the technology or as a result of the lessons being learned from the earlier 'management information systems' era, the next (and current) generation of systems corrected many of the earlier faults. These systems provide information for managers on a much more individual, interactive basis. This development has occurred in two dimensions as indicated in chapters 3, 4 and 6. Firstly, the systems have become more interactive in the sense that, by virtue of time sharing and multi-access, terminal based systems, it is possible for the user to engage in a question and answer 'conversation' with the computer. The second dimension concerns the control placed in the hands of the user, or the range of choice at his disposal. The new systems do not prescribe the one form in which information is available but allow the user to construct or select a suitable service whether it be by searching a data base, constructing a data base or by defining required forms of processing. Systems vary considerably in the range of choice available to the user but,
compared with earlier systems, they are much more flexible in use.

The evidence from the survey in chapter 3 and the case studies in chapter 6 suggests that these systems have overcome to a considerable degree, some of the earlier problems. There is now much less concern about irrelevant data, about inaccuracies and breakdowns and lack of comprehensiveness. It is much more in the hands of the manager to get the service he wants at the time that he wants it and, by and large, this has resulted in a better 'fit' between manager and computer system.

The development of these systems has, however, brought with it some new problems which threaten the translation of greater potential into better task performance. We can classify these problems under two headings, the 'ease of use' problem and the 'task model mismatch' problem.

7.5.1 The 'Ease of Use' Problem

The very important move to give the end user more control over what the computer does in his service has the effect of leaving the user with a more complex operational task. He has to know the facilities available to him, how to bring them into effect and how to interpret the results. In chapter 3 we used an analogy which is worth repeating; it is as though the user has ceased to be a user of public transport (with all the constraints of fitting its timetable and arriving not exactly where you wish to be) and has become a private motorist, able to define exactly the time of travel and destination, but now having to learn to drive, plan the route, maintain the vehicle etc.

Many user types, notably the specialist user (the
engineer, the scientist, the designer etc), are seemingly able to take on these tasks and make effective use of complex, flexible computer aids. The manager's response as revealed in chapters 3, 4 and 5, has not been so positive. It would appear that the provision of more complex facilities has led many managers to conclude that systems require too much time and effort to master them. They complain about the problems of operating computer terminals and, indeed, one of the features of this research, has been the continuing search for, and failure to find, large number of managers making direct use of computer terminals. They also complain about the difficulties of understanding and using software procedures; of knowing the facilities available and of how to apply them to their tasks. In chapters 4 and 5 we have explored many aspects of this 'ease of use' problem and why it is particularly critical for managers. Broadly it appears to relate to the episodic and never ending nature of the management task where thoroughly mastering a computer system is rarely perceived as a task warranting top priority and urgent action. The effort required is perceived as largely a peripheral activity when set against urgent management problems.

As a result of this problem, management users adopt a number of expedient strategies which, by and large, mean they do not make full and effective use of their computer aids. They may, for example, refuse to use the complex system (dis-use) or, more probably, they will only use those features they find easy to use and have a regular use for (partial use). Finally, and very commonly, they ensure that some one operates the system on their behalf (distant use).
7.5.2 The 'Task Model Mismatch' Problem

If an agent is to effect a task transformation where the task configuration may vary, it must be possible for the agent to 'model' the actual task, i.e. to represent within itself the essential characteristics of this task. One of the principal reasons why man is capable of effecting task transformations in very varied circumstances is his ability to build a representation of the task which he may use to examine alternative courses of action.

It is possible to consider the degree to which the other agent in man-computer task performance also 'models' the task. Before it can be of any use it has to be fed details of the specific task and it must possess facilities which match, or can be made to match, processes in the task environment if it is to usefully process the data it has been given. Since present day computer systems cannot automatically build up a task specific model for each transformation they are reliant upon having been pre-programmed with the required facilities or upon being given the relevant task characteristics by their human partner when the task is undertaken.

One of the most common results running through the research reported here is that the model built up by the manager is at variance with the model implicit in the way the computer system behaves or the facilities it places at the disposal of its user. This is not a problem that relates directly to the movement towards more powerful and interactive systems but it does tend to become more critical with these systems because the user and the system are in a closer, mutually dependent relationship. Although no formal analysis
was made of this emergent problem in the course of the research, it was noticeable that the task model mismatch issue was a much greater problem for some kinds of computer aid than it was for others. Figure 7.2 attempts a scalar representation of this effect by ranking different kinds of systems according to the degree to which their software appears to make specific assumptions about the task environment in which it was designed to be used.

Types of Computer Aids

<table>
<thead>
<tr>
<th>Strong Task Assumptions</th>
<th>Weak Task Assumptions</th>
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<tbody>
<tr>
<td>(1) Automatic Control Systems</td>
<td>(8) Communication Systems</td>
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<tr>
<td>(2) 'What happens if?' Evaluation Models</td>
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<td>(3) Clerical Procedure Systems</td>
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<td>(4) Standard Output Systems</td>
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<td>(5) Exception Reporting Systems</td>
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<tr>
<td>(6) Data Base and Retrieval Systems</td>
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<tr>
<td>(7) Word Processing /Text Handling Systems</td>
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</tbody>
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Figure 7.2: Task Assumptions in Computer Aids

The rank positions given in figure 7.2 are based on the survey and case study data. However, since this is a post-hoc interpretation they are based on impressions of the data rather than quantitative analysis.

Automatic control systems embody explicit models of what they are controlling; in effect they include cause and effect assumptions so that, for example, when
a variable reaches a critical level, a procedure comes into operation which is known to impact upon this variable. An automatic control system which does not have an adequate task model of the system under control loses control of it. This is not an unknown event when unusual conditions prevail and frequently there is a human operator standing by to take over in this eventuality.

The 'what happens if' evaluation models used by managers incorporate a cause and effect model of some aspect of the task environment in order to give a future projection given specific starting conditions. Managers using these systems were particularly outspoken about unwarranted or over-simplistic assumptions contained in such models which frequently, in their view, rendered the prediction unrealistic.

Clerical procedure systems do not so much model the external world as dictate the way things are to be done. In dictating what data are necessary, in what form and when they will be given, these systems make very strong assumptions about the task as perceived by the operator. Many clerical users are confronted by tasks which do not fit the required pattern; which involve additional issues, do not involve some of the issues, do not provide all the information required, present it in a different way etc. The presence of separate offices to deal with 'exceptions' is an illustration of this problem.

Standard output systems simply give information and therefore do not dictate directly how the task is handled. Inasmuch as the programmer has determined the information pertinent to the task, the form in which it will be re-
quired and when it will be required, the potential contribution of the system to the task has been prescribed. Exception reporting systems are a special class of information giving system in which a trigger point has been set to indicate when action is required. Unfortunately the trigger point may vary with time and the nature of task, giving rise to more user cries of lack of realism.

The remaining systems carry less explicit task assumptions. Data base and retrieval systems carry defined types of information in formal relationships but the user has the freedom to search and extract that which is relevant to his task and there were very few comments that these systems involved task mismatches. This thesis has not formally evaluated the word processing, text handling and communication systems now becoming available in management environments but, inasmuch as they handle any text they are given and do not demand specific fields of data about which they make specific assumptions, they appear to carry few assumptions about the task environment. These conclusions are supported by evidence found in a survey of these systems conducted by the author and his colleagues (Simpson, Eason and Damodaran 1980).

This analysis is largely qualitative and would benefit from a systematic analysis of the interactive properties of systems to establish whether different types do correlate with user comments about task implications. A possibly fruitful approach might be to use the analysis of interaction in terms of the components of language that have become popular (e.g. Stamper, 1975).

In these analyses interaction is usually divided into its lexical and syntactical elements (the grammatical structure of the language) and its semantic and pragmatic
elements (concerned with the meaning of the interaction). Most of the systems which exhibit task implications make assumptions at the semantic and pragmatic elements whereas other systems do not. Perhaps progress could be made in removing unwanted task implications by ensuring that the semantic and pragmatic elements of a system are under user control either in the design process or locally when the system is in use.

It would seem from this analysis that there are some systems which are closely engaged in the execution of the task and which carry assumptions about the task with which users may not agree. Other systems are essentially passive and enable the user to build up the specific model of the task with which he wishes to work. Unfortunately, if the latter is the case, the user has the problem of 'driving' the system to construct the model and he may therefore feel he has an 'ease of use' problem. The manager confronted by a system that does make task assumptions has the choice of rejecting its contribution or of using it and making allowances for any questionable assumptions. There is also the possibility that the user, in time, ceases to question the assumptions and adapts his task model to that of the system. It is this seemingly insidious process that Sackman (1974) has called 'computer tunnel vision' and Weizenbaum (1976) 'operational thinking' which has become a source of anxiety for many commentators although, by its nature, it is difficult to isolate and measure.

7.6 Manager-Computer Task Performance Revisited

The early proponents of man-computer interaction, e.g. Licklider (1960), spoke of the achievement of 'man-computer symbiosis'; a state in which a high level of task performance
was to be achieved as a result of the computer providing man with a rapid and wide ranging information handling service thus freeing him from such routine, mechanical activities and leaving him the opportunity to think creatively and adaptively about the task. The previous discussion hardly suggests that manager-computer interaction has to date achieved such a symbiotic state. The latest range of systems seem to be creating a change in task performance but (cf. chapter 6) it does not seem that the full potential of computer systems is being utilized or that the presence of these systems is liberating managers to use their full range of creative and adaptive talents. In short, manager-computer interaction has made some progress but there are many obstacles to clear before a truly effective partnership can be created.

In summary the main lessons to be learned from progress to date appear to be the following:

1. If one accepts the division of functions for man and computer outlined in section 7.3, it follows that a specific kind of relationship must exist between the two partners. If the task is variable it is necessary that the adaptive partner is permitted to diagnose the specific configuration of each task and to establish the strategy for effecting the transformation. The non-adaptive partner, the one that conducts mechanical information search and processing activities, must be subordinate, being called in to provide required services within an emerging structure.

2. This superordinate-subordinate relationship has in fact developed. However, in the early batch processed systems, the services provided were rigid and could not be modified locally to meet the emergent task demands as perceived by the adaptive partner. As a consequence the adaptive partner (because it can be adaptive) responded either by not using the facility or by making selective use of it. A major complication is
that by using a non-adaptive service, the nature of the adaptive function may become channelled. The adaptive element in question (man) has a tendency to become channelled into set responses and there is every reason to suppose that in the continued presence of a non-adaptive service, a compatible form of set may develop which renders the adaptive partner less adaptive.

3. The development of more flexible and interactive computer systems meant that there was a greater possibility of the adaptive partner being able to select appropriate services and a considerable improvement in the partnership has resulted. However, two obstacles remain:

(a) The flexibility of these systems loads the adaptive partner with the need to learn how to use them (to adapt to them) and, because of other demands, he has not, in practice, been willing or able to do this.

(b) Despite their flexibility many types of system, especially evaluation models, carry fixed assumptions about the task environment which the adaptive element does not find to be true in some or all manifestations of the task.

As a result of these problems there are many situations where the potential of the computer service is not realised either because the manager is unable to select an appropriate service or because it contained untenable assumptions. In these circumstances the adaptive responses are against the system (distant use, partial use or non-use).

The essential dilemma which lies at the root of all these issues may be stated as a question. Given an open and variable task, how can an adaptive and a non-adaptive agent work in a mutually dependent relationship without rendering
the adaptive capability non-adaptive? It seems inevitable that, in these circumstances, the adaptive component will be caught between the changing task demands and the stable non-adaptive provisions. Whilst this problem may be unsolvable in an absolute sense, it may be possible to provide the non-adaptive service in ways that assist the adaptive component with minimum inhibition. The progression to a flexible service which can be interrogated and used selectively represents a move in this direction.

7.7 Strategies for the Future

The purpose of this section is to take the resolution of the dilemma stated above as a target for the development of manager-computer interaction and to examine the contribution to it of a variety of strategies.

7.7.1 Management Training

There is general recognition that managers have not readily adapted to direct computer aids and one strategy that has been advocated (cf. Kanter (1972), Ward (1973)) is the widespread education of managers in the uses of computers. In particular this strategy has been aimed at the education of management students and there appears to be an assumption that, whilst the present generation of managers may never master this tool, the next generation will have no such problem. This assumption carries with it the idea that all of the issues discussed in this thesis will be resolved by management education. It may therefore be useful to examine what can and cannot be reasonably expected from such a strategy.

A general education in the nature of computers and the functions they can fulfill in business might be reasonable educational targets. It may also be possible to provide 'hands on' experience in using well known packages or
in writing simple programs. What would such a back­
ground provide when the student is subsequently a
practising manager? If the education was success­
ful it may have dispelled many of the mysteries that
surround computing and may have removed ill-founded
and negative attitudes. It may also have dispelled
unwarranted optimism and the manager's attitudes may
be realistic. If he has some 'hands on' experience it
may also mean he has some understanding of the process
of programming and that he can approach a keyboard with
confidence.

These are all general lessons. Faced with a specific
application related to his own business, he will have
acquired little of direct assistance. He will know
nothing about the software facilities of the application
or how to relate them to his own tasks. He will know
nothing of the task assumptions made within the soft­
ware. Similarly it is likely that he will have to learn
the specific keyboard skills necessary to operate the
system. At the time he needs to acquire these specific
skills, it is also likely that he will be suffering from
the usual management stresses; a never ending in-tray,
perpetual interruptions and a host of 'instant' decisions
to take. His background in computing may have given him
a willingness to try and master the system but he still
has to find the time and the effort. It was salutary
in the survey and case studies to find a few managers
with a computing background finding it just as difficult
as their colleagues to find the time, effort and will
to master their systems. It appears that the nature of
the role has at least as much influence as the back­
ground of the individual.

It is likely therefore that, whilst a sound background
may be a positive contribution, it is by no means a
a sufficient answer to the development of effective manager-computer interaction.

7.7.2 The Human Interface

Since it is difficult to make direct computer interaction acceptable to managers, an emerging solution is to employ a human interface to operate the system on their behalf. One strategy might be to recognise this as inevitable given the nature of the managerial environment, and to plan all systems for managers, or at least all senior managers, with a human interface as the mode of operation. In theory this could provide managers with the service of a very flexible and powerful resource without the burden of having to learn how to operate the system. It may be that this could be a very effective strategy but a few cautionary notes should be entered. A great deal seems to depend upon the skills and motives of the human interface. If the role is to be effectively played it is not merely a typist role; it involves the sensitive matching of the manager's task needs and the facilities of the system to produce an output in the time required and which the manager can readily assimilate. If the goal is to simply answer each query as it comes it is likely that the processes in which the interface engages will remain difficult because the manager's conception of the system will not be developing. His formulation of questions to put to the system may remain unrealistic and his ability to assimilate the reply may remain limited. If, however, the role of the interface is perceived as a supporting and educational role in which the aim is to develop the manager's understanding of the potential of the system to aid him and to do this in an evolutionary manner, the process may become progressively easier and more powerful. In this formulation the manager is saved the problem of physically operating the system but has to be helped to understand
the facilities available, the tasks they can be used for, the assumptions that are made, possible facilities that can be added etc. This entails a considerable degree of knowledge on the part of the manager and it would take considerable skill on the part of the interface to develop it progressively without confronting the manager with unacceptable levels of effort at key times. The concept of evolutionary development of knowledge is discussed further below.

It appears then that whilst the human interface might be conceived as a way of saving the manager the burden of operating a complex system, the real questions concern the need to develop understandings of system facilities and assumptions and how they may be related to the manager's task. It is likely that much of this knowledge must reside with the manager if there is to be effective task performance.

7.7.3 A Personalised System

One of the underlying reasons for task mismatches is that systems are designed for multiple purposes and without specific reference to the needs of an individual manager. Alternatively the needs of the individual may be treated normatively; what he ought to need rather than what he thinks he needs. A strategy for avoiding the mismatches that result from these approaches is to develop small scale systems closely tailored to the needs of one person or a small group who work closely together. The advent of mini- and micro-computers has made this an economically feasible proposition and there are signs that many people are taking this option. It can be construed as a way of decentralising; of designing your own local service rather than relying upon a centralised service.

A personalised system can also be a major contributor to
the removal of 'ease of use' issues. One of the problems with big de-personalised systems is that they offer facilities in different terms and unfamiliar ways; a personalised service avoids these problems. A further problem with big systems is that they offer many choices that may be appropriate to other people but not to you. Unfortunately each person has to go through all the decision nodes to select those facilities relevant to him. A personalised system can avoid such unnecessary complications.

One of the methods of achieving a personalised system is to engage in detailed user involvement procedures (e.g. Mumford 1980) with a small group of users in order to help them arrive at a detailed specification of the system they require which can then be programmed. This procedure has worked well for small groups of users but has met more difficulty when the number of users has been large (e.g. Hedberg 1980). This procedure functions best when the target group are functionally separate from other groups and can operate as an independent system.

This conclusion seems to imply that the future will have small personalised systems and large, de-personalised ones where there is a need for people to coordinate or to share common facilities. However, it is possible to arrange a degree of personalisation within big standardised systems by the development of specialised 'front ends' which incorporate special features unique to the user. Newman (1978) has described, for example, a system whereby a ticket issuer may provide the full array of ticket types and destinations by using standard procedures but may also have short-cut software to issue tickets which are frequent requirements on his particular routes.

It is likely, therefore, that the provision of much more
personalised services will avoid many of the task mismatches and ease of use problems we have encountered. However, as described here, personalisation remains a static process, i.e. the user has only one occasion upon which to define his needs and there remains the probability that his tasks will change. As a result task mismatches may re-appear. Similarly the one-step implementation concept underpinning this approach implies that managers will have to provide a good deal of effort at a specific point in time and, given other job demands, this may not always be forthcoming. There are ways of avoiding these obstacles to which we now turn.

7.7.4 Evolutionary Use of a System

One of the ironies of the lessons we have learned about manager-computer interaction is that a complex, flexible service is required because of the variable nature of the task but managers find such services complex to use. They then tend to retreat into a 'partial use' approach and much of the flexibility and potential of the system may be lost. If we accept that busy managers are not going to devote a lot of time at system implementation in order to completely master the system, what can be done to avoid this problem? What managers may be willing to do is to learn by doing i.e. to develop some idea of a specific facility they need to use for a particular purpose. If this is true, it could be that managers may develop a working knowledge of a system by an evolutionary process consisting of building blocks related to their needs of the system.

Could such a process be facilitated or is it a random process dependent upon the nature of the manager's task? A manager is always likely to determine his task needs in the light of known facilities and there is a tendency to establish a 'steady state' of knowledge. It is here that a human interface may be the key, not as-system operator, but as someone with sufficient insight into
the manager's task and state of systems knowledge to recommend something which will slightly broaden his experience and continue the developmental process.

Is there anything that can be done within the system software to facilitate this process? As we have noted there are many ways in which facilities may be offered to users; some are easy to use but are relatively predetermined whilst others offer the user great scope for specifying his requirements but are more difficult to use. Perhaps a system could be constructed which is 'computer driven' initially but can become progressively 'user driven'. Palme (1981) has suggested a system which has 8 levels of interaction through which the user can progress, each successive level offering him a more powerful medium for expressing his requirements. For example, in level A the computer leads and controls the interaction by virtue of menus and question/answer routines. In levels D and E the user gains access to a variety of system commands which he can use to specify his needs and at higher levels he is able to combine commands into macros. In this way the user gradually assumes greater control over the system.

This approach has very great promise in circumstances where users will only learn by doing but, from the findings of this research, it will have to guard against the ever present danger that the manager becomes satisfied with what he knows and simply finds ways of exploiting this knowledge. It is unlikely to be sufficient to provide the progression within the system; it is also likely to be necessary to provide a human facilitator or support agent who can encourage progression to the next level.

7.7.5 Evolution of the System.

All of the above strategies assume that the system as implemented remains static. Inasmuch as
it is a very flexible resource and users have the ability to tailor its services to their specific needs, this may be adequate in the short term. However, it would constitute an attempt to serve an adaptive capability by a non-adaptive capability and ultimately this must prove inadequate. If tasks change and managers learn, inevitably the service required will change and at times the system will not be able to meet the need or will only be able to do so by contorted and inefficient means. In addition, the technical capabilities of computer equipment will continue to evolve, and there may be pressure to change on a technical front.

Another strategy therefore would be to treat the system not as the subject of a 'one-slot implementation' but as the provision of a facility that can evolve and grow in accordance with the needs of the user population. It is beyond the scope of this thesis to discuss the technical problems of introducing this concept but they are being debated by computer scientists (e.g. Edmonds (1974, 1980) and the approach is becoming more accepted. It is within the scope of this thesis to discuss the necessary relationships that must exist between a user and a system if the requirements for evolution are to be identified and implemented. It must be possible for the user to be able to specify a change and for it to be introduced in a timescale in which the facility will still be useful. Edmonds (1980) notes four ways in which this might be accomplished:

(a) **Programmer.** The conventional method is to refer the request to a programmer who prepares special purpose software. It is interesting to note that many groups of scientists now employ technician programmers for just such developmental purposes and it may be that groups of managers will seek
similar services. The shortage of trained programmers may preclude this becoming a universal solution.

(b) Trained Users. There are certain advantages in taking some users and training them to occupy supportive roles for their colleagues in which they operate higher order software (but not at a programming level) to modify and elaborate the services to end users. Their knowledge of the task environment should give them a sensitivity to the needs of their colleagues and, if they can be provided with easy-to-use facilities at the higher end of Palme's levels, they may be able to provide new facilities very quickly.

(c) End Users. Once a user has begun to evolve his own knowledge of the system it is possible he would progress to being able to modify the operational procedures he himself uses.

(d) Self-Adapting Systems. A more advanced concept (to be discussed more fully below) is the notion that the system itself may be equipped with sensors to recognise the new need and with self-adapting software so that the new facility can be automatically provided.

Currently systems evolve by method (a) and it is often a difficult method because the initial system architecture did not make allowance for further system development. In the future, this provision will need top priority in system construction and the method of modification may make increasing use of methods (b), (c) and (d).

One element of system evolution relates to the question of user involvement in systems design. A major problem
in participative design schemes is that it is difficult for end users to specify their needs in a vacuum and to appreciate what kinds of service they might be given. The decreasing costs of computing make it more possible to quickly introduce trial systems with limited facilities which are essentially learning systems for users and designers to be replaced when they have served the purpose of showing what can be provided and what is needed. The process of user and system evolution thus begins at the beginning of what has been considered the design phase. The author and his colleagues have been advocating and practising this strategy in action research projects for some years (Eason and Sell 1981).

7.7.6 Adaptive Systems.
The obvious solution to the problem of obtaining an adaptive system from an amalgam of an adaptive capability and a non-adaptive capability is to make the non-adaptive capability adaptive. Unfortunately this is proving to be a very difficult feat to accomplish. The problems of designing computer systems which are sensitive to changes in their environment and adaptable in the ways in which they accomplish tasks in their environment have made progress in research on artificial intelligence very slow. There has been some success in robotics and we do have systems with some capability for recognising physical world objects and responding to them appropriately. However, this is a very long way from recognising the diversity of inputs which may signal the need for an adaptive response in a managerial task environment and it will be a very long time before we can consider systems capable of adaptation in such unstructured settings.

If it is accepted that the manager is the principal source of task adaptation it might be possible to make
progress with a lesser target; that of making the system adaptive to its user. Here it is not a case of the system trying to understand task demands directly but rather of trying to learn about and respond adaptively to its user. We may usefully make an analogy with human communication. When a person engages in a sequence of conversations with another person, he establishes a progressively more detailed model of the other person; what interests him, what opinions he holds, the way he speaks, what knowledge they share in common, etc. This model guides the nature of the conversation and makes it easier for each person to converse. At present computer systems often retain no more knowledge about their users than their password. However, many systems retain detailed logs of user behaviour; what facilities are used, what errors are made, what use is made of help facilities etc. Usually very little use is made of this log. It might be possible for each system to hold a memory of each user which contains an updated record of facilities used and not used, characteristic errors, preferred forms of output, levels of software interface etc. The system could be given the facility to modify its response to the user in accordance with this model. Accordingly as an example a person who has never used a specific facility might be given a full explanation of it whereas a regular user may receive only a terse message.

This particular strategy is perhaps a more long term concept than the others and it requires considerable research before it could be employed but it could represent an important additional feature of offering a personalised service.

Another development which is also a form of adaptive system is the 'expert' or 'smart' system. In a major
change of direction artificial intelligence research has turned away from general-purpose adaptive problem solvers towards systems which offer advice in specific domains about which they have an expert knowledge base. The best known systems are in medical diagnosis, for example, MYCIN (Shortliffe 1976). These systems can be fed with a patient's symptoms and will respond with diagnosis, advice on drugs etc. Other systems give 'Consultant' advice on such topics as machine assembly. Boden (1980) provides a review of systems of this kind. These systems are being built to solve problems in their own right but are used as specialist advice givers and, in order to be effective, it has been found that they have to be able to explain and justify their advice. MYCIN, for example, logs the route by which it arrives at advice and can provide outputs so that the user can follow the logic and can therefore evaluate the model within the system. These systems have not been used within a management environment but, inasmuch as they make it possible for the user to understand how they operate, they may have a valuable role to play.

7.8 Individual Manager-Computer Interaction and Organisational Effectiveness

The strategies outlined above reveal that the flexibility of computer technology can be used in many ways to improve manager-computer interaction. The strategies can be used singly or in combination and they seek to ameliorate different elements of the problems we have discussed. Underlying them all are some assumptions about the direction which developments need to take which should be made explicit. These assumptions are that, faced with variable or open tasks it is imperative that man (in the shape of the manager) plays the dominant role and is supported in his efforts to try to find the best adaptive response. This assumption carries with it the consequences that the system must adapt to the manager's view of the task,
must meet his expectations of the time and effort he has available etc. The general direction in which this thinking goes is towards smaller scale systems more tightly linked to the needs and task conceptions of small groups of managers and evolving as their work and their conceptions of their work evolve. One logical progression may be a scenario in which the computer aid is a kind of external manifestation of an individual's 'mental model' of his work; rather like a personal filing system it may make sense to the individual but to no one else.

How does this direction fit the direction taken by applications of the computer for organisational control and coordination? At first sight it appears to be a recipe not just for organisational decentralisation but for organisational anarchy. Every organisation is faced with the problem of coordinating its disparate activities in order to fulfill its primary goals and information systems are one of the vehicles by which this is done. Could it be that the organisational goal and the individual goal will prove to be quite incompatible? This is a large question deserved of more extensive treatment than can be given here. The report of the 'Computer Information Systems and Management' project (which includes the material from chapter 6) will provide a detailed examination of the issue (Andersen and Eason 1981). The following represents a summary of key points.

The first point to make is that tension between objectives at the individual and the organisational level is nothing new; the centralisation-decentralisation issue is as old as organisational theory and this is simply a further impetus to local autonomy. It probably means that the likelihood of the developments discussed in the previous section coming to fruition will not be based solely upon the efficacy of these ideas but will depend upon prevailing attitudes in the centralisation-decentralisation debate. For example, a potent organisational force at present is the scientific management philosophy particularly in its modern guises of organisational
rationality and management cybernetics. As was outlined in chapter 2 these forces involve normative views of task behaviour and frequently underpin the design of management information systems. The concept of personalised systems may in fact meet most resistance from quarters in which designers are pursuing these normative traditions. Andersen and Eason (1980), for example, see this drive towards rationality as a major obstacle to the creation of flexible, evolutionary and personalised systems. It is worthy of note that in the U.S.A. this debate has a mirror image in the disaffection with concepts like total, integrated management information systems and their replacement by decision support systems (Bennett 1976, 1977; McCosh and Scott Morton 1978) which are user-oriented systems designed to support the unstructured tasks of small groups of managers.

The second general point is that to perceive the issue as a clash between two extreme approaches is to oversimplify. It is an oversimplification to believe that to be effective an organisation must coordinate, rationalise and standardise all of its parts. One of the important lessons from organisational theory in recent years is that organisational effectiveness is strongly linked to the degree and form of coordination that exists in those parts of the organisation which are functionally interdependent (cf. Thompson 1967). Where an organisational unit can act unilaterally in response to environmental demands without repercussions for other units, close coordination is not necessary. Conversely where there are tight interdependencies close coordination is necessary. Therefore the scope of a system should not be a matter of ideology but a matter of organisational analysis for functional interdependencies.

Another variable to be considered is the extent to which tasks are unstructured. Leaving aside questions of job satisfaction, the main reason for managers to preserve local autonomy and to have systems that mirror their individuality,
is that unstructured tasks need their ability to be adaptive. Structured tasks are more predictable, hence the reliance on local adaptability is weaker and a more standardised system may be effective. However, to make use of this variable in systems design we have to be able to measure it and current methods of assessing the degree of task structure are fairly crude (for a discussion of this issue see Harker and Eason 1979).

Finally, the nature of the system must be considered as a relevant variable. The main danger of a standardised system is that it will evoke a task mismatch and curtail how the manager responds to his task. We have, however, suggested that some types of system carry tight task implications whilst others do not. We could thus envisage designing small scale, personalised systems with task implications matching those of the user group (e.g. evaluation models) alongside company wide systems which carry fewer task implications (e.g. electronic communication systems). In fact a pattern such as this is emerging. We can also envisage a more complex system structure which has standardised 'data highways' flowing around the company to which are coupled a host of localised, personalised systems unique to specific users. This would be the equivalent of a company filing system linked in some way to an array of personal filing systems.

In summary, following this argument, the question of system decentralisation or centralisation becomes a question of 'contingency theory' (Lawrence and Lorsch 1969) in which the appropriate form of system is dependent upon an assessment of the variables listed above.

7.9 Conclusions

This research programme has extended over a period of eight years. It was a period in which manager-computer interaction in practice underwent considerable change. It was also
a period when the authors thinking on the subject underwent rapid change. Both types of change are represented in this thesis. This chapter has attempted to summarise both the status quo in practice and my interpretation of it. It has also attempted to look forward to the way manager-computer interaction may develop in the future.

The conceptual formulation I have advanced is by no means a finished product. It is a very long way from an elegantly formulated theory whose predictions have been tested and support found. Hopefully it is a framework which adds to our understanding of why the managerial environment has been such a difficult one in which to get acceptance for computer aid. The nature of managerial tasks appear to make them an ideal target for information processing aids. However, as we have seen, the unstructured nature of the task makes it difficult to pre-design structured aids that can give worthwhile support. The image of the manager that has emerged is of an adaptive agency tracking a variable task in a difficult, episodic and stressful environment. He finds computer aid, at the same time, a potentially useful ally and an infuriating tool which constrains or channels the way the task may be undertaken. The more complex, interactive tools which have even greater potential cause problems because of the effort and time they demand of their user. One of the recurrent themes of this research is the 'least effort' principle upon which users operate when employing computer tools and which may be a critical feature of managerial behaviour because of the nature of the managerial role and workload. We have also been able to document managerial responses to the problems they experience including task responses (changes to accommodate system characteristics) and system responses (misuse, disuse, partial use and distant use).

It remains to be seen whether these problems can be overcome to the degree necessary to realise the full potential of computer aid in the managerial environment. The flexibility
of this technology means there are many avenues still to be explored as we have discussed in section 7.7. It is not, however, an area in which technologists can sit back and wait for the human population to adjust to and accept the new technology. It is an area in which, if this is allowed to happen, the most likely strategy for future manager-computer interaction is distant use and there must be doubts about whether this is a method by which the computer's full potential can be harnessed. For these reasons it is an exciting and rewarding field for human factors specialists because they are dealing with crucial issues upon which system acceptability will depend.

It is conventional to end with a statement of research questions that remain unanswered and a summary of the practical implications of the research conducted. In the sections that follow I have drawn attention to the main issues emerging in these two directions.

7.9.1 Research Questions

The following are the questions which need pursuing in no particular order of importance:

(a) How can the extent of task modification by computer aid (or 'computer tunnel vision') be assessed?

(b) How, more generally, can we assess the changes that result in task performance and in the task conceptions of the user when a computer aid is employed?

(c) Can we make formal assessments of the degree to which system acceptance-nonacceptance strategies are adopted, e.g. distant use, partial use, disuse, misuse etc., and the conditions which determine the degree and type of strategy adopted?
(d) What are the positive and negative consequences of adopting a distant use strategy for systems to aid managers?

(e) What factors determine the 'least effort' response and can the tendency towards partial use be mitigated by reducing the productive effort necessary to search new facilities?

(f) Can we assess the degree of structure in a task and can we assess the degree and type of task implications in different kinds of systems?

(g) Are the goals of effective manager-computer interaction congruent with the goals of computer-based information systems for organisations?

(h) Do manager and system 'models' have to be compatible or is it sufficient for the systems model to be transparent?

7.9.2 Practical Implications

No attempt has been made to document the practical implications of this research in a way that would provide guidelines for systems designers. The comments below are areas of systems design which need greater attention if manager-computer interaction is to be improved.

(a) **Task Analysis.** There is a need for greater attention to be paid to the specific needs of managers in order to avoid subsequent task mismatches. Paradoxically it is not what can be specified in advance which is important but what cannot be specified because this implies lack of structure and delineates the flexibility and evolutionary potential that will be needed in the system.
(b) Support, Feedback and Developmental Mechanisms. To be accepted and to continue to be accepted in the managerial environment, it is not sufficient for computer systems to provide a task-centred information service. In addition the system must embody mechanisms which help and support the user as he tries to understand how the system can help him, which enable him to indicate when the service is inadequate and which encourage the user to develop his own competence in using the system. Some of these mechanisms may be computer-based but many will become the roles of crucial human 'gate-keepers' facilitating the use of the system.

(c) Testing of New Methods of Providing a Service. Of the strategies listed earlier in this chapter which may become the basis for future manager-computer interaction, some will obviously remain research topics for some time to come. Others, however, have already reached the stage where they may be tried and tested in major applications. We have, already, for example, been involved in the evolutionary development of several systems and the ideas behind the evolutionary use of a system by users need similar testing. In addition the concepts of distant manager-computer interaction and of personalised systems are at a stage where they are being applied in applications and they should be thoroughly evaluated.

7.10 Automation or Man-Computer Interaction?

As a final footnote I would like to return to a question that seemed relevant at the outset but which became progressively less relevant. Will we witness in the future a growth in the numbers of automatic factories with automatic managers and a consequent decline in the numbers of human managers? I have been impressed throughout this research by the flexibility
and potential of computer technology but I have been forcibly reminded that in the messy, uncertain, changeable world in which we live, man is an essential ingredient in any system purporting to deal with the real world. The one abiding conclusion I reach from this research is that the route to effective use of computer technology remains and will remain reliant upon effective man-computer interaction.
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APPENDIX 1 : QUESTIONNAIRE FOR MANAGER INTERVIEWS

The following is an abridged version of the questionnaire which shows the main questions and some of the follow-up questions used in the survey of managers reported in chapter 2.

Key
TF = Task Fit  
EU = Ease of Use  
SM = Support Measure  
IC = Indirect Consequences.

Section A: Job, person and system characteristics

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer (semi structured or open-ended)</th>
<th>Follow Up</th>
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</thead>
<tbody>
<tr>
<td>Name</td>
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<tr>
<td>Position</td>
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<td>Organisation</td>
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<td>System</td>
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<tr>
<td>Job Description</td>
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<tr>
<td>Job Classification</td>
<td>Code</td>
<td>manager 1,2 or 3</td>
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<tr>
<td>Purpose of Use</td>
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<tr>
<td>Facilities, information used etc.</td>
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<tr>
<td>Time devoted by user</td>
<td>% of job</td>
<td></td>
</tr>
<tr>
<td>Time devoted to other systems</td>
<td>% of job</td>
<td></td>
</tr>
<tr>
<td>Other systems used</td>
<td>purpose, mode, medium</td>
<td></td>
</tr>
<tr>
<td>How long have you used the system?</td>
<td>Mode of interaction</td>
<td>Medium of interaction</td>
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<td></td>
<td>Data Input Only (DIO)</td>
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<td>Data Input and Predefined Outputs (DIPO)</td>
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<td>Predefined Outputs Only (PO)</td>
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<td>Predefined Outputs as Requested (POR)</td>
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<td></td>
<td>Instructions for Data Processing (IDP)</td>
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<td></td>
<td>High Level Language Programming (HLLP)</td>
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<tr>
<td>Experience of specific system</td>
<td>General experience</td>
<td>Appreciation course</td>
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### Section B: Assessment of System

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Follow Up</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can you rely on the information you receive from the computer to be sufficiently accurate to be useful?</td>
<td>No</td>
<td>Why not?</td>
<td>TF</td>
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<td></td>
<td>Yes</td>
<td>Can you check it?</td>
<td></td>
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<td></td>
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<td>Are there errors?</td>
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<td>Where are the errors</td>
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<td></td>
<td></td>
<td>- original source?</td>
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<td>- data preparation?</td>
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<td></td>
<td>- machine/system?</td>
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<tr>
<td>Is there any information provided by the computer you could do without?</td>
<td>No</td>
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<td>TF</td>
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<td></td>
<td>Yes</td>
<td>What information?</td>
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<td>?</td>
<td>Does it help</td>
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<td>- to explain related data?</td>
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<td>- to provide context?</td>
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<td>or hinder</td>
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<td>- by making it harder to find what you want?</td>
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<tr>
<td>Is there any other relevant information that should be provided by the computer?</td>
<td>No</td>
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<td>TF</td>
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<td></td>
<td>Yes</td>
<td>What information?</td>
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<tr>
<td>Is it easy to read the output in the form you receive it?</td>
<td>No</td>
<td>Is there - blurred print?</td>
<td>EU</td>
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<td>- wrong size characters?</td>
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<td>- poor spacing?</td>
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<td>- flicker on VDU screen?</td>
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<td>- glare from VDU screen?</td>
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<td></td>
<td>Yes</td>
<td>Do you have difficulty in</td>
<td>EU,TF</td>
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<td>- identifying critical information?</td>
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<td>- recognising groupings?</td>
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<td>- understanding codes?</td>
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<td>- cross referencing?</td>
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<tr>
<td>Do you have to work on the computer output before you can use it?</td>
<td>No</td>
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<td></td>
<td>Yes</td>
<td>Do you have to</td>
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<td>- separate sheets of output?</td>
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<td>- re-arrange data?</td>
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<td>- analyse in greater depth?</td>
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<td>- reclassify category headings?</td>
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<td>- check contents?</td>
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<tr>
<td>Question</td>
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<td>Yes</td>
<td>TF</td>
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<td>Is this information out of date by the time you receive it?</td>
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<td>No</td>
<td>Is it still useful?</td>
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<td>Is there a more up-to-date source for the same information?</td>
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<td>What is it?</td>
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<td>Yes</td>
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<td>When using the terminal, do you have problems?</td>
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<td></td>
<td>No</td>
<td>With:-STORAGE - Manuals, computer documents, etc.</td>
<td>EU</td>
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<td>Personal belongings</td>
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<td>Other (specify)</td>
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<td>Yes</td>
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<td>CLUTTER - Trailing wires, scrap paper, other (specify)</td>
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<td>SEATING</td>
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<td>OVERCROWDING OF TERMINALS</td>
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<td>NOISE</td>
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<td></td>
<td>ANYTHING ELSE?</td>
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<td>Have you experienced any difficulty in operating the terminal itself?</td>
<td>No</td>
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<td>EU</td>
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<td>What?</td>
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<td>Yes</td>
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<td>Is the computer response time</td>
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<td>Too long?</td>
<td>EU</td>
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<td></td>
<td>Just right?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not long enough?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (specify)?</td>
<td></td>
</tr>
<tr>
<td>Have you experienced any difficulty in understanding the operating</td>
<td>No</td>
<td></td>
<td>EU</td>
</tr>
<tr>
<td>procedures?</td>
<td></td>
<td>What?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>How well does the system &quot;fit&quot; the task you use it for?</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Very good fit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good fit</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Average fit</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Poor fit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very poor fit</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Follow Up</td>
<td>Index</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Overall, how useful do you find the computer system?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much effort is involved in using the service?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How satisfactory is the amount of effort involved in using the system?</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Section C: User Support Facilities</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Have you ever experienced a breakdown in the computer system?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>If this did happen would it be difficult for you? (C1.2)</td>
<td>TF</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Was it difficult for you?</td>
<td></td>
</tr>
<tr>
<td>When a breakdown occurs can you get help easily?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>Why not?</td>
<td>SM</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>From whom? Supervisors, Colleagues, Subordinates, Computer personnel, etc.</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>No</td>
<td>Yes</td>
<td>Why not?</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>----</td>
<td>-----</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>In general can you get help easily if you have any difficulty?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would you like to know more about the computer system?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there any problems in finding out more about the system?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were you asked to assist in the development of the computer system?</td>
<td>No</td>
<td>Yes</td>
<td>Did this bother you?</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td>How?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Programming</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Overall system analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analysis of own job</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Choosing the service</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Choosing accessories</td>
</tr>
</tbody>
</table>

**From whom?**
- Supervisors
- Colleagues
- Subordinates
- Computer personnel
- Manuals, etc.

**What sort of help do they provide?**
- Computer appreciation
- Overall performance of system
- How it works
- Future plans

**Will it help you to do your job? How?**
- Not enough time
- No accessible experts
- "not done"
- Too much jargon
Would you like to assist in future development of the system? No
Yes
?

How? Programming
Overall system analysis
Analysis of own job
Choosing the service
Choosing accessories
Will you have the opportunity?

Section D: Impact of System on the Job

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Follow Up</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has using this computer system helped you to develop any new ideas, skills, methods, etc.?</td>
<td>No</td>
<td>What are they?</td>
<td>IC</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Since using this computer system, has your work become more routine?</td>
<td>No</td>
<td>Less routine?</td>
<td>IC</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Is this good, bad or makes no difference?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent are the procedures by which you work determined by the computer?</td>
<td></td>
<td>Completely</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A lot</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A little</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not at all</td>
<td></td>
</tr>
<tr>
<td>Since using this computer system, has the scope of your job changed?</td>
<td>No</td>
<td>Increased or decreased?</td>
<td>IC</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Is this good, bad or makes no difference?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has using the computer system changed the extent to which you need to communicate with people to do your work?</td>
<td>No</td>
<td>Increased or decreased?</td>
<td>IC</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>IC</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Do you feel the opportunities you have to talk to people at work are?</td>
<td>Insufficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satisfactory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Too Much</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the advent of the computer system changed your prospects of promotion?</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are they better, worse or no different?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the computer system affect your level of job satisfaction?</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased or decreased?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Could the computer system be usefully extended to assist you in your job?</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In what ways?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Given the choice, would you prefer to work without the computer system?</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Why?</td>
<td></td>
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</tr>
</tbody>
</table>
APPENDIX 2 : QUESTIONNAIRE ON INQUIRY CODE USAGE IN A BANK

On-Line Inquiry System Questionnaire

We are at present carrying out some research into the use which is made of the On-Line Inquiry System. In order that we may establish how the facilities available fit into the overall supply of information which is available within the branch we should be grateful if you would complete the attached questionnaire.

Section A of the questionnaire is designed to establish how well the facilities available on the On-Line System are known.

Section B presents examples of queries that arise in a branch for which information is required. We are interested in the action you would take in the circumstances outlined. In some cases a terminal inquiry may be appropriate and in others an alternative source of information may be better. Please select the course of action which you consider best, and detail the alternative sources which would also have given the information required, together with the reason for your choice.

For the purposes of this survey it should be assumed that the information required will be available on Inquiry i.e. Inquiries of the Microfilm Inquiry Bureau would not be necessary.

PLEASE DO NOT REFER TO BOOK C OR ANY OTHER DOCUMENTS WHEN COMPLETING THIS QUESTIONNAIRE.

WE WOULD STRESS THAT THIS QUESTIONNAIRE IS NOT A TEST OF YOUR KNOWLEDGE BUT AN EXERCISE TO ENABLE US TO DETERMINE HOW THE ON-LINE INQUIRY SYSTEM IS USED. FOR THIS REASON WHEN ANSWERING THE QUESTIONS PLEASE INDICATE WHAT YOU WOULD DO EVEN IF THIS IS DIFFERENT TO WHAT YOU KNOW SHOULD BE DONE.
SECTION A - USE OF INQUIRY CODES

1. Branch __________________________ 2. Position _______ Grade ________

3. Length of experience of On-Line System ________________

4. Positions during this time
   __________________________
   __________________________
   __________________________

5. When you need information from the On-Line System and are unsure how to obtain it what do you do? (Please tick where appropriate)

   (a) Ask someone
   (b) Refer to Book C
   (c) Refer to Inquiry Code Card
   (d) Try a likely Code

<table>
<thead>
<tr>
<th>Often</th>
<th>Occasionally</th>
<th>Infrequently</th>
</tr>
</thead>
</table>

6. If you ask someone for help who is it likely to be? (Please give the job position, e.g. A.B.A.)

7. If you refer to Book C or the Inquiry Code Card is information readily understandable? Book C Inquiry Code Card Yes/No Yes/No

8. How did you learn about the use of the Inquiry Codes? (Please tick where appropriate).
   Course
   Installation Staff
   In Branch Training
   Reading Instructions
   Trial and Error
9. Please list the Inquiry Codes you use regularly or have used regularly in the past. (Code Nos. and short names, or short names if Code No. is not known).

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name</th>
</tr>
</thead>
</table>

10. Please list the Inquiry Codes you have used very occasionally (Code Nos. and short names, or short name if Code No. is not known).

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name</th>
</tr>
</thead>
</table>

11. Please list any Codes you have not personally used but which you know are available.

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name</th>
</tr>
</thead>
</table>
SECTION B: The following questions are to be answered with respect to the six tasks listed on the next page.

1. What source of information would you use?

2. Could the information required be obtained from another source? (If your answer is Yes please give details).
   Yes/No

3. If the answer to Question 2 is Yes please explain why the answer to Question 1 is preferred.

4. If you were not sure what to do, how would you resolve your difficulty? (Please tick where appropriate).
   Ask someone [ ] Refer to Book C [ ]
   Refer to Inquiry Card [ ] Try a likely Code [ ]

5. How often have you experienced this task or one similar?
   Daily [ ] Weekly [ ] Monthly [ ] Infrequently [ ]
Task A: Customer asks if a cheque for £33.15 has been paid. The cheque was drawn on the 10th February but the cheque number is not known.

Task B: A customer's auditor requests the balance of his client's account as at the 31st January. The branch have authority to disclose the relevant information.

Task C: A customer asks for details of the charges he paid in December 1975.

Task D: On the 27th February customer asks if his salary credit has been received. This is normally credited to his account on the 22nd of each month. The exact amount is not known.

Task E: A customer has drawn a cheque No. 123456 but has not made a record of the amount. The cheque was issued on the 12th February and he asks if it has been paid and how much it was for.

Task F: Customer advises the branch that a cheque book containing blank cheques Nos. 654321 - 654337 was lost on the 27th February. He asks if any have been presented for payment and for stops to be placed on all of the cheques.

Task G: An account appears 'Out of Order' on the daily printout apparently due to entries in yesterday's work, investigations must be made and recommendations passed to Branch Management.

Task H: A customer has an unexpected interview with the Branch Manager with a view to loan facilities. Provide the Manager with appropriate information about the working of the account.
APPENDIX 3: QUESTIONNAIRES FOR THE INTERNATIONAL STUDY OF MANAGERS

The full list of measures used in this study is given in Eason, Stewart and Damodaran (1977). Two of the measures provided the data presented in Chapter 6 and these are the measures summarised below.

Task Fit

Manager's 'Before and After' Comparison (Repeated for Task A and Task B)

1. Up-to-date
2. Immediately Available
3. Precise
4. Reliable
5. Comprehensive
6. Relevant
7. Valid
8. Secure
9. Safe

Scale
+2 Major improvement
+1 Small improvement
0 No Difference
-1 Small deterioration
-2 Major deterioration

Computer Impact on Task and Evaluation of the Impact

Task:

(Repeated for Task A and Task B)

1. DEGREE OF COMPLEXITY IN THE TASK
   (Complexity refers to the number of different alternatives, consequences and elements you have to take into account before making the decision or carry out the task).

2. NUMBER OF PROBLEMS YOU RECOGNISE WITHIN THE TASK
   (Including problems discovered or pinpointed because of feedback from the computer, or because of mistakes made by the computer system or mistakes made by the people working with the computer).
3. **WORK PACE IN THE TASK**  
(Pressure to make decision or do the task faster)

4. **VARIATIONS IN WORK PACE IN THE TASK**  
(Fluctuations, because for example no work can start until output is available and then it has to be finished very quickly).

5. **WORK LOAD WITHIN THE TASK**  
(Work load might, for example, be increased because working with the computer output has been added without any other work being removed or reduced).

6. **DEGREE OF ROUTINE OF THE TASK**  
(Routine refers to the methods by which the task is carried out. Is there a routine for doing the task? The computer system might have meant that some new or more detailed work procedures have been designed for your task).

7. **STANDARDISATION OF CODES OR TERMINOLOGY IN THE TASK**  
(Whether for example in your task you have to use new or different codes or terminology in order to meet the requirements of the computer system).

8. **POSSIBILITY OF DEVELOPING NEW IDEAS OR METHODS**  
(Whether for example the computer system has introduced new restrictions or new possibilities).

9. **FEEDBACK ON DECISIONS**  
(Whether for example the computer system is giving more detailed or more timely feedback on the results of your decisions).

For each of these variables the respondent was asked to specify:

(a) whether there had been a change as a result of computer use

Scale:  
+2. increase  
+1. increase  
0. no change  
-1. some decrease  
-2. major decrease

(b) his satisfaction if there had been a change

Scale:  
+2. major improvement  
+1. some improvement  
0. makes no difference  
-1. some deterioration  
-2. major deterioration