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IMPLEMENTING STRATEGIC DECISIONS

The implementation of capital investment projects in the U.K. manufacturing industry

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ABSTRACT

Keywords: CAPITAL INVESTMENT; CAPITAL PROJECTS; MANUFACTURING INDUSTRY; BUSINESS POLICY; ORGANISATIONAL CHANGE; CYBERNETICS; STRATEGY.

This thesis reports an exploratory, quantitative study into the implementation of strategic decisions. Implementation was viewed as a discontinuous organisational activity involving strategic change. The organisational vehicle of change is seen as "the project" and the specific unit of analysis adopted is the capital investment project. Manufacturing organisations were studied because these were shown to most frequently undertake such projects.

Adopting a theoretical perspective derived from systems theory and cybernetics a model of implementation was developed which recognises two dimensions of implementation success (modes of organisational change) to be contingent upon a dimension of project uncertainty and two dimensions of information. From this model ten hypotheses were developed.

Data on 45 projects was collected from a diversity of manufacturing companies. This was obtained using a structured questionnaire instrument administered to a single informant during a retrospective personal interview. Initially the data was analysed using principal components factor analysis to determine the factorial compositions and reliabilities of scales measuring theoretical constructs. Subsequently, causal modelling and stepwise regression techniques were employed to test the hypotheses.

Analysis demonstrated that the essentially structural approach to implementation taken in the study adequately explained many of the observed associations between constructs. Hypothesised associations between organisational structure and implementation success could not, generally, be supported. Finally, the theoretical model adopted was not able to account for a number of empirically observed associations. These associations were explicable in terms of a behavioural or social dimension. The wider implications of the study are also discussed.

PREFACE

Completion of a project of this nature requires more than just the efforts of the author. I would therefore like to thank all who offered aid and encouragement in the completion of this thesis.

In particular, a special thank you is owed to my supervisors Mr. Stuart Sanderson and Professor John Sharp. Their insightful criticism and creative suggestions were of more assistance than they probably realise. Recognition is also extended to those members of the staff of the University of Bradford Management Centre who gave willingly of their time and assistance. Of course nothing could have been accomplished without the time and interest afforded by those senior executives who participated in the study. A final thank you is also owed to the Economic and Social Research Council for providing the funding necessary to undertake this research.

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CHAPTER 1

INTRODUCTION

1.1 SUBJECT RATIONALE

This thesis reports an original, exploratory, quantitative study into the implementation of strategic decisions. A number of authors writing during the mid 1980's commented on the dearth of research on this subject. Bonoma (1984) noted that "the literature is silent" on the problems of implementation. Hrebiniak and Joyce (1984,p.2) note, "problems of strategy implementation have received less attention than have those of strategy formulation". Alexander (1985) comments that "little has been written or researched on it". Bernard Taylor, writing a decade earlier in the preface to Mumford and Pettigrew (1975,p.xi) makes a similar comment about the "vital but neglected area of implementation". Finally, if we introduce the concept that implementation involves "change" to an organisation (e.g. Nutt, 1986; Pettigrew, 1990) we note that the literature on the effects of technological change on organisations is not well developed either (Tushman and Nelson, 1990). Issues pertinent to the study of technological change are subsumed within the approach to implementation used in this study, hence Tushman and Nelson's observation supports those of Taylor, Bonoma, Hrebiniak and Joyce, and Alexander. For a decade and a half therefore, it has been recognised that the implementation phenomenon has been a neglected area of study.

No doubt as a consequence of such recognition, interest in the implementation question has increased in recent years (Porter, 1987; Wheelen and Hunger, 1987,p.209; Reed and Buckley, 1988). This is distinct from an earlier emphasis on the decision-making, strategy formulation or strategic planning processes (Hrebiniak and Joyce, 1984,p.2; Alexander, 1985). A logical reason for the historical lack of interest in implementation is furnished by Stonich (1982,p.xv) who comments "The philosophy was that if the formulation effort was sound, implementation would follow automatically". Ansoff (1984,p.387) in a similar vein, notes three assumptions underpinning the prescriptions developed for strategic planning. The second of these was the assumption that "the key problem in strategy was to make the right decisions". Ansoff continues by noting that the "accumulated experience of the past twenty years has progressively cast serious doubts on all three assumptions". These doubts by the early and mid 1980's were prompting a number of authors to comment in the vein of Glueck and Jauch (1984) that "A good strategy without effective implementation is not likely to succeed", hence good implementation was critical to effective performance (see also Paul *et. al.*, 1978; Hitt and Ireland, 1985; Alexander, 1985; De Geus, 1988). Ultimately, Bonoma (1984) in a formulation now adopted by management teachers (Wheelen and Hunger, 1987) explicitly contrasts a dimension of appropriate/inappropriate strategy with a dimension of excellent/poor implementation. From this he concludes that poor implementation can disguise good strategy, and conversely that excellent implementation can rescue an inappropriate strategy. This conclusion gives the subject of implementation at least equal importance with that of strategy formulation.

Finally it has been noted by several of the above authors that, in practice, implementation is frequently poor. Alexander (1985) comments that, "significant difficulties are often encountered during implementation". Bonoma (1984) and Hrebiniak and Joyce (1984,p.2) talk about the problems of implementation and De Geus (1988) notes that in a crisis "implementation is rarely good". It would appear from these comments that implementation needs to be improved.

The above discussion has noted, firstly, that little has been written in the literature about implementation. Secondly, that implementation is an important and relevant subject and thirdly, that understanding how to improve implementation efforts would be of practical benefit. Taken together this suggests that expanding the existing body of knowledge of the implementation phenomenon is a valid topic for research.

1.2 RESEARCH APPROACH

In the Business Policy/Strategic Management literature (the grounded discipline for this study) there is a careless use of the terms "strategy" and "strategic decision" when used in connection with implementation. This is illustrated by Ansoff (1984,p.387):

> "strategy formulation and strategy implementation... could start after the strategic decisions were made."

or Alexander (1985):

> "after a comprehensive strategy or single strategic decision has been formulated, significant difficulties are often encountered during the subsequent implementation process."

Both passages imply that implementing a strategy is synonymous with implementing a strategic decision. Are they synonymous? The approach taken in this study is that they are not. At risk of preempting chapter 2, the broad justification for this follows.

A popular definition of the word "strategy" (Andrews, 1980; Mintzberg and Waters, 1985; Quinn, 1978) is to view strategy as a pattern in a stream of decisions. This definition does not single out strategic decisions and must incorporate operational decisions also. Drawing on sources such as Simon (1960), Hickson *et. al.* (1986) the essential characteristics of operational decisions are that they are routine, frequent and repetitive, whereas strategic decisions are novel, infrequent and unstructured. Noting the definition of strategy given above, we observe that strategy is being simultaneously defined in both continuous and discontinuous terms. Whilst some authors may be happy with such a conundrum, this author is not. Therefore, in terms of the problem of strategy implementation, it will be helpful to restrict the study to investigating either the continuous aspects of strategy implementation or the discontinuous aspects.

The distinction between implementation being a continuous or a discontinuous phenomenon is not explicitly stated (to the author's knowledge) by writers and researchers in this field. If one focuses on the continuous aspects of strategy implementation one is drawn to investigate an essentially operational phenomenon. Such a perspective is adopted by academics and practising managers. For example, a manager in a U.K. owned financial services group was heard by the author to state "Implementing strategy is the process of managing the business." Academics such as Wheelen and Hunger (1987) Glueck and Jauch (1984) Stonich (1982) view implementation as synonymous with the routine processes of operational planning and or budgeting. They emphasise resource allocation, planning, control and information systems and the role of structure and culture in achieving action as the outcome of implementation. Such a perspective frequently views implementation as a process intermediate between planning and control processes. This model is widely found in the literature of not only Business Policy (e.g., Steiner, 1979; Luffman *et. al.*, 1987; Wheelen and Hunger, 1987) but also Accountancy (e.g. Neale and Holmes, 1988) Management Science (e.g. Higgins, 1980) Marketing (e.g. Weitz and Wensley, 1984) and no doubt other literatures. However, in the author's opinion, such a model more correctly describes strategy maintenance, which is viewed as one component of strategy implementation.

The other component of strategy implementation is strategic change. This comes from taking a discontinuous view of strategy by restricting one's perspective to the implementation of strategic decisions. The plan, implement and control model is found to be unsuitable in this situation. So, just as strategy making may be dichotomised into continuous strategic planning and discontinuous strategy formulation processes (Stonich, 1982) so we believe strategy implementation should be properly dichotomised into continuous strategy maintenance and discontinuous strategic change processes. This thesis investigates the strategic change process only, a process referred to as programming.

Although this thesis is grounded in the Business Policy literature, perspectives and ideas have been drawn from several other disciplines. Research by organisational theorists into strategic decision making has been heavily drawn on and made a major contribution to this study. Studies into the problems of implementing Management Science/ Operational Research projects have been underway since the early 1970's and this literature too has been extensively used. Several other literature bases have also contributed, to a greater or lesser extent, to the study. However, probably the greatest contribution comes from the Systems Theory and Cybernetics literature. These two related disciplines and most notably the work of Ross Ashby (1956) provide the grounded theory for this study.

1.3 THESIS OUTLINE

Chapter 2 of this thesis investigates the meaning of strategy and strategic decision. This investigation leads to a model of organisational planning which highlights the differences between the two alternative approaches to the implementation question noted above. This model is used to develop the view that implementation is "programming" and ultimately leads to the decision to focus the study on strategic change. In chapter 3 the idea that change is the product of implementing a strategic decision is elaborated. This perspective, together with ideas drawn from systems theory and Cybernetics, is developed into a taxonomy of strategic decision types. Finally, this taxonomy in turn leads to the identification and definition of a taxonomy of project types.

Chapter 4 develops the ideas of chapter 3 further in order to determine the principle dimensions of the implementation phenomenon. This leads to a particular view of organisational learning and identifies this concept as providing a basis for measuring the success of implementing a strategic decision. Finally, the theoretical developments within the chapter are used to arrive at ten testable hypotheses. In chapter 5 concepts identified in chapter 4 are operationalised and a research instrument is designed. Methodological issues regarding the administration of the research instrument are discussed.

Chapter 6 describes the data collection phase of the research and outlines a number of the sample's statistical characteristics. The construct validity of the research instrument is investigated, primarily through the use of Principal Components Factor analysis. Finally a number of scales for the theoretical constructs are developed. In chapter 7 the system of theoretical hypotheses is investigated using causal modelling techniques. In the main the theoretical hypotheses are proven. A number of anomalous findings are also identified and investigated to arrive at a final model of the relationships between the theoretical constructs. Chapter 8 draws on anecdotal evidence, theoretical and methodological arguments to account for the anomalous relationships identified in chapter 7. A number of other topics are discussed relating to the study's validity and questions of wider concern. Finally in chapter 9, the major conclusions of the research are summarised. In addition, further research is suggested which takes into account the limitations of the study and also how perspectives and models developed during the study could be used as a basis for additional future research.

1.4 SCOPE, LIMITATIONS AND CONTRIBUTION

The foregoing discussion has established that this thesis is only concerned with the implementation of strategic decisions. The hypotheses developed in chapter 4 of this thesis, the theory on which they are based and other perspectives used and developed up to this point are entirely general and are therefore not restricted to a particular subset of such decisions. However, validity considerations (discussed in chapter 5) indicate that the operationalisation of the theoretical concepts should be focused on investigating the implementation of capital investment decisions in U.K. manufacturing companies. No other restrictions on organisational size or manufacturing industry sector were applied. The use of personal interviews as the principal data collection technique imposed restrictions on the size and geographical distribution of the sample studied. Attempts were made to disperse the sample geographically and to include a representative selection of industry sectors within it. The sample size was large enough for the appropriate use of the analytical techniques employed.

In terms of Clark's (Bennett, 1986) taxonomy of approaches to research the contribution of this study is seen by the author as being of the "Basic objective research" type. Bennett (1986) summarises this as:

> "Here, the research is concerned with tackling a general problem of the application of knowledge which can arise in many contexts but does not aim to solve a particular practical problem...the level of generality is still high [relative to pure basic research] and the people receiving the feedback about the research are professionally trained and/or academic."

Reviewing the Business Policy literature on strategy and strategic decision implementation, one rapidly realises that the majority of it is descriptive or normative. Where prescriptive or contingency theory approaches are adopted then the literature tends to focus solely on human and behavioural aspects of the phenomenon. In particular, the literature is dominated by studies of the social behaviour stimulated by change and the tactics to be adopted to counter such behaviour (see for example Hutt, 1986; Ansoff, 1984). There appear to be relatively few studies which have taken a wider approach to the subject. Because of this relative lack of prior research this study adopts an exploratory approach, seeking to contribute to an understanding of the structure and contingent dimensions of the implementation phenomenon. In keeping with this philosophy the principal research questions addressed are of a very general nature. They may be summarised as, what is implementation? What are the principal contingent dimensions of the phenomenon? What happens to an organisation when a strategic decision is implemented? What is implementation success? The answer obtained to this final question is potentially of considerable importance as it relates to the strategic advantage(s) both explicit and more especially implicit, stemming from the implementation. This is particularly important in Business Policy, when in Strategic Management guise, it relates to the central question of "why some firms develop and thrive while others stagnate and go bankrupt" (Wheelen and Hunger, 1987). Although the study is of the basic objective research type, a number of its findings and conclusions are of direct benefit to practising managers. These are explicitly stated in the final chapter of the thesis and suggest a number of items that managers need to be sensitive to when evaluating capital investment proposals and systems that need to be installed if strategic decisions are to be successfully implemented.

CHAPTER 2

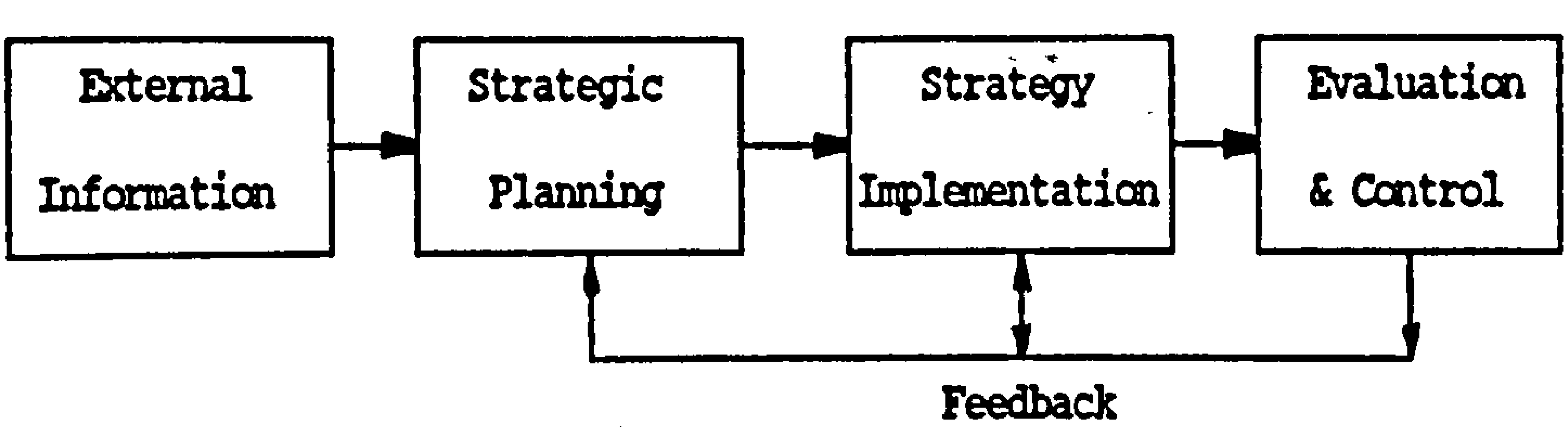
IMPLEMENTATION

The aim of this chapter is to achieve an operational definition of the word "implementation". Initially we view implementation as a managerial process. This leads to a consideration of planning processes, which in turn ultimately identifies two contending views of the implementation question. In choosing one of these views the implementation of strategy question is narrowed to a question of the implementation of strategic decisions.

2.1 A MANAGERIAL DICHOTOMY

When one encounters the term "implementation" in the Business Policy literature, it is frequently viewed as an activity positioned between "strategy formulation" and "control" (Wheelen and Hunger, 1987) "strategy formulation" and "monitoring" (Luffman *et. al.* 1987) "choice" and "evaluation" (Glueck and Jauch, 1984) or "short-range planning" and "evaluation" (Steiner, 1979). Similar models can also be found in the Accountancy (e.g., Neale and Holmes, 1988) Management Science (e.g., Higgins, 1980) and Marketing (e.g., Weitz and Wensley, 1984) literatures. The general form of all these models is summarised in figure 2.1 below. The figure is primarily based on Wheelen and Hunger (1987) - with some minor changes in nomenclature.

Figure 2.1: A Model of Strategic Management



This "Plan, Implement, Control" model implies that implementation is an activity (i.e., process) intermediate between, but logically separate from, the planning and control activities. If this is the case, then strategy implementation will be definable through a detailed review of the planning and control processes. The questions to be asked are therefore, "In what way do planning and control differ?" and "Does this difference correspond to implementation?". We now address these questions.

2.1.1 THE MANAGERIAL PROCESS

The model illustrated in figure 2.1 above is a model of the managerial process. It is one description of what managers do. The early views of management were set forth in the 1900s by Fayol who suggested five basic managerial functions: planning, organising, coordinating, commanding and controlling and in the 1930's by Gulick using the acronym "POSDCORP" standing for planning, organising, staffing, directing, coordinating, reporting and budgeting (Mintzberg, 1973). Steiner (1979) took the view that "planning cannot be usefully distinguished from the rest of the management process...". Mintzberg (1973) identified three broad categories of role fulfilled by managers; the Interpersonal role, the Informational role and the Decisional role. (Although Mintzberg's study was biased towards top managers, he felt that the results were applicable to all managers.) Simon (1960) viewed "decision making" as synonymous with "managing". This decisional perspective is implicitly recognised by Luffman *et. al.* (1987) by the description of their equivalent model to figure 2.1 above, as a model of the strategic decision making process. Anthony (1965) also associates planning, control and decision making by noting that planning (roughly, deciding what to do) and control (roughly, assuring that desired results are obtained) are used to facilitate decision making. However, Anthony (1965,p.10) makes the following observation:

> "a classification into (1) planning and (2) control [functions]...is *not* a useful breakdown. The trouble essentially is that, although planning and control are definable abstractions and are easily understood as calling for different types of *mental* activity, they do not relate to separable major categories of activities actually carried on in an organisation, either at different times, or by different people, or for different situations." (Original emphasis retained.)

In other words, while planning and control are separate mental activities carried out in support of managerial decision making (which, to adopt Simon's view, is synonymous with the managerial process) they do not exist as two separate definable activities. Anthony noted that this is contrary to the ideas of Fayol. This observation is particularly troublesome to our goal of identifying an objective definition of implementation as an organisational process. It in fact implies that no *actual* separation between planning and control exists. Therefore, what "space" exists to accommodate implementation? There are two possible explanations for this conclusion. Either implementation is inseparable from a managerial planning/control process, or the model in figure 2.1 above is fundamentally flawed. If we adopt the first explanation then we are dealing with a nonexistent phenomenon. This is unlikely given the literature cited in chapter 1. The second explanation appears to be most probable and implies a need for a new model of the managerial process. We will attempt to develop such a model in the following sections.

2.1.2 TOWARDS A CONCEPTUAL FRAMEWORK

Discussed above was a model of the managerial process which included planning, control and decision making. These items were shown to be intimately interconnected and mutually dependent upon each other. Indeed, as all of these descriptions are perspectives on the same phenomenon then we would expect them be complementary. However, while we are able to identify these items as global attributes of the managerial process, they do not indicate how many types of managerial process exist.

The literature supports the view that there are two types of management (Steiner, 1979) or managerial "regimes" (Ansoff, 1984). Chandler (1962) noted that the Pennsylvania Railroad (circa 1880-1910) was one of the first American businesses to distinguish between the broad long-term entrepreneurial activities of the vice-president and the day-to-day operational responsibilities of the general manager. Steiner (1979) identifies two types of management. That which is done at the top being strategic, everything else being operational management. This view is shared by Ansoff (1984) who identifies the concerns of strategic management as setting objectives and goals for the organisation. The end product of which is a "potential for future fulfilment". Operations management, on the other hand, is concerned with converting this potential into actual profit. These ideas correspond closely to Drucker's (1974) ideas of effectiveness and efficiency. Effectiveness, Drucker states, stems from the manager taking an optimising approach to his job of administration and focusing on new opportunities to produce revenue. Efficiency is doing better what is already being done; it is a minimum condition for survival. In other words, we can say that strategic management is effectiveness seeking, whereas operations management is efficiency seeking. Emery (1969) likewise identified two forms of planning echoing many of the attributes identified above. One type he describes as high-level, which he equates with strategic planning. This was broad in scope, used aggregated variables and was concerned with an extended planning horizon. The other form was described as low-level and was concerned with limited activities, used detailed disaggregated data and had a relatively short horizon. These attributes equate low-level planning with operational planning.

Looking at characteristics of managerial decision making we again identify a simple dichotomy of types. Chandler (1962) notes two types of administrative decision, the strategic and tactical. Strategic decisions are long-term and look towards the provision of future resources. Tactical decisions ensure the efficient use of current resources. Simon (1960) noted two polar types of organisational decision. These he labelled programmed and non-programmed decisions. Non-programmed decisions are seen by Simon as novel, unstructured and consequential. They are made using judgment, intuition and creativity. Programmed decisions, by contrast, are routine and repetitive. They are handled by internalised habits and formal written standard operating procedures. It is interesting to compare the attributes assigned by Simon for programmed and non-programmed decisions with the model of decision style, or strategy, devised by Thompson and Tuden (1979). Focusing solely on the decisional dimension of beliefs about causation (dichotomised as Agreement/Disagreement) then the decision styles adopted along this dimension are judgmental or inspirational for disagreement (uncertain cause) and computational or compromise for agreement (certain causes). Simon's programmed decisions are therefore made using the decision strategies, computation and compromise. Mintzberg *et. al.* (1976) associate the decisional attributes of novelty, consequentiality and complexity with strategic (important) decisions. Hickson *et. al.* (1986) also identify attributes of novelty and consequentiality with "top level" or strategic decisions. These descriptions associate non-programmed decisions with strategic decisions and the strategic managerial process. We therefore equate programmed decisions with the operational process.

Finally, we will look at the information required to make strategic or operational decisions. Emery (1969) describes strategic information as being broad in scope and aggregated. Operational information is limited and detailed. Lucas (1976) used Anthony's (1965) planning and control framework to characterise the information required for managerial decisions. As Anthony's framework identifies three planning/control types (c.f., our two) Lucas also identified three sets of informational characteristic. However, two of Lucas's sets of characteristics were virtually identical and we may combine these with no meaningful loss of information. The so modified informational characteristics identified by Lucas then closely parallel those of Emery.

The above discussion has attempted to demonstrate the utility of characterising managerial processes as being of two types, the strategic and the operational. Attributes of these two types have been identified for planning, decision making and their associated information requirements. However, a question remains as to whether these define two distinct categories, or identify two poles of a single dimension. During the above discussion it was noted that strategic decisions are not wholly different from all others but are towards one end of a continuum, every day questions being at the other (Hickson *et. al.*, 1986). Simon (1960) views programmed and non-programmed decisions similarly. Likewise, many of the planning and informational attributes identified above do not identify distinct categories, but represent polar opposites. We conclude therefore, that strategic and operational managerial processes define extremes of a single continuum. We will call this continuum the Managerial Dimension. Many of the characteristics defining the strategic and operational poles of this dimension are summarised in table 2.1.

Table 2.1: The Managerial Dimension

Attributes		
Management Regime[1,7]	Strategic	Operational
MANAGERIAL		
Management Style[2]	Entrepreneurial	Administrative
Management Group[7]	Top Managers	All other managers
Managerial Focus[3]	Broad	Limited
Managerial Purpose[3]	Seeks effectiveness	Seeks efficiency
Managerial Aim[1]	Profit potential	Actual profit
Time horizon[2]	Long-term	Day-to-day
DECISION MAKING		
Decision Type[6]	Non-Programmed	Programmed
Decision attributes[6]	Novel	Routine
	Un-Structured	Repetitive
	Consequential	
Decision Styles[8]	Judgmental	Computational
	Inspirational	Compromise
INFORMATION[5]		
Source	External environment	Internal records
Accuracy[4]	Unimportant	Vital
Detail	Summaries	High
Frequency	Periodic	Frequent
Time horizon[4]	Long	Medium/Short
Use	Predictive	Control/Action

(Refs. 1: Ansoff, 1984; 2: Chandler, 1962; 3: Drucker, 1974)
(4: Emery, 1969; 5: Lucas, 1976; 6: Simon, 1960)
(7: Steiner, 1979; 8: Thompson and Tuden 1979;)

Our goal is to arrive at a workable (objective) description of implementation as a managerial process. The description typified by the model illustrated in figure 2.1 above was shown to be unsatisfactory. As a first step in arriving at an alternative description we have identified a key dimension, labelled the Managerial dimension. This dimension was shown to have strategic and operational poles. As this dimension characterises the managerial process, we would also expect it to characterise the planning and control processes within an organisation. Planning and control should therefore exist in two dichotomous forms, which we may label as strategic planning and operational planning. We will now look in more detail at the meaning of "planning" and in the first instance, "strategic planning".

2.2 PLANNING MODELS

2.2.1 STRATEGIC PLANNING

Several authors have used the words "strategic planning" to mean a particular type, or style, of high-level planning. Steiner (1979) saw strategic planning and long-range planning as synonymous, the difference being a change in nomenclature between the 1960s and late 1970s. Ansoff (1984,p.15) however, while acknowledging many similarities between strategic and long-range planning, drew a clear distinction between them:

> "In long-range planning the future is expected to be predictable through extrapolation of the historical growth...In Strategic planning the future is not necessarily expected to be an improvement over the past - nor is it assumed to be extrapolative."

Valid though these distinctions are, they are not the concern of this discussion. Our use of the term "strategic planning" simply means planning carried out at the strategic end of the managerial dimension. As such it is concerned with the long-term future of the organisation and is primarily the responsibility of top management. This definition encompasses Ansoff's interpretation of both long-range planning and strategic planning.

Steiner and Cannon (1966,p.11-12) used the term "strategic planning" more in the sense we intend to use it. The characteristics that Steiner and Cannon attributed to this form of planning are presented in table 2.2, below.

Table 2.2: Strategic Planning

1. Conducted at the highest level of management.
2. Concerned with the development of fundamental objectives and goals and the development of resources.
3. Concerned with both long- and short-range decision making.
4. Deals with parts of the whole enterprise. Only in a few selected areas does it involve much detail.
5. Continuous process, irregular subject matter.
6. It requires large amounts of information derived from, and relating to, disciplines outside the corporation.

The key words for our purposes in the above definition are given in characteristic number 2; namely "objectives" and "goals". We have previously noted that Ansoff (1984) uses similar terms to describe the activities of strategic management. Formen (1982,p.19) sees the essence of planning as "The transformation of corporate goals and objectives into polices...". Finally, Anthony (1965) used the same three key words (objective, goal, policy) to define strategic planning.

2.2.1.1 Objectives and Goals

Andrews (1971) refers to words such as, objective, goal, policy, as "accordion-like", i.e., their definitions appear to expand and contract depending on which author is using them at the time. In the absence of universally accepted definitions of these terms, authors have considerable, but not infinite, licence to define them as they see fit and for the ends they are to serve. The spirit of this study is not to identify every definition in the literature but to select those definitions which best suit the needs of the conceptual framework.

How are we to define these three key words to achieve a conceptual model for planning? Drucker (1974) does not shed much light on this problem when he states "...objectives are 'strategy'". Reviewing the literature on the meaning of such words as 'policy' and 'strategy', Higgins (1980) identified several definitions in the literature. These definitions frequently use the words objective, goal and policy in a form similar to those used above to define strategic planning. From this one may conclude that titles like "strategy", "corporate strategy", "strategic planning" and "strategy formulation" are largely synonyms. Andrews (1971) identified 'a policy' as a guide to action serving an objective. He also states that objectives can be all-encompassing or specific and that in descending hierarchical order objectives can be policies for reaching higher goals. This contains two ideas that will help in our definitions. Firstly, we are dealing with a hierarchy of terms. Secondly, policies are essentially questions that ask - how?

Wilson (1980) adopted the view that policy was essentially a macro level concept. Bonoma (1984) noted that there are many policies within an organisation. These he broadly categorised as identity policies (theme and culture) and directional policies (strategy and leadership). This identifies a strategy as a directional policy. As planning is concerned with the direction of the organisation we will, in the spirit of Andrews, state that "strategy" is a guide to action serving an "objective". This definition is similar to that of Ansoff's (1984) "...a strategy is a set of decision making rules for guidance of organisational behaviour".

Having arrived at a definition for "policy" and "strategy", what about "objective" and "goal"? Ackoff (1970) took the view that objectives are "states or outcomes of behaviour that are desired" whereas "goals are objectives whose attainment is desired by a specific time". This view is similar to that of Bower "An objective is typically enduring and time-less" whereas goals are "achievement targets shorter in time range or narrower in scope than the objectives, but designed as specific sub-objectives in making operational plans" (Steiner, 1979,p.6). These authors suggest that the prime difference between these two terms is that objectives are relatively permanent, whereas goals are transitory. Bower makes the additional distinction that goals are achievement targets serving a particular operational plan. We can now look in detail at the meaning of objective.

Ansoff (1984) sees the distinction between objectives and goals differently to that adopted here. However, he indicates that objectives provide a yardstick by which the present and future performance of a firm may be measured. This view is supported by Wetherbe and Montanari (1981) "objectives must be reasonable, measurable (desired level and range) and have a time horizon specified". Drucker (1974) similarly suggests that objectives must make possible the concentration of resources and effort and provide the "standards against which performance is to be measured". These ideas indicate that objectives must be quantifiable and that they provide a basis for control and resource allocation. Hofer (1976) views an objective as having four components; an attribute, an index, a target and a time frame. An objective on this basis could be stated as:

To sustain growth (attribute) of $ sales (index) at ≥10% per year (target) in the short term (time frame).

While accepting the above as a valuable contribution to the current debate, we will take exception to the inclusion of a time frame within the definition of an objective. As noted above, objectives are to be seen as relatively time-less. An objective therefore, does not require a time frame. We may also note that the attribute associated with an objective (growth, in the above example) is relatively superfluous as it is implied by the target. The attribute therefore only serves as a categorical device, in the above example to demonstrate that the objective is derived from a growth strategy. Hence, the essence of an objective is that it specifies a target value for a particular variable. To use the terminology of control theory, an objective specifies a "set point". Thus we define an archetypal objective as being of the following form:

To [strategic aim] of [variable] at [target value].

Adapting the above example to this form we may rewrite it as,

To [sustain growth] of [$ sales] at [≥10% p.a.]

Drucker (1974) suggests that objectives should be set in the eight key areas of; marketing, innovation, human organisation, financial resources, physical resources, productivity, social responsibility and profit requirements. He also suggest that objectives must be derived from the "purpose" and "mission" of a company, these terms are defined by asking the question, "What is our business and what should it be?". (In a business enterprise, economic performance is the rational and purpose.) Ansoff (1984) however, suggests that a firm will pursue no more than four or five objectives (e.g. growth, solvency, market share). As noted earlier, we are dealing here with hierarchical terms. We may therefore choose to refer to Ansoff's four or five objectives as 'prime objectives' and Drucker's as 'sub-objectives'. The objective at the top of the hierarchy is the organisation's 'purpose'. As noted above, strategies provide the guidance for formulating objectives. Here, we say they connect the prime- to the sub-objectives. The organisation's purpose is, using Drucker's ideas, linked to the prime-objectives via the mission statements.

The above classification of terms has defined two parallel hierarchies. One hierarchy covers mission and strategy and refers to the rules or policies that state *how* an aim is to be achieved. Purpose, prime- and sub-objectives refer to *what* is to be achieved, i.e., they identify targets for the organisation. At the top of each hierarchy items are effectively permanent. At the bottom are items which will probably change from time to time. In addition, the two hierarchies are highly interdependent, each adding meaning to the other. It is tempting to continue these two parallel hierarchies of terms to include goals as sub-sub-objectives, perhaps arguing that they are connected to sub-objectives via a sub-strategy, or tactic. This idea is untenable, for it was argued above that goals differ from objectives by the inclusion of a time frame. Although permanence is a feature of hierarchical level, it is not a necessary feature. However, impermanence is a necessary feature of the idea of goal. Goals are not therefore sub-sub-objectives but exist as logically independent entities. In addition, as objectives embody the aim of a plan and goals exist to serve that plan, then goals must be defined only in terms of objectives. Our general definition of a goal is therefore:

To attain [a specific objective] by [a specific time].

2.2.1.2 <u>Critical Success Factors</u>

Having defined, for our purposes, the meaning of objective, goal etc., and identified where each is appropriate, we still have not arrived at a satisfactory description of strategic planning as a process. To do this we must look in greater detail at the variables to which targets are being assigned. Rockart (1979) built on the ideas of Daniel, and later Anthony, Dearden and Vancil to arrive at the concept of "critical success factors". These Rockart defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation". Although Rockart's interest was in identifying executive information needs, the concept is of use here when we note that "critical success factors support the attainment of organisational objectives". (Rockart actually uses the word goal. However, examples of these 'goals' are; earnings per share, market share, new product success, which correspond more closely to our objectives.) As strategic planning was earlier identified as been concerned with the "development of objectives", a concept identified with the "attainment of objectives" must be included in our conceptual model of strategic planning. What is more, we have identified objectives as providing a basis for business control. Rockart (1979) noted that critical success factors are centred on the information needs of management control and identified the attributes of these information needs as:

1. External to the organisation (e.g. information on market structure, future trends.) This data is generally unavailable from the company's financial accounting system and, in the majority of cases, unavailable from the company's usual day-to-day transaction-processing systems.

2. Data are from multiple data sets. This requires coordinating pieces of information from, organisationally, widely dispersed parts of the company.

3. Data may be based on subjective assessments.

Referring to the classification of informational characteristics in table 2.1, we see that the frequent reliance of critical success factors on external sources of data, and the inadequacy of the routine data from within the organisation, place these factors at the strategic end of the strategic/operational dimension.

Some examples of critical success factors cited by Rockart and their associated "prime measures" are listed in table 2.3.

Table 2.3: Some Critical Success Factors

Critical Success Factor	Prime Measure
Image in financial markets.	Price/earnings ratio.
Technological reputation with customer.	Orders/bid ratio. Customer "perception" interview.
Market success.	Change in market share. Growth rates of company markets.

Rockart suggests that any one organisation will have typically five to eight critical success factors. He identifies four sources for these:

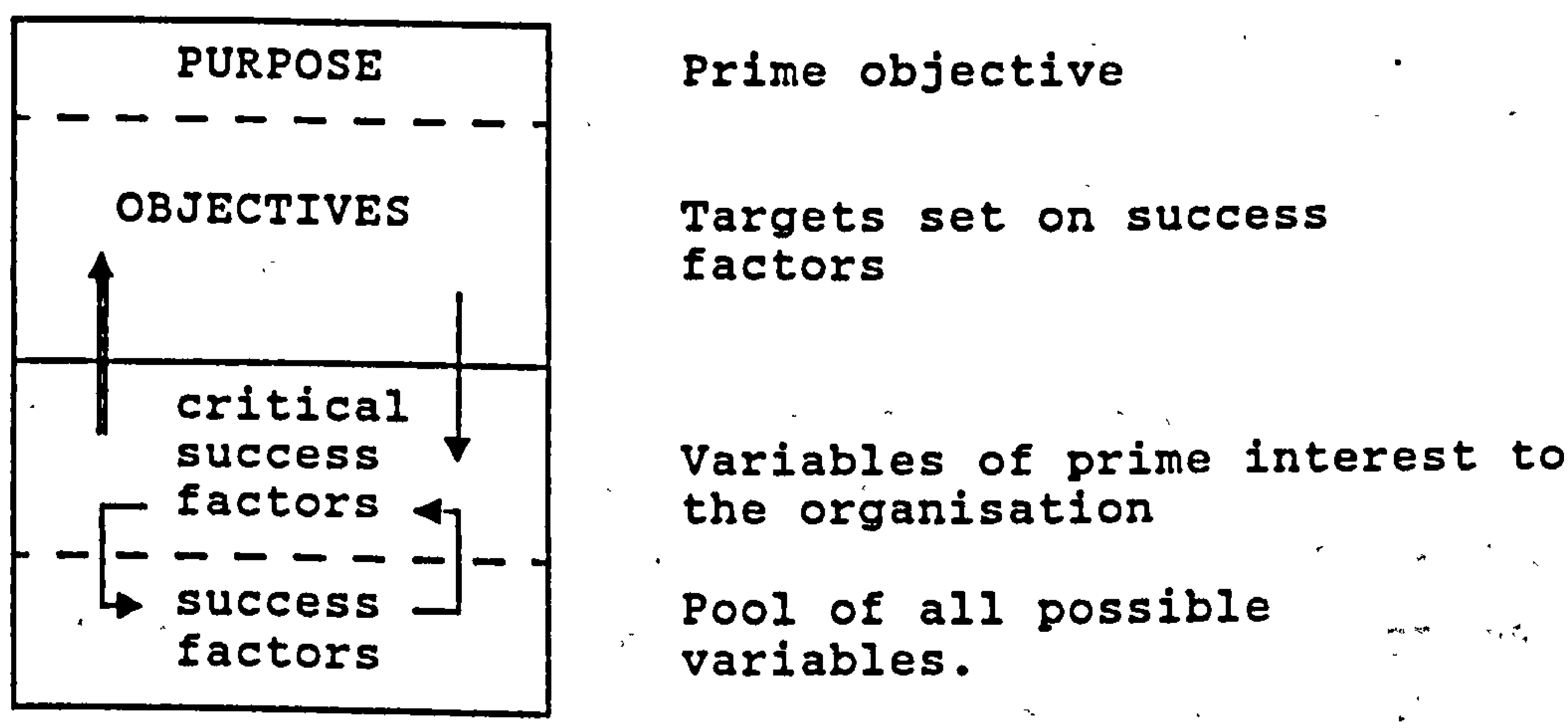
1. Structure of the particular industry.
2. Competitive strategy, industry position, and geographical location.
3. Environmental factors.
4. Temporal factors.

The critical success factors relating to the type of industry will be relatively stable over time. However, those relating to strategy, environment and temporal factors could be highly transitory. We see therefore, that critical success factors sit at the head of a hierarchy of "success factors". This is, however, a very fluid hierarchy, with an interchange occurring between the top and bottom levels, reflecting changes in the organisation's environment, or anticipated future changes. Both Steiner (1979) and Ansoff (1984) make reference to entities which they call "key success factors". Ansoff defines these as "the small number of variables which are critical to success", and cites examples as; response to market, product innovation, portfolio balance etc. Both Ansoff's definition and examples are sufficiently similar to Rockart's concept, for us to consider key and critical success factors to be one and the same.

2.2.1.3 A Model of Strategic Planning

The above discussion has identified two related items which we may use to define the substance of strategic planning. The first of these items is a hierarchy of variables or "success factors" a smaller subset of which will be critical at any one time. The other, a hierarchy of target values or "objectives" to be ascribed to the success factors. These two ideas enable us to arrive at the model of steady-state strategic planning illustrated here as figure 2.2.

Figure 2.2: Strategic Planning



The process of strategic planning, as we perceive it here, can be viewed as consisting of three stages:

1. The identification of those success factors which are, or are likely to become, critical.
2. Comparing actual values of success factors against target values (objectives).

and 3. Establishing target values (objectives) for the success factors.

The arrows in figure 2.2 represent information flows. The first process above is indicated in figure 2.2 by the arrows connecting the pool of success factors with the pool of critical success factors. This stage will involve forecasting and/or surveillance and probably require external information. The second process, that of strategic control, is illustrated by the double arrow and single arrow connecting variables and targets. This process is essentially a form of variance analysis and will initiate action if the variance is outside acceptable limits. The third process is illustrated by the double arrow connecting variables to targets. The motive for using a double arrow to connect the variable and target levels in the figure, is to highlight the fact that this information flow is involved in both the second and third strategic planning process. It therefore represents a dominant information flow.

Whereas the first and second process may be viewed as continuous, the third process will be intermittent, as it will only be initiated when an objective needs to be added or changed. The idea that strategic planning involves both continuous and intermittent components is recognised implicitly by Steiner and Cannon (1966). They note that strategic planning is a continuous process with irregular subject matter (see item 5 in table 2.2). Stonich (1982) explicitly recognised this point and uses the term strategy formulation to refer to the intermittent activity and strategic planning to refer to the continuous activity. Some authors (e.g., Stein, 1981; Ansoff, 1984) do not make this distinction and see formulation as a continuous process. Here we will find it a useful distinction and so follow Stonich's idea and nomenclature.

Above we defined a goal as that which serves the attainment of an objective. A goal (or goals) must therefore come into existence when an objective is not being met. This situation could occur when either a new objective is specified, or an existing objective is outside its critical range. In either case a success factor has become critical, in Rockart's sense that the factor is (or has become) important to organisational success. To quote Hunsicker (1980) "Changes in key success factors...often create the most important strategic threats and opportunities". Goals are therefore generated by changes in success factors. To illustrate this point we may consider two examples. The first is hypothetical and illustrates an objective becoming critical. Consider the success factor of stock level. Stock control is usually an operational concern, but still necessary for organisational success. If the total stock level moves outside its acceptable range stock control will have become an issue of strategic concern, a success factor will have become critical. Such a situation will initiate some goal orientated activity, the object of which will be to return stock levels to their target value as quickly as possible. Once back under control stock level ceases to be critical, although still a success factor. An example of an instance where an objective is changed also illustrates this point. This example is based on an interview between the author and a director of the company.

A mail order company identifies customer service as a critical success factor. A prime measure of customer service is seen as order delivery time. An objective is set that the order delivery time should not exceed 48 hours. Further investigation shows that to satisfy this objective, with the projected increase in sales volume, increased warehousing/order packaging facilities are required. In other words, warehouse capacity is seen as another, but potentially temporary, critical success factor. The goal to build extra warehouse capacity is therefore established and actioned. Once the warehouse is built (assuming a successful outcome) the goal no longer need exist, warehouse capacity ceases to be critical, although it will remain a success factor. The objective (delivery in 48 hours) will have been achieved and remain in place. Similarly customer service still remains a critical success factor.

This second example illustrates a further point, namely that a single changed objective may generate several goals. In the example quoted above, computing capacity was seen as another critical success factor. The additional goal to install increased computer capacity was therefore also required to attain the objective of delivery within 48 hours. Having determined a model of strategic planning, we now consider its polar opposite, operational planning.

2.2.2 OPERATIONAL PLANNING

Besides strategic planning, Steiner and Cannon (1966,p.12-13) also identified a type of planning which they call Tactical. (Steiner and Cannon noted that Schorr used 'administrative' planning to convey the same idea.) The characteristics that Steiner and Cannon attributed to tactical planning are presented in table 2.4.

Table 2.4: Tactical Planning

1. Done within, and in pursuit of, strategic plans.
2. It is detailed.
3. Covers the whole of an organisational unit (and its sub-units).
4. Done in detail for short periods of time.
5. Large numbers of people usually participate, compared to strategic planning.
6. Relies more on qualitative measures and internally generated data.
7. More routine than strategic planning.

Comparing the characteristics listed in table 2.4, with those in table 2.1 identifies Steiner and Cannon's tactical planning with the operational end of our managerial dimension. We will therefore refer to planning possessing these characteristics as <u>Operational planning</u>.

Unfortunately, Steiner and Cannon's characteristics do not give any real clues as to how we may develop a conceptual framework of operational planning. However, they do note that operational planning is done within and in pursuit of strategic plans. Also, as noted earlier, operational management is primarily concerned with the efficient use of resources, hence operational planning must also deal with resources. Glueck and Jauch (1984,p.315) observe that "resource allocation expressed in the budget needs to be carefully linked to strategy" and "...a budgeting methodology integrated into the planning framework is likely to lead to a higher attainment of the key objectives of an organisation". Newman and Logan (1981) in their discussion of management control state that financial budgets are "the best 'comprehensive' control system". Wetherbe and Montanari (1981), Stonich (1982), and others make similar statements. Hrebiniak and Joyce (1986) describe objectives and budgets as "measures of desired performance", and Anthony (1965) identifies budget preparation as a planning activity and as a basis for control. As budgets are prepared routinely and in detail for short periods of time, typically one year, we may identify a major component of operational planning as budget preparation. In addition and in an analogous way to objectives, we see that budgets are targets that form a basis for operational control. Finally, we should note that budgets, although given in financial terms, in fact govern the allocation of all the company's resources, whether they be technological, personnel or informational.

On what basis are budgets prepared? The literature appears to have two views on this question. These may be labelled the top-down and bottom-up approaches. The above discussion implies the top-down approach as budgets are reflections of the strategic objectives. Wetherbe and Montanari (1981) also take this view by citing Lin's comment that "budget generation should start with the setting of objectives". Traditionally however, budgets are based on the previous level of appropriation. In relatively stable environments historical budget data may accurately reflect the primary focus of the output area. In other environments, an understanding of the rank order of the value of the tasks to be performed by each unit may be a better basis for budget preparation. (This idea is the basis for Zero Base Budgeting (Wetherbe and Montanari, 1981) and Priority Base Budgeting (Sketchley, 1982)). This implies a bottom-up approach to budgeting as the definition of the "prior activities and tasks are appropriate regardless of the budgeting model used, with the major difference being the source of operational information" (Wetherbe and Montanari, 1981). Budgets therefore appear to be determined either by "objectives" or "tasks". However, if we accept the view that strategic managerial processes are concerned with directing an organisation by searching out new opportunities, then prescriptively we would anticipate budgets to be determined by higher level objectives, not lower level tasks. We therefore argue in favour of the top-down approach of Lin and others (e.g., Glueck and Jauch 1984,p.316) as indicating the "correct" information flow in the model being developed here. Steiner (1979,p.215) summarises this approach and the connection between objectives, budgets and tasks in the sentence "budgets are integrating methods to translate strategic plans into current actions".

In the above passage by Steiner (1979) we equated "current actions" with "tasks" and noted that they are determined by budgets. Budgets were also identified with targets as they identify what resources are available to perform operational tasks. A task is also a target as it specifies what actions have to be performed and the logical outcome of a decision making process, e.g., planning, is a commitment to action (Mintzberg *et. al.*, 1976). We therefore, have identified a hierarchy of terms (task and budget) relating to what has to be done by operational management. The question as to how the resources are to be allocated and how the actions are to be performed are, as Simon (1960) noted, determined by habit, or written standard operating procedures. Wheelen and Hunger (1987) saw procedures and standard operating procedures as synonymous. They define procedures as "a system of sequential steps or techniques that describe in detail how to perform a particular task or job". Procedures therefore are the set of rules used to translate budgets into tasks. Finally we may note that different terms within the hierarchy defined here have associated with them differing levels of permanence. Budgets are fixed over relatively long periods of time (a year typically) and the decisions leading to routine actions (tasks) are made on a day-to-day basis. In a manner analogous to the two parallel hierarchies of strategic targets (objectives) and policies (strategies) identified previously, we have two operational hierarchies of targets (budgets) and policies (procedures). The planning terms so far identified may be summarised using these two hierarchies, as in figure 2.3 below.

Figure 2.3: Planning Hierarchies

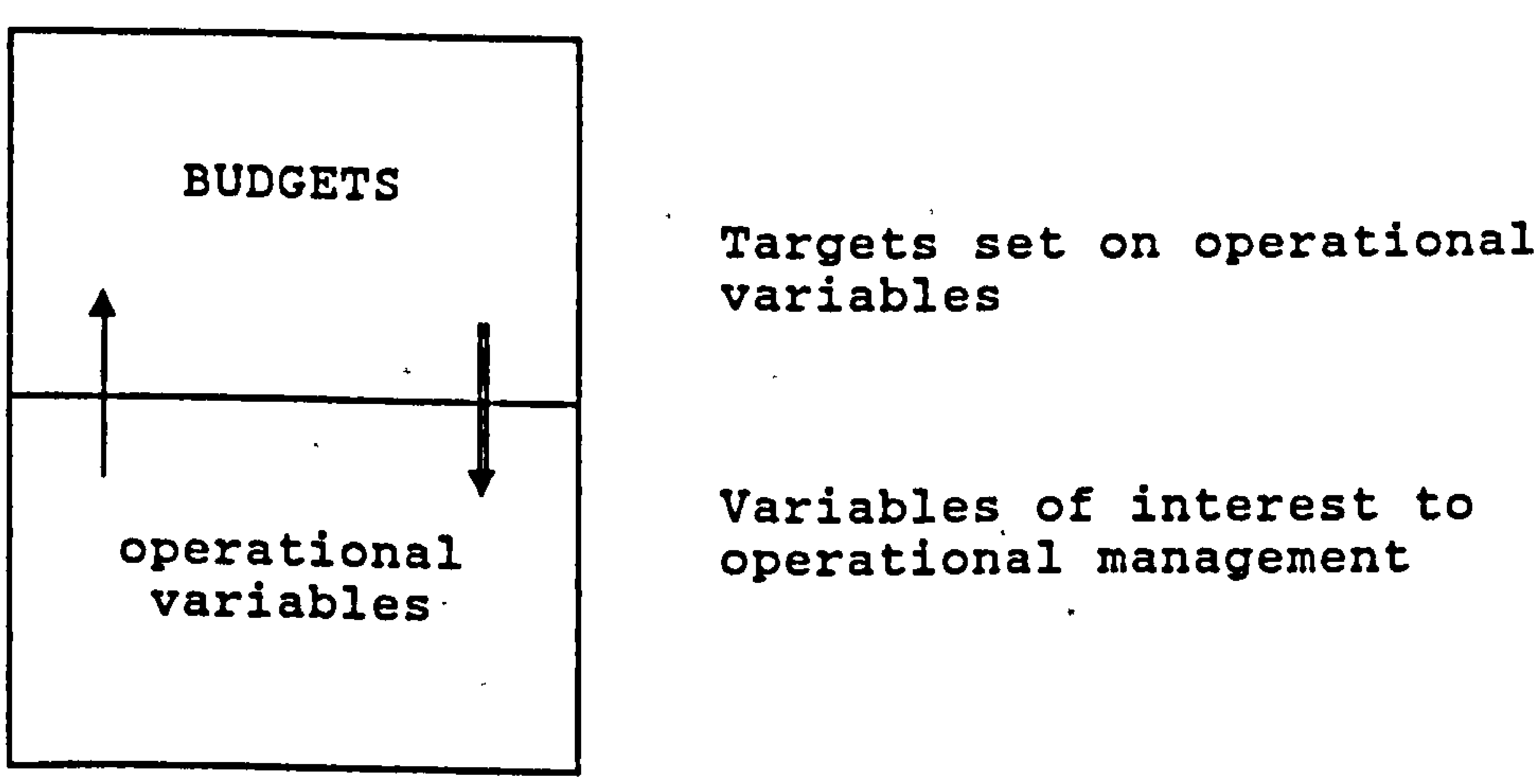
Target (what)		Policy (how)	Permanence of target	
PURPOSE	→	Mission	High	Life of organisation
PRIME-OBJECTIVE	→	Strategy		May change, but infrequently
SUB-OBJECTIVE	→	Tactic		
BUDGET	→	Procedure		A year.
TASK			Low	Day-to-day

It will be observed that goals do not appear in either hierarchy. The reason for this was stated previously. In addition the term "tactic" has been used to identify the point at which the hierarchies change from being predominantly strategic to predominantly operational. The use of this term is arbitrary but has been adopted reflecting its use in the literature as implying something less than a strategy and nearly operational in character. The figure is also prescriptive, as the arrows imply the status of terms relative to each other. In the remainder of this discussion we will focus our attention on the hierarchy of targets, leaving the policy hierarchy implicit.

2.2.2.1 A Model of Operational Planning

We are now able to specify a model of operational planning. Budgets are operational targets and are the operational equivalent of objectives. In place of success factors, which are the variables to which objectives refer, we identify "operational factors" as the variables to which budgets refer. These operational factors will, in some instances, be a sub-set of the strategic success factors. As Rockart (1979) noted, success factors relating to the organisation's internal operations are likely to be summaries and aggregates of many operational measures. Our model of operational planning therefore takes the form illustrated in figure 2.4.

Figure 2.4: Operational Planning

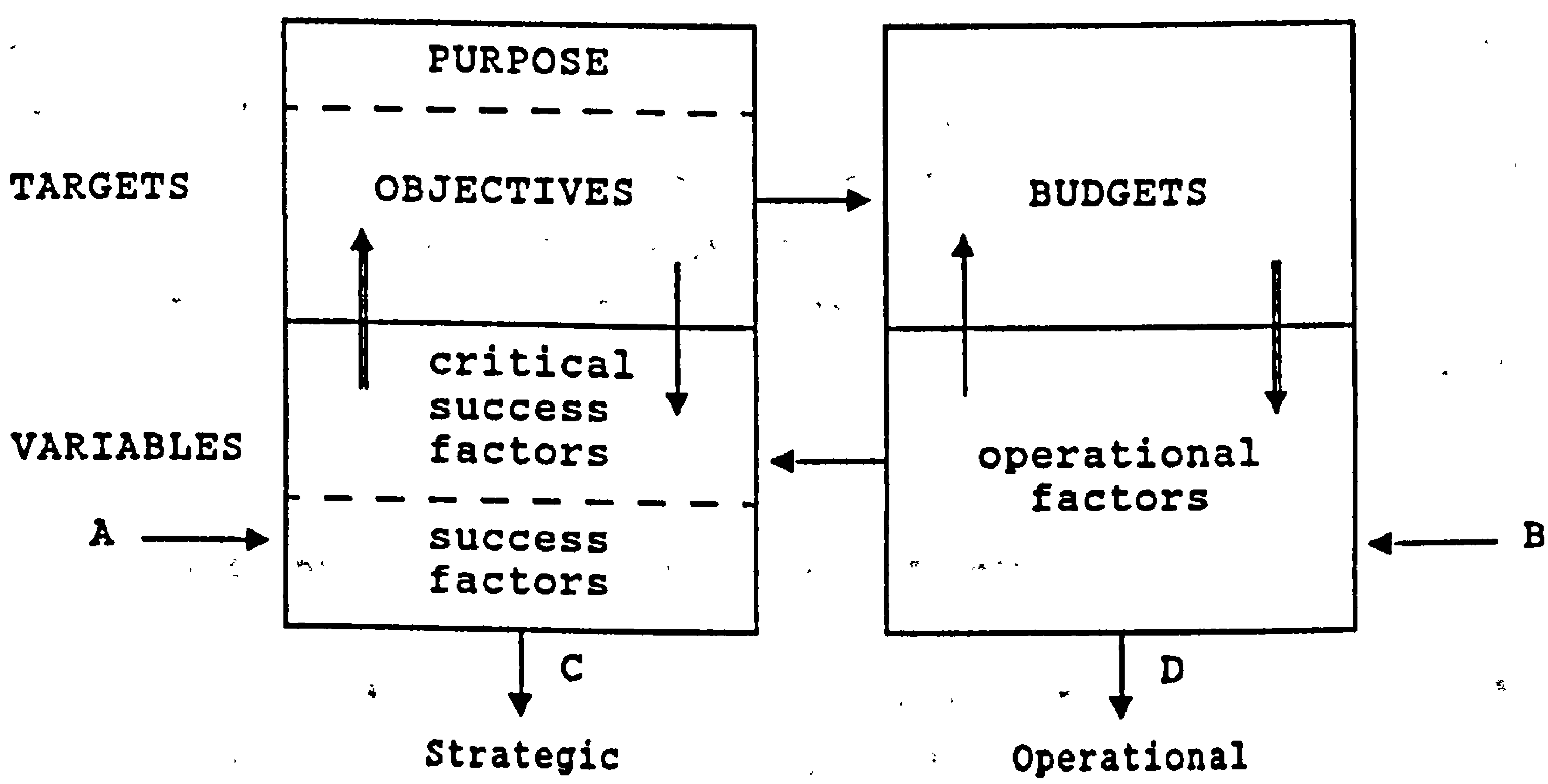


We view operational planning as a two stage process. One stage is budget variance assessment (i.e., assessing actual against expected resource use) illustrated by the double and single arrow in the model. The other stage is implied by the double arrow alone and sees the budget as determining the level of operational activity. The dominant information flow in operational planning is therefore from the budget to the operational variables box.

2.2.3 ORGANISATIONAL PLANNING

Finally we are able to define a model of the planning process within an organisation by simply combining the strategic and operational planning models described above. This model is illustrated in figure 2.5 below.

Figure 2.5: Organisational Planning



In addition to the information flows previously identified, figure 2.5 includes two additional internal and four external information flows. The internal flow connecting objectives to budgets reflects the previous discussion that budgets are determined by objectives. Similarly the information flow between operational and success factors reflects Rockart's (1979) (and others, e.g., Lucas, 1976; Emery, 1969) observation that aggregated internal information will form or contribute to the success factors. The external information flow labelled "A" in the figure corresponds to Rockart's, Lucus's and Emery's emphasis on the role of external information in strategic planning. The nature of this information has been extensively studied by Aguilar (1967) and others (e.g., El Sawy, 1985). The strategic information flow from the organisation (labelled "C") will typically consist of information published by the organisation, e.g., annual accounts. Finally, the two external operational information flows labelled "B" and "D" represent information about the organisations transactions. For example, the "B" stream will include customer orders and the "D" stream invoices.

The above model is prescriptive, as certain information flows are excluded. For example it does not indicate that budgets determine objectives, or that objectives directly determine operational factors. The model also implies that, with the exception of information exchanges to assist with control, the two planning systems operate largely independently. Finally the model, although labelled a model of the planning process, is also a model of the organisational control process. It therefore satisfies Anthony's (1965) observation that planning and control are not separable activities carried out in an organisation. While being congruent with this aspect of Anthony's work, it does not appear to be congruent with Anthony's conclusion that organisational planning systems fall into three categories. We will investigate this point next.

2.2.3.1 A Comparison with other Planning Models

The above discussion has lead us to develop a model of organisational planning and control consisting of two piers, one strategic the other operational. Several authors (e.g., Steiner, 1979) advocate a three cycle planning process, such as the planning, programming, budgeting system (Wheelen and Hunger, 1987,p.303). These systems were generally viewed as having a theoretical grounding in Anthony's (1965) framework of planning and control. This consisted of three activities which he termed Strategic planning, Management control and Operational control. This three term framework has been used by many authors since as a basis for their research (e.g. Lucas, 1976; Leader and Mendelow, 1986). Anthony (1965) was not entirely satisfied with his framework however. As he points out (p.15) "we found it easy to identify two rather different types of planning activities", which were strategic planning and management control. With the inclusion of a third category, operational control, Anthony (p.17) states, "even now [we] are by no means satisfied with the results" and later in the text "the lines between categories are blurred...it is easy to find situations that do not fit clearly in a single category".

The activities characterising Anthony's framework are reproduced here as table 2.5 (Anthony, 1965,p.19):

Table 2.5: Examples of Activities in a Business Organisation Included in Major Framework Headings.

Strategic Planning	Management Control	Operational Control
Choosing company objectives. Planning the organisation. Setting personnel policies. Setting financial policies. Setting marketing policies. Setting research policies. Choosing new product lines. Acquiring a new division. Deciding on non-routine capital expenditures.	Formulating budgets. Planning staff levels. Formulating personnel practices. Working capital planning. Formulating advertising programs. Deciding on research projects. Choosing product improvements. Deciding on plant rearrangement. Deciding on routine capital expenditures. Formulating decision rules for operational control. Measuring, appraising, and improving management performance.	Controlling hiring. Implementing policies. Controlling credit extension. Controlling placement of advertisements. Scheduling production. Controlling inventory. Measuring, appraising, and improving workers' efficiency.

Support for a two-cycle planning process model, similar to the model developed here, is supplied by Camillus and Grant (1980). They criticise planning systems based on a three stage cycle while acknowledging that such schemes had "hitherto been accepted as sound theory" and noting that "The three cycle process is in apparent consonance with Anthony's (1965) framework". With reference to three stage planning cycles and Steiner's (1979) classification in particular, Camillus and Grant (1980) say the following:

> "Steiner's classification is largely based on the time dimension and to that extent is somewhat more arbitrary and descriptive than normative in character...In short, while the three-cycle process does not necessarily violate any basic planning and control concepts, it is equally true that other more efficient processes involving fewer cycles can also be designed in keeping with the basic constructs."

It is this view that lead them to a model of planning similar to the one developed here. The model they finally propose is reproduced here as figure 2.6.

Figure 2.6: Camillus and Grant, Two-Cycle Process

Cycle 1: Strategic Planning	
Level:	Corporate management
Focus:	Defining corporate mission, objectives in terms of rates of change in key parameters, strategies, and policies, articulating basic strategic assumptions
Horizon:	3 to 15 years (operating cycle plus redeployment time)

Cycle 2: Operational Planning	
Level:	Executive and operating management
Focus:	Defining quantitative goals in terms of financial statements, physical targets and time deadlines; generating action plans intended to achieve goals; developing contingent plans of action
Horizon:	1 to 3 years (depending on operating cycle)

The semantic differences between Camillus and Grant's model and our model are not too different if it is assumed that "defining quantitative goals in terms of financial statements" is synonymous with our idea of 'budgeting'. Camillus and Grant further point out that:

> "any *corporate* planning process would fall within the first two segments of Anthony's framework. It also follows that corporate planning processes designed in keeping with Anthony's framework would not *necessarily* require more than two distinct cycles." (original emphasis retained.)

So, while criticising three-cycle planning processes and arguing for a two stage process similar to that developed here, Camillus and Grant (1980) do not reject Anthony's (1965) framework of planning and control systems even though Anthony, as we have seen, had reservations about it. The model developed here does account for this apparently contradictory conclusion. If we focus on the *internal* information flows identified in figure 2.5 we observe three counter flows within and between, the two managerial piers. It is these information flows which define Antony's framework but it is the orientation of the information which define the two piers. The orientation of the information has been defined previously and summarised in table 2.1, e.g., strategic information is long-range and aggregated; operational information is short-range and detailed. The internal information flows identified in figure 2.5 and their congruence with Anthony's framework are discussed below.

Anthony (1965,p.16) describes strategic planning thus:

> "*Strategic planning* is the process of deciding on objectives of the organisation, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use and disposition of these resources."

From previous discussions this description identifies the information flows within the strategic pier (particularly the circular flow between critical success factors and objectives) with Anthony's idea of strategic planning. As the dominant flow is from variables to targets, this circular flow represents a planning process.

Anthony (1965,p.17) describes management control thus:

> "*Management control* is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organisation's objectives."

This description (together with inspection of table 2.5) identifies "management control" with budget setting. As such it is identified with the information flow joining objectives and budgets. The other part of the description, "in the accomplishment of the organisation's objectives" is descriptive of the reverse information flow illustrated in our model as joining operational and success factors. Management control is therefore the two information flows operating *between* the two piers of our model. As neither flow is viewed as dominant, then describing this process as "control" is arbitrary.

Anthony (1965,p.118) describe Operational control thus:

> "*Operational control* is the process of assuring that specific tasks are carried out effectively and efficiently."

This description associates operational control with the information flows within the operational pier of our model. As the dominant flow in this instance was from targets to variables, then this represents a control process.

So, to summarise the discussion so far, we have been able, through a discussion of planning concepts, to develop a model of organisational planning and control . This model is congruent with the seminal conceptual framework of Anthony (1965) as it implies that planning and control are closely allied activities and accounts for the three categories within this framework. At the same time the model satisfies criticisms of planning systems based, in apparent consonance with Anthony's framework, on more than two cycles. However, none of this development has enabled us to explicitly identify the boundaries of the implementation process as something intermediate between planning and control (figure 2.1). However, we have laid the foundations for this step.

2.3 PERSPECTIVES ON IMPLEMENTATION

The discussion so far has been developed around a single dimension of managerial activity, or process. This dimension was dichotomised into strategic and operational poles. Ansoff (1984,p.183) identifies two major organisational dimensions:

"Inside the organisation, there are two major streams of activity (or two subsystems): (1) *logistic* subsystem which is engaged in conversion of the input resources into goods/services; and (2) *managerial* subsystem which is concerned with guidance and control of the activities of the organisation."

Ansoff further observes that the logistic subsystem works with resources, whereas the managerial subsystem works with information and is sub-divided into strategic and operational management. It appears reasonable to equate our managerial process dimension with Ansoff's managerial subsystem. Ansoff's Logistic/Information dimension we will refer to as an "activity" dimension. Viewing these dimensions as two rectangular coordinates produces a four cell matrix which provides a convenient basis for representing planning systems. Three of the four cells of this matrix are occupied by Anthony's (1965) categorisation of planning systems. This matrix is illustrated below in figure 2.7.

Figure 2.7: Organisational Planning Systems

ACTIVITY			
	Logistic		Operational Control
	Information	Strategic Planning	Management Control
		Strategic	Operational

M A N A G E R I A L

The justification for this arrangement is through inspection of table 2.5. In the strategic planning and management control classifications words like setting, choosing and deciding predominate. These are information based activities. In operational control the words controlling, scheduling and measuring are used. These are resource based activities. In addition Anthony's definition of operational control refers to "tasks" which we have previously equated with "actions" and are therefore logistical. The correspondence between the matrix in figure 2.7 and the information flows in figure 2.5 can be noted by viewing the matrix from the lower right corner. This shows strategic planning, managerial control and operational planning in the correct orientation to one another. But what of the fourth planning process identified by the matrix but not included in Anthony's framework? We posit that this cell is identified with project planning. Steiner (1979) notes that project plans are made for a concrete activity. This associates projects with the logistical pole of our activity dimension. Steiner also notes that project plans are detailed and have a time span. The idea of a fixed time span is reminiscent of our definition of a strategic goal; namely, a goal actions a specific objective by a specified time. The association of goals with projects identifies project planning as a strategic activity. Project planning therefore satisfies the criteria for a strategic and logistical planning process to occupy the missing cell in figure 2.7. The completed planning process matrix is reproduced in figure 2.8. Here we have also included the "targets" of concern to each planning process.

Figure 2.8: Organisational Planning Systems (II)

ACTIVITY	Strategic	Operational
Logistic	Project Planning (GOALS)	Operational Control (TASKS)
Information	Strategic Planning (OBJECTIVES)	Management Control (BUDGETS)

M A N A G E R I A L

Having arrived at the planning framework of figure 2.8 the question is, why did not Anthony (1965) include project planning in his framework? A possible answer could be that Anthony was interested in *continuous* planning processed. Project planning, by its emphasis on transitory goals, is *intermittent*. This follows from our earlier discussion of strategic planning processes where a distinction was drawn between a continuous strategic planning process and an intermittent strategy formulation process. Strategy formulation was concerned with changing objectives and these changes generated goals.

2.3.1 IMPLEMENTATION AND PROGRAMMING

As the ultimate aim of organisational planning is to translate objectives into routine day-to-day tasks, then we are able to identify in figure 2.8 two routes by which this may be achieved. One route operates through budgets as an intermediate stage. Here we are talking about a process which is primarily concerned with ensuring the adequate allocation of resources to enable *established* organisational objectives to be achieved. Glueck and Jauch (1984,p.315) appear to take this approach to budgeting and implementation by noting that routine year-to-year allocation decisions are important to the "strategic direction of the firm". Stonich (1982) and Wheelen and Hunger (1987) adopt a similar approach to implementation. In this situation it is difficult to see how the process of implementation differs from that of managing the organisation. Indeed, this point of view was expressly made to the author by a manager in a U.K. owned financial services group, "Implementing strategy is the process of managing the business." If we adopt this perspective, then figure 2.5 is not only a model of organisational planning, but also of implementation. As we observed earlier, implementation as a concrete, independent, definable activity does not exist as such.

If however, we view a route from changed objectives to tasks, then we see implementation as synonymous with project planning. Implementation is now a definable independent concrete activity. It has its own specific aim, namely to realise a goal. Steiner (1979) points to this interpretation by observing that the time span of a project is the implementation time. Ansoff (1984) also takes the view that projects implement strategy; which is the same as implementing objectives if we adopt Drucker's (1974) view that "objectives are strategy". Ultimately though, once the new objective has been achieved its continued implementation becomes a matter of budgeting. It may therefore be more appropriate to describe the continuous mode of implementation described above as "strategy maintenance" and the discontinuous mode as "strategy change". Both views of implementation expressed here are appropriate. Indeed they are not necessarily contradictory. There is a view, for example, that an organisation at any one time is composed of a variety of projects (Hawthorne, 1978).

These may be "candidate" or "executed" projects (Bussey, 1978). What we have stated here is that the implementation of executed projects involves different processes to the implementation of candidate projects. So a project focus on implementation appears to be quite appropriate.

A further congruence between the two implementation modes is possible if we adopt a decision-making perspective. Simon (1960,p.4) the main proponent of this perspective, states that "Executing policy...is indistinguishable from making more detailed policy". Hence he views decision making as the paradigm for most executive activity. As both budgeting and project planning connect the unstructured, non-programmed, decision making activities of the strategic managerial process to the structured, programmed, operational decision making process, then we may reasonably describe implementation as "programming"*. A general definition of implementation, from a decision theory perspective, is therefore:

> "Implementation is the process of interfacing an 'unprogrammed' decision making process to the organisation's 'programmed' decision making processes."

Although this definition demonstrates a unison of approach to the question of implementation, it does not assist with narrowing down an approach for study. However, the decision making perspective of our definition is relevant to our concern with the implementation of strategy, as a well recognised definition of strategy is 'a pattern in a stream of decisions' (Andrews, 1980; Mintzberg and Waters, 1985; Quinn, 1978). Previously we identified two types of decision, the operational and strategic. We will now assess the literature on the strategic type in greater detail, with a view to determining an appropriate focus for this study.

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* This view of implementation as programming differs significantly from the way other authors use the term. One of the earliest uses of the word 'programming' is by D. Novick (Steiner, 1963). It was used in the same sense as Steiner and Cannon's (1966) tactical planning, which we have called operational planning. Later, Steiner (1979) used the word to mean an intermediate form of planning between 'long-term planning', and 'budgeting'. Programming in this sense is also referred to by various authors as 'Action planning' or 'medium-range planning' and budgeting as 'short-range planning'.

2.3.2 THE STRATEGIC DECISION

Mintzberg *et. al.* (1976) defined a *decision* as a specific commitment to action (usually a commitment of resources) and the term *strategic* as meaning "important", in terms of the actions taken, the resources committed, or the precedents set. The political literature on strategic decisions defines them as the major definitions of principles of operation within which smaller sub-decisions can take place Wilson, 1980). Some authors (e.g. Wheelen and Hunger, 1987) would reserve this description for a definition of policy.

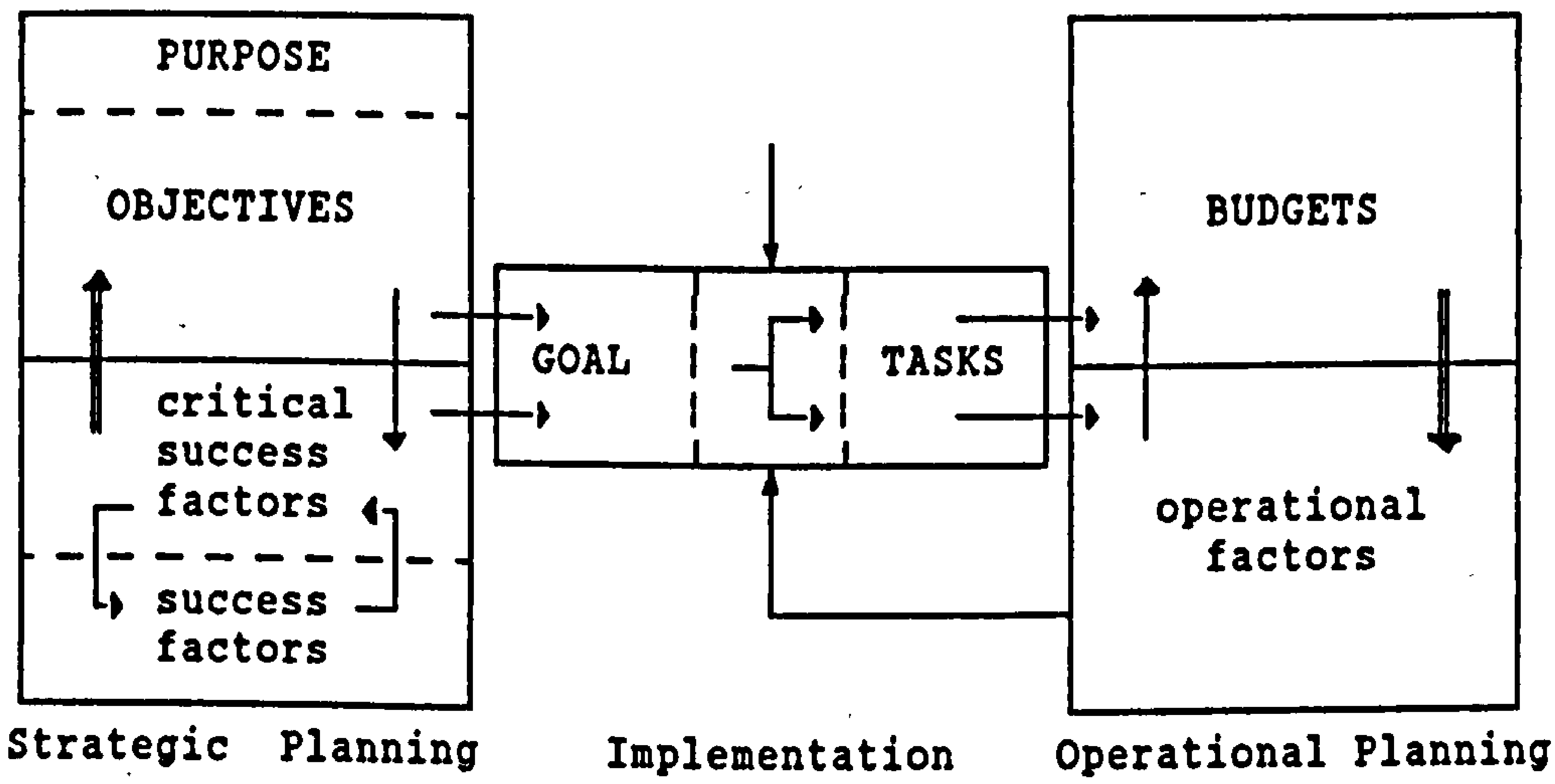
In terms of the attributes used to define strategic decisions Mintzberg *et. al.* (1976) Stein (1981) Pennings (1985) Hickson *et. al.* (1986) and others identify novelty, rarity, complexity, lack of structure and open-endedness. They are made at high level, are non-routine and will set off "waves" of lesser decisions and commit substantial resources. In addition standard procedures are rarely sufficient to cope with the complexities posed by these decisions. Although there are few precedents for the strategic decision it will set precedents. As previously noted, strategic decisions are also non-programmed (Simon, 1960). Finally, words like "significant" and "consequential" are relative terms that must be interpreted by the organisations themselves. It is possible that a big matter in one organisation will be less weighty in another (Hickson *et. al.*, 1986).

The emphasis in the above definitions on novelty and rarity show strategic decisions to be intermittent. This observation associates the implementation of strategic decisions with implementation by projects and therefore strategic change. Indeed, some authors prefer to view strategy solely in these terms. Stein (1981) defines strategy as a "system whose elements are strategic decisions". Pettigrew (1990) states "my current preference is to approach the study of strategy with a vocabulary that leans rather more heavily on change than choice". The association between strategic change and strategic decisions implies that implementation by projects is the more substantive approach to the implementation issue than implementation by budgets. This study will therefore be concerned only with the implementation of strategic decisions, i.e., we adopt Stein's definition of strategy.

2.3.3 A MODEL FOR IMPLEMENTATION

Having reduced the implementation question to that of implementing projects enables a model of organisational planning to be drawn containing an explicit implementation stage. This model is illustrated in figure 2.9.

Figure 2.9: Strategic Change



Our aim here has been to identify implementation as an independent organisational activity. Equating implementation with project planning satisfies this aim as projects start with a definable goal. It has also been shown that the end product of a project is task definition. These are the concrete activities that have to be performed if the new objective installed by the project is to be maintained by the normal budgeting activity of the organisation. The key information flows necessary for the implementation of a goal are also indicated in figure 2.9. Goal recognition is a product of strategic planning and in particular, of strategy formulation. A major information input into the implementation process must therefore originate from the strategic pier of the organisation. The process of converting the project goal into a larger number of tasks is referred to as "factoring" (Hrebiniak and Joyce, 1986) or "means-end analysis" (March and Simon, 1958). March and Simon (1958,p.191) describe this as a technique of successive approximation, i.e., starting from a general goal discover a set of general means of accomplishing the goal and then take each of these means in turn as new sub-goals. The process proceeds:

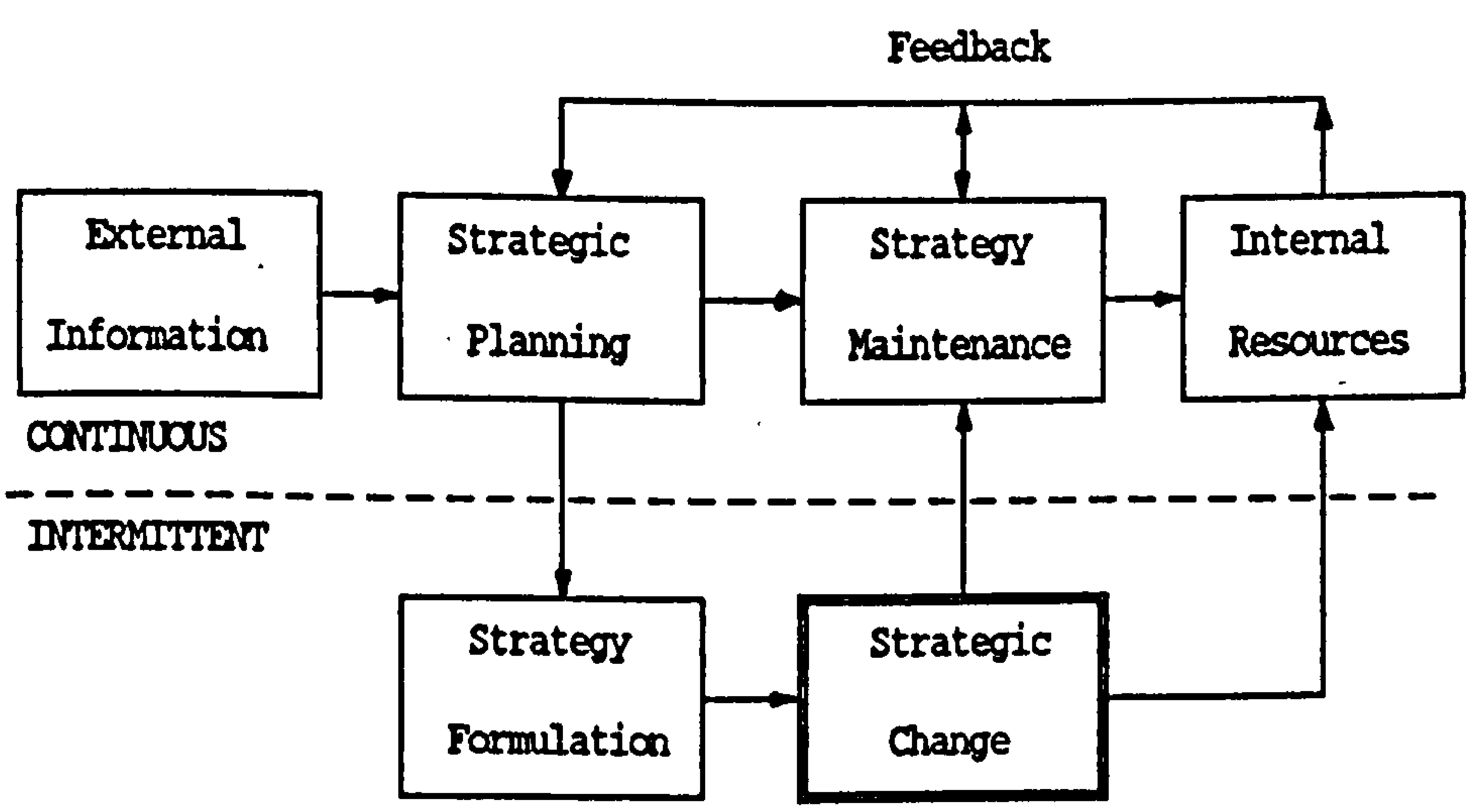
"until it reaches a level of concreteness where known, existing programmes (generalised means) can be employed to carry out the remaining detail. Hence, the process connects new general purposes with an appropriate subset of the existing repertory of generalised means."

Using our nomenclature, "generalised means" are "tasks" and "general purposes" are "objectives".

It would appear reasonable to assume that much of the information needed to enable a means-end analysis to proceed will be detailed and supplied directly to the project. One source of such information will be internal and from the operational pier of the organisation. Another information source will be external, and again we would expect this information to be highly detailed and specific to the particular project.

We are now also in a position to identify the flaw in the construction of figure 2.1 noted previously. Superficially figures 2.1. and 2.9 are similar. However, the flaw with figure 2.1 is that it does not make explicit the distinction made here between implementation as strategy maintenance and implementation as strategy change. Noting that planning may also be viewed as continuous and intermittent leads to a modified model of the management process to replace that of figure 2.1. This model is illustrated in figure 2.10.

Figure 2.10: A Modified Model of Strategic Management



The main feature of figure 2.10 is that it is divided into two levels. The continuous level refers to strategic planning and strategy maintenance. The lower, intermittent, level indicates that, periodically, the strategic planning process signals possible changes in strategy. This initiates a strategy formulation process, which in turn initiates strategic change. Ultimately the change is integrated into the continuous strategy maintenance activity of the organisation. As strategy maintenance is an essentially logistic process, it influences the organisations internal resources directly. If we take internal resources to include "procedural techniques" (Wheelen and Hunger, 1987) then strategic change also directly influences the organisation's internal resources. The theory underlying this point is discussed in chapter 4 and is an important concept within the remainder of the thesis. Finally, we note that the focus of the remainder of this thesis is solely with the issue of strategic change, hence the emphasis placed on this process in figure 2.10.

2.4 CHAPTER SUMMARY

In this chapter we have sought to answer the question, what is the implementation of strategy? We concluded that two approaches may be taken in order to answer this question. While noting that both approaches have aspects in common (they may both be defined as "programming") they are sufficiently dissimilar to enable them to be investigated separately. One approach is to equate implementation with the normal budgeting, or resource allocating, activities of the organisation. A justification for this perspective was made if implementation is equated with strategy maintenance. An alternative approach and the one to be adopted in this study, is to view implementation as an intermittent activity strongly associated with strategic decisions and change processes. This approach leads to a view of strategy implementation as the implementation of specific projects. Each project has a definite start and end and are "grafted" on to the organisation as required. As such, implementation is seen as a temporary bridge joining the strategic and operational piers of an organisation.

In the following chapter we will look in greater detail at the origin of and type of projects that may be implemented. This will rest on a deeper understanding of what strategic decisions are and how organisational change is involved in implementation. At this point we abandon the broad question of implementing strategy and focus on the narrower question of the implementation of strategic decisions.

CHAPTER 3

STRATEGIC DECISIONS, PROJECTS AND CHANGE

It was demonstrated in the previous chapter that a substantive issue within the implementation of strategy question concerned the implementation of strategic decisions. Strategic decisions were shown to be implemented through projects and a key concept linking strategic decisions to projects was the concept of change. In this chapter we aim to develop a clearer understanding of the associations between these items, thus laying the foundation for further operationalisation of the study.

This chapter is broadly structured into three parts. Initially we adopt a number of different perspectives on the "organisation". One of these, the cybernetic, is used to develop a taxonomy of strategic decisions based on types of organisational change. In the second part this taxonomy is tested using a secondary data analysis of a well respected U.K. study of strategic decision making. Finally, the taxonomy of strategic decisions is linked to a taxonomy of strategic projects.

3.1 A TAXONOMY OF STRATEGIC DECISIONS

Our concern here is only with organisations constituted for the purpose of the production of wealth or well-being in the form of goods or services. These may be public or privately owned. There are many perspectives that an individual researcher may use to describe and explain those organisational variables with which they are concerned. Machlup (1974) felt sure that there were at least 21 concepts of the firm. Here we will use three of these, the organisational (or bureaucratic) perspective, "a typical co-operative system with authoritative co-ordination", the accounting perspective, "a collection of assets and liabilities", and the cybernetic (Beer, 1967) an "exceedingly complex and probabilistic system...(which is) a tightly knit network of information..". We start by investigating the concept of information and uncertainty in cybernetic systems.

3.1.1 INFORMATION AND UNCERTAINTY

The idea that an organisation, such as a factory, bank or hospital, may be viewed as a collection of "bits and pieces", connected together by communication channels operating through input/output interfaces, is central to the Cybernetic, General System Theory and Communication theory approach to the study of such organisations. Such a description identifies a system, which is defined by Ackoff and Emery (1972,p.18) as :

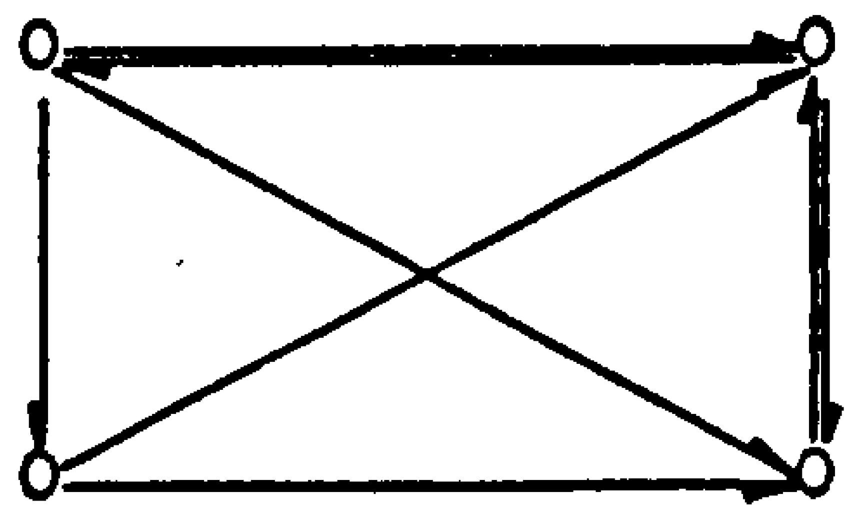
> "...an entity composed of at least two elements and a relation that holds between each of its elements and at least one other element in the set. The elements form a completely connected set that is not decomposable into unrelated subsets".

Note that although a system may be part of a larger system, it cannot be decomposed into independent subsystems. Calling the bits-and-pieces, "entities" (in the sense that they are subsystems) then the larger system may be represented as a directed graph. Figure 3.1 illustrates such a graph showing four entities and eight active communication channels, or relations.

Figure 3.1: Graphical Representation of a System.

Legend

O - Entity.
——→ - Communication channel.



This graph, or network, shows the "connectiveness" of the system. It is a relatively trivial matter to show that the maximum number of one way communication channels that can exist in a system of 'n' entities is n(n-1). In figure 3.1, therefore, twelve communication channels could have been drawn between the four entities. This is because the channel, or relationship, between entities A and B say, is not necessarily the same as that between B and A. The nature and the extent of the control which the system displays is revealed in the behaviour of the connectiveness of the network. This connectiveness will probably change from moment to moment, and the states of the communications lines at any instant represents the amount of information in the system (Beer, 1967).

This idea of information as being represented by the pattern of states (active, inactive) of the communication channels within a system leads to the counter intuitive notion, used in cybernetics etc., that information is a measure of choice. To expand on this, we note that the number of entities in the system determines the permutative capacity of the system's possible states. This permutative capacity is referred to in the cybernetic literature as "variety". Bertalanffy (1973), Beer (1967) and others note that the permutative capacity of a system in which each communication channel may be active or inactive (on or off) is $2^{n(n-1)}$. Increasing the number of entities in a system, therefore, greatly increases the variety and hence the uncertainty, in the system. In the sense that an organised system may be thought of as "a machine for doing so-and-so", Beer (1967,p.44) notes:

> "A machine in its pristine state is therefore full of uncertainty; its content is chaos. Once the machine begins to operate, however, a degree of order is introduced; and this ordering begins to eliminate the ruling uncertainty. This is what enables us to handle...systems: it is 'information'. Information kills variety; and the reduction of variety is one of the main techniques of regulation;..."

The design of an organisation is therefore determined by the need to handle the inherent uncertainty within that organisation. The means by which this is done is through handling information. In this sense an organisation is an information processing machine (Beer, 1967; Galbraith, 1979; Feldman and March, 1981).

The idea that uncertainty is an important organisational variable also pervades much of the organisational theory literature. Van De Ven and Ferry (1980) use domain uncertainty as one of three underlying dimensions of organisational design. They note that this dimension underlies most conceptions of organisational rationality. In particular, they argue that the well-known Thompson and Tuden (1979) typology of decision-making strategies as Computational, Judgmental, Bargaining or Inspirational, is based on the dichotomisation of this dimension of uncertainty.

Burns and Stalker (1961) found the rate of change of the market and technology, a variable which distinguished the appropriateness of organisational form. Woodward (1965) found the type of production process important, Harvey (1968) the number of new products introduced, and Hall (1962) the predictability of the task as determinants of organisational form. From these and other studies Galbraith (1969) hypothesised that organisational form was determined by the need to process information. The amount of information generated, Galbraith reasoned, was dependent on the size of the organisation, the amount of connectivity or interdependence among the elements necessary for decision making, and the degree of uncertainty concerning the organisation's task requirements.

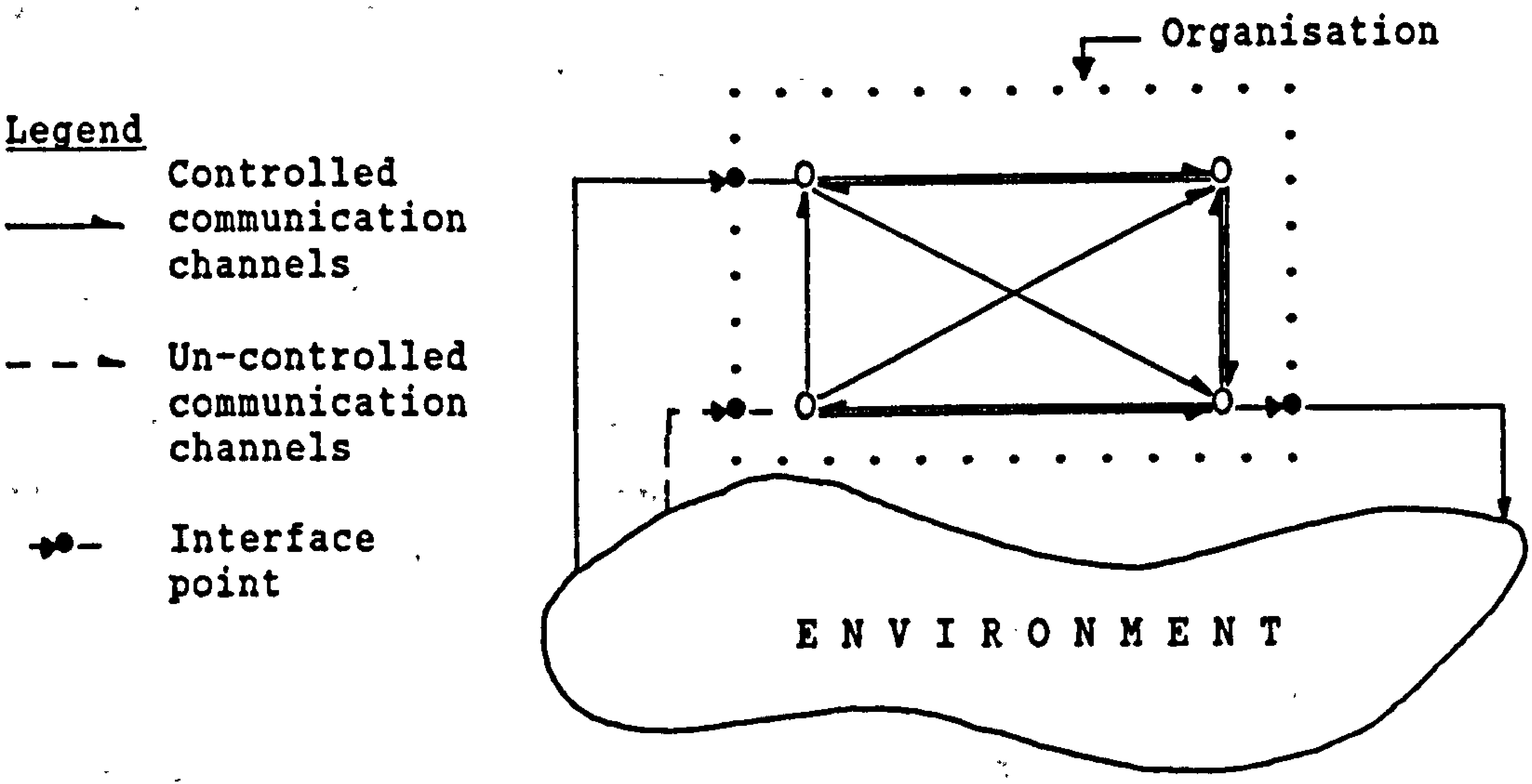
Simon (1960) and Emery (1969) both observe that the hierarchical character of most organisations stems from the need to reduce the complexity of the organisation and is therefore a response to uncertainty. Uncertainty can also be reduced by using various de-coupling techniques between entities. For example, the specification of standard rules and procedures (March and Simon, 1958) buffering and the use of flexible or slack resources. A third method for handling uncertainty is through the use of coordinating methods, namely plans and budgets. Galbraith (1969) identifies several more techniques used by organisations to handle uncertainty.

From the above discussion it is noted that uncertainty can originate from several sources. The number of entities constituting the system, or organisation, affects the variety of the system and hence its uncertainty. Similarly the production process used and the nature of the tasks performed by the organisation will affect uncertainty. Such sources may be thought of as internal uncertainty. However, no organisation exists in isolation, it must be responsive to, and exist within, a much wider system, its environment. In the language of Systems theory, the organisation is an open system (Katz and Kahn, 1966). That the environment is multi-dimensional and has a significant effect on an organisation is acknowledged by many authors (e.g. Sanderson and Luffman, 1988) and a number of definitions and measures appear in both the organisational (Downey *et. al.*, 1975) and business policy (Ansoff, 1984) literature. In addition, several authors observe that an organisation has little control over the effect the environment has on itself (e.g. Hayes and Wheelwright, 1979). This is not universally true, however. In some respects the organisation has control over its environment. It can, for example, partially determine its market and also its suppliers - its domain. In this sense Van De Ven and Ferry (1980,p.92) note that "in varying degrees organisations create their own environments by their choice of domain".

The above discussion suggests that an organisation is subject to two sources of environmental uncertainty. First is the uncertainty stemming from the organisation's transactions with its environment. We will call this endogenous uncertainty, in the sense that it is under partial control by the organisation. Second is exogenous or uncontrolled uncertainty. Beer (1985) identifies two forms of exogenous uncertainty, i.e., sources or types of strategic environmental information. These he identifies as focusing on what is actually happening to correctly assess trends (the alpha loop) and being alert to novelty, i.e., being able to judge its relevance (the beta loop). Porter's (1980) model of the forces driving industry competition can be identified with these ideas of environmental uncertainty. Specifically, the force due to industry competitors is identified with exogenous, alpha uncertainty, whereas the forces due to potential entrants and threat of substitutes is identified with exogenous, beta uncertainty. Finally, we would identify the forces due to suppliers and buyers bargaining power with endogenous uncertainty.

The above arguments lead us to an extended view of the system and its environment. This is illustrated in figure 3.2.

Figure 3.2: The System and its Environment



3.1.1.1 Organisational Change

To summarise the above discussion, we see that a purposeful organisation is confronted with uncertainty. This can stem from the internal nature and structure of the organisation itself, its transactions with its environment as well as the nature of the environment in which it operates. This uncertainty gives rise to the need to process information. Because of limitations on the processing capacity of the organisation, a system of priorities is imposed upon the communication channels connecting the entities within the organisation. These priorities take the form of allowed relationships; the development of an hierarchical authority structure is probably the most obvious effect of this process. However, it is also manifest in the way resources are allocated, as formalised in plans and budget.

The definition of strategy adopted in this study was given in chapter 2 as the pattern of strategic decisions made by an organisation (Stein, 1981). Chandler (1962) demonstrated that an organisation's structure and its strategy were interdependent. Namely, as organisations pursued a diversification strategy, say, then the organisational structure also needed to change. From this we may infer that strategic decisions change the structure of an organisation. In addition, we have noted previously that an organisation's structure is determined by the uncertainty with which the organisation has to deal. If we therefore assume that a strategic decision occurs because the organisation is subject to exogenous uncertainty and that the response is to alter the organisation's structure via strategic decisions, then we are in a position to be able to define a taxonomy of strategic decisions in terms of the structural changes made to an organisation in the implementation of the decision.

3.1.1.2 <u>The Taxonomy</u>

Assuming that an organisation has sufficient control over its structure to effect appropriate changes, then we note that such changes will influence the internal and, or, endogenous uncertainty with which the organisation has to cope. This conclusion is a consequence of a basic law in cybernetics dealing with regulation and control, the Law of Requisite variety (Ashby, 1956). This law is stated by Ashby (1956,p.207) as, "only variety can destroy variety". We may paraphrase this as, "only controlled uncertainty can destroy uncontrolled uncertainty". Galbraith (1969) acknowledges this law (wittingly or unwittingly is not clear) when he hypothesised that "the information processing capacity of an organisation must be equal to the information processing requirements of the task." Ansoff (1984,p.471) makes a similar point.

Here, we use this law to note that if an organisation is subjected to an increase, say, in exogenous uncertainty, then it can only respond effectively by increasing the permutative capacity (variety) of the organisation's internal "network". Reference to figure 3.2 shows there to be only three ways in which this can be achieved. These are:

1. An entity can be added (or deleted) from the network. This will greatly change the potential internal variety of the network, in accordance with the relationship noted earlier. Decisions of this type will be referred to as ENTITY decisions. Creating an entirely new department or product line, or building a new factory are examples of this type of decision.

2. The communication channels, or relationships, between entities can be modified. For example, although all channels exist in potential, in practice only a small fraction will be officially sanctioned. Changes to the number of official channels will change the internal variety of the network. Alternatively, the capacity and/or quality of the existing channels could be changed. Decisions involving changes to the internal communication channels of the organisation will be referred to as RELATIONAL decisions. Reorganisations using existing resources, training programmes, budgeting and planning are examples of such decisions.

3. Finally, the controlled communication channels between the environment and the organisation can be changed, providing new sources of variety. Decisions of this type will be referred to as INTERFACE decisions. Beer (1985) notes that advertising serves this purpose. Similarly, finding new product markets or raw material sources are examples of this type of decision.

These three types of strategic decision, Entity, Interface and Relational, constitute a taxonomy based on modes of organisational change.

A consequence of these definitions and Ackoff and Emery's (1972) previously cited definition of a system, is to note that an Entity decision cannot be a pure type. It must also involve a relational component to connect the new entity to the rest of the system, and may also involve an interface decision. If this is not so, then the new entity would not be part of the original system. Interface and Relational decisions on the other hand, which only involve the communication channels of the network, hence the control exhibited by the organisation (Beer, 1967) can both exist as pure types. A further point relates to what we may term the "strategicality" of decisions involving changes to an organisations communication structure. March and Simon (1958,p.188) note:

> "when decisions are satisficing rather than optimising decisions, resource allocation to new programmes will depend substantially on the communication structure through which proposals are processed..."

In other words, changes to the organisation's communication structure, by any of the above means, will influence the pattern of future decisions and therefore resource allocation within the organisation. Hickson *et. al.* (1986,p.27) make precisely this point in their description of strategic decisions:

> "A strategic decision is one in which those who are involved believe will play a bigger rather than a smaller part in shaping what happens for a long while afterwards."

It is also noted by Mintzberg *et. al.* (1976) that strategic decisions are likely to set precedents for future decisions. Decisions which change an organisation's communication structure are therefore strategic and the above taxonomy is a taxonomy of strategic decisions.

3.1.2 OPERATIONALISING THE TAXONOMY

In order to test the efficacy of the above taxonomy it is necessary to define measures of these decision types, i.e. some parameters along which the three types may be differentiated. Two dichotomous parameters will provide sufficient variety, or permutative capacity, to achieve this. In suggesting a scheme for identifying these measures, we need to take a closer look at the nature of the entities in the network. The problem in doing this lies in the fact that the boundaries of a system are essentially arbitrary, at both the macro and micro levels (Beer, 1967). As Emery (1969,p.4) comments:

> "The game of building larger systems from smaller ones can go on almost indefinitely. Where one stops this process depends on one's interests and point of view...[at the micro level the terminal points] are also essentially arbitrary...At some point, however, one ceases to be concerned with the structure of a component [and treat it] as an elementary black box with known transformations between inputs and outputs but with unknown internal structure."

As Emery's "viewpoint" was the hierarchical structure of the system, he viewed the entities as consisting of "elementary tasks" and "nodes". The elementary tasks could be equated with operational personnel, and the nodes with supervisory/managerial personnel. However, structure is not directly our concern. We may note, however, that the larger system-in-focus must be a viable system, that is, capable of maintaining a separate existence within a specified environment (Beer, 1985). This viable system may contain viable systems within itself, and it may also be contained within a larger viable system. We do not need to focus on these systems. However, we do need to look at the separate entities constituting the system on focus.

Emery noted that an entity should be a black box with known input/output relationships. One of the features of large systems, a company say, is their high complexity. This makes the determination of input/output relationships very difficult. As Beer (1967) notes, one is reduced to a process of input manipulation and output classification when investigating such complex systems. To reduce this complexity to a level at which the input/output relationships are known suggests that an entity must be a simple system of low complexity. A further property of an entity is that it is a source of information, in the sense that removing the entity reduces the variety in the system. We may also stipulate that it is man-made. As such it will embody standardised skills. We have already noted the idea that our systems are organised towards a purpose. Therefore, we would expect the entity to also serve the same purpose and to facilitate the process of achieving this purpose. These requirements define a technological artifact (Van Wyk, 1979). Such artifacts can be considered as concrete (physical devices) or abstract (standardised procedures of conduct). However, one important way to conceptualise such artifacts (derived from General Systems theory) is to view them in terms of three attributes; matter, energy and information. The matter and probably energy components can be viewed as being a physical object. The information component can be supplied by a human operator. Thus, the elementary black box, or entity, with which we are concerned, is a physical technological artifact. In other words, a single or collection of, fixed assets.

3.1.2.1 An Accounting Perspective

Edwards and Kellar (1979) observe that all organisations of the type being considered here, combine economic resources for the production of goods and services. Further, they classify economic resources as being either "Work" or "Property", where work is taken to be the sum total of the tasks performed by everybody in the organisation, and property is the collective name for all the assets used. This classification, coupled with the idea that entities are technological artifacts, suggests that we may view the organisation as a collection of assets - a view of the organisation very similar to that of the accountant (Machlup, 1974). Ijiri *et. al.* (1974) observe that accountancy data are generally surrogates used in place of a principle; where the principle is the measure one wishes to use, but the surrogate is more convenient either to obtain or use. This suggests that an accounting view of the organisation (a view not frequently encountered in the organisational literature) may be used to identify surrogate measures of the three decision types.

Using this accounting perspective, we define the larger system-in-focus as an accounting unit or entity. French (1985) defines an accounting unit as "something which is a party to financial transactions, or an activity or scheme for which financial transactions are undertaken, and for which accounting records are kept relating only to its transactions". Examples could be the administration of a trust fund, the trade of one branch of a chain of retail stores or the entire chain of stores. Essentially an entity is a profit centre, and as such is capable of existing as a viable unit in its own right. This accords with the view that the larger system-in-focus must be a "viable system". In addition, the separate entities constituting this larger system may be viewed as the assets of the organisation, either taken singly or aggregated to satisfy the requirement of a technological artifact. The Fund Theory in accounting (Gynther, 1967) defines the accounting-unit-area as a group of assets and a set of activities or functions for which the assets are employed. This definition of a Fund is similar to that of a technological artifact and further suggests the association between entities and assets.

On this basis, an Entity decision can be seen to represent the acquisition (or disposition) of assets (plant, machinery, buildings etc.). As such, implementing a decision of this type requires capital expenditure, say, both on the fixed assets (called capital assets in America, (French, 1985)) and current assets (i.e., via working capital). Implementing an Entity decision, therefore, involves a down side risk to the organisation's Balance Sheet statement. That is, if the anticipated benefits due to the decision do not materialise, through the retained earnings mechanism, then the shareholders / owners equity will be reduced in both the long and short term. In addition, we note that capital expenditure decisions can be difficult to reverse if things do go wrong (Jones and Trentin, 1971). This could be due to losses incurred on resale of the asset and the "visibility" of the decision to outside stockholders. In summary, an Entity decision may be identified as a Balance Sheet risk decision and as such, represents the acquisition (or disposition) of capital resources by the organisation.

In contrast, we hypothesise that a Relational decision will involve no, or negligible, commitment of financial resources during its implementation. This is not to say that such decisions are without financial consequences. Any strategic decision, by the definition used here, is aimed at providing a long term benefit for the organisation. We are simply saying that Relational decisions will not pose a significant risk to the organisation's statutory financial statements in the period covering the decision's implementation. They may, however, involve the redistribution of existing resources, as defined in plans and budgets and the commitment of non-financial resources could have been significant, making a reversal of the decision far from trivial. Finally, Interface decisions, being concerned with the establishment of communication links, are unlikely to involve capital expenditure to a significant extent. These decisions may however, involve revenue (i.e. recurrent as opposed to once and for all) expenditure for advertising and promotion, or the purchase of raw materials. As such they represent a down side risk to the organisation's Profit and Loss statement, in the sense that the organisation is being committed to an on-going expenditure. An interface decision therefore, involves the consumption of existing resources. If the anticipated benefits are not forthcoming it could be relatively simple to review the situation and reverse the decision, thus eliminating the risk.

As the above identification of decision type with accounting statement risk requires deciding whether the expenditure is capital or revenue, significant or not, it cannot be expected that these identities will be perfect surrogates of the decision types. The distinction between capital and revenue expenditure, for example, is not as simple as one would expect and has on occasions to be determined by the law courts (Skitmore, 1977). Consider also the case of a fleet of vehicles used by an organisation to distribute its goods. This fleet represents a communication channel between the organisation and its environment and is therefore an Interface topic. However, if the fleet is purchased outright, or, on recent current U.K. legislation, leased, it will appear as a capital or Balance Sheet item and not, as anticipated here, a Profit and Loss item. If, however, the fleet is contract hired, it will then appear as a profit and Loss item. Contract hire is currently gaining in popularity in the U.K. Similarly, it is conceivable that a reorganisation could create a new department, thus a new Entity, without using capital resources. This decision would, using the surrogate measures developed here, be incorrectly classified as a Relational decision.

The above discussion suggests that the proposed taxonomy of strategic decisions can be tested by noting the down-side risk (present or absent) to each of the organisation's two statutory financial statements, implicit in the nature of the resource commitment required to implement the decision. Specifically, we anticipate that an Entity decision is associated with a Balance Sheet risk, an Interface decision with a Profit and Loss risk, and a Relational decision with neither a Balance Sheet nor a Profit and Loss risk; it is a Non-financial risk. No decision on this taxonomy is identified with both a Balance Sheet and a Profit and Loss risk. Unfortunately most work in the area of strategic decision making has not reported the financial information necessary to test this hypothesis. However, the original data gathered during one longitudinal empirical study of strategic decision making in U.K. organisations (Hickson *et. al.*, 1986) was accessible, and has been reinterpreted here in terms of our taxonomy.

3.2 THE BRADFORD STUDIES

The largest single study of strategic decision making reported in the literature to date is that of Hickson *et. al.* (1986). This study investigated 30 diverse U.K. organisations. Five strategic decisions were selected from each organisation, based on their variety of subject matter, from a list prepared by each organisation's Chief Executive Officer (CEO). This yielded a sample of 150 decisions. Five cases were chosen because this was the lowest common denominator to the number identified by each CEO. The average number of decisions listed was six or seven and the maximum was nine. The majority of the decisions studied were made during the late 1970's.

The 30 organisations studied by Hickson *et. al.* were categorised as public manufacturers (N=2) private manufacturers (N=9) public commercial service (N=3) public non-commercial service (N=8) and private commercial service (N=8). In addition to this classification by organisation, each of the 150 cases were classified by decision topic. The ten topic classifications (in order of frequency) were:

Table 3.1: Strategic Decision Topic Categories

Technology(N=23)	- Equipment and/or premises.
Reorganisation(N=22)	- Internal restructuring.
Controls(N=19)	- Planning, Budgeting and requisite data-processing.
Domain(N=18)	- Marketing and distribution.
Service(N=16)	- New, expanded or reduced services.
Product(N=12)	- New products.
Personnel(N=12)	- Job assessment, training, unions.
Boundary(N=11)	- Purchases of, and mergers with other organisations.
Inputs(N=9)	- Finance and other supplies.
Locations(N=8)	- Site and site disposal.

Inspection of these topic categories and their description allows a tentative classification according to the taxonomy proposed here. On this basis the categories will be:

Table 3.2: Hypothesised Decision Topic Categories

Framework	Decision Topic
ENTITY	Location; Boundary; Technology;
INTERFACE	Domain; Inputs;
RELATIONAL	Reorganisation; Personnel; Controls;

Product and Service topics have been omitted as there is no clear indication on this basis as to which category they belong, other than to state that it should not be the Relational category. This difficulty stems from the observation that these two topics are both output topics. Product decisions apply to the outputs of manufacturing organisations; whereas Service topics apply to the outputs of private and public service organisations. As output decisions one would anticipate an Interface type of organisational change. However, they may also require an Entity type of change for their expedition.

For the purpose of this investigation, each of the 150 decisions were categorised during an interview with the principal author of "Top Decisions" according to the financial risk associated with its implementation. Essentially, whether the predominant financial commitment required to implement the decision was seen as capital, revenue or neither. This reclassification of the 150 decisions indicated that 42% were Balance Sheet risk decisions, 19% Profit and Loss risk, and 39% Non-financial risk decisions. (Note, four of the cases were decisions not to take some action. These have been classified on the basis of the risk that would have occurred if the action had been taken).

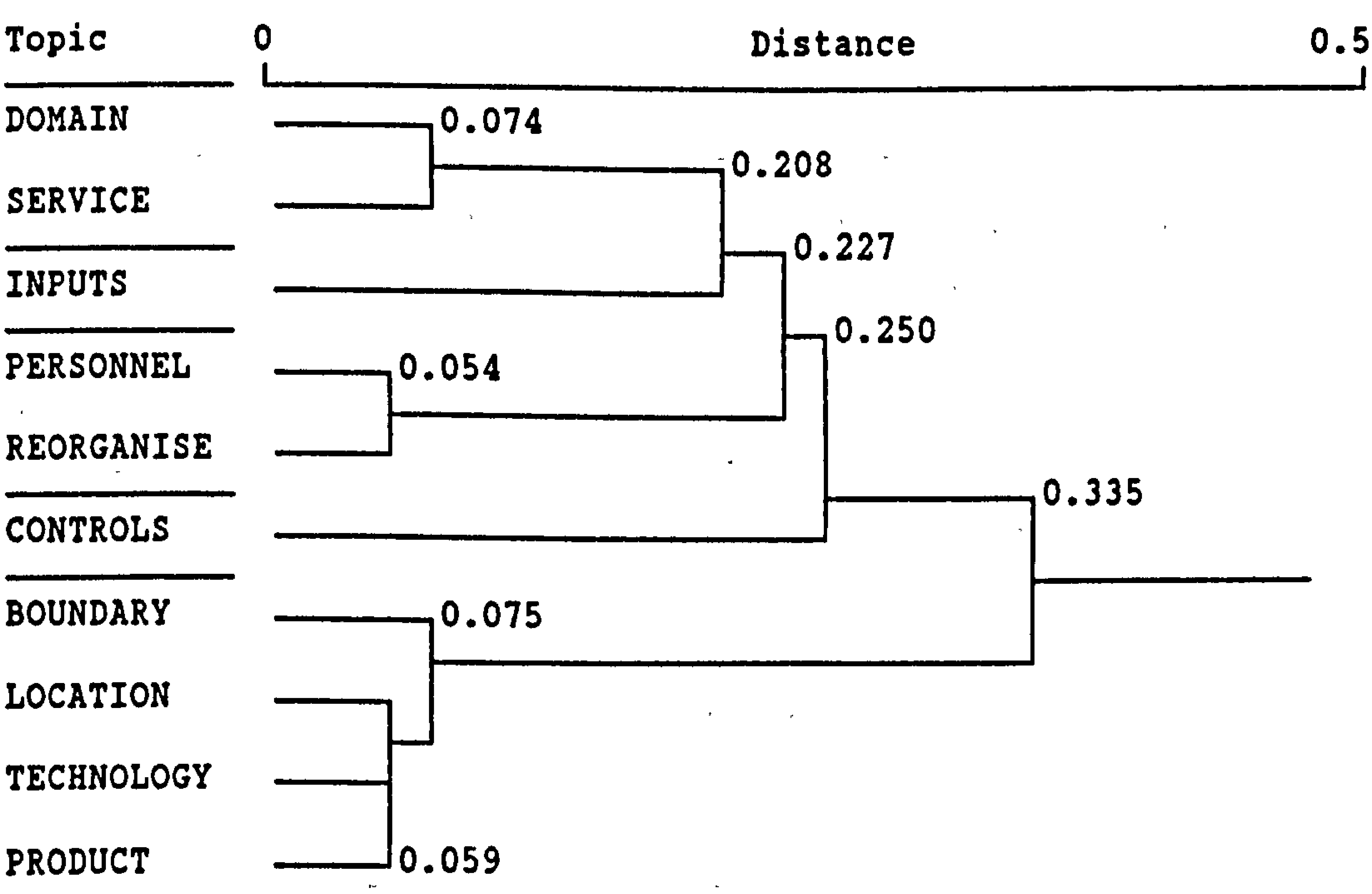
3.2.1 ANALYSIS OF DATA

To test the thesis presented here, the empirical technique of hierarchical cluster analysis was used. This technique identifies similarities between objects using some aspects of the objects to assess their similarity. In this instance the objects are decision topics and the aspects, or variables, are the three risk categories. Aldenderfer and Blashfield (1986) cite a number of uses of the technique; it was used by Hickson *et. al.* in their study.

Clustering was performed using the Euclidian distance metric, single linkage method. This technique was chosen as being the least contentious of the numerous methods available (Aldenderfer and Blashfield, 1986). For the same reason each variable was not standardised. However, the Euclidian metric is sensitive to a measure of similarity called elevation. In this case the similarity variables are frequency counts and this means the Euclidian metric will simply cluster on the basis of sample size. To remove this effect the variables were normalised by dividing each frequency count by the total of the three risk categories within each topic category. The variables actually used were therefore relative frequencies.

The hierarchical cluster analysis produces a tree diagram, which is illustrated in figure 3.3.

Figure 3.3: Cluster Analysis on Topic Categories



In interpreting this structure, one notes that initially each object (decision topic) is treated as a separate category and that finally, all objects are treated as a single category. The dissimilarity between objects is measured by 'distance'. The greater the distance at which objects are joined together, the greater their dissimilarity. Figure 3.3 indicates two zones where topic categories are joined. One zone occurs at approximately one eighth of the total distance (between 0.054 and 0.078) and reduces the original ten objects to five clusters. A second combination zone at about half of the total distance (between 0.208 and 0.338) reduces the number of clusters to just one. This indicates that the ten topic categories used by Hickson *et. al.* can be reduced to just five. These five clusters have been delineated using horizontal lines in figure 3.3.

Some measure of the internal validity of this structure can be inferred by noting that the same clusters were identified using other, notably Pearson, distance metrics. No tests for the significant number of clusters, or validity between clusters were performed, the reason being that the use of discriminant analysis, MANOVA, multiple ANOVA, F-Ratios and other tests are, as Aldenderfer and Blashfield observes, "useless at best and misleading at worst." Hence the following observations are based on the simple heuristic method of inspection described above.

Each of the decision topics categorised by Hickson *et. al.* is itself a cluster of decisions. This analysis indicates that their ten categories can be further reduced to five clusters, each on average covering 30 decisions. The relative frequencies of each risk category characterising each of the five topic clusters and the number of decisions within each of these five clusters is illustrated in Table 3.3. A chi-squared analysis of table 3.3 indicates a strong association between the two of 'risk' and 'topic' (d.f.=6, $p<0.005$).

Note: B/S, refers to a Balance Sheet risk decision. P/L and N/F to Profit and Loss, and Non-financial risk categories, respectively.

Table 3.3: Relative Frequency of Risk Categories by Topic Clusters.

CLUSTER TOPICS	RISK (%) B/S	P/L	N/F	Decisions in clusters. Number	%
c1	85	6	9	54	36
c2	3	12	85	34	23
c3	26	50	24	34	23
c3 Controls	37	5	58	19	13
c4 Input	0	44	56	9	6

c1 - Product, Technology, Location and Boundary topics.
c2 - Personnel and Reorganisation topics.
c3 - Domain and Service topics.

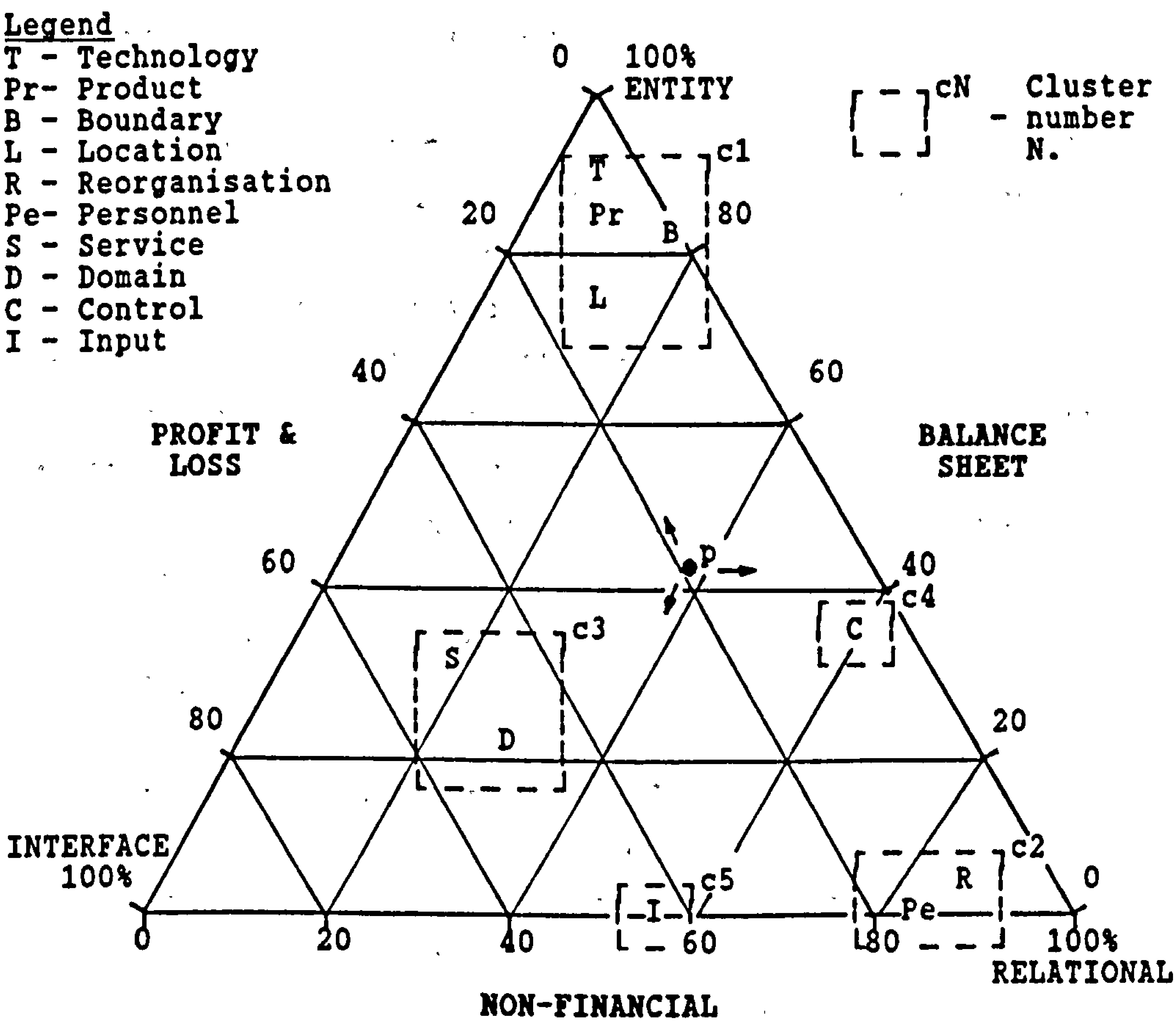
Comparing the hypothesised cluster membership relationships (Table 3.2) with the cluster analysis results (figure 3.3) identifies cluster c1 as Entity decision topics plus the Product category. In addition, the resource commitment to these topics is, as anticipated, characterised by a high (85%, table 3.3) proportion of Balance Sheet risk decisions. Similarly, cluster c2 is primarily associated with decision topics involving negligible financial risk and comprises Relational decisions. An explanation as to why control topics were not included in this cluster is obtained by observing that 7 of the 19 decisions in this category involved the purchase of data processing equipment and were therefore classed as Balance Sheet risk decisions. This was sufficient for the analysis to separate this topic as a separate cluster. Inspection of figure 3.3 however, shows this category to be 'near' the Relational cluster. This conclusion is supported by discriminant analysis, which assigns to control decisions a 92.6 per cent probability of being associated with cluster c2. Finally, clusters c3 and c5 correspond to Interface topics. The separation into two clusters, with the introduction of Service decisions, is explained by the observation that cluster c3 is concerned with interfacing the organisation to its environment, whereas c5 interfaces the environment to the organisation. The observed separation into two types of Interface decision is therefore not surprising. In terms of Porter's (1980) model of the five forces driving competition, two (the bargaining power of buyers and suppliers) can be equated with Interface topics. This model, therefore, also indicates that Interface decisions are essentially of two types.

It will be observed that, although three variables were used to identify the topic clusters in the above analysis, these three variables exhibit only two degrees of freedom. This is because the sum of the relative frequencies of the three risk categories is constrained to total 100 per cent. Specifically, arbitrarily specifying two of the variables uniquely fixes the third. As only two degrees of freedom are present, the locations of the decision topics, and the resulting clusters, can be accurately represented in two dimensional space. The problem is how to construct the axes defining this space. Factor analysis could be used to combine the three variables into two orthogonal factors. These two factors would account for all the variation in the data, because there are only two degrees of freedom. This approach has not been used, however, because of the difficulty in interpreting such factors. Instead, a representation based on equilateral triangular co-ordinates has been used. This method uses three axes, one for each of the three risk categories, thus enabling a straight forward interpretation of each axis. The chemical literature makes extensive use of this method to illustrate graphically concentrations within ternary systems (Treybal, 1968).

Figure 3.4, over, shows the ten decision topics specified by Hickson *et. al.* (1986) plotted on equilateral triangular co-ordinates. Each axis is scaled from 0 to 100 per cent to represent the relative frequencies of each risk category. Each apex of the triangle corresponds to only one risk category being present. In line with the postulated relationship between the taxonomy and surrogate measures, each apex has been labelled with the appropriate organisational change category. In addition, the five topic clusters identified by cluster analysis are represented by broken boxes, and labelled in accordance with the convention used in table 3.3a. Boxes have been used because they are convenient, not because the clusters are assumed to be rectangular in shape.

The point labelled 'p' on figure 3.4 represents the average of all 150 decisions, that is the mid-position of all the data if they formed a single cluster. The co-ordinates of this point have been given previously as 42% Balance Sheet risk, 19% Profit and Loss risk, and 39% Non-financial risk. The three small arrows point to the appropriate axis from which these figures may be read, namely, horizontal for Balance Sheet, upwards and to the left for Profit and Loss, and downwards and to the left for Non-financial. The input decision, cluster c5, is therefore seen to correspond to 0% Balance Sheet, 44% Profit and Loss and 56% Non-financial risk, as given in table 3.3a. The data in table 3.3a may be used to locate the centroids of the topic clusters which are not shown on figure 3.4.

Figure 3.4: Decision Topics positioned by Risk Category.



Initially we observe that most of the universe defined by the axes in figure 3.4, is empty. This is in line with the postulate that decisions should cluster around the apexes of the diagram. In addition, further inspection of figure 3.4 confirms the previous discussion, namely that cluster c1 corresponds to Entity decisions and c2 with Relational decisions. Cluster c3, however, is fairly well displaced from the 100 per cent Profit and Loss apex postulated for Interface decisions. A possible explanation of this is that such decisions would not be viewed by senior management as strategic. Note that Profit and Loss risk decisions are decisions involving revenue expenditure to implement the decision. Revenue expenditure is normally the province of operational managers with budgets. The strategic component of revenue expenditure is therefore handled during the budget fixing process, which is a control topic. This may explain why Profit and Loss risk decisions are relatively poorly represented in the total sample. Thus, although Interface topics are strategic, Profit and Loss risk is not as good a surrogate measure for such decisions as Balance Sheet risk is for Entity decisions or Non-financial risk is for Relational decisions.

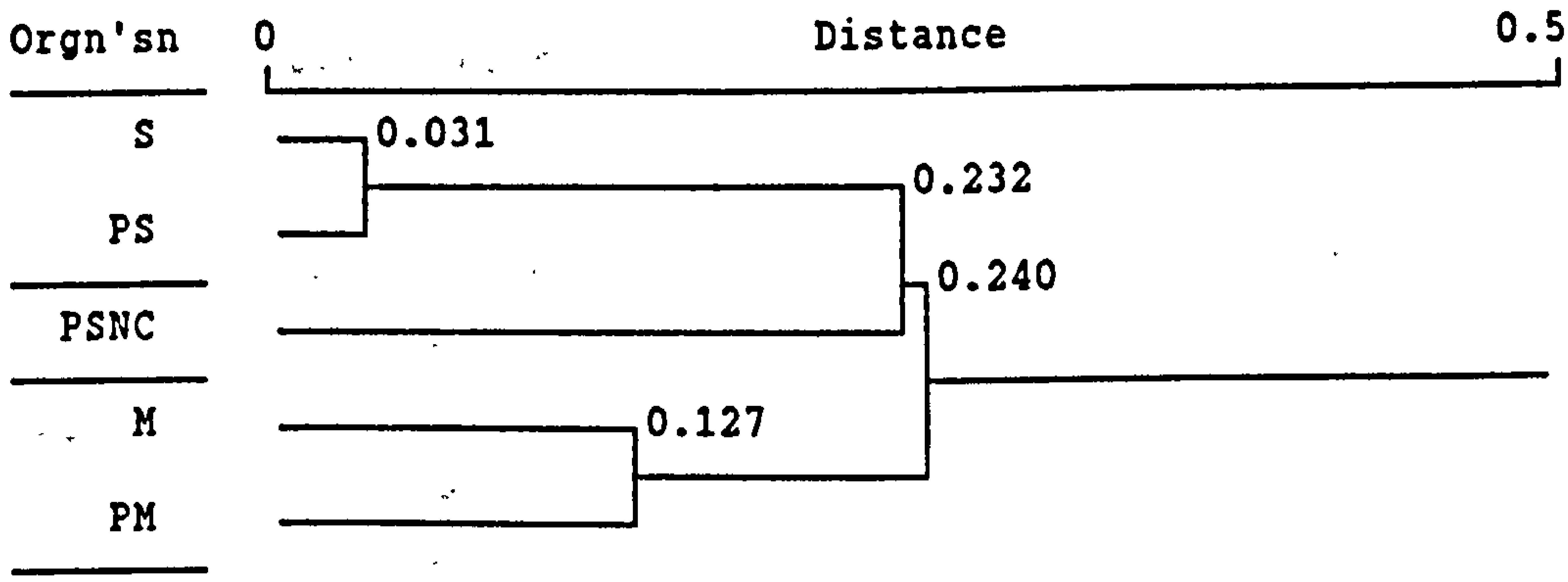
If the above discussion on the absence of pure Profit and Loss risk categories is valid, then it implies that a non-strategic / strategic dimension can be drawn on figure 3.4. This dimension will bisect the figure, passing through the 100 per cent Profit and Loss risk apex on the left, and the Balance Sheet risk axis at the 50 per cent scale point on the right. It will be observed that such an axis passes nearly through the point 'p'. The significance of such an axis will be returned to latter, but provisionally we may note that if strategic decisions are viewed as being 'important' (Mintzberg *et. al.*, 1976) then topic clusters c3 and c5 may be viewed as being relatively less important than topics c1, c2 and c4.

In conclusion, empirical cluster analysis produces results consistent with the theoretical taxonomy developed at the beginning of this chapter. Also, a non-strategic / strategic dimension has been identified within the decision topics which has implications for the relative importances of strategic decisions. Finally, the placing of product and service topics in two different categories justifies the classification of output decisions as being of two inherently separate types dependent on the nature of the organisation's purpose.

3.2.1.1 A Classification of Organisations

Hickson *et. al.* placed each of their 30 organisations into one of five categories. A hierarchical cluster analysis was performed in the manner previously described on these organisational categories. This analysis is illustrated in figure 3.5 over.

Figure 3.5: Cluster Analysis on Organisation Categories



Legend

S - Private Service
PS - Public Service (Commercial)
PSNC - Public Service (Non-commercial)
M - Private Manufacturing
PM - Public Manufacturing

Three clusters of organisations are identified from the above analysis. These may be titled, Manufacturing, Commercial service and Non-commercial service. (No construction, retail or tourism organisations were studied by Hickson *et. al.* (1986) whether such organisations would form their own cluster or fall within one of those identified is open to speculation.) The actual distribution of risk category by organisation cluster is illustrated in table 3.4.

Table 3.4: Relative Frequency (%) of Decisions in Organisation Clusters by Risk Category.

ORG'N	RISK B/S	RISK P/L	RISK N/F	Number
MFG	65	9	25	11
CS	31	36	33	11
NCS	25	10	65	8

MFG - Manufacturing (public and private)
CS - Commercial service (public and private)
NCS - Non-Commercial service (public only)

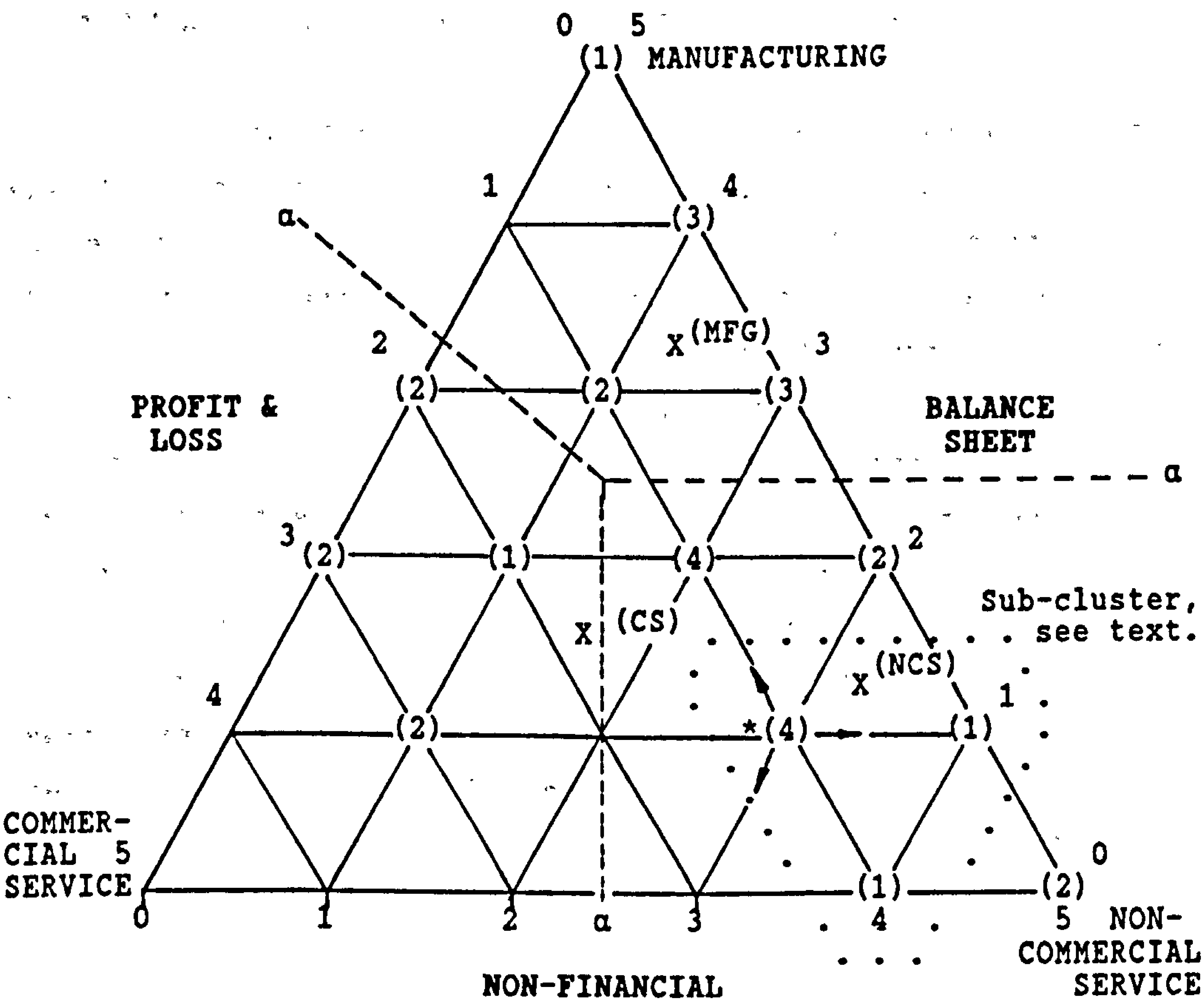
A chi-squared analysis for this table shows a high degree of association between the two dimensions of risk and organisation (d.f=4, $p<0.005$). The data presented in table 3.4 indicates that the three types of organisation differ quite markedly in the relative proportions of each risk category, and by inference the proportions of

Entity, Interface and Relational decisions considered by them. That this is so can be partially justified through the work of Aguilar (1967). Aguilar was interested in the sources and content of external information used by organisations as input into their strategic decision making processes: essentially, information about the exogenous factors affecting an organisation. In defining strategic decisions Aguilar decided, based on his studies, that strategic decisions were not, day-to-day, or pertaining to organisation and staffing. In effect, Relational decisions were not strategic decisions. In Hickson *et. al.*'s sample, reorganisations alone were the second most frequent decision topic encountered. This discrepancy can be understood by noting that, firstly 91 per cent of the organisations studied by Aguilar were manufacturing companies, predominantly chemical manufacturers and secondly, the manner in which Hickson *et. al.* selected their decisions for study, would tend to under represent the most frequent decision types. It is possible, therefore, that Aguilar identified so few organisation and staffing decisions in his sample that he concluded they were not strategic. Hence, although the proportions between decision types indicated in table 3 are partially artifacts of the method by which the investigators selected the decisions, nevertheless significant differences do exist between types of strategic decisions encountered within the three types of organisation studied.

The three organisation types identified above may be represented by plotting each organisation's position using equilateral triangular co-ordinates (figure 3.6). As exactly five decisions were studied by Hickson *et. al.* within each organisation the three axes on this figure represent the frequency (0 to 5) of the number of times that risk category was studied within a given organisation. The apexes of the diagram have been labelled with the type of organisation for which the appropriate risk category is most likely to occur within, as indicated by inspection of table 3.4.

Figure 3.6: Organisations positioned by Risk Category.

Legend
α - - - - - - - Discriminant boundaries between 3 organisation types.



*-Example: (4) - Number of organisations at location, each having one Balance Sheet, one Profit and Loss and three Non-financial strategic decision.

The mid points of each organisation cluster are indicated by an 'X' on figure 3.6 and labelled in accordance with table 3.4. As there is some overlapping of clusters on this diagram, discriminant analysis was used to locate the cluster boundaries. The broken lines shown on figure 3.6 and labelled 'α', represent the boundaries separating the three organisation type clusters. Of 11 manufacturing organisations studied, 9 occur in the manufacturing section of figure 3.6. Of 11 commercial service organisations, 6 are placed in that sector. All 8 non-commercial organisations studied are correctly located. Most of the variation caused by the overlapping of clusters occurs within the indicated sub-cluster. Three of the organisations within this sub-cluster are commercial service organisations. These are an insurance company, an entertainment company (both private) and a public utility (water) organisation. A private manufacturing company (brewery) is also located within this sub-cluster.

3.2.1.2 The Relative Importance of Topic Clusters

A further valuable conclusion that may be drawn from the analysis of Hickson *et. al.*'s (1986) data, and the framework used here, is in determining the relative importance of the types of decision. In the study by Hickson *et. al.* a variable called 'consequentiality' was defined for each decision topic category. This was a composite variable consisting of two Likert 5 point rating scales (Radicality - how far the decision changed things, and Seriousness - how serious it would be for the organisation if things went wrong) and two measured factors, one discrete (Diffusion - how widespread were the decision's effects) and one continuous (Endurance - how far ahead people looked when making the decision). Ranking each of these factors leads to an overall ranking of the consequentiality of a decision topic. Using the five decision topic clusters identified above, the consequentiality rating has been used to determine the relative importance of each topic cluster. This is summarised in table 3.5, below.

Table 3.5: Consequentiality of Decision Topic Clusters

Cluster	Mean rank on 1-10 scale	Overall rank
c1 Location/Product/Technology /Boundary	3.5	1
c4 Control	5	2
c2 Reorganisation/Personnel	5.5	3
c3 Service/Domain	7.5	4
c5 Inputs	10	5

The observation that the control cluster is ranked very close to cluster c2 lends further support to the thesis that these items are associated.

Cluster c1 (Entity decisions) is seen to be the most significant group of decisions. This should not be too surprising, once it is noted that any Entity decision also involves, as a necessary consequence, a Relational decision. This effect was noted by Woodward

(1965) where, on a number of occasions, Technology and Location decisions were simultaneously used as opportunities for reorganisations. Further support for seeing cluster c1 items, the Balance Sheet risk decisions, as the most consequential is provided by Paul *et. al.* (1978). They comment that "an overly bold and un-recoverable Balance Sheet risk is the true risk [whereas] the effects of a poor Profit and Loss risk...can often be managed within the time frame of the current fiscal year". However, their reason for stating this is observed in the comment that, "a Balance Sheet mistake is almost always corrected by a clean sweep of existing management". A similar conclusion is reached by Pahl and Winkler (1974). Pahl and Winkler studied the processes of power among directors of 19 companies. They decided that power was not, necessarily, synonymous with authority but depended on the ability to control the allocation of capital. Hence, decisions involving capital will involve power interests not present in non-capital decisions. Finally, we note that the rank order of each topic cluster is in agreement with the predicted rank based on the notion of decision reversibility identified earlier. Specifically, cluster c1, the Entity topics involving capital expenditure are the least reversible and therefore the most consequential. Clusters c3 and c5 are Interface topics involving revenue expenditure are the most reversible and therefore the least consequential. This association between reversibility and type of financial commitment to a project was also observed by Jones and Trentin (1971,p.132):

> "Because the commitment of funds in capital projects is irrevocable, plans and proposals for these expenditures are carefully examined by management and the directors. A faulty decision to enlarge the staff for a particular function may be corrected by cutting back, thereby terminating the effect of the decision. But funds put into brick and mortar represent sunk or fixed costs and cannot generally be terminated or retrieved without considerable financial sacrifice."

We therefore conclude that decisions involving Balance Sheet risks (Entity decisions) are the most consequential for organisations. Interestingly, Non-financial risk decisions (Relational) are more consequential than the least consequential Profit and Loss risk decisions (Interface). This observation supports the hypothesis made earlier, namely that a non-strategic / strategic dimension can be drawn bisecting figure 3.4 and that decisions involving predominantly

Profit and Loss risk (revenue expenditure) are essentially operational in nature. This ranking also reflects the relative frequencies of Balance Sheet, Non-financial, and Profit and Loss, risk decisions in the total sample; namely 42%, 39% and 19% respectively. This again supports the thesis that Profit and Loss risk decisions are the least strategic and therefore least consequential.

3.2.2 STRATEGIC DECISION-MAKING PROCESSES

The central conclusion of Hickson *et. al.*'s work was that decision making at the level of top management or administration can be described by three types of organisational, or social, process. These three processes were derived by factoring ten process variables into two dimensions (labelled 'Discontinuity' and 'Dispersion') and then using hierarchical cluster analysis on the 136 decisions for which data was complete. The three process clusters so identified were named, Sporadic (informally spasmodic and protracted) Fluid (steadily paced, formally channelled and speedy) and Constricted (narrowly channelled). It was also observed that each of the three types of process accounted for approximately one third of the total sample, and that they form a triangular pattern when represented on the Discontinuity / Dispersion dimensions. By combining clusters c3 with c5 and c2 with c4, table 3.3 shows similar relative proportions between the three resulting aggregate clusters, that is, approximately one third of the decisions fall into each combined cluster.

On inspection of the factor loadings published by Hickson *et. al.* for the 10 process variables on the two dimensions, it is observed that the Dispersion dimension is primarily (67%) a dimension of authority. Specifically, how high within the hierarchy the process culminated, indicated by a score for the level at which implementation was authorised and could then commence. Assuming that authority level is a measure of importance, then the non-strategic / strategic dimension previously noted in connection with figure 3.4 is seen to be analogous to the Dispersion dimension identified by Hickson *et. al.* Their Discontinuity dimension would then appear on figure 3.4 as a line passing through point 'p' (the centroid of all decisions; on the figure located at 42% Balance sheet, 19% Profit and Loss and 39% Non-financial risk) and parallel with the Balance Sheet risk axis. The pattern formed by the three main clusters c1, c2 and c3 in terms of these Dispersion and Discontinuity dimensions suggests the possibility of a correspondence between the taxonomy of organisational change presented here and Hickson *et. al.*'s taxonomy of decision-making process. Furthermore, the examples cited by Hickson *et. al.* as archetypes of the three processes are:

- o Sporadic - Boundary topic in manufacturing company; categorised as Balance Sheet risk.
  and Product topic in manufacturing company; categorised as Balance Sheet risk.

- o Constricted - Service topic in commercial service company; categorised as Profit and Loss risk.

- o Fluid - Input topic in commercial service company; categorised as Non-financial risk.
  and Input topic in non-commercial service organisation; categorised as Non-financial risk.

These examples identify Sporadic processes with the c1 cluster of topics, Constricted processes with c3 topics and Fluid processes with c5 topics. However, Hickson *et. al.* (1986,p.161) point out that "a topic label is not an instant selector of one single type of decision-making process...In fact, there is no topic which is handled in one single way". A contingency table analysis bears out this observation, as non-significant results are obtained between both the Risk v Process categories (d.f.=4, p=0.90, Goodman-Kruskal Gamma = -0.08). and organisational Change v Process categories (d.f.=4, p=0.27, Goodman-Kruskal Gamma = -0.14). A further analysis does indicate however, that c1 cluster topics (Balance Sheet risks) are primarily associated with Sporadic processes. These topics may also be processed in a Fluid mode, except Product topics which can be processed in a Constricted mode. The associations between Fluid and Constricted processes with Non-financial and Profit and Loss risk topics respectively are less well defined than between Sporadic processes and Balance Sheet risk topics. However Hickson *et. al.* (1986,p.248) conclude that in determining decision process the "matter for decision matters most", which again suggests that decision process is dependent upon the nature of the organisational change implicit in the decision under consideration. As previously noted, certain types of decision appear to predominate in each of the three types of organisation, as illustrated in table 3.5 and figure 3.6. Hickson *et. al.* also make this observation, but tend to view the demarcation more along ownership lines than the categorisation used here based on nature of output.

Hickson *et. al.* (1986,p.257) comment on the way in which one process may be changed into another type:

> "For instance, what begins as an idea for a complete new product line can be scaled down so that the topic under consideration becomes just a modification to existing product lines. Thus its consequences will become less serious and more susceptible to confident forecasts...So a vortex matter is replaced by one that is familiar and can be moved along in a less bothersome constricted way."

The "vortex matter" refers to a subject processed in a Sporadic way. Hickson *et. al.* state that such decisions are characterised by high complexity and high politicality. Tractable matters are processed Fluidly and are characterised by lower complexity and least politicality. Familiar matters are processed in a Constricted mode and are characterised by least complexity and are only mildly political. This dual explanation of decision process in terms of Complexity and Politicality is the primary theoretical framework used by Hickson *et. al.* However, if the associations presented here are valid, then instead of concluding, as Hickson *et. al.* (1986,p.241) do, that "to know the process, first know the complexity of the problems and the politicality of the interests", we would conclude - to know the process, first know the nature of the organisational change being proposed, - which, in terms of the taxonomy presented here would be, Entity, Interface or Relational changes.

The theoretical explanation presented by Hickson *et. al.* for their findings is not necessarily different to the explanation of process proposed here. We have previously noted, from the work of Pahl and Winkler (1974) that Entity changes (equated with capital investments) involve high powered interests. Hickson *et. al.*'s association of politicality with Sporadic processes is therefore in agreement with the approach presented here if we equate power with politicality. However, although knowing the nature of organisational change implicit in a decision may be a necessary condition for determining process, the work of Hickson *et. al.* shows that it is not a sufficient condition. Specifically the conditions and mechanisms by which a matter of nominally one type may be transformed into a that of another is worthy of further research. The basic cybernetic arguments with which this paper started would lead us to hypothesis that six such mechanisms exist, as the mechanism by which a Vortex matter is translated into a Tractable one, say, cannot be assumed to be the same as that by which a Tractable matter is transformed into a Vortex one.

Starting from the premise that strategic decisions involve changing an organisation, a taxonomy of three decision topics was proposed. This taxonomy was operationalised in terms of financial accounting concepts, specifically in terms of the risk to the organisation's statutory financial statements inherent in the decision's implementation. Finally, empirical data was analysed which lead to a confirmation of the taxonomy. It was also tentatively shown that a correspondence may exist between the taxonomy of strategic change proposed here and the empirical categorisation of strategic decision making processes developed by Hickson *et. al.* (1986). We now aim to investigate the possibility of adapting the proposed taxonomy to identify a taxonomy of implementation projects.

3.3 A TAXONOMY OF IMPLEMENTATION PROJECTS

Extending the taxonomy of strategic decisions developed above to a taxonomy of implementation projects is quite natural in light of the method used to operationalise the taxonomy. This was achieved by assessing the down side risk to the organisation's statutory financial statements during the implementation of the decision. This operational definition enabled risk to be categorised as either balance sheet, profit and loss, or non-financial. In chapter 2 it was argued that implementation (in the form of strategic change) was carried out via projects. Projects may also therefore be categorised according to the nature of the down side risk, in financial terms, to the organisation during implementation. If the risk is to the balance sheet, then implementation will be via the capital project. If it is to the profit and loss account, it will be by the revenue project. Finally, if no, or insignificant, financial resources are to be committed, implementation will be by the social project. This scheme is summarised in table 3.6 below, together with the type of change implicit in the strategic decision initiating the project.

Table 3.6: Taxonomy of Projects

Strategic Change	Financial implementation risk to:	Project type to implement
Entity	Balance Sheet	CAPITAL PROJECT
Interface	Profit and Loss Account	REVENUE PROJECT
Relational	Negligible risk involved	SOCIAL PROJECT

The inclusion within the taxonomy of projects involving no, or negligible, financial risk may, at first sight, appear superfluous. As we are considering the implementation of strategic decisions then all projects within the taxonomy will have long term financial consequences for the organisation. In addition, the taxonomy is based only on a financial dimension. Low consumption of financial resources does not imply low consumption of other resources, such as managerial time or effort. Indeed, we have already noted the priority ordering of the risk categories in terms of decision consequentiality. This showed that non-financial risk decisions, i.e., social projects, are the second most consequential, next to capital projects. Woodward (1965,p.44) notes this point when referring to "technical and administrative developments" as causes of radical change within organisations. In terms of our implementation taxonomy we may note that "technical developments" refers to technology topics, which are likely to be implemented via capital projects. "Administrative developments" will be implemented by social projects, being reminiscent of reorganisation and personnel topics. Woodward's identification of these two items is therefore in agreement with the implied prioritisation of the project categories imputed from our earlier discussion of decision making. Thus social projects are an important category of our taxonomy.

This scheme of classifying projects as capital, revenue or social can be readily accommodated within a general definition of a project, viz:

> "An activity directed towards a specific objective, with an expected duration, is the responsibility of a named individual, and a budget."

This definition (based on Coomds *et. al.* 1987,p.70) includes our definition of a goal (derived in chapter 2, i.e., objective and duration) but also includes reference to a named individual and a budget. Our project classification scheme can be accommodated by simply changing the budget aspect of this general definition. Coombs *et. al.*'s reference to a project being made the responsibility of a named individual is also interesting. It accords with one of the three key questions to be addressed if strategy implementation is to succeed (Wheelen and Hunger, 1987). Failure to allocate responsibility was also noted by Mills (1988) as a key problem in implementing capital projects within the U.K. The definition above is therefore prescriptive and not a trivial statement of normal practice.

Our three way definition of projects also appears to have utility in terms of describing how strategy is implemented. Wheelen and Hunger (1987,p.210) give an example of how various *programmes* would have to be developed to implement a forward vertical integration growth strategy in a retail organisation. Examples of these *programmes* are; (1) an advertising programme: (2) a training programme: (3) a programme to develop reporting procedures and: (4) a programme to modernise the stores. If we view these programmes in terms of Hickson *et. al.*'s (1986) decision topic categories and equate with our project taxonomy, then we identify programme (1) with a revenue project: (2) with a social project: (3) also with a social project and (4) probably with a capital project. Wheelen and Hunger appear to see programmes and projects as synonymous; other authors do not. Jones and Trentin (1971) and Bonoma (1984) both view a programme as a collection of projects. Adopting and expanding this idea we will define a programme as a linear combination of, at least one but possibly several, capital, revenue and social projects. The common starting point will be a single strategic objective. This will have been factored into a number of separate goals, each generating its own project.

3.4 CHAPTER SUMMARY

From the basic proposition that strategic decisions are essentially about changes to an organisation, three types of organisational change were identified using arguments derived from cybernetic concepts. These three types of change were labelled, Entity, Interface and Relational. By invoking concepts derived from accountancy practice and technology it was postulated that the three types of organisational change could be identified by considerations of the downside risk, in financial terms, to the organisation during the decision's implementation. Three types of risk were identified, namely Balance Sheet, Profit & Loss and Non-financial.

Empirical data collected by Hickson *et. al.* (1986) were re-analysed to test the above taxonomy. These data, originally analysed from a behavioural perspective of the organisation, enabled a number of conclusions to be reached. First, the three risk categories identified were reasonable surrogates for the three types of organisational change proposed. Specifically, Balance Sheet risks were surrogates for Entity changes, Profit and Loss risks for Interface changes and Non-financial risks for Relational changes. Second, the same three risk categories were shown to identify three types of organisation. These were labelled as Manufacturing, Commercial service and Non-Commercial Service. These three organisational types were characterised by the relative proportion of each risk category encountered in a sample of strategic decisions from each type. Specifically, Balance Sheet risk decisions predominated in Manufacturing organisations, whereas Non-financial risk decisions predominated in Non-commercial Service Organisations. In Commercial Service organisations no risk category predominated to any great extent. Third, using concepts defined by Hickson *et. al.* (1986) it was shown that Balance Sheet risk decisions were viewed as being the most consequential for an organisation. Non-financial risk decisions were second in consequentiality with Profit and Loss risk decisions viewed as being the least consequential. this prioritisation was seen to reflect the irreversibility of the strategic decision after implementation. Fourthly, an association between the taxonomy presented here and the three modes of decision-making process identified by Hickson *et. al.*, was tentatively affirmed. This lead to the assertion that decision-making processes are primarily explicable in terms of the nature of the organisational change implicit in the decision topic. However, a fuller explanation of process also needs to take into account the factors that cause, as Hickson *et. al.* observe, a process of nominally one type to be changed into another type.

Finally, a categorisation of projects was derived based on the aforementioned risk categories. From this it was hypothesised that strategic decisions involving an Entity change would probably be implemented via a capital project. Relational changes would be implemented via social projects and Interface changes via revenue projects. The prioritisation of risk categories also leads to the conclusion that capital projects are the most important to an organisation. We also defined a programme as a combination of several projects. In this sense, a project is the atomic unit of analysis for the study of the implementation of strategy. Having produced a parsimonious classification of projects we now need to develop a model of project implementation and identify a meaning of implementation success.

CHAPTER 4

FRAMEWORK AND HYPOTHESES

The purpose of this chapter is to introduce a conceptualisation of project implementation which is quantifiable. Initially we will identify the concepts and constructs necessary to define a contingent framework for the analysis. Following this, a case study is presented illustrating some of the points made during the theoretical discussion. The contingent framework is developed in the third section and the chapter ends with a number of hypotheses based on the principle causal relationships identified within the framework.

4.1 IMPLEMENTATION AND ORGANISATIONAL LEARNING

4.1.1 CHANGE AND CULTURE

It has been argued here that change is the natural outcome of an implementation process. The observation that implementation produces change within organisations is a common theme in much of the literature dealing with the implementation of Management Information Systems (e.g. Mumford and Pettigrew, 1975; Sorensen and Zand, 1975; Ginzberg, 1978) the literature dealing with the adoption of technological innovation (Seashore *et. al.*, 1983; Zaltman *et. al.*, 1973) as well as the business policy literature dealing with strategy implementation (Hrebiniak and Joyce, 1984). In the previous chapter change was conceptualised using cybernetic concepts and we will continue to adopt this approach here. In doing so we focus more on the structure of the change than on its social and behavioural aspects. In other words, we are looking at the implementation effects which are inevitable.

In any academic endeavour it is probably the intention of the author(s) that their thesis will make a relevant contribution to theory and practice. Hrebiniak and Joyce (1984) identified three criteria that must be satisfied for this to be the case:

1. Logic - The use of a logical model to enable the deduction of consequences.
2. Action - Variables must be 'objective' and 'manipulable'.
3. Contingent perspective - Not to say "It all depends" but to say what it all depends on. In addition the choice and the criteria for choosing must be indicated.

To satisfy these criteria it will be necessary to identify those factors which affect change. Two such factors (identified in chapter 3) are the concepts of Uncertainty and Information, both of which have received considerable attention in the contingency theory literatures (e.g., Downey *et. al.*, 1975; Galbraith, 1969). Another factor, identified by Stonich (1982) as important to strategy implementation, is the concept of organisational culture. This concept has, over the last decade, also been implicated in discussions on, socialisation processes and outcomes, leadership, employees' commitment, motivation and satisfaction at the workplace, and organisational effectiveness and efficiency. However, a problem with the culture concept is the large number of differing conceptualisations found within the management literature. As Alvesson (1989) commented:

> "Culture can be - and sometimes is - used in a way which comprises everything and, thus, nothing."

Culture is therefore another of Andrew's (1971) "accordion-like" words. We will take the approach adopted in chapter 2 for dealing with it, namely define it in the way that most suits or needs. The need here is for an instrumental conceptualisation.

Many authors define culture as behavioural "norms", "values", "symbols" and "assumptions". Alvesson demonstrated that many of these definitions are tautological. Schein (1984) defines organisational culture in these terms but makes the additional point that his definition "derives from a dynamic model of learning". Clegg *et. al.* (1988) in a discussion of Economic Culture, produce an instrumental definition of culture as an 'institutional framework', thus making the term "culture" effectively redundant.

Norman (1985) in his discussion of strategic management capability commented that "perhaps culture could be defined as the institutionalised [communication] language and values of an organisation." This formulation is interesting in the light of cybernetic theory, as in this theory entities within a system communicate through channels and transducers. The function of the transducer is to code and decode the information passing into or from the communication channel. How the transducer is designed determines how information is coded and decoded for transmission. In organisations the most common form of transduction is converting thoughts and ideas into language, written or spoken. Whether the original thoughts can be decoded will depend upon the recipients' understanding of and the ambiguity of, the words communicated. This may depend upon a shared understanding of the organisations norms, values etc.

Both Clegg *et. al.*'s and Norman's conceptualisation of culture appears to view the concept in terms of the institutions prevailing in the organisation, be they at the macro- or micro-economic level. These in turn can be conceptualised in terms of communication nets and principles incorporated within the organisation's transducers. This raises the question of how these institutionalised properties of an organisation come into existence and how they can be changed. Schein points to an answer of this question by noting the connection between culture and learning. Norman also takes the view that culture acts as a "storage of past learning" and as an instrument to "communicate this learning throughout the organisation". Subsequently, Norman (1985, p.231) makes the following formulation:

> "I would interpret the increasing interest in the concept of culture as really an increasing interest in organisational learning"

The thesis that concepts of change and learning are closely related is supported by several authors. Cyert and March (1963,p.99) viewed the firm as an "adaptive system". The dictionary definition of adaptation is the act of adjusting to change. Cyert and March (1963,p.100) argue that:

> "a business organisation is an adaptive institution. In short, the firm learns from its experience."

Cadwallader (1959) in a paper on the analysis of change in complex social organisations makes a similar point "...open systems adapt to a fluctuating environment through processes of learning and innovation."

4.1.2 ORGANISATIONAL LEARNING

Superficially, redefining the concept of organisational change, via the concept of organisational culture, as organisational learning, does not appear to advance us very far. In addition, some authors would tend to reject the concept of organisational learning outright. Lupton and Tanner (1987,p.77) state unequivocally:

> "An organisation cannot learn. The term organisational learning can only mean *firstly*, that each individual member of the organisation can learn more about what it is and how it functions as a socio-technical system with economic purposes and *secondly*, that the knowledge and understanding gained can be more widely shared by the organisational members."

From a social, behavioural viewpoint this comment may make sense. From a Cybernetic standpoint it does not. Firstly, Katz and Kahn (1966,p.391) point out in a discussion of organisational change that:

> "The major error in dealing with problems of organisational change...is to...confuse individual change with modifications to organisational variables.
>
> The confusion between individual and organisational change is due in part to the lack of precise terminology for distinguishing between behaviour determined largely by structured roles within a system and behaviour determined more directly by personality needs and values."

In other words an organisation is more than the sum of its individual members. The constraints imposed upon its members by the structure of the organisation are also important in understanding change. It may also be supposed, from the preceding argument, that these structural constraints are important in understanding organisational learning.

A second critique of Lupton and Tanner's stance comes from Cybernetic theory. The Cybernetic paradigm views the organisation as having a limited repertoire of action patterns or programmes (Steinbruner, 1974). These patterns persist until feedback on critical variables forces a variable out of its tolerable range, whereupon there is a change in the pattern. If the new pattern restores the variable back to its tolerable range the pattern will persist. "Learning occurs in the sense that there is a systematic change in the pattern of activity in the organisation" (p78). This process manifests itself as a change in behaviour of the organisation. Furthermore, Steinbruner identifies these action patterns, or programmes, with the organisation's standard operating procedures. The limited repertoire of action patterns therefore refers to a repertoire of standard operating procedures. These procedures embody the organisation's past learning and constitute its skills. They are distinct from the skills of the organisational members as they define the constraints under which those members must operate.

That standard operating procedures are important to the study of organisations was recognised by Cyert and March (1963,p.101):

> "standard operating procedures should be one of the major objects for study by students of organisational decision making... We do not think a reasonable theory of the firm can ignore such procedures."

They follow this comment with a twofold categorisation consisting of; 'Specific standard operating procedures' (task performance rules, information handling rules, recording and reporting rules, plans and budgets) and 'General choice procedures' (maintaining the existing rules, use simple rules and rules to avoid the need to predict uncertain future events). In addition Cyert and March linked changes in standard operating procedures with the organisation's learning behaviour. Specifically, "Standard operating procedures are the memory of an organisation (p100)".

The importance of standard operating procedures to the study of organisations may also be illustrated if we accept Stonich's (1982,p.34) view of corporate culture as, "the way an organisation performs a given set of tasks". This approach to corporate culture is supported by invoking the socio-technical concept developed by Trist and others (see Trist *et. al.*, 1963). The principle of this approach is that socio-psychological factors are in-built characteristics of work systems, they are not additional characteristics. If standard operating procedures define the way given tasks are performed (Wheelen and Hunger, 1984) then standard operating procedures must also determine an organisation's socio-psychological climate, in other words its culture. Accepting Norman's (1985) statement that an interest in corporate culture is an interest in organisational learning shows that the focus of our study is properly with an organisation's standard operating procedures.

A further link between organisational learning and standard operating procedures, if we accept some minor changes in nomenclature, is provided by some of the more recent anecdotal writings of Waterman (1988) and Peters (1984). Waterman writes about 'skill building' and viewing the company as a 'bundle of skills, capabilities and competence' and that firms should seek to develop new, better skills. Peters (1984) uses similar metaphors referring to organisations having a repertoire of skills and distinctive competency and these form the basis for adaptive strategy. These comments echo the cybernetic view of the organisation developed above and, in addition, suggest that skills, or standard operating procedures, are the basis for 'finding' or 'discovering' business unit strategies in the learning organisation.

4.1.3 SKILLS AND VARIETY REDUCTION

In chapter 3 it was suggested that the primary task of an organisation when implementing a strategic decision, was variety absorption. Variety represents uncertainty and it is reduced by processing information. Finally this leads to organisational learning, reflected in changes to the standard operating procedures and thus, behaviour. The method by which a repertoire of standard operating procedures absorbs variety can be derived from Ashby's (1956) conceptualisation. A slightly modified version of Ashby's arguments will be presented here.

Consider a game of two players, D and R. The object of the game is that R should score an *a*. All possible moves and outcomes are represented in table 4.1. Note that no outcome is repeated in any column of the table; a restriction which will be modified later.

Table 4.1: Adapted from Ashby, table 11/3/1. p202.

		R		
		α	β	γ
D	1	*b*	*a*	*c*
	2	*a*	*c*	*d*
	3	*c*	*b*	*a*

D plays first by selecting a number (1..3) corresponding to a row in the table. R responds by selecting a Greek letter corresponding to a column in the table. If the outcome (given by the intersection of the selected row and column) is an *a*, then R wins, else R looses.

Now consider the case where D has a fourth move available but R still only three responses. The situation will be as illustrated in Table 4.2.

Table 4.2: Increased Variety to D

		R		
		α	β	γ
D	1	*b*	*a*	*c*
	2	*a*	*c*	*d*
	3	*c*	*b*	*a*
	4	*d*	*d*	*b*

It will be apparent that R cannot win in all cases. If D selects row 4, then R can only make a sub-optimal choice by selecting γ say, with outcome *b*. In effect the variety of possible outcomes from the game has increased from 1 (*a* only) to 2 (*a* or *b*). In general, the minimum variety of outcomes from the game is given by the quotient:

$$\frac{\text{D's variety}}{\text{R's variety}}$$

This is a demonstration of Ashby's Law of Requisite Variety which states "the variety in the outcomes, if minimal, can be decreased further only by a corresponding increase in that of R" (p207).

In other words, the only way R can return to a wholly optimal outcome from the game i.e. a variety of 1 (*a*'s only) is by inventing, or learning a new response, δ say, such that the game's outcomes are as illustrated in table 4.3.

Table 4.3: Increased Variety to R

		R			
		α	β	γ	δ
D	1	*b*	*a*	*c*	*c*
	2	*a*	*c*	*d*	*b*
	3	*c*	*b*	*a*	*d*
	4	*d*	*d*	*b*	*a*

A consequence of the restriction imposed upon the construction of tables 4.1 to 4.3, i.e. no outcome can be repeated in a column, is, that if R's response to D's move is unvarying, always selecting α say, the variety of the outcomes will equal that of D. If this restriction is removed, by allowing say each element in a column to be repeated k times, then the variety of the outcomes will be:

$$\text{Variety of Outcomes} \geq \frac{\text{D's variety}}{k \times \text{R's variety}}$$

In this situation, if R's move is unvarying, some of D's variety will be absorbed.

Ashby (1956) demonstrated that the basic formulation of a game between two players had considerable generality and could be readily extended to give useful insights into the functioning of physical and biological systems. Specifically player D was equated with a disturbance influence, e.g. environmental, which threatens the system. Player R is a regulator whose function is to prevent the essential variables of the system from moving outside their proper ranges. The values of these essential variables correspond to the outcomes of the game. Of all the possible outcomes only a few are compatible with the system's survival, so that "...the regulator R, to be successful, must take its value in a way so related to that of D that the outcome is, if possible, always within the acceptable set" (p209). In terms of the current thesis, D the disturbance, is the specific strategic decision being implemented*. More specifically it will be a particular project (Capital, Revenue or Social). R is the organisation that has at its disposal a repertoire of skills or standard operating procedures (α, β etc.) that it may use to help absorb the variety from the project, thus ensuring an acceptable outcome for the organisation.

Using this formulation we gain a more fundamental insight into the meaning of the definition of implementation developed in chapter 2. To reiterate:

> Implementation is the process of interfacing an 'unprogrammed' decision making process to the organisations 'programmed' decision making processes.

In chapter 2 the process of programming was identified with "Means-end" analysis (March and Simon, 1958). Specifically, this process requires the organisation (the regulator) to select from its repertoire those procedures that will maintain the organisation's essential variables within bounds. We may hypothesise therefore that if the organisation's procedures are flexible (k as defined above much greater than 1) and, or, the programme's variety (the disturbance) is small, then this may be achieved using existing procedures. If on the other hand the organisation's procedures are relatively inflexible (k close to unity) and, or, the programme's variety is large, then this integration may not be possible using existing procedures and, as argued above, new procedures will have to be invented/learnt. In one important respect this latter outcome for the implementation process is the more substantive; the logic being that an increase in the flexibility of the organisation's standard operating procedures and or an increase in the number of standard operating procedures, will lead to an increased ability by the organisation to handle future disturbances, i.e. environmental variety. In other words the organisation's relative competitive advantage will have been increased, provided it can capitalise upon its new found flexibility. This concept, that changes to procedures can lead to longer term competitive advantage,

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* Ultimately D is an environmental threat to which the strategic decisions is a response. The variety absorbed between, D the strategic decision and D the environment, is the province of strategy formulation. This is outside the scope of this study.

appears to be similar to the idea of *Gateway Capacity* identified by Zaltman *et. al.* (1973,p.45) in their book looking at factors leading to the adoption of innovations within organisations. They define the concept thus:

> "In addition to the intrinsic value derived from the adoption of an innovation, an additional value can accrue to the extent that the *adoption of an innovation can open avenues to the adoption of other innovations.* It could well be that the increased opportunity for the adoption of other innovations is the intrinsic value of the initial facilitating innovation." (Original emphasis retained.)

By way of anecdotal evidence for this supposition a case study from the author's research will be discussed next.

4.2 <u>A CASE STUDY</u>

4.2.1 CASE DESCRIPTION

The research took place within a packaging manufacturing company that, at the time of the research, was a subsidiary of a division of a U.K. owned multinational. The following summarises over four hours of tape recorded unstructured interviews within the company, combined with the author's reflective surmising upon the data. Four interviews were held, initially with the Managing Director (C.E.O.) and subsequently with the Financial Manager, Departmental Manager and the Project Engineer principally responsible for the project. The initial interview with the C.E.O. had a number of objectives not in common with the three following interviews. Firstly, to identify a recent project (now fully implemented and part of the day-to-day operations of the firm) which was seen, at the time of its inception, as being important to the company. Secondly, to identify the team responsible for the project's implementation and to obtain the C.E.O.'s cooperation in arranging interviews with them. This project was then used as the principal subject during all following interviews, as well as the remainder of the C.E.O.'s interview. Of the managerial team that had been principally involved in the selected project, only one member was unavailable for interview, having left the company. Besides the interview data, the project's capital application documentation was also made available for inspection but not, unfortunately, for copying.

The selected project was the development of a new packaging product for an existing customer to package an existing product. The customer was, at the time of the early stages of the project, in a situation of single supply with respect to their existing packaging supplier for the particular product. As a result it was the customer that first broached the possibility of the project, partly stimulated by the desire to break the monopoly of its existing supplier, partly to reduce packaging costs and partly to have an innovative package that would differentiate it from its U.K. competitors. At the same time this customer approached another packaging supplier for a similar product to package another similar product line. This second packaging company was able to make an exclusivity deal with a continental equipment supplier for their technology within the U.K. This left the author's company having to select an equipment supplier with, what was generally seen as, second best technology. However, the company was able to make prototype products on a machine from this supplier using their chosen materials and subsequently were able to negotiate a contract with the customer guaranteeing minimum orders and prices for the product. The calculated financial yield for the project was approximately four times the minimum normally considered acceptable.

The product requested by the packaging company's customer included some innovative (for the U.K.) features, but otherwise was similar to a range of products already being manufactured in small volumes by the company. These products were being produced in a separate department within the company and it was decided to install the new production equipment within this 'Speciality Products' department. This resulted in a substantial increase in this department's annual turnover.

There were several specific features of this project that made it complex. Firstly, it included some innovative technology; as far as the U.K. in general and this firm in particular was concerned. Having seen the technology in operation at various European demonstration sites and having used the equipment to produce prototype packages, this technological innovation was not perceived as a risk. Secondly, the product that the customer was packaging had a highly seasonal sales pattern, concentrated in the winter months. Although the other speciality packaging products produced by the company also had seasonal sales patterns, the vast majority of the company's normal product line (collapsible boxes for consumer non-durable products) did not. In addition these other speciality products were produced in small volumes resulting in an under utilisation of some of the existing production equipment. In fact one of the attractions to the company of this project was that use could be made of some of these slack resources, thus increasing overall production efficiency. Thirdly, the customer required large volumes of the package (over 20 million units per annum) when they were producing. As production was effectively continuous, this necessitated that a new shift system be introduced, compared to the normal day working arrangement previously used. Fourthly and finally, because of the large volumes of packages being produced by this production facility and noting that the package was not collapsible and therefore occupied large volumes of space, it was effectively not possible to store the product. In effect it had to be manufactured and shipped without passing through intermediate buffer stores. This was again a novel feature as the company's previous experience was that production passed into buffer storage.

In discussing the implementation of this project there was a clear perceptual split between the managers and the engineer responsible for the installation and commissioning of the project, as to what the major problems with the project had been. The engineer focused his attention on the technical problems associated with the project. These were, that the delivery of the equipment from the manufacturer was about 3 weeks late and more importantly, a feature of the technology of the equipment was that a cutting tool would wear out and then need resharpening. Initial information supplied by the equipment manufacturer and continental users was that this tool would need replacing about once a shift. In fact early experience showed it to need replacement about every hour. The consequences for the utilisation of the equipment were dire; particularly as the late delivery of the equipment and its poor utilisation, meant the company was experiencing extreme difficulties in meeting contractual obligations with its customer. The managers on the other hand took a different perspective.

The C.E.O. for example, when asked what the major implementation problem had been, identified the above described technical problems, then changed his mind and identified liaison with the customer as the major difficulty. In the end this problem was only solved when the initial person responsible for liaising with the customer was replaced. In the final analysis the project was adjudged to have been highly successful, to the extent that the capital for a near identical project, to supply a different customer, had been approved for commissioning about six months after these interviews took place.

4.2.2 CASE ANALYSIS

Analysis of this case leads to a number of conclusions, some of which will be referred to at appropriate points during the remainder of this chapter. As to the argument in hand, namely that changes to standard operating procedures are an important consequence of implementation and result in gateway capacity effects, it is particularly significant. The major difficulty, from the managerial perspective, was the difficulty of achieving close liaison with the customer. This problem stemmed from the large volumes being produced and the lack of buffer storage prior to shipment to the customer. The technical problems (which in the end were solved) only served to exacerbate the liaison problem, which otherwise would probably not have become so obvious so early in the project's history. The principal cause of the liaison problem was that, with buffer stocks, the company traditionally could solve its production problems without affecting supplies to its customers. In this instance the company had, in effect, become a Just-In-Time (JIT) supplier, where any disruption to its production would have an almost immediate effect on the customer. To minimise the upset to the customer a new (or highly modified) standard operating procedure had to be learnt and in this case the person principally responsible for operating the liaison procedure required replacing.

JIT is not just a scheduling technique, but can also be viewed as a business strategy (Doll and Vonderembse, 1987). It could be argued therefore, that a manufacturing company with a JIT capability, or at least some of the principal skills required to successfully implement JIT, has a competitive advantage of some worth. Whether or not the company would wish to use this capability is another question. In terms of the company researched here, the departmental manager was at pains to point out that the principal customer to be supplied by the new machine on order, was in fact being supplied by another company also. In the event of a breakdown by one supplier they could switch to the other. This possibly suggests that he viewed the rigours of being a JIT supplier more of a threat than a strategic opportunity.

4.3 A CONTINGENCY MODEL OF PROJECT IMPLEMENTATION

4.3.1 A SOCIO-TECHNICAL PERSPECTIVE

A concept to be taken into consideration in the construction of a contingency framework is the view of the organisation as a Socio-Technical entity (e.g., see Trist *et. al.*, 1963). This concept originates in the work of Trist and Bamforth who, in a study into the introduction of new coal mining techniques, found that predicted productivity improvements did not occur due to the disruption of the workers' social relationships. This approach has since been developed by several authors into a formal research methodology (e.g. Herbst, 1974) particularly for the implementation of computer-based information systems projects (e.g., De Maio, 1980; Courbon and Bourgeois, 1980) and was the basic perspective adopted by Mumford and Pettigrew (1975) in their treatise on the implementation of strategic decisions. It possibly also accounts for the observation made by Ansoff (1984) that most of the research into implementation has focused on the human problems associated with change.

A number of similar dichotomous concepts appear in several areas of the literature. Bonoma (1984) refers to a Structural-Human dichotomy within an organisation. Schultz and Slevin (1975) introduced the concepts of Technical and Organisational Validity in connection with the implantation of Operational Research/Management Science projects. Technical-Validity is associated with whether the project met its design specification, Organisational Validity is associated with whether the project was used and/or contributed to organisational effectiveness. Their argument being that the probability of success of an OR/MS/MIS project is a function of these two aspects. Mushkat

(1987) adopted these concepts and applied them at the strategic level in developing an understanding of plan acceptance in public organisations. Randolph and Posner (1988) in discussing Project Management (be it a production, marketing or accounting project) commented "Projects involve a merging of technical and people issues...". They went on to outline ten principles, four technical or planning aspects and six social or managerial aspects, for effective project management. Schultz and Slevin (1979) noted that different people within an organisation take different attitudes to what constitutes the success of management science projects, which echo the two aspects identified here. Similarly the case study quoted above showed that the technical and managerial staffs within the firm held differing views of what constituted the major problem encountered with the projects' implementation.

The aim of the above discussion was not to present a comprehensive summary of the uses etc. of a socio-technical approach, but to present evidence for two valid perspectives which may be adopted when investigating organisational questions and in particular, implementation. Any contingent framework must therefore recognise and include both these aspects of the phenomena.

4.3.2 A CYBERNETIC APPROACH

The discussion of Ashby's (1956) concepts developed earlier identifies the principal contingent dimensions required to construct a model of project implementation. The principal exogenous factor driving the adaptation of the organisation was D, the disturbance which injects variety into the organisation. In the context of this thesis, D is a specific project resulting from a strategic decision. It follows, therefore, that one of the principal independent variables affecting implementation success, conceptualised as organisational learning, will be variety injected. Variety is not a particularly simple concept to measure (Beer, 1985). However, it has been noted that the concept of variety is closely allied with the concept of uncertainty. We therefore identify project uncertainty as a principal contingent factor in our model.

Again returning to the earlier development based upon Ashby's concepts, we note that the function of the regulator R, is to select procedures that will restrict the variety of possible outcomes to a limited acceptable set. In chapter 3 it was noted that information is the destroyer of variety i.e. uncertainty. We therefore identify project information as a second principal contingent factor in our model.

The final concept identified here as important to a contingency model is organisational learning. Learning reflects organisational change, identified with the adaptation of organisational procedures or skills. Implementation success is therefore the extent and type of learning or adaptation occurring in the organisation. Figure 4.1 illustrates these ideas. The description of the figure follows.

Figure 4.1: Organisational Adaptations.

	(A)	R: α	β	γ
D	1	*b*	*a*	*c*
	2	*a*	*c*	*d*
	3	*c*	*b*	*a*

=>

	(B)	R: α	β	γ
D	1	*b*	*a*	*c*
	2	*a*	*c*	*d*
	3	*c*	*b*	*a*
	4	*d*	*a*	*b*

OR

	(C)	R: α	β	γ	δ
D	1	*b*	*a*	*c*	*c*
	2	*a*	*c*	*d*	*b*
	3	*c*	*b*	*a*	*d*
	4	*d*	*d*	*b*	*a*

Ashby's (1956) Law of Requisite Variety states that the variety of the disturbance D has to be matched by the variety of response of regulator R. The function of R is to maintain the organisation's essential variable within tolerable range. This acceptable outcome is illustrated in figure 4.1 by table entry *a*. Taking model (A) in figure 4.1 to represent the initial state of the organisation, the organisation may respond to an increase in environmental variety (from 3 to 4 in the figure) in two ways. Either an existing procedure (β) may be identified capable of absorbing the increased variety (situation B) or a new procedure (δ) may be developed to absorb the increased variety (situation C). In a real organisation there will be many essential variables, each effected differently by the disturbance. The total organisational response will therefore be a combination (in varying degree) of both types of adaptation. We also observe that the two types of adaptation are independent of each other, indeed, at the level of a single essential variable, they are mutually exclusive.

These ideas are reflected in March and Simon's concepts of short- and long-run adaptiveness. A particularly interesting passage, in light of the above formulation, is the following (March and Simon, 1958,p.170):

> "If an organisation has a repertoire of programmes, then it is adaptive in the short-run insofar as it has procedures for selecting from this repertoire a programme appropriate to each specific situation that arises. The process used to select an appropriate programme is the "fulcrum" on which short-run adaptiveness rests. If, now, the organisation has processes for adding to its repertoire of programmes or for modifying programmes in the repertoire, these processes become still more basic fulcra for accomplishing longer-run adaptiveness. Short-run adaptiveness corresponds to what we ordinarily call problem-solving, long-run adaptiveness to learning."

March and Simon's ideas are referring to the processes underlying the two types of adaptation. Our formulation based on Ashby's concepts is concerned with the results of the adaptations. These adaptations are therefore the outcome of the project implementation process. They represent dimensions of implementation success. Long-run adaptation requires organisational change. As argued and demonstrated previously, this can lead to long-term gateway capacity benefits (long-term in the sense of been realised after the "implementation-time" of the specific strategic goal initiating the project). Short-run adaptation refers to problem-solving and we equate this with achieving planned or expected outcomes from the project via existing, known, procedures.

Cyert and March (1963) also make reference to the concepts of short- and long-run adaptation in their treatise, "A Behavioural Theory of the Firm". Specifically they concentrate upon the "...relatively short-run adaptive process and its consequences (p100)" arguing that long-run effects "...are of modest relevance for a theory of firm behaviour." Our concern is not "behaviour" and it would appear reasonable, in view of the discussion within this chapter, that equivalent weight should be given to both outcomes. Further, it is not at all clear to this author what Cyert and March meant by their concepts of Long- and Short-Run adaptation. They talk about the long-run <u>consequences</u> and the short-run <u>results</u> of an adaptive process. One interpretation would be Strategic versus Operational adaptation, which is similar in meaning to the intended use of the concept here. However, they appear to argue that long-run adaptation can only occur or become manifest within a stable environment. There is no such intended meaning in this work. In fact, it has been argued here that it is the long-run consequences, or adaptation to the change introduced by the implementation of a strategic decision, that is one source of future strategies.

The above discussion has provided us with a socio - technical perspective and the principal concepts necessary for constructing a contingency framework of project implementation. These concepts are project uncertainty, information and implementation success, identified with long- and short-term adaptation. We will further refine these concepts in the following sections.

4.3.3 CONTENT VALIDITY

For the reader to more fully understand the purpose underlying the following sections of this chapter it is necessary to introduce some methodological notes relating to the theory of measurement. The issues involved here are more fully explained in chapter 5 so this discussion will be brief.

Our ultimate aim is to develop measures of the concepts identified as belonging to our contingent model. The concepts Uncertainty, Information and Success are very broad and we would reasonably expect different people to interpret these terms differently. What is more, they would not necessarily interpret these concepts in terms of the cybernetic basis used here. If we are to reliably measure these concepts it is necessary to remove the ambiguity surrounding these words. This involves identifying concepts within these broad concepts which serve to define the terms. We have already noted that Success is composed of two broad sub-dimensions, provisionally labelled short- and long-run adaptation. We will call such sub-dimensions "secondary concepts", whereas Uncertainty, Information and Success we call "primary concepts". We will also ultimately identify "tertiary level concepts". In terms of the nomenclature introduced in chapter 5, our concern here is with establishing the "content validity" of our primary constructs. Finally we note that, in the absence of agreed criteria for assessing content validity, its determination rests mainly on an appeal to reason (Nunnally, 1978). This is essentially the approach taken here.

4.3.4 PROJECT UNCERTAINTY

We focus here on identifying those parameters of a project that contribute to its uncertainty and subsume these within a variable called Project UNCERTAINTY. Uncertainty is identified with items contributing to the variety of the project. Raine *et. al.* (1981) in a study into the management and commissioning of industrial projects identified a subset of projects which they called 'complex'. They defined a 'complex' project as one possessing one or more of the characteristics; Large, Novel and Urgent. All three characteristics were to be seen as relative to the organisation's usual experience. Each of these characteristics appear to be identified with some aspect of uncertainty. We will therefore use this framework as a starting point for defining our project uncertainty concept. We will also include complexity as a further concept within Uncertainty. Specifically we view complexity as a perceptual component of Uncertainty, not an objective component.

The term 'Large' conveys a meaning of size. However, Raine *et. al.,* point out that this term should also be taken to include a sense of dependence upon distinct technical and other skills. Here the term SCOPE will be used rather than 'Large' to incorporate a meaning of SIZE (e.g. cost) a meaning of STRATEGICALITY (e.g. how important and consequential was the project to the company) and a component relating to the project's use of technical and other skills, called SKILL USE.

The term NOVELTY, when associated with a project, suggests a number of components that may contribute to the overall concept and are identified in the business policy literature (see for example, Steiner, 1979,p.180; Ansoff, 1987,p.110). Specifically we would identify the SITING for the project (new or existing) the PRODUCT (new or existing) the MARKET (new or old customers) and INNOVATION (well proven contractor supplied or highly experimental). A further component of the Novelty construct would be TECHNOLOGY, used in the same sense as Woodward (1965). Woodward categorised technology as Custom, Batch and Mass Production (Production Continuity, Workflow, are terms with similar meaning used by various authors). Woodward's original thesis was that Technology was a principal determinant of certain important aspects of organisational structure within manufacturing organisations. Hickson *et. al.* (1970) were some of the first authors to question Woodward's thesis. Miller and Dröge (1986) similarly found no contribution of technology to structure in their study. However, Hickson *et. al.* (1970) did find a relationship between technology and seven 'secondary' structural features. They conclude "...only those [structural features] directly centred on the production workflow itself show any connection with technology." In this context it is noted that implementation is a process that will directly affect the production workflow. Hayes and Wheelwright (1979) used a categorical scheme, similar to Woodward's original formulation of the technology concept, to define a Process Life Cycle. They noted that an organisation needed to departmentalise or divisionalise when different technologies are used within the same organisation. This was recommended because of the problems in finding one set of controls to suit all types of technological process. From this argument we conclude that an important contribution to the Novelty concept will be the "fit" between the technology predominant within the organisation and the technology of the project. This certainly appears to have been the case with the project illustrated in the case study. Here the organisation's predominant technology, even within the department where the project was installed, was medium to large batch. The new project introduced a continuous mass production technology. That managerial problems subsequently occurred is not surprising in light of the above discussion.

The third concept contributing to Uncertainty suggested by Raine *et. al.* (1981) is URGENCY. Urgency suggests associations with concepts of SURVIVAL and SIMULTANEITY (Hrebiniak and Joyce, 1984). Survival refers to the organisation's life expectancy without the project. Simultaneity is associated with a lack of time for decision making. Both, in tern, imply the project will be given high PRIORITY and that there will be diverse PRESSURE promoting the project. A further concept that may affect Urgency is that of the strategic WINDOW. This concept relates to the idea, found within the strategic marketing literature, that a product launch can occur too early or too late to have an impact. In other words there is an optimal time to develop and launch a product, the strategic window (Abell, 1978). Finally we identify FINANCIAL ATTRACTIVENESS as a component of Urgency, particularly in the case of for-profit organisations; the logic being that a project with a very high return on investment will be viewed as more urgent and promoted more vigorously than one with only a minimal return on investment.

The final component of Uncertainty is COMPLEXITY. Complexity was defined above as a perceptual concept. We therefore identify PERCEIVED COMPLEXITY as a component of the Complexity concept. Risk is a further concept identified as a generator of uncertainty (Mumford and Pettigrew, 1975). Here we focus on PERCEIVED RISK as a second and final component of the Complexity concept.

Secondary and tertiary components of the UNCERTAINTY concept derived from the above discussion are summarised in table 4.4.

Table 4.4: The Uncertainty Concept

Primary Concept	Secondary Concepts	Tertiary Concepts
UNCERTAINTY	SCOPE	SIZE
		STRATEGICALITY
		SKILL USE
	NOVELTY	SITING
		PRODUCT
		MARKET
		INNOVATION
		TECHNOLOGY
	URGENCY	PRIORITY
		SURVIVAL
		SIMULTANEITY
		WINDOW
		PRESSURE
		FINANCIAL ATTRACTIVENESS
	COMPLEXITY	PERCEIVED COMPLEXITY
		PERCEIVED RISK

4.3.5 PROJECT INFORMATION

4.3.5.1 Secondary Information Concepts

The second contingent variable of our model is INFORMATION. Here we need to consider concepts that absorb variety, or lead to a reduction of Uncertainty. The cybernetic model illustrated in figure 4.1, identifies two properties of the organisation's procedures that will influence project success; interpreted here as adaptation or organisational learning. These two aspects of the organisation's procedures are their RANGE and FLEXIBILITY. (Flexibility is identified with the parameter k in Ashby's formulation; section 4.1.3.) Specifically we note that the greater the procedural Range and or Flexibility, the greater the variety that can be absorbed by the existing set of organisational operating procedures. In addition Range and Flexibility are organisational parameters exogenous to any particular project. Following earlier arguments we further note that both these parameters will be a product of the past history, or experience, of the organisation. However, it does not follow that an organisation with a large Range of procedures has to have (or not have) Flexible procedures. Range and Flexibility are therefore independent of each other (i.e., orthogonal).

In addition to the innate capability for variety absorption reflected in the concepts of Range and Flexibility, an organisation will also perform specific activities associated with decision making and problem solving. In other words it will initiate a specific process to collect, assimilate, etc., information to achieve the project goal. Invoking the socio-technical perspective outlined above we may also reasonably expect this process to reflect social, or human, and technical activities. The social processes we see as been primarily focused on preempting, or overcoming, any social or human resistance to the project, or the changes introduced by the project. The "resistance-to-change" phenomenon and strategies for handling it, is a common theme in the literature dealing with implementation issues (see for example Sorensen and Zand, 1975; Hawthorne, 1978; Steiner, 1979; Ansoff, 1984; Janis, 1985). Here we will subsume these processes within a concept of behavioural LUBRICATION. The technical processes we will subsume within a concept of information ACTIVITY. As we noted for the Range and Flexibility concepts, there is no reason to suppose that the concepts of Lubrication and Activity are other than orthogonal to each other. We will therefore treat them as separate sub-dimensions of Information, but it will also prove convenient to subsume them within a single information Process dimension.

The above discussion has identified four secondary concepts contributing to the overall Information concept. These have been identified as the experience dimensions of procedural Range and Flexibility, and the process dimensions of behavioural Lubrication and information Activity. We now further develop these concepts.

4.3.5.2 Tertiary Information Concepts

The procedural Range dimension relates to the variety of historically predefined procedures at the disposal of the organisation. One concept measuring Range will therefore be FAMILIARITY. This concept refers to the similarity of the project to past projects, the experience gained through having a wide product and or market base, etc. A further component of Range is simply the SIZE of the organisation, measured in terms of number of employees. The greater the size the more information the organisation can process. A perceptual indicator of Range will be ABILITY, ability to implement projects. Finally we identify DELEGATION as an indicator of procedural Range. This concept corresponds to the organisation drawing on the experience, or procedural range, of other organisations, e.g., outside consultants and contractor.

The concept of procedural Flexibility suggests an organisation with an organic structure (Burns and Stalker, 1961). Randolph and Posner (1988) point out that projects require people to communicate, particularly across departmental boundaries, in a fairly unstructured way. The lack of a clear hierarchical structure and a broadening of role responsibility beyond that of a functional department, are features that characterise organic organisations. Covin and Slevin (1988) note that organic structures have a greater information processing capacity than do organisations with the polar opposite mechanistic structures. Hawthorne (1978) states that organic organisations are better able to respond to technological change and De Geus (1988) believes organic organisations are better at organisational learning. Finally, we note that Khandwalla (1977) explicitly equates the flexible organisation with an organic top management style. From these arguments it is concluded that procedural Flexibility may be equated with the concept of structural ORGANICITY.

Turning now to the process concepts we first look at behavioural Lubrication. Noting that Lubrication is associated with achieving social change enables us to look at such models for insight into the Lubrication concept. One such theory (originally formulated by Kurt Lewin, but commonly referred to as the Lewin-Schein Change Theory) views social change as a three stage process of Unfreezing, Moving and Refreezing. This theory has found some utility in understanding the process of implementing management science projects (Zand and Sorensen, 1975; Ginzberg, 1978). Ginzberg summarised the model as follows:

> "Unfreezing, entails the disconfirmation of existing, stable behaviour patterns - establishing a "felt need" for change - and the development of an atmosphere in which the individual feels he can safely try something new.
> Moving is the "action" phase of the change effort. This requires the presentation of information necessary for change and the learning of new attitudes and behaviours which are necessary parts of the change.
> Refreezing entails the stabilisation of the change and the integration of new attitudes and behaviours into existing patterns and relationships."

We will adopt this model as identifying three basic dimensions to Lubrication. These are UNFREEZING, MOVING and REFREEZING.

Finally we have the information Activity concept. If we equate this process with problem solving then we may also equate it with decision making. This suggests one approach to identifying dimensions of the Activity concept. Simon's (1960) model of decision-making consists of three phases. These are Intelligence, Design and Choice. Mintzberg *et. al.*'s (1976) model of strategic decision making recognises, Identification (Recognition & Diagnosis) Development (Design & Search) and Selection (Screen, Evaluation & Authorisation) phases. An alternative non-decision-making approach is based on a taxonomy of

Information Occupations for the U.S. information industry sector (Rubin and Sapp, 1981). These classifications are Producers; Processors; Distributors and Infrastructure.

There are several similarities between these alternative approaches and models; although we note that the Identification stage of Mintzberg *et. al.*'s model is an aspect of strategy formulation, not implementation, we therefore reject this stage from our formulation. Mintzberg *et. al.*'s Development stage contains two of Simon's stages, namely Design and Intelligence (Simon equates Search with Intelligence). Selection and Choice are also congruous. Hence, Simon's and Mintzberg *et. al.*'s models are similar over the area of the strategic decision making process of concern here. The congruence between Rubin and Sapp's taxonomy is not as clear. Processors imply activities like Analysis or Design. Producers could be identified by a Search, or information gathering activity. Distributors imply Communication, which could be a precursor to making a Choice. These associations are quite tentative. Also, there is no obvious correspondence between Rubin and Sapp's Infrastructure category and any of the stages of Simon's or Mintzberg *et. al.*'s models. In the event, the Rubin and Sapp (1981) taxonomy was adopted as offering the greatest scope for constructing a broad Activity concept. In addition, being empirically rather than theoretically based, this model is likely to be simpler to reify. To better place the concepts within a project (as opposed to industry) context, the dimensions, ANALYSIS, SEARCH, COMMUNICATION and INFORMATION TECHNOLOGY were adopted from Rubin and Sapp (1981) and incorporated into the information Activity concept. Information Technology was seen as a dimension in its own right, but was also seen as a facilitator of the other three dimensions. A further dimension, DESIGN RESOURCES, is also included in the Activity construct to subsume the effort, time and money spent by the organisation to carry out the Activity processes.

Besides actively processing information an organisation can take steps to reduce the need to process information. Galbraith (1969) notes that "slack resources" (e.g., long delivery time, high inventory levels, overtime) serve this function in an organisational setting. We suggest that "contingency allowances" serve this function within the context of a particular project. CONTINGENCIES are therefore identified as the final sub-dimension of the information Activity concept.

Components of the INFORMATION concept derived from the above discussion are summarised in table 4.5.

Table 4.5: The Information Concept

Primary Concept	Secondary Concepts	Tertiary Concepts
INFORMATION	FLEXIBILITY	ORGANICITY
	RANGE	FAMILIARITY
	Experience	DELEGATION
		ABILITY
		SIZE
	LUBRICATION	UNFREEZING
		MOVING
		REFREEZING
	ACTIVITY	ANALYSIS
	Process	COMMUNICATION
		SEARCH
		INFO. TECH.
		DESIGN RESOURCES
		CONTINGENCIES

4.3.6 IMPLEMENTATION SUCCESS

The final concept within the contingency framework is Implementation Success. It has been argued that this concept has two dimensions, short- and long-run adaptation. We will refer to short-run adaptation as EXPECTATION and long-run adaptation as CHANGE.

Expectation refers to achieving anticipated outcomes from the implementation and relies on historical skills used to assess the particular project. Most researchers in the implementation area define success only along this dimension. They adopted a wide variety of perspectives and biases, hence the variety of dimensions of Expectation that we identify from the literature are also wide. For example, measures found in the literature dealing with implementation success (e.g. business policy, innovation, project management) could typically include, achieving anticipated financial returns (e.g. return on investment) or, "...outperforming the competition in terms of profit" (Vasconcellos e Sá, 1988). The literature on project management tends to define project success in terms of completion on time, to budget and performance to specification (Randolph and Posner, 1988). Many writers would argue that an important measure of success relates to the achievement of objectives (which should be quantified and measurable). Alexander (1985) subsumed many of these approaches by defining an 'implementation index' consisting of the three dimensions outlined above. These are:

1. Achieved the initial goals and objectives of the strategic decision;

2. Achieved the financial results (sales, income, and/or profits) that were expected; and

3. Was carried out within the various resources (money, manpower, time, etc.) initially budgeted for it.

A potential difficulty with any formulation of a construct to measure implementation success, is the difficulty of separating the effects of the implementation from the strategy being implemented. Inspecting the success dimensions above it is seen that some (e.g. the project success measures, dimension 3 above) are specific to the implementation. Others, however (e.g. Sales, income, profit returns) are as likely to depend upon the strategy being appropriate, as on the quality or success of the implementation. In other words, an Implementation Success measure should, with reference to the definitions given in chapter 2, at most only include factors relating to Goal achievement (e.g. the building of a new warehouse) not to the achievement of the Objective that gave rise to the Goal (e.g. to satisfy customer orders within 48 hours). To paraphrase Drucker's (1974) definitions of efficiency and effectiveness, we may summarise this argument by saying that the concern here is not, "was it the right thing to do?" but "was it done right?"

Referring to Alexander's success dimensions, only the last one, achieving budgets, unequivocally refers to the project. We identify this dimension with the concept of ACCURACY. A second dimension of Expectation will be EASE, the Ease of achieving Accuracy. Ease therefore relates to the lack of problems, particularly unanticipated problems, encountered during the project. A third and final dimension will be project SATISFACTION. This relates to a willingness to repeat the project and an overall sense of "a-job-well-done".

The long-term dimension of implementation success, labelled Change, refers to procedural changes that may confer gateway capacity benefits on the organisation, i.e., possible future benefits that spin-off from the project. We posit that the effects of such changes may operate at a social and a technical level. Changes at a social level we will label CULTURE. These refer to structural and behavioural changes attributable to the project. The motive for adopting this nomenclature stems from an association between Schein's (1984) definition of organisational culture and the organic - mechanistic organisational taxonomy of Burns and Stalker (1961). Schein defines organisational culture in terms of "values" and "beliefs". Burns and Stalker refer to the two types as exhibiting two managerial styles and note, in connection with a discussion of the differences between the two types, that the Organic form achieves its cohesion by the development of "shared beliefs about the values and goals of the concern". Khandwalla (1977) also identifies the organic - mechanistic forms as representing two management philosophies. Finally we note that in the paper by Schein (1984) he describes two cultural types which mirror the Burns and Stalker taxonomy. These associations between Schein's ideas for organisational culture, Khandwalla's and Burns and Stalker's description as management philosophy and style, together with our previously noted association between the organic - mechanistic taxonomy and procedural flexibility and therefore organisational structure, forms the basis of the above assertion that project implementation changes culture. Culture, therefore, is an important dimension of Change.

On the technical side we have previously noted that the procedures of an organisation represent, or embody, its skills. As implementation can change procedures, then it will also change skills. SKILLS is therefore another dimension of change. We will draw a distinction here between Skills as a dimension of change to wide organisational procedures and COMPETENCY as change to those procedures specifically associated with implementing projects. Competency is therefore associated with changes in the organisation's ability to and time taken to, implement projects. Finally we identify APPLICABILITY as a further dimension of Change. This concept refers to whether the Culture, Skills and Competency changes that occur have a wider organisation value and use beyond the department or subsidiary implementing the project. It is also associated with how well these changes and immediate strategic advantages are communicated throughout the organisation.

Components of the SUCCESS concept derived from the above discussion are summarised in table 4.6 below:

Table 4.6: The Success Concept

Primary Concept	Secondary Concepts	Tertiary Concepts
SUCCESS	EXPECTATION	EASE
		ACCURACY
		SATISFACTION
	CHANGES	CULTURE
		COMPETENCY
		SKILLS
		APPLICABILITY

The theme running through all of the concepts identified here is that of organisational change or learning. Uncertainty represents the size of the change or learning task imposed on the organisation by a particular project. Information broadly identifies the innate adaptability of the organisation to change (experience) and what it does to change (process). Finally, Success is defined in terms of what the organisation learnt in the past that helped it to implement a particular project (Expectation) and what learning adaptations occurred that may lead to new opportunities in the future (Change). We now seek to formally identify the associations between these concepts.

4.4 HYPOTHESES

The specific hypotheses to be tested in this study may be conveniently portrayed as the expected associations between the concepts of our contingency model. It will be necessary to work with five contingency variables in explaining these associations. These will be Uncertainty (UXX) and the Information sub-dimensions of Experience (i.e., procedural Range, IRX; and Flexibility, IFX) and Process (i.e., Lubrication, ILX; and Activity, IAX). The Success dimensions of Change (SCX) and Expectation (SEX) are the principal dependent, or outcome, variables in our model. We will now formulate specific hypotheses between these variables. These hypotheses will be formulated as the statistical alternative hypothesis. The null hypothesis being that the association between variables is not of the form suggested.

Uncertainty is a measure of the variety injected into an organisation by a particular project. It is determined by the strategic goal initiating the project. Uncertainty is therefore an exogenous variable in our model. We have argued that Uncertainty is absorbed through adaptation of the organisation's procedures. The greater the Uncertainty of a project, the greater the adaptation or procedural change that will have to occur to accommodate the new project. Conversely, the greater the Uncertainty of a project the less is the chance of the organisation having appropriate past experiences to draw on. Finally we will adopt the basic proposition of Galbraith's thesis (Galbraith, 1969,p.5; also 1979,p.409) that:

> "the greater the uncertainty of the task, the greater the amount of information that has to be processed during the execution of the task."

In terms of our framework this hypothesis relates Uncertainty to information Process. The three propositions may be formally stated as the following hypotheses.

Hypothesis 1: Increased project Uncertainty (UXX) causes an increase in Change (SCX).

Hypothesis 2: Increased project Uncertainty (UXX) causes a decrease in Expectation (SEX).

Hypothesis 3: Increased project Uncertainty (UXX) causes an increase in information Process (Lubrication, ILX and Activity, IAX).

The experience items of Information (procedural Range and Flexibility) are properties of the organisation brought to the particular project situation. These items are therefore exogenous to the project. Specifically we note that they represent the innate ability of the organisation to absorb variety. An organisation with a large degree of Experience will be able to accommodate Uncertainty without Change and also achieve a high degree of Expectation. This Experience also represents a pool of procedures that will benefit the information Process. Formalising these statements as hypotheses we have:

Hypothesis 4: Increases in information Experience (Range, IRX and Flexibility, IFX) will cause a decrease in Change (SCX).

Hypothesis 5: Increases in information Experience (Range, IRX and Flexibility, IFX) will cause an in crease in Expectation (SEX).

Hypothesis 6: Increases in information Experience (Range, IRX and Flexibility, IFX) will cause an in crease in information Process (Lubrication, ILX and Activity, IAX).

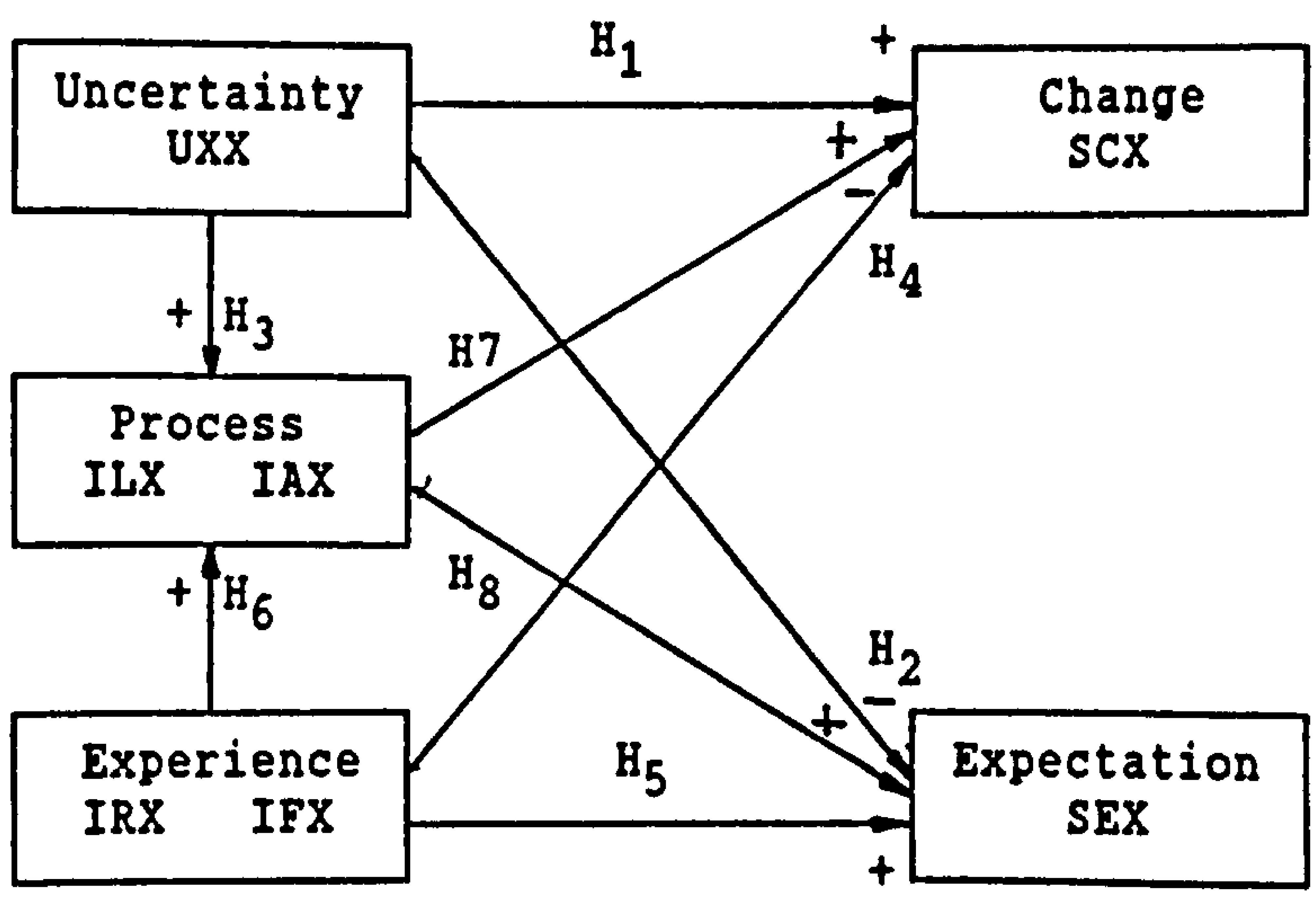
The information Process variables, Activity and Lubrication, operate to reduce Uncertainty by either processing information or reducing the need to process information. These activities will raise the Expectation of implementation Success. Information Process will also be used to design new procedures resulting in Change. Process is therefore also related to Change. Specifically we state the following hypotheses:

Hypothesis 7: Increases in Information Process (Lubrication, ILX and Activity, IAX) will cause an increase in Change (SCX).

Hypothesis 8: Increases in Information Process (Lubrication, ILX and Activity, IAX) will cause an increase in Expectation (SEX).

Hypotheses 1 to 8 may be conveniently summarised in a path diagram, figure 4.2. In figure 4.2 boxes represent concepts and arrows represent hypotheses. The direction of the arrow represents the presumed direction of causality and the sign indicates the direction of association.

Figure 4.2: Path Model of Hypotheses



Besides the above hypotheses, arguments presented in this chapter also exclude certain associations between constructs. The first of these is that no association should exist between the Uncertainty and Information Experience concepts. The other is that there should be no association between the two implementation Success concepts of Change and Expectation. Specifically we state the following hypotheses:

Hypothesis 9: Uncertainty (UXX) and Experience (Range, IRX and Flexibility, IFX) are orthogonal.

Hypothesis 10: Change (SCX) and Expectation (SEX) are orthogonal.

Hypotheses 9 and 10 are implicitly indicated on figure 4.2 by the absence of paths connecting Uncertainty and Experience, and Change and Expectation.

Here we have established the theoretical basis of the study, identified and developed concepts from the theory and formally stated ten testable hypotheses. In the following chapter we discuss the operationalisation of the concepts and the methodological issues involved in testing the hypotheses.

CHAPTER 5

RESEARCH INSTRUMENT DESIGN AND METHODOLOGY

The aims of this chapter are threefold. First, to describe the design of a research instrument that operationalises the concepts identified in the previous chapter. Second, to discuss the methodological issues associated with the administration of the research instrument and finally to discuss some of the practical aspects of the chosen methodology with respect to data collection.

It will be appreciated that all three strands of this chapter are closely interconnected. It is therefore unreasonable to assume that each of these three topics can be discussed in a sequential order, each logically separated from the other. While this ideal is aimed for, the reader must be prepared to occasionally find methodological issues discussed during instrument design, data collection issues discussed with methodological issues, etc.

5.1 RESEARCH DESIGN

In chapter 4 a theoretical perspective and hypotheses were developed relating the variables Uncertainty and Information to the Success of implementing a strategic decision. In addition secondary and tertiary concepts underlying these three broad concepts were identified. The concern here is with the measurement of these theoretical concepts.

This "statement of intent" implicitly rejects the idea of a research design based on case studies. Case studies and related methodologies (i.e., Action research, where the author participates in the study and Application description, where the author, usually a practitioner, details their experience) are valuable where exploration, classification and hypothesis development are the aims of the study. They are also valuable where the investigator has not, or cannot, specify the set of independent and dependent variables in advance (Benbasat *et. al.*, 1987). Here the hypotheses, dependent and independent variables have been specified and so a quantitative, non-case, research approach is suggested. In addition the pattern of hypotheses identified in figure 4.2., suggests a form of data analysis based on the statistical technique of path analysis (see chapter 7). As with most statistical techniques path analysis requires a relatively large numbers of cases to be analysed if confidence is to be placed in the findings. Hence, a research instrument had to be designed which was suitable for statistical analysis and capable of being administered within the resources available to the researcher. These considerations suggest the construction and administration of a questionnaire type instrument. This questionnaire would have to yield quantitative data suitable for statistical analysis and thus be highly structured, i.e., unambiguous and closed questions would be asked.

The construction of such an instrument requires the concepts identified in chapter 4 to be operationalised into constructs. 'Concept' and 'construct' are defined by Kerlinger as follows:

> "A *concept* is a word that expresses an abstraction formed by generalisation from particulars. A *construct* is a concept. It has the additional meaning, however, of having been deliberately and consciously invented or adapted for a special scientific purpose." (Quoted in Venkatraman and Grant, 1986)

This process of operationalisation raises important research issues of reliability, instrument validation, construct measurement etc. As these topics are subsumed within the broader research topic of validity we will discuss them within this context. However, as the immediate concern is with the validity of quantitative research the discussion will be biased in this direction.

5.1.1 THE VALIDITY ISSUE

A full treatment of this topic would require us to discuss the philosophical basis of scientific explanation, what Nunnally (1967) refers to as "the deepest innards of scientific explanation". The summary that follows will not refer to these issues and is therefore, of necessity, superficial. (The interested reader is referred to Chapter 1 of Cook and Campbell (1979) for a summary of these "deeper" issues.) The validity question is applicable to all forms of research, be it qualitative or quantitative. However, our particular need here is with validity as it relates to quantitative research. We will therefore further restrict this summary to validity issues as they relate to quantitative research studies.

The question of validity, in its broadest sense, appears to be implicated in all aspects of research, with the exception of theory development. In fact we may posit that research can be defined in terms of just theory and validity issues. The literature on this topic abounds with adjectives attached to the word 'validity'. Many of these variants are hierarchically related and those encountered are summarised here in figure 5.1 over. In reading the body of the table, those items in upper case type are viewed as independent. Those items in lower case type are subsumed within the item to which they are attached by the line. Where two items appear to be alternative forms of the same concept, they are related with an equals symbol. A broken line indicates ambiguity within the literature regarding placement of the item. A fuller description is given subsequently.

Different authors would identify different elements and structure the hierarchical associations within figure 5.1 differently. The list in figure 5.1 is not necessarily exhaustive but represents this author's attempts to clarify and understand the issues raised by the question of validity. We will now investigate more precisely the meanings of some of these terms, principally for the purpose of identifying those items of greatest significance to the task in hand.

The broadest definition encountered of the 'validity' concept is that due to Cook and Campbell (1979,p.37) as "the best available approximation to the truth...of propositions". To this they note that "one can never know what is true. At best, one can know what has not yet been ruled out as false." This latter point is important, as it implies that establishing absolute validity is an impossible goal (also see Peter, 1981, for a similar view).

Figure 5.1: A Glossary of Validity Terms

- FACE VALIDITY
- ABSOLUTE VALIDITY
- CRITERION-RELATED VALIDITY[+]
  - Predictive Validity
  - Concurrent Validity
  - Postdictive Validity
- INTERNAL VALIDITY[*]
- EXTERNAL VALIDITY[*]
- STATISTICAL CONCLUSION VALIDITY[*]
- CONTENT VALIDITY[+]
- CONSTRUCT VALIDITY[*+]
  - Content Validity = Domain Validity[■]
  - Nomological Validity = Extrinsic Validity[#]
  - Trait Validity = Intrinsic Validity[#]
    - Factorial Composition[x]
    - Internal Consistency
      - Unidimensionality
      - Reliability
    - Discriminant Validity
    - Convergent Validity

Principal sources for figure 5.1:

+ Carmines and Zeller, 1979.
* Cook and Campbell, 1979.
x Nunnally, 1967.
■ Section 5.1.2.
Van De Ven and Ferry, 1980.

Face validity is, as Nunnally points out, an important (and occasionally the only) starting point in instrument design. However, the impossibility of achieving absolute validity should not be used as justification for face validating constructs. That validity is 'assumed' by some authors is attested to by a number of articles published during the 1980's criticising the lack of formal validity assessment; see Peter (1981) in marketing research, Venkatraman and Grant (1986) in strategy research and Straub (1989) in MIS research.

Criterion-related validity was synonymous with the word 'validity' until the mid 1950's (Peter, 1981). It is established by correlating performance on a test with some criterion variable. The correlation coefficient obtained is then referred to as the Validity Coefficient (Carmines and Zeller, 1979). Criterion-Related validity is usually established without recourse to any theoretical background, or theory of measurement; it is based solely on the existence (or otherwise) of an association. It will not be discussed further. The remaining five "independent" items on figure 5.1 constitute the substantive validity issues, as far as this thesis is concerned.

Internal and External validity are two issues that appear to be principally concerned with issues of research design. Both concepts are defined and discussed by Cook and Campbell (1979). Internal validity concerns the type of statements that can be made about a causal relationship of the presumed form. External validity concerns the generalisability with which such statements or conclusions can be drawn across different persons, settings and times. The principal aim of internal validity is to eliminate alternative causes for the observed relationships, i.e. if the principal hypothesis is that A causes B, internal validity attempts to eliminate alternative hypotheses such as C causing both A and B, or A causing C which causes B. This is equivalent to the statement that internal validity is concerned with the elimination of systematic (non-random) variation or bias from the observations. In terms of a methodology to assess internal validity Cook and Campbell (1979,p.55) comment:

> "Estimating the internal validity of a relationship is a deductive process in which the investigator has to systematically think through how each of the internal validity threats may have influenced the data ... In all of this process the investigator has to be his own best critic..."

External validity is established in a similar way. We will address issues of internal validity at several points throughout the remainder of this chapter. Factors judged to be threats to this study's external validity will be discussed in chapter 8 on limitations.

An issue closely related to internal validity is Statistical Conclusion validity. Both are concerned with "drawing false positive or false negative conclusions about causal hypotheses," (Cook and

Campbell, 1979,p.80) however, whereas internal validity is concerned with the effects of systematic error on validity, statistical conclusion validity is concerned with the effects of random error. As such it relates principally to three questions of data analysis, or more specifically, statements about the covariation between data (Cook and Campbell 1979,p.37):

1. Is the study sensitive enough to permit reasonable statements to be made with the sample data in hand?

2. If it is sensitive enough, is there any reasonable evidence from which to infer the presumed cause and effect covary?

3. If there is such evidence, how strongly do the two variables covary?

The first of these questions concerns statistical power, the second statistical significance and the third is concerned with the estimation of Effect Size. Whereas the issue of statistical significance generally receives adequate attention in most reported research the issues of statistical power and effect size (like validity in general) have been given far less attention: see Sawyer and Ball (1981) Mazen *et. al.* (1987) and Baroudi and Orlikowski (1989) for discussions concerning the Marketing, Management and MIS literatures respectively. Establishing statistical conclusion validity is therefore a quantitative procedure. However, it is considered to be more appropriate to defer a full discussion of these issues and of statistical conclusion validity in general, until chapter 7 where the specific theoretical hypotheses will be tested.

Finally this discussion brings us to the issues of content and construct validity. Indeed, most of the literature specifically addressing validity tends to focus solely on these aspects. Content and Construct validities relate to the issue of measurement and as such articles in the literature discussing these topics appear with titles like; Construct Measurement, Instrument Validation, as well as Construct Validity.

The first exponents of these concepts appear to have been Cronbach and Meehl (1955). Their formulation has been endorsed by Cook and Campbell (1979) as well as others. There is however, some disagreement within the literature as to whether content validity is subsumed within a broader concept of construct validity, or whether it exists as a separate item in its own right. Cook and Campbell (1979) take the former view, as do those authors following their lead (Peter, 1981; Vankatraman and Grant, 1986; Straub, 1989). Nunnally (1967 & 1978) and Carmines and Zeller (1979) take the latter view and Van De Ven and Ferry (1980) appear to ignore it altogether. Here a middle of the road approach is adopted, in that content validity can be taken to have either interpretation, as indicated in figure 5.1. The justification for this rests principally upon the technique used to establish content validity.

Carmines and Zeller (1979,p.20) define content validity as "the extent to which an empirical measurement reflects a specific domain of content." The method for establishing this is essentially qualitative and consists of interviewing a number of "experts" and probing them for their conceptualisations of the concept. This technique is also advocated by those authors in the Cook and Campbell mould cited above. There are a number of problems with this approach, which Carmines and Zeller discuss. Basically these objections rest upon firstly the "*acceptance* of the universe of content as defining the variable to be measured" (Cronbach and Meehl, 1955,p.282) and secondly there is no agreed criterion by which content validity can be measured therefore, "inevitably content validity rests mainly on appeal to reason" (Nunnally, 1978,p.93).

From the perspective of this research, the principal abstract concepts underpinning this thesis are; Information, Uncertainty and Success of Implementation (Chapter 4). As these concepts are derived from the cybernetic theory on which this thesis is based, it was thought to be highly improbable that a sample of "experts" would converge on the same theoretical conceptualisations. This "interviewing of experts" approach to establishing content validity was therefore judged to be an inappropriate technique. In its place we approached the question of content validity in chapter 4 from a review of the literature and face validity perspective. The reader is referred to Nunnally (1967,p.83 and 84) for examples of further instances in which content validity is an inappropriate or an insufficient indicator of validity. This discussion now brings us to what is for this thesis, the major topic of interest, that of construct validity.

5.1.2 CONSTRUCT VALIDATION

The issue of construct validity is closely allied with the issue of external validity, i.e. both are concerned with the justifications of making generalisations (Cook and Campbell, 1979). Construct validity however, is specifically related to measurement. Establishing construct validity involves establishing the degree of correspondence between a construct and its (observable) measures and is therefore principally a quantitative approach. Nunnally (1967,p.87) identifies three processes required to do this:

1. Specify the domain of observables for the construct.

2. Determine to what extent all, or some, of these observables correlate with each other or are affected alike by experimental treatments.

3. Determine whether or not one, some, or all measures of such variables *act* as though they measure the construct.

The first of these processes appears to be closely allied to the issue of content validity. They differ (or converge) to the extent that content validity establishes a "domain of content", whereas here we wish to establish a "domain of observables". It appears reasonable to suppose that in some instances the two processes are co-incident and this could explain the confusion within the literature referred to earlier. It is further noted that an important stage in instrument design (section 5.2) is establishing the domain of observables of the underlying theoretical concepts.

As regards the techniques required to establish the domain of observables for a construct (referred to in future as establishing "Domain Validity") Nunnally (1967,p.88) comments:

> "No precise method can be stated for properly outlining the domain of variables for a construct. The outline essentially constitutes a theory regarding how variables will relate to one another; ...the theorising process is necessarily intuitive."

The second of Nunnally's three processes essentially describes what Cook and Campbell (1979) refers to as trait validity, and Van De Ven and Ferry (1980) call intrinsic validity. Closely allied with the question of validity (and measurement in general) is reliability. Reliability concerns the consistency, stability, or dependability with which an instrument measures a set of dimensions. Validity refers to whether or not an instrument accurately measures what it is intended to measure. The two criteria are highly dependent mathematically and from a practical standpoint the concept of reliability becomes indistinguishable, or is subsumed within, the overall concept of validity (Van De Ven and Ferry, 1980; Venkatraman and Grant, 1986). In particular, a number of authors identify establishing reliability as a necessary but not sufficient criterion for establishing trait validity. Apart from reliability, a number of other issues are associated with establishing trait validity, these will be discussed subsequently.

The last of Nunnally's three processes for establishing construct validity relates to the usefulness of the construct within a theoretical framework; "To determine construct validity, a measure must fit a theory about the construct;" (Nunnally, 1967,p.93). This statement equates this process with what Cook and Campbell (1979) call nomological validity, and Van De Ven and Ferry (1980) call extrinsic validity. A related view is expressed by Carmines and Zeller (1979,p.17) "one validates not the measuring instrument itself but the measuring instrument in relation to the purpose for which it is being used". In practice therefore, the methods for establishing nomological validity are indistinguishable from the techniques used to test a set of theoretical hypotheses based upon the constructs (Cronbach and Meehl, 1955). Whether a researcher testing such a set of hypotheses is engaged in an exercise of hypothesis corroboration or construct validation depends upon the researcher's *a priori* intentions when undertaking the research. The function of the research undertaken and reported in this thesis was to test a set of theoretically derived hypotheses. In this sense therefore, nomological validity will not be assessed here. The reader is however free to interpret the testing of these hypotheses (the subject matter of chapter 7) as a test of nomological validity.

Before moving on to a more detailed examination of trait validity, there are some final comments about the limitations of assessing construct validity. It has previously been noted that absolute validity cannot be established, nor can absolute construct validity, it can only be inferred (Peter, 1981). Again, to quote Nunnally (1967,p.98):

> "Strictly speaking, science can never be sure that a construct has been measured or that a theory regarding that construct has been tested, even though it may be useful to speak as though such were the case. ...as far as science takes us, there are only (1) words denoting constructs, (2) sets of variables specified for such constructs, (3) evidence concerning internal structures of such sets, (4) words concerning relations among constructs (theories), (5) which suggest cross-structures among different sets of observables, (6) evidence regarding such cross-structures, and (7) beyond that, nothing."

Hence, as Cronbach observes, a single study does not establish construct validity (Peter, 1981).

5.1.3 TRAIT VALIDITY

Nunnally (1967,p.101) comments that the explication of constructs mainly consists of determining:

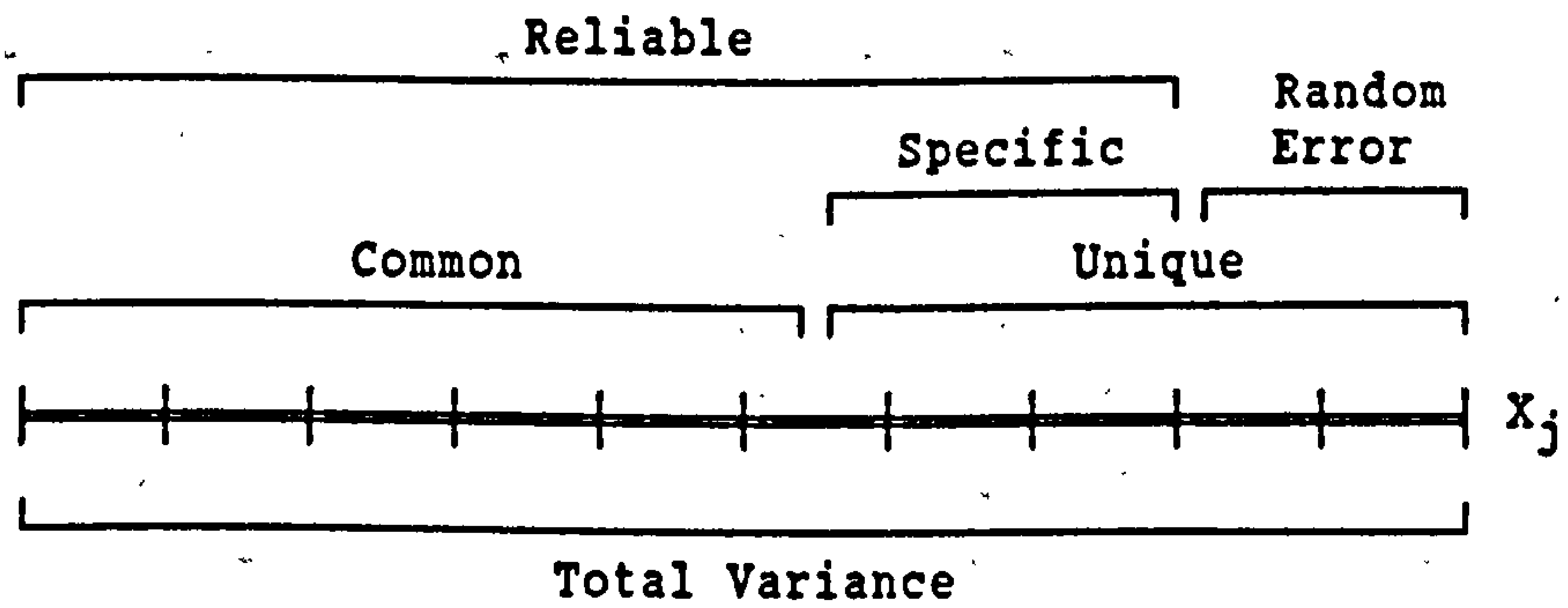
1. The internal statistical structure of a set of variables said to measure a construct.

2. The statistical cross-structure between different measures of one construct and those of other constructs.

The second of these processes is essentially the process of theory testing, or establishing nomological validity. The first item refers to establishing trait validity.

In assessing trait validity we are principally interested in the way single indicators of a construct vary across cases within a sample. The statistical structure of interest is therefore the *variance* structure of the indicators. Rummel (1970) identified the components contributing to the total variance of one variable within a set. These variance components are illustrated on the figure 5.2:

Figure 5.2: Components of X_j's Variance



The common variance, or communality of the variable X_j, is the variance the variable shares with other variables of the set, whereas the uniqueness is the variance not shared with other variables of the set. The specificity of the variable is that portion of its uniqueness that is repeatable, whereas the random error is that portion of the uniqueness that is unrepeatable, in the sense that repeated measures would yield different values. The tendency towards consistency found in repeated measures of the same variable or phenomenon is referred to as reliability (Carmines and Zeller, 1979). The degree of communality shared by a set of variables purporting to measure the same phenomenon is taken to be indicative of the validity with which the set measures a hypothetical common concept. In truth, as stated previously, all that can be said is that the variables appear to be measuring something similar. Whether or not this is the hypothesised concept can only be inferred.

With reference to figure 5.1 each of the components identified as contributing to trait validity will now be discussed. These are the factorial composition, internal consistency, discriminant and convergent validities.

5.1.3.1 <u>Factorial Composition</u>*

A statistical technique specifically designed to partition the variances of several variables into common and unique components is factor analysis (Kim and Mueller, 1978a). Nunnally (1978) suggests that factor analysis can play an important part in assessing predictive (criterion-related), content and construct validities. With respect to construct validity factor analysis provides useful information regarding the dimensions of the construct as revealed by the indicators chosen; this is an aspect of trait validity (Peter, 1981). For example, the Uncertainty concept defined in chapter 4 is, at the first level of abstraction, hypothesised to contain four dimensions, which were identified as Scope, Novelty, Urgency and Complexity. If a factor analysis of all the indicators of the uncertainty construct yields four dimensions that can be identified with these concepts, then this is supportive evidence of construct validity in general and trait validity in particular.

5.1.3.2 <u>Reliability</u>

The second item listed in figure 5.1 as contributing to trait validity is internal consistency. Internal consistency is in its turn sub-divided into unidimensionality and reliability. Unidimensionality is the extent to which the indicators being considered reflect one underlying construct, and an appropriate technique for demonstrating unidimensionality is factor analysis (Vankatraman and Grant, 1986). The approach here though, in comparison to establishing factorial composition discussed previously, is that the researcher's principal interest is only in the first, unrotated, factor extracted by the analysis. In establishing factorial composition the researcher is primarily interested in a more complete description of the factor structure. This distinction between factorial composition and unidi-

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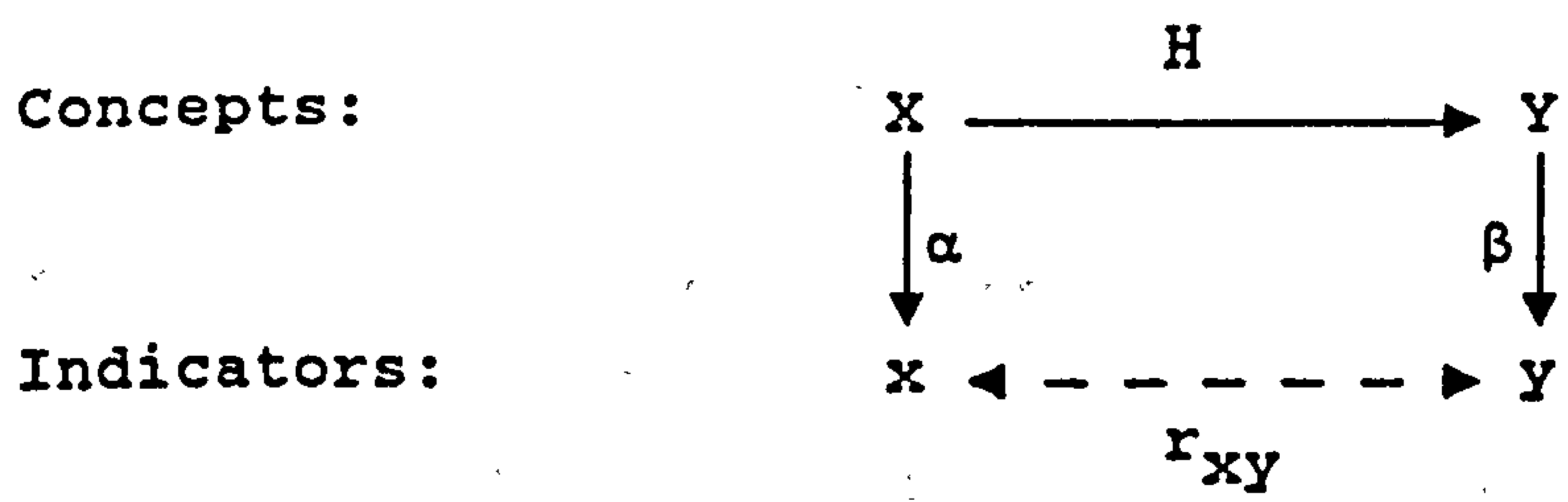
* The term Factorial Composition is Nunnally's (1967) preferred term for what some authors refer to as Factorial validity.

mensionality has been made by the author drawing upon diverse source material.

The second issue relating to internal consistency is reliability. This has been mentioned previously and relates to the tendency for multiple measures of the same construct to be consistent and as such is inversely related to the degree of random error encountered when measuring a phenomenon (Carmines and Zeller, 1979). Assuming that the indicators of a construct are valid (i.e., measure a given construct) then reliability assumes major importance as it relates to the accuracy with which a set of indicators measures a construct. This in tern influences the confidence with which observed correlations between indicators of different constructs can be said to correspond to relationships between the constructs. By way of illustration, consider two concepts X and Y and their, in this instance, single indicators x and y. We further assume that X is causing Y, and that x is influenced only by X and y by Y. A simplified path diagram for this situation is represented in figure 5.3 below:

Figure 5.3: Two-Concept, Two-Indicator Model



If all of the variables are standardised (i.e. have unit variance and a mean of zero) then H, the structural parameter linking X and Y is given by:

$$H = r_{xy}/\alpha.\beta$$

Where r_{xy} is the correlation coefficient between the indicators x and y, and α and β are so called *epistemic correlations*. This equation expresses H, the parameter of interest, in terms of one known, r_{xy}, and two unknown quantities, α and β. It follows therefore, that little can be stated about the relationship between the constructs X and Y unless α and β are known. In actual fact, the epistemic correlations are the square roots of the reliability coefficients of each indicator. Therefore, in order to make inferences about relationships between hypothetical constructs, the indicators of these constructs must be known to be valid and reliable. The reader is referred to Sullivan and Feldman (1979) for a fuller and more rigorous treatment of these concepts.

5.1.3.3 <u>Discriminant Validity</u>

The third component of trait validity identified in figure 5.1 is discriminant validity. Discriminant validity refers to the extent to which a concept differs from other concepts (Venkatraman and Grant, 1986).

5.1.3.4 <u>Convergent Validity</u>

The final component to be discussed here as an assessment of trait validity is that of Convergent Validity. This concept owes its origin to Campbell and Fisk's Multitrait-Multimethod Matrix. The idea underpinning convergent validity is based on a specific view of validity, namely that validity is represented in the agreement between two attempts to measure the same trait through maximally different methods. Achieving "maximally different" methods in practice is fraught with problems, although a common approach is to ask equally knowledgeable respondents to complete the same questionnaire (Phillips, 1981) or administer one questionnaire by interview and another by paper and pencil (Baroudi and Orlikowski, 1989). In either instance such techniques require a considerable increase in the cooperation from an organisation and the work load on the researcher. (For a full discussion of, and critique of, the Multitrait-Multimethod procedure, the reader is referred to Sullivan and Feldman, 1979).

5.1.4 PRIORITISING VALIDITY

To end this discussion of the validity issue it should be noted that methods for increasing one kind of validity will probably decrease another kind. For example, rigid control of stimuli impinging on respondents will increase statistical conclusion validity, but probably decrease external and construct validity. Multi-item measures increase construct validity, but the tedium of answering them can decrease reliability. Many such tradeoffs are inevitable in the design of a single study. Cook and Campbell (1979,p.83) comment:

> "...we think it unrealistic to expect a single piece of research will effectively answer all of the validity questions surrounding even the simplest causal relationship."

If Cook and Campbell's view is accepted it becomes necessary to explicitly state the priority ordering of the various validity types in a piece of research. The purpose of this research is substantive theory validation. In particular, specific causal hypotheses are to be tested and therefore high internal validity is required. Next in importance to this study is construct validity. This is because construct validity relates to the accuracy with which theoretical constructs are measured, hence the inferences that may be drawn about the hypothesised theoretical associations. Third in importance is statistical conclusion validity and finally, external validity. This priority ordering is the one proposed by Cook and Campbell (1979) for research aimed at theory testing.

Issues of internal validity will be addressed during the remainder of this chapter. Construct validity, principally in the guise of trait validity, will be assessed in chapter 6. Statistical conclusion validity will be addressed in chapter 7 and external validity in chapter 8. We now turn to instrument design.

5.2 INSTRUMENT DESIGN

The instrumental requirement of this section is to take the theoretical concepts identified in chapter 4 and turn them into measurable constructs. The above discussion on reliability suggested that single-item scales are limited in that they cannot adequately and accurately capture the broader concept being measured. Single item scales can be considered acceptable when they relate to a simple unidimensional construct and are measured with minimal measurement error. These assumptions cannot generally be defended (Vankatraman and Grant, 1986) hence multi-item scales are a better alternative to reduce the level of measurement error and to capture the breadth of a concept. We will not, therefore, attempt to reify our concepts by single item scales, or necessarily by two or three scales. But what scale metrics to use? We address this question next.

5.2.1 A SCALE METRIC

Section 5.1 identified a number of criteria to be met by the research instrument. It should be a questionnaire, highly structured and amenable to numerical analysis. Furthermore the techniques to be applied in examining the results have been identified as multivariate regression (the basis of Path analysis) and Factor analysis for assessing trait validity. These techniques require interval level data. However, many types of data of interest to the Social Sciences are not amenable to measurement at the interval level and recourse to ordinal level data has to be made. The extent to which ordinal level data can be substituted for interval level data has been a source of major controversy. Asher (1983,p.27) discusses this controversy with respect to path analysis techniques and concludes that the interval level requirement of the technique "does not appear to be a troublesome one". Kim and Mueller (1978,p.74) discuss the question with respect to factor analysis and arrive at a similar conclusion. They note that "...correlation coefficients are fairly robust with respect to ordinal distortions in the measurement". Another important conclusion of Kim and Mueller's discussion is that it is inappropriate to substitute ordinal measures of association (Kendall's tau, Goodman and Kruskal's gamma) for the interval measure, Pearson's r, even when Pearson's r is calculated using ordinal data.

Having determined that the proposed analytical techniques may be used with ordinal level data, the next question is how many divisions should be used on the ordinal scale? Asher (1983) notes that the greater the number of categories in the ordinal variable, the less critical is the interval requirement. Kim and Mueller (1978) note that "variables must contain at least four different values,". A further set of constraints comes from the psychological literature which shows that an individual cannot simultaneously compare more than seven objects (plus or minus two) without being confused (Saaty, 1983). Taken together these constraints suggest that an ordinal scale with between four and nine categories would be satisfactory. However, this represents an extreme range and five to seven categories is probably safer. It is not difficult to identify studies in the literature using ordinal scales within the above range. Hickson *et. al.* (1986) used five point scales in their study into strategic decision making, as did a study reported in Carmines and Zeller (1979,p.64). Both studies employed factor analysis. Hence, where the research instrument required ordinal scales, five point scales were used.

In the interest of giving the questionnaire a unified appearance, hence minimising a threat to internal validity through respondent confusion, five point ordinal scales were used throughout; unless unavoidable. This rule was obeyed even if measures from other studies were being incorporated in the questionnaire which had been validated using different ordinal scales. However, where possible, nominal scales were chosen in preference to the ordinal scale, as suggested in Asher's (1983) review of the nominal/ordinal debate.

5.2.2 DESIGN PARAMETERS

5.2.2.1 Units of Analysis

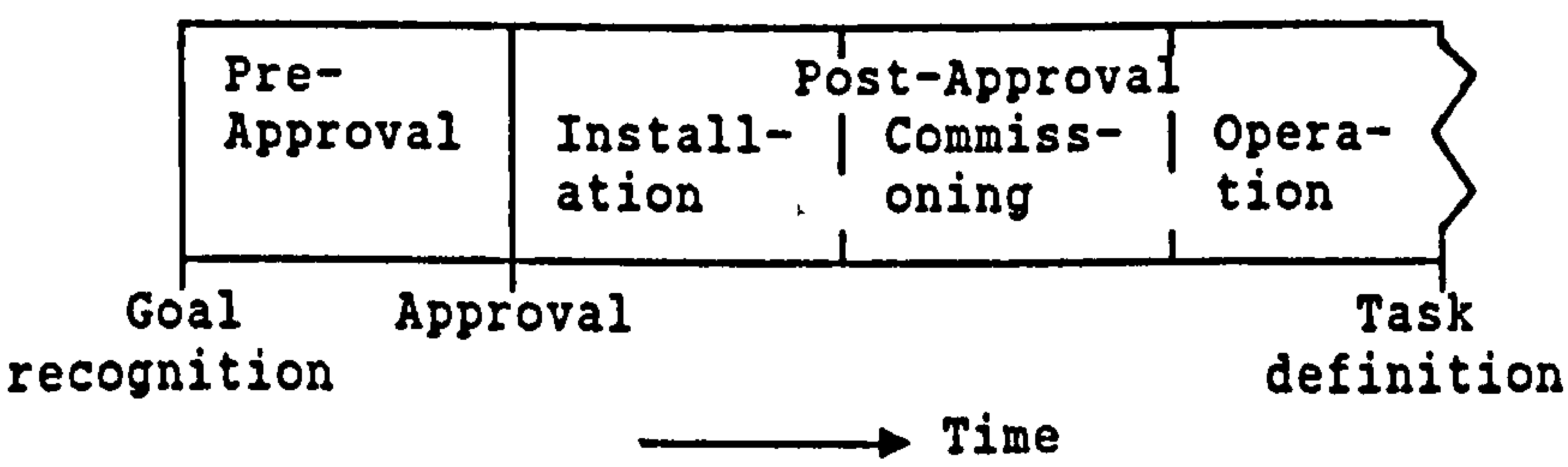
It is likely that the construction of a research instrument will be facilitated and internal validity enhanced (at the expense of external validity) if the study is restricted to a smaller sub-set of strategic decisions than the universe of such decisions so far considered. In chapter 3 it was demonstrated that a parsimonious classification of strategic decisions could be produced by analogy with the types of organisational change produced by the decision. In chapter 2 the project was identified as the basic unit of analysis for the study of implementation. This, together with the taxonomy of strategic decisions developed in chapter 3, enabled projects also to be classified according to a three term framework, as capital, revenue or social projects. It was further shown that the capital project was generally seen as being the most strategic for the organisation. For this reason the research instrument will be developed specifically with capital projects in mind. Any perceived extensibility of the framework to other project types will therefore be unintentional.

Although the primary research interest is the capital project, it will be necessary to obtain some data about the organisations in which the project took place. This is dictated principally by the Information Experience concepts Range and Flexibility outlined in chapter 4 but such information will also be valuable when comparing samples of organisations and for categorisation. This requirement dictates two units of analysis, the first and most important is the "capital project", the second is the "organisation".

5.2.2.2 <u>Logical Model</u>

A model of the logical stages that a capital project could pass through is illustrated in figure 5.4 below:

Figure 5.4: Capital Project Stage Model



This model is derived from the conceptual model of implementation developed in chapter 2, starting with Goal Recognition and ending with Task Definition, or integration. Between these extremes there is a requirement for formal approval to be given for the expenditure of capital monies. In the case study (reported in chapter 4) this followed the submission of a formal Capital Application document, specifying the case for the project to the divisional head office. In some, probably smaller, firms there may not be a need for a formal approval procedure. This point corresponds to the final stage in the strategic decision model developed by Mintzberg *et. al.* (1976).

Approval logically separates the model into two parts. That preceding approval represents a planning, design period for the project during which time support for the project is developed information is collected, analysed etc. and generally a case for the capital expenditure made. In many instances this stage will be a simple extension of the strategic process that initiated the change in objective that generated the project's goal.

Following approval (labelled Post-Approval) there are potentially three stages. The precise number will depend upon the project being implemented. An acquisition will logically not contain an installation, or commissioning stage. A project to acquire and install a new item of capital equipment will logically include an installation (or building) phase in which the equipment or plant is ordered and erected/installed. Following this is a commissioning phase during which the equipment, plant etc. is handed over from its makers to its users. Makers includes those who designed it and users includes those who will maintain it. The meaning of the word commissioning can vary from industry to industry and its meaning can differ between people working on the same project (Raine *et. al.*, 1981). Here we will take it to be the technical proving time for the project, involving precommissioning (unit testing, no-load trials and cleanness checks) start-up (testing and loading systems to their design capacity) and trials (safety, output and efficiency checks). The start of the final operational phase will probably be co-incident with the start-up stage of commissioning, hence the demarcation line between the two will be blurred (as indeed it is between installation and precommissioning). The principal difference between the commissioning and operational stages is along the Socio-Technical dimension identified in chapter 4. Commissioning is a technical activity or process; the operational stage is seen as principally a social or managerial process of assimilating the new tasks etc. into the organisation. The end point for this stage is also, therefore, rather arbitrary.

Nothing can be inferred from the stage model illustrated in figure 5.4 about the relative importance or duration of each stage. It does, however, represent a more or less logical progression of activities through time, moving as indicated in the figure. A research instrument broadly structured around this model is more likely to be familiar to potential respondents than one structured around say, the theoretical constructs. This structure could therefore assist the respondents' recollections of the project and thereby increase the study's internal validity. Ginzberg's (1978) description of the Lewin-

Schein change model suggests similarities between this project stage model and the precepts of the change model (section 4.3.5.2). Specifically, Unfreezing is associated with the preapproval stage; Moving, the "action" stage, with installation and commissioning and Refreezing with operation.

5.2.2.3 Sample Frame

The total time between goal recognition and the end of commissioning in figure 5.3 above could be quite long (at least a year) and will probably show considerable variation. The use of "procedural change" as a measure of success in the study requires that the projects investigated should have been in operation for sufficient time for the organisation to have at least identified procedural changes. This time period could be arbitrarily set at six months. In order to capture the full range of data required in the study, respondents will have to be able to recollect events nominally spanning an eighteen month period. This consideration has two consequences for the study. First, can respondents be reasonably expected to recollect information at least eighteen months old? Second, can the sample frame be chosen to minimise the time between completion of the project and the research taking place?

The first question above was relevant to the case study reported in chapter 4. A case methodology based on unstructured interviews with several respondents was used to collect this data. The project to which the case relates was initiated by a customer inquiry some 5 years before the interviews took place. Analysis of transcripts of the four interview tapes did not indicate any significant difficulty on the part of the respondents in recollecting events this far in the past. Although the respondents were shown to emphasis different aspects of the project (most noticeably showing up the Managerial vs. Technical perspectives) on matters of fact there were no noticeable variations. It is concluded, therefore, that respondents are quite likely to be able to remember facts about important strategic decisions several years after the event. The same conclusion is reached by looking at the study into strategic decision-making reported by Hickson *et. al.* (1986). This major study of 150 strategic decisions in 30 organisations used, in the main, retrospective interviews. However, the early (1974) stage of this research involved intensive case analysis of six decisions, three of which were tracked over a two to three year period as they happened. The final stage of the research (1978-1980) included retrospective interviews with informants about these same six decisions. Hickson *et. al.* (1986,p.25) comment:

> "The hindsight story that is forthcoming in interview is the same in main events and characters, just less cluttered with detail. The main pathways of the process are recalled and less attention is given to what became byways and dead ends".

This passage suggests that retrospective interviews with informants giving information "about what had happened and not about themselves or their opinions...minimally biased by personal perspective" (p.24) concerning events several years in the past, will be reliably recalled.

Accepting the above conclusion that retrospective factual information can be reliably recorded, it appears reasonable to presume that the reliability of the data will be further improved if relatively recent decisions are studied. The analysis presented in chapter 3 demonstrated that the chosen unit of analysis (capital projects) were undertaken in all three organisational types identified within the study of Hickson *et. al.* (1986). (Strictly this holds for the Balance Sheet risk category which the capital project classification derives from.) However, it was also noted that capital projects were most common (at least twice as frequent) within manufacturing type organisations. Therefore, the study used a sample frame based on manufacturing organisations. The precise specification of the sample frame will be deferred until section 5.3.

5.2.3 CAUSALITY CONSIDERATIONS

The question of establishing causality between a set of variables or concepts is a subject of discussion and inquiry dating back to the early Greeks, Plato and Aristotle (Green and Tull, 1975). It is also one of Nunnally's (1967) "deepest innards" issues mentioned in section 5.1.1 above. More recently the question has been addressed by

Simon (1957) particularly with respect to causal modelling, of which path analysis is one technique (see chapter 7).

In Simon's conceptualisation independent variables are viewed as "causing" dependent variables. The system of hypotheses developed in chapter 4 views dimensions of implementation Success as the dependent variables, with Uncertainty and Information causing these. Information Process is in its turn viewed as being caused by Uncertainty and Information Experience. In establishing causal inferences, Green and Tull (1970,p.76) note that three kinds of evidence can be used, no one type of which "nor, indeed, all three types combined, can ever demonstrate conclusively that a causal relationship exists". Green and Tull's three types of evidence are: (1) associative variation, (2) sequence of events and (3) absence of other possible causal factors. The first item is essentially demonstrating that a significant association exists between events. This is the aim of chapter 7. The third item is the question of internal validity noted previously. The second item is typically construed as meaning that the causal event precedes the caused event in time. Questions relating to the precedence of the causal association between Uncertainty and Information will be addressed in chapter 8. Here, however, we note that the precedence between Uncertainty and Information with Success will be more readily established if the Uncertainty and Information measures relate primarily to the pre-approval stage in model 5.4 and the Success measures do not. A further design constraint on the research instrument is therefore, to aim to separate the Uncertainty/Information indicators from the Success indicators around the time of project approval.

5.2.4 QUESTION CONSTRUCTION

5.2.4.1 Questionnaire Architecture

The discussion above has identified a number of design constraints for the research instrument. These are summarised as:

1. The instrument be highly structured.
2. Use five point ordinal scales if nominal scales are not available.
3. Two units of analysis, the "organisation" and the "capital project".
4. Base sample frame on manufacturing organisations.
5. Structure the instrument using the model of figure 5.4.
6. Aim to ensure that Uncertainty and Information indicators are temporally precedent to Success indicators.

To these are added:

7. Use validated measures where possible.
8. Jumble up different measures of the same concept.

Constraints 7 and 8 are added to improve the validity and reliability of the instrument.

A copy of the research instrument is attached as Annex A. So as to conform with requirements for the binding of theses, the instrument in annex A is formatted differently to the instrument used to carry out the study. In addition question 13 in section 1 and question 6 in section 2b are presented to emphasis their theoretical construction and not as they were presented in the actual research instrument.

The instrument started with a page of instructions for the respondent. These instructions were based mainly on Khandwalla (1977,p.666) and served to introduce the study, its broad aims, identify the type of respondent required, define some of the terminology used in the instrument and reassure the respondent with respect to the type of information being sought, the type of responses required and the confidentiality of the information supplied.

The remainder of the instrument was structured into two sections corresponding to the two units of analysis identified above. Section 1 related to the firm and its environment. Section 2 related to the particular capital investment project selected by the respondent and was subdivided into sub-sections reflecting the project stages model of figure 5.4 above. The first of these sections collected general information about the project. The next sub-section, labelled 2a, related to the early pre-approval phase while section 2b related to the post-approval phase of the project. The final sub-section, 2c, was orientated towards the project's late operational phase.

The broad correspondence between the theoretical constructs and instrument architecture was as follows. Section 1 contained questions aimed at categorising the organisation and respondent, plus questions about the Information Experience constructs of Range and Flexibility. Section 2 contained questions to categorise the project, plus information about the Uncertainty and Information constructs. Section 2a contained most of the questions defining the Uncertainty and Information Activity constructs and section 2b contained questions defining the Success and Information Lubrication constructs. Finally section 2c contained further questions defining Success. This correspondence was, as stated above, broad and questions relating to constructs other than those outlined above were included for a variety of logistical reasons, the most important of these being the desire to keep the method of answering questions similar. For example, questions answered using a centre zero scale (principally those measuring change) were grouped together, multiple part questions were separated from single part questions, etc.

5.2.4.2 <u>Question Sources</u>

Here we aim to identify the principal sources used to construct the research instrument. The section will be structured around the theoretical constructs, not the architecture noted above. Specific questions are referenced as <Section.Question number>. So, for example, question 2a.15 refers to question number 15 in section 2a. The detailed operationalisation of the theoretical constructs is covered in chapter 6.

5.2.4.2.1 Categorical Questions

A number of questions were included in the research instrument for purposes of categorisation and comparison. Several of these served a dual function as they were also of use in reifying the theoretical constructs.

The dimensions used for categorisation were: respondent status, organisational size, ownership, industry sector, product diversity and performance. Respondent status was determined from job title (question 1.1) and post-coded into status and functional responsibility dimensions. Organisational size was measured using annual turnover (question 1.15) and number of employees (question 1.14). Ownership was categorised in terms of nationality (question 1.2) independence (question 1.3a and 1.3b) and share holding of the C.E.O. (question 1.10a and 1.10b). Industrial sector (question 1.4) was categorised using the common industrial economics categories for manufacturing industries (Hitt and Ireland, 1985). Product diversity (question 1.5) was based on the major strategic categories identified by Rumelt (Glueck and Jauch, 1984,p.238). However, two of Rumelt's categories, Related and Un-related businesses, were deemed to be too fine for the purpose of this study and were combined into a single Multi-Business category. Finally, performance (question 1.16) was measured relative to major competitors using growth in profit, sales volume, market share and return on investment criteria (Hooley and Jobber, 1986).

5.2.4.2.2 Uncertainty Questions

The principle underlying the Uncertainty concept was that of variety injection into the organisation. Secondary Uncertainty concepts (principally identified from the study by Raine *et. al.*, 1981) were Scope, Novelty, Urgency and Complexity (figure 4.4). The first of these concepts was sub-divided into Size, Skill Use and Strategicality. Size was simply measured by project cost (question 2a.1). The rationale for this comes from Ouchi, who noted that the market price for an item subsumed the item's information content; provided the market was efficient (cited by Macintosh, 1985,p.176). The information content of a project is the project's Uncertainty, viewed from the perspective of the organisation. A further consideration with respect to size comes from the comment by Hickson *et. al.* (1986,p.27) that what constitutes a strategic decision "is a relative judgment, relative to the organisation in which the decision is being made" which suggests that size should be measured relative to the organisation. For this reason the turnover at the time of project authorisation (question 2a.2) and the organisation's annual capital budget (question 1.11a) was also recorded. Skill Use was measured using a single item (question 2b.14). Strategicality measured the importance of the project. One indicator was Consequentiality, a term taken from Hickson *et. al.* (1986) and operationalised in terms of their concepts of Diffusion (question 2.4) Endurance (question 2a.11) Seriousness (question 2b.36) and Radicality (question 2c.1). Further indicators of Strategicality were: the proportion of capital projects normally accepted by the organisation (question 1.9) the use of post-completion audit techniques (question 2.8) relative to the normal use of such techniques (question 1.8) and the number of goals set for the project (question 2.6). Categories used to construct question 2.6 were largely derived from Hickson *et. al.*'s (1986) Diffusion measure (question 2.4).

Novelty was operationalised using a number of objective single item scales. Siting (question 2.2) was partially designed using categories identified during the case study investigation noted in chapter 4. Product novelty (question 2a.15) categories were based on Andrews, D. (1971). Market novelty (question 2a.14) was constructed along market and customer dimensions and based principally on question 1.6. Novelty of Innovation (question 2a.16) was designed using a number of sources including Raine *et. al.* (1981) and face validity arguments. Finally Technological novelty measures were based on Khandwalla's (1977) operationalisation of Woodward's (1965) operating technology concept (Khandwalla's scales were identified by Miller and Dröge (1986) as the best available). A uni-dimensional measure of operating technology was preferred in this study over multi-dimensional measures (e.g., Perrow, 1967) because Technological novelty was defined as the difference between two technology levels, one for the project (question 2a.29b) the other for the department (question 2a.29c) or organisation (question 2a.29a) and subtraction is more clearly defined where uni-dimensional measures are employed. A feature of the Novelty construct worth mentioning here, is that each item is orthogonal to the others, i.e., independent. For example, high Product novelty does not necessarily imply high Market novelty, i.e., a novel product could be targeted at an existing market, and vice versa. In the language of measurement theory, the indicators of Novelty are theoretically not parallel. This point will be returned to in chapter 6.

The majority of the Urgency indicators were derived from face validity arguments and analysis of the case study reported in chapter 4. These included Priority (questions 2a.5, 2a.6, 2a.9 and 2b.7) Pressure (questions 2a.7, 2a.8 and 2a.10) and Financial Attractiveness (questions 2a.18 and 2a.25) indicators. The Window concept (question 2a.12) was suggested by the strategic marketing literature (Abell, 1978). The Simultaneity (question 2b.8) and Survival (question 2a.13) indicators came respectively from the "Strategic Problem Size" and "Implementation Horizon" concepts of Hrebiniak and Joyce (1984).

Finally, Complexity was constructed from perceptual measures of Complexity and Risk, both measured along Technical and Organisational dimensions. Risk (question 2a.26a) included Financial risk and Complexity (question 2a.27) included a measure of the diversity of design options available to the organisation (question 2a.3).

5.2.4.2.3 **Information Questions**

The principle underlying the Information concept was that of variety reduction or absorption by the organisation. Secondary Information concepts were constructed in chapter 4 using Experience - Process (past-present) and Social - Technical dichotomies. The concepts so identified were procedural Flexibility, Range, behavioural Lubrication and information Activity. An appropriate measure of Flexibility for this study was identified from Burns and Stalker's (1961) classification of organisations as exhibiting Mechanistic or Organic forms. An 11 item measure (question 1.13) was developed using Khandwalla's (1977) 7 item Flexibility scale and the 9 items identified by Zaltman *et. al.* (1973) in their discussion of Burns and Stalker's concepts. The actual study instrument had a number of scale items reflected.

A number of tertiary concepts identified in chapter 4 as contributing to procedural Range were; Familiarity, Delegation, Ability and Size. The idea underpinning these concepts was, what experience had the organisation of similar projects and what changes had the organisation undergone in the past that could assist the current project's implementation. These concepts were viewed as attributes of the organisation and so would have to be operationalised in an organisational context. Indicators of these concepts were developed primarily through face validity arguments, although Hickson *et. al.*(1986) and Ansoff (1984) suggested some. Size (question 1.14) was interpreted as number of employees. If employees are viewed as information processing units (a perspective based on the idea that organisations process information, Galbraith, 1969; Feldman and March, 1981) then the greater the number of employees in an organisation, the greater its innate information processing capacity. Perceived Ability (question 2c.5) was constructed along high and low technical and organisational dimensions, yielding a 4 item measure. Delegation (question 2b.23) was used to measure the extent of external (to the organisation) expertise used for each stage of the project, yielding a 4 item measure. Finally, Familiarity was constructed on a number of sub-dimensions measuring the organisation's "innovativeness". These were; existence and use of standardised capital project evaluation procedures (questions 1.7 and 1.8) proportion of capital and revenue expenditures directed towards innovation (question 1.11 parts a, b and c) frequency of similar types of project encountered in the past (question 2.1) diversity of product base (question 1.6) and, approach to new product development (question 1.5). Question 1.5 was based on the Miles and Snow strategic groups (Wheelen and Hunger, 1987:96) as Defenders, Reactors/Analysers combined and Prospectors. A final indicator of Familiarity was Environmental Uncertainty (question 1.12). This related to the rapidity and intensity of change in the organisation's industry and was measured using the validated instrument recorded by Miller and Dröge (1986).

The basis for constructing the Behavioural Lubrication variable was the Lewin - Schein Change Model. This model was operationalised by Sorensen and Zand (1975) for the case of software implementation projects, using a 60 item questionnaire. These 60 items were divided into six groups obtained by dichotomising as Favourable - Unfavourable each of the three precepts of the Lewin - Schein model; Unfreezing, Moving and Refreezing. In another report of their work (Zand and Sorensen, 1975) they noted the test-retest reliabilities of each of the six groupings, or "forces", as being in the range 0.69 to 0.97 and commented that, "the forces do not seem limited to management science projects". In addition they presented a parsimonious listing of their instrument containing 39 items. By changing references in these items from Management scientist to Engineer and deleting one of two near identical items from the list, a 38 item question was constructed to measure Behavioural Lubrication (question 2b.6). In the actual research instrument, items in question 2b.6 were grouped together according to managerial responsibility, i.e., items referring to Top managers were grouped together, as were items referring to Unit managers, etc.

The fourth and final secondary component of Information is Activity. Several indicators of this concept were derived from face validity arguments, e.g. Contingencies (question 2a.26b) and Design Resources (question 2a.31). A further multi-item indicator of Design Resources (question 2.7) was based on the decision-topic categories used by Hickson *et. al.* (1986). This question also served to categorise individual projects. The remaining sub-dimensions of Activity were derived from Rubin and Sapp (1981) as Analysis, Communication, Search and Information technology. Analysis was viewed as measuring the use of formalised capital evaluation procedures. Drucker (1988) summarised the principal aims of such procedures (question 2a.24) and Ho (1988) was used as a source for items specifically relating to capital project risk assessment (questions 2a.19 and 2a.20). Many of the Communication indicators were suggested by the study of Hickson *et. al.* (1986). These included a project politicality indicator (question 2a.4) and indicators of the extent of formal and informal meetings (question 2a.21 to 2a.23). Information Search indicators were questions 2a.30, 2a.32, 2a.33 and 2a.35. Questions 2a.32 and 2a.33 were multi-item "interest unit" measures derived from Hickson *et. al.* and, for question 2a.32, the "Role Specialisation" measure developed by Pugh *et. al.* (1968). Question 2a.35 was based on a number of sources, including Mintzberg's (1973) study of managerial activities. Information Technology (I.T.) was viewed as being of potential use when performing Analysis, Communication and Search activities, therefore indicators were designed for each of these dimension. Question 2a.36 looked at the value of written documentation, question 2a.34 (based on the previously noted Mintzberg study) was used to measure I.T. use in Communication and question 2a.39 (based on Freyenfeld, 1984) was designed to capture the I.T. component in information Search. Questions 2a.37 and 2a.38 were included to capture the global aspect of I.T. use.

A final note with respect to the Activity concept relates to the problem of differentiating between Information and Data. McRae (1971) notes that data and information are "joint products", as both are normally produced simultaneously and the two words frequently used interchangeably. However, data are individual facts and information (in the Computer Science sense, Woodhouse *et. al.*, 1982; Tsichritzis and Lochovsky, 1982) is meaning attached to data. Information is defined in this study as that which reduces variety, a perspective which for practical purposes was taken to be the same as the Computer Science definition. In formulating questions relating to the collection or use of information, it was therefore necessary to clearly differentiate the <u>value</u> of information collected from the <u>quantity</u> of data collected. This differentiation was achieved in the research instrument by appending a definition of information value to question 2a.32.

5.2.4.2.4 Success Questions

Questions relating to theoretical constructs were based upon the tertiary concepts identified in chapter 4. The Success concepts were summarised in table 4.6.

The dimensions of Success/Expectation identified in chapter 4 were Ease, Accuracy and Satisfaction. The principle underlying the Ease concept was lack of problems. Implementation problems were identified using a multi-part question (question 2b.20) developed from Alexander (1985) and Raine *et. al.* (1981). In addition, the perceived overall extent of problems was measured along technical and non-technical dimensions, together with the overall ease of implementation (questions 2b.28, 31, 33 and 34). To assist with the interpretation of the data, question 2b.21 was included to encourage respondents to provide anecdotal accounts of how problems identified in question 2b.20 were resolved. The next concept, Accuracy, refers to the achievement of targeted specifications. Questions 2b.2, 2b.3, 2b.30 and 2b.32 used centre zero scales for this purpose. The basic dimensions used to construct these questions came from the "implementation success index" developed by Alexander (1985) with the addition of adequacy of contingency allowances (question 2b.2). The third and final Success/Expectation concept was Satisfaction. This concept was operationalised by questions 2b.9 to 2b.13 (based on the behaviourally anchored success measures used by Sorensen and Zand (1975) in their study of implementing OR/MS projects) and questions 2c.3 and 2c.4 measuring the willingness of the organisation to repeat the project.

Success/Change dimensions identified in chapter 4 were Culture, Competency, Skills and Applicability. Cultural change was measured along structural and behavioural dimensions. The structural change indicators (question 2b.5) were taken as changes to the Organicity of the organisation and were operationalised from question 1.13. Behavioural change indicators (question 2b.4) were taken from Mirvis and Macy (1983,p.520). Two Competency indicators were used, one relating to the time taken to carry out projects (question 2b.29) the other was multi-part and investigated the competency of the organisation along technical and organisational dimensions (question 2c.6). Culture and Competency measures used scales centred on "no change". Skills related to changes in the organisation's operating procedures and was measured using two global single measure items (questions 2b.35 and 2c.1) and a multi-item measure (question 2b.15) investigating the effects of the project on specific functional areas of the organisation. This question was adapted from the "Role Specialisation" measure developed by Pugh *et. al.* (1968) and Hickson *et. al.* (1986). Finally, questions measuring Applicability and diffusion throughout the organisation of procedural changes introduced by the project (questions 2a.28, 2b.19, 2b.24 to 2b.27 and 2c.2) were developed using face validity arguments.

5.2.4.2.5 Miscellaneous

A number of questions were contained in the research instrument which may be best placed under the heading of, miscellaneous. These questions were included for a variety of reasons, such as, general interest, testing ideas contained in the thesis not necessarily conforming to the theoretical model developed in chapter 4 and increasing respondent co-operation. To assist with possible follow up work, the title of the particular capital projects was also asked for.

The idea developed in chapter 3 that projects are components of (possibly larger) programmes was investigated with question 2.3. The stimulus that initially generated the project was investigated with question 2.5. This question was based on a modified version of Porter's (1980) five force model (Wheelen and Hunger, 1987:94) and Hickson *et. al.*'s (1986) Diffusion concept. Hickson *et. al.*'s Authority measure (question 2a.17) was included as an indicator of decision-process. One of the major theses of this study, underlying the argument that procedural Change is a dimension of Success, is that the Getaway Capacity of an innovation (as defined by Zaltman *et. al.*, 1973) may be overt and/or covert. Here, strategic projects are viewed as innovations and the word covert is used in the sense that the Gateway Capacity was unintentional and indeed may remain unrecognised by the innovating organisation. While the Success/Changes concept is designed to measure the covert Gateway Capacity of a decision, question 2a.28 was included in the study to identify the overt (if any) Gateway Capacity of the project. Question 2b.1 was included as a potential moderator in interpreting the findings, particularly with respect to Success/Change measures. The total duration of the project was determined by question 2b.16 and anecdotal information about the project's implementation was obtained with question 2b.22b, being prompted by consideration of question 2b.22a. Finally, the relative contribution made by each stage of the project to the overall absorption of variety (question 2b.17) and the relative value of the Analysis, Search, Communication and Information Technology activities to the overall pre-approval design effort (question 2b.18) were measured. Questions 2b.17 and 2b.18 were constructed for analysis by the analytic hierarchy process (Saaty, 1980). The main advantages of the analytic hierarchy process are that it measures the consistency with which items are ranked and also enables the relative differences between ranked items to be determined.

5.3 METHODOLOGY

5.3.1 PILOT STUDY

The initial instrument design was tested for comprehensibility by subjecting it to scrutiny by academic colleagues. Subsequently it was administered to two senior executives (one Managing Director, and a Production Director) in two different manufacturing organisations (Fine Chemicals and Textiles) using taped personal interviews. The interviews took nominally three hours and two hours respectively and were conducted during February and March 1989. Following analysis of each interview a number of changes were made to the questionnaire. These changes were then "tried out" by posting the modified questions to the respondent for completion and comments. After two such piloting and subsequent iterations, confidence in the comprehensibility of the instrument was sufficiently high to attempt the main study.

The instrument resulting from the above procedure (Appendix A) required over 400 separate responses and took nominally 90 minutes to complete. No decision had been taken at this point on the final administration of the instrument. Two approaches were considered, personal interview and mailed questionnaire.

5.3.2 RESPONSE RATE

The mailed approach has the advantage that, being relatively inexpensive, a large number of respondents can be contacted simultaneously, thus a large number of responses could potentially be obtained. With nominally 200 responses advanced analytical techniques could be employed which combine Factor analysis and Path analysis in a single procedure (Bone *et. al.*, 1989; Miller and Dröge, 1986). Even with smaller samples, confidence in the Factor and Path analysis results increases with increasing sample size. The negative side of the argument is that mailed questionnaires can have very low response rates. A low response rate seriously effects the validity of the study and prompts the use of follow-up interviews to control for respondent bias (Green and Tull, 1975). It was noted in section 5.1.4 above that Statistical Conclusion Validity (most effected by sample size) was not as important to this study as Internal validity or Construct validity. As Fitz-Gibbon and Morris (1987,p.116) note, "size of your sample is not nearly as important as the adequacy of the design." A low response rate was therefore considered unacceptable, even if a large sample were obtained.

Green and Tull (1975,p.152) note that the modal response rate to mailed questionnaires is often in the range 20 to 40 percent; even after steps to increase response rates are taken, e.g., follow-up mailings. Jobber *et. al.* (1985) note that, "Particularly low response can be expected from industrial populations...single figure responses have been obtained". They found that an effective technique for increasing the response to a mailed questionnaire was to obtain verbal agreement (by telephone) from respondents that they would complete the questionnaire. A 55 percent response rate was achieved in their study through telephone prenotification, telephone reminder and letter and questionnaire follow-up. This compares with 38 percent achieved with letter and questionnaire follow-up only.

Because of the size and complexity of the research instrument grave doubts were expressed as to the ability of a mailed survey to achieve a 20 percent response rate; the minimum considered acceptable. To test the probable response two trials were set-up. One involved a "blind" mailing of the questionnaire with no pre-contact, the second was sent only to C.E.O.'s who had previously agreed to return the questionnaire. Tables of Binomial distribution probabilities were inspected to determine the sample size yielding 95% confidence that a zero response to the sample would imply a less than 20% response to a full scale study. The sample size found to satisfy this criteria was fourteen, hence two sets of fourteen questionnaires were mailed out during March 1989 (organisation selection will be described later). One questionnaire was received from the blind mailed group and three to the prenotified group. However, one of the three prenotified responses was judged to be unusable, hence this sample yielded two usable responses. It should be noted that a comparison of the response rates to the two groups as 2:1 (i.e., 2:14 to 1:14) is incorrect. This is because a total of 19 companies were contacted in the prenotified group to obtain 14 companies agreeing to look at the questionnaire. The true, usable, prenotified response rate is therefore 2:19, i.e., 11% not 14%. This 1.5:1 (2:19/1:14) relative response rate to the two samples was in broad agreement with Jobber *et. al.*'s (1985) finding where, without any follow-up, response rates of 43.2% and 27% (1.6:1) were reported for prenotified and blind samples respectively. Further, taking the actual prenotified response as 11% and applying Jobber *et. al.*'s finding for the effect of follow-up reminders etc., it was estimated that the most probable response to a prenotified survey with the research instrument would be less than 20 percent. The use of a mailed survey in this study was therefore rejected.

Hickson *et. al.* (1986) reported a two-thirds response rate to their requests for personal interviews taking one to two hours (c.f. the maximum 55% response rate reported by Jobber *et. al.*, 1985). Hickson *et. al.*'s response was similar to the 74% (14/19) of companies agreeing to complete or "have a look at" the prenotified questionnaire in the study reported above. It appeared probable, therefore, that an adequate response to the study would be obtained if personal interviewing was used as the data collection technique.

5.3.3 PERSONAL INTERVIEW

Personal interviews are relatively expensive to conduct in both time and money terms and so restrict the total sample. However, as previously noted, large samples were not necessarily viewed as being of prime importance to this study. Green and Tull (1975,p.150) identify three advantages for the personal interview over other types of data gathering technique. First a better sample can be obtained, as non-response and question omission can be kept to a minimum. This is important where small samples are being studied. Secondly it gives an opportunity to obtain more information, particularly by recording the interview. Again, in an exploratory study of the type being undertaken here, additional anecdotal evidence could be potentially valuable when interpreting results. Finally, the personal interview has greater flexibility, offering the researcher opportunities to give extra clarification concerning the information being sought. As this study was primarily attempting to elicit factual information such opportunities would serve to enhance the reliability of the data obtained. Further, the tedium effect of multi-item questions (Cook and Campbell, 1979,p.82-83; Peter, 1981) which threatens internal validity may be controlled to some extent during an interview by the use of supportive comments. Overall therefore, the tape recorded personal interview was judged to be the most appropriate data collection method for this study, bearing in mind the priority ordering of validity considerations specified in section 5.1.4 above. We now turn to respondent selection.

5.3.4 RESPONDENT SELECTION

The questionnaire design required a respondent familiar with all stages of the project, from initial goal recognition through to final integration into the day-to-day operations of the organisation. In addition the respondent would need to be familiar with all functional areas of the organisation. These criteria identify the organisation's Chief Executive Officer as being the most likely respondent. Phillips (1981) found that the most reliable informant within an organisation was not necessarily the most senior. This suggests that, once having familiarised the C.E.O. with the needs of the research design, they should be allowed to identify a more suitable respondent for the study. Hitt and Ireland (1985) used this approach for their mailed survey into corporate distinctive competence.

The question of whether to use a single respondent for each unit of analysis is a methodological issue of considerable importance. Doing so can present a threat to construct validity due to what Cook and Campbell (1979) refer to as Mono-Method bias. The rationale for assessing convergent validity (section 5.1.3.4. above) relies on multiple respondents being used. Phillips (1981) in a multiple respondent mailed survey study of organisational measures used in marketing research found that, "key informant reports should be validated by the reports of other informants". However, two points need to be born in mind when assessing Phillips' findings. First, it was a study of marketing variables. Fenwick (1979) notes that:

> "Given marketing's frequent use of search techniques supported by little in the way of prior hypotheses, it is particularly important that analyses be validated"

Using the validity concepts outlined in figure 5.1, Fenwick's comment may be paraphrased by saying that research in marketing frequently does not have high *a priori* nomological validity. Hence, particular attention has to be paid to trait validity issues, so that construct validity is preserved. This study and its hypotheses are grounded in the relatively well established theory of cybernetics, thus *a priori* nomological validity is relatively high. A reduction in trait validity, through the use of a single respondent say, may therefore not seriously threaten the studies overall level of construct validity. The second point is that Phillips' findings were based on a mailed survey. Hickson *et. al.* (1986) conducted personal interviews with single respondents, asking them about "what had happened". They found adequate reliability when these responses were compared with case study results taken years previously (section 5.2.2.3. above). Phillips makes a similar observation:

> "Questions which ask informants to report on relatively objective, observable phenomena...should be less demanding and less subject to distorting influences."

The research instrument used in this study was designed with objective measures in mind and so should be less subject to single respondent distortions. Finally Phillips comments that multiple informant studies, "would be time-consuming and expensive and would require extensive presurvey contact with each organisation to select informants" and that the gains in terms of reliability and validity only "might" offset the costs.

In summary, the use of objective measures, obtained through personal interview and based on a reasonably well grounded theory will probably achieve adequate levels of construct validity, even if single respondents are used. Combining these findings with the pragmatic consideration of greatly increased cost (financial and non-financial) to carry out multiple respondent research, the decision was taken to administer the questionnaire to a single respondent for each organisation and capital project studied. This research strategy would necessarily preclude the assessment of convergent validity. The question of organisation selection will now be considered.

5.3.5 ORGANISATION SELECTION

We stated previously (section 5.2.2.3.) that this study would focus on manufacturing organisations. Here we refine this specification so that individual manufacturing organisations can be identified for sample selection. Information presented here focuses specifically on the organisation selection procedure used for the mailed pilot study (see section 5.3.2 above). Only minor differences exist between the sample selection procedure used for the pilot and main studies. This section may therefore be viewed as an introduction to chapter 6.

The sample frame adopted for company selection was the 26th edition of the KOMPASS directory (KOMPASS, 1988). This directory is one of the most comprehensive available, listing over 30,000 companies and includes fairly extensive information about those listed. In terms of the requirements of this research, Volume III of the directory "Company Information" identifies Company name, address, telephone number, size (employees and turnover) a two digit industrial group classification, the principal officers, and positions held by them within the company.

In selecting companies for inclusion in the sample, the following criteria were adopted:

1. The company's two digit industrial group code(s) were in the range 11 to 49 (Codes 10, 15, 17, 18 and 50 do not exist). These codes are not the same as two digit SIC product codes, but do correspond approximately, with the addition of "Energy" industries, to the HMSO Annual Abstract of Statistics "Manufacturing" grouping (Annual Abstract of Statistics, 1989; Table 17.25). Companies with codes outside this range were tolerated, provided they were not wholly outside this range. A complete list and description of each product code is given in Appendix B.

2. The company size equalled or exceeded 100 employees. Size is not an important variable within the research model. However, selecting this criterion proved to be an effective way to screen out companies engaged in importing and/or distribution; not manufacturing.

3. The C.E.O. was identified. The C.E.O. was usually taken to be the Managing Director or, if not identified, the Chairman, Chief Executive or General Manager was used.

4. Companies were not subsidiaries of companies already selected. The motive for adopting the "no subsidiaries" criterion was to preserve the statistical independence of the sample, as the assumption of statistical independence underpins most statistical techniques used to evaluate data of the type being collected here. The selection was carried out by inspecting the company's address and list of directors. If a match was found with an already selected company, then one was rejected.

5. Use a systematic sampling procedure. Systematic sampling is a short cut method for obtaining a virtually random sample (Harper, 1982) and is therefore a relatively bias free sampling technique.

Only companies satisfying all of the above criteria were selected for contact. Further analysis of the directory (see chapter 6) indicated that some 8500 companies satisfied these criteria, which therefore specifies the available sample frame. However, the composition of the KOMPASS directory may introduce some measure of bias into the sample. For example, many companies operating in the unlisted market do not have full entries. This tends to bias the sample towards U.K. owned companies. Also, many large divisionalised companies only contain a single entry referring to the company's registered office. Thus individual manufacturing sites of these companies either have no entry, or incomplete entries in the directory. As a result the sampling procedure adopted tends to exclude "Times 1000" companies and their divisions and/or subsidiaries. Some of these possible biases could be eliminated by cross referencing with other directories, notably the EXTEL unlisted companies directory, and by using personal contacts through the university etc.

Finally, a note about the organisational unit of analysis. There is no guarantee that the organisational unit of analysis chosen by the compilers of the KOMPASS directory corresponds with that of the organisation itself, or, more importantly, the individual respondents contacted for the study. For this reason no attempt was made to precisely predefine the organisational unit of analysis for individual cases. This was left to the discretion of individual respondents to define in a way most suited to their experience.

This chapter has sought to identify indicators for the theoretical concepts defined in chapter 4. It has also sought to determine the sample frame and units of analysis for use in the study, and discussed methodological issues pertinent to its administration. In the next chapter we focus on the data collection carried out with the research instrument and the determination of construct validity.

CHAPTER 6

CONSTRUCT MEASUREMENT

The purpose of this chapter is to develop measures for each of the principal theoretical constructs identified in chapter 4 and is structured into four broad areas. The first describes the sample on which this study is based. The second assesses how representative this sample is. The third analyses the study data to establish the construct validity of the research instrument developed in chapter 5, and the last generates measures of the theoretical constructs.

6.1 <u>THE SAMPLE</u>

The sample on which the findings of this study are based is, in fact, two samples. These samples will be referred to as the *main* sample and the *pilot* sample. Together they constitute the *study* sample.

The origin of the 5 pilot sample cases was described in chapter 5. It is composed of; 2 cases from personal interviews, 1 case from the blind mailed questionnaire study and 2 from the pre-notified mailed questionnaire study. A third response from the pre-notified mailed questionnaire was, as previously noted, adjudged to be unreliable and therefore discarded. This was because of a lack of variation in the way some questions, notably the later ones, were answered. We have described the methods used to collect the 5 pilot sample cases in chapter 5 and will not be referring to them again here. Instead, we focus on the main sample and the combined study sample, only.

6.1.1 THE MAIN SAMPLE

This section describes the major data collection stage of this research. In total 40 companies were able to assist in the study and these constitute the main sample.

6.1.1.1 Sample Size Determination

A common heuristic used by researchers when determining the number of cases to be included within a study was found by Sawyer and Ball (1981) to be 30 subjects per cell. This heuristic probably derives from the Central Limit Theorem in statistical sampling theory. Some authors suggest that a sample of 30 cases is sufficient to satisfy the Central Limit Theory condition of a statistically "large" sample. Mendenhall *et. al.* (1986,p.263) indicate that this is not always the case and suggest that the sample size to apply the theorem should be determined according to the specific application. A review of research in the Business Policy area indicated that a sample of approximately 30 cases would be appropriate. (Glueck and Jauch, 1984, provide excellent summaries of large areas of business policy research and the above conclusion is based on these summaries for non-mailed survey research.) To these observations can be added the comment that statistical conclusion validity generally increases as the sample size on which the analysis is based increases. (The word 'generally' is used above, because with very large samples, statistically significant associations can be found purely by chance. Cattell (1966) observed that in nature most things are associated to some extent and that sampling errors alone can prevent a precisely zero correlation from occurring. Very large samples, therefore, can be a source of spurious results if the researcher attaches too great an importance to chance but statistically significant associations.)

In summary, the number of cases to be obtained for the main sample was determined by the requirement to obtain as many as possible, but at least 30, within budgetary constraints. It was anticipated that the pilot cases would be included in the study sample, but that the main sample should be large enough to allow meaningful analysis of the data in the event of excluding the pilot cases from the data base. Within the constraint of the above heuristic, 40 cases were obtained.

6.1.1.2 Case Selection

In discussing methods of case selection the issue of concern is that of *bias*, i.e. allowing a particular influence to have more importance than it really warrants. Sources of bias should be eliminated as far as practical, as failing to do so will invalidate the findings. The sample frame used for the main sample was the same as that used for the mailed pilot studies reported in chapter 5; namely the 1988 KOMPASS directory. Chapter 5 commented on the appropriateness of KOMPASS as a sample frame and possible sources of bias introduced by its use. In addition, five organisation selection criteria were specified for identifying organisations for inclusion within the mailed pilot studies. The first four of these criteria were adopted, without modification, for selecting the main sample. The final criteria specified the sampling procedure used. The discussion here will focus specifically upon this potential source of bias, i.e., that due to the method of sample selection within a given sample frame.

One of the least biased methods of sample selection is to select randomly from the sample frame. This method does not necessarily yield a sample free of bias; it is the sampling method that is free of bias (Harper, 1982). In random sampling there is a finite probability that the same organisation would be selected more than once. This possibility was specifically excluded in this study, the sampling procedures adopted were therefore, non-random. For the mailed pilot studies reported in chapter 5 a systematic sampling procedure was adopted. This yields a virtually random sample (Harper, 1982). For a study based on personal interviews this sampling procedure was impractical. This is because the procedure would disperse cases throughout the country and the cost of travel etc., would be prohibitive. A sampling technique that is useful where cost is a major constraint is Multi-stage sampling. This sampling procedure was adopted when selecting cases for the main sample.

The sampling procedure adopted, consisted of selecting towns from the directory and taking those manufacturing companies satisfying the four criteria noted in chapter 5 as possible candidates for study. However, the target areas to be sampled needed, for budgetary reasons, to be close to Bradford. Therefore, not all the requirements of the Multi-stage sampling technique were adhered to. In particular, as the Leeds/Bradford area contains a major concentration of the British Wool Textiles industry, it is possible the sample would be biased through over representation of this industrial sector. This issue will be discussed later.

Besides possible biases inherent within a sampling procedure and the sample frame, a further possible source of bias is due to the sample frame being finite. Most statistical methods assume the parent population is infinite and when it is not, the estimators of the population mean need to be adjusted by the finite population correction factor (Mendenhall *et. al.*, 1986). If the sample is random this correction can be ignored, for all practical purposes, if the sample size is less than one twentieth of the population size. A systematic sample drawn from the KOMPASS directory indicated a population of companies (satisfying the number of employee and product group criteria used in this study) to be in the order of 8500. The sample of 45 cases used in this study is therefore about 10 times smaller than would be required for the finite correction factor to apply. In summary, possible biases introduced into the study by the sample frame were not judged to be serious. Bias due to sampling procedures will be attended to later.

6.1.1.3 <u>Access</u>

Selected companies were initially contacted by telephone, primarily to establish the accuracy of the KOMPASS data with respect to the named chief executive officer (CEO) and also any change of business that may have occurred, e.g. from manufacturer to distributor. The KOMPASS data was inaccurate with respect to CEO's name in about 30% of the companies contacted: in one instance the named CEO had been dead for over two years! After verifying the basic information (telephonists were most helpful here) an attempt to speak with the CEO was made. More often than not this initial telephone contact was unsuccessful, usually he (no female CEO's were identified in the sample) was unavailable. If the CEO's secretary was available, then it was established whether a letter summarising the research objectives would be a more appropriate form of contact. If so, a letter was posted; see appendix C. (The secretaries' cooperation in ensuring that a letter would bypass the companies "junk mail" screening procedures was required in this instance. Such screening procedures extend in some cases to telephone calls. On one occasion it was necessary to convince the company's switchboard that the call was not aimed at selling a product or service before being put through to the secretary.) If it appeared reasonable that the CEO would prefer a telephone contact, appropriate times for a recall were established. Alternatively the secretary could pass messages.

As explained in chapter 5 it was not automatically assumed that the CEO would be the most appropriate informant for the research. The purpose of contacting the CEO was therefore to establish the name of the person best able to provide the required information. For this reason it was not always necessary to speak with the CEO and subsequent contacts with the company could be directed towards the preferred informant. Care was taken during any contact with a company to stress that any information given to the researcher would be treated in strict confidence; using a form of words similar to that used in Appendix C. If cooperation from the company was obtained a time and date for an interview was arranged and confirmed by letter. Two confirmatory letters were used, the format depending upon whether the letter in appendix C had previously been posted. Attempts to arrange interviews continued up until the 10 July 1989. This was the last practical date for arranging an interview if data collection was to be completed by 31 July.

6.1.2 SAMPLE STATISTICS

Sample statistics are presented here on the geographical distribution of the sample, the size etc. of individual companies, the key informants within the companies and for the projects studied. These statistics will be presented for the main sample (N=40) and the study sample (N=45) i.e., the main and pilot samples. The results are presented as a series of tables, and comments on the tables will be kept to a minimum. It should be noted that here the data is taken directly from the information supplied by the informants. The correspondence between the data to be presented here and the secondary data derived from KOMPASS is not very close, on occasions, for principally one or both of two reasons. These are firstly inaccuracies within the KOMPASS directory and secondly (and more substantively) because the unit of analysis in the study does not necessarily correspond with that used within KOMPASS. The methodology discussion in chapter 5 explains this point and the basis for selecting the unit of analysis. Note in particular that the number of employees within several of the companies is less than the 100 used to select the company in the first instance. Also note that one non-manufacturing company was included. This company was in fact principally involved in electrical contract work.

6.1.2.1 <u>When and Where Collected</u>

Data for the pilot sample was collected during February and March 1989, and for the main sample between April and August 1989 inclusive. The initially budgeted interview schedule had aimed to finish data collection in July, the August interviews were interviews postponed from July.

The monthly frequency distribution of main sample interviews is reported in table 6.1.

Table 6.1: Interview Dates

MONTH	No. OF INTERVIEWS
February	2 p
March	3 p
April	6
May	11
June	7
July	14
August	2
Total	45

p - Pilot study

All companies responding to the study (pilot and main samples) were based in England only; no Scottish or Welsh companies were contacted and/or responded. The distribution of localities within England is illustrated on Figure 6.1.

Figure 6.1: Geographic Distribution of Cases

The concentration of interviews within the Leeds/Bradford area of West Yorkshire is clearly seen from inspection of figure 6.1. In an attempt to broaden the geographic and industry base of the sample, 5 interviews were held in the Greater London/Sussex area and 4 interviews in the Newcastle-Upon-Tyne area. Budgetary constraints prevented substantially broadening the geographical base of the sample. Using postal town as the basis for categorisation (i.e. the first two letters of the British Royal Mail Post Code) the geographical distribution of companies in the sample may be represented; table 6.2. Note that in table 6.2 three samples are defined. The main and study samples have previously been defined. The non-participants sample refers to 37 companies contacted as part of the main sample, but which declined to be interviewed. We will discuss this group later.

Table 6.2: Distribution of Sample Companies by Post Town

CODE	POSTAL TOWN	MAIN SAMPLE	STUDY SAMPLE	NON-PARTICIPANTS SAMPLE
LS	Leeds	15	15	16
BD	Bradford	8	9	9
RH	Redhill	4	4	4
NE	Newcastle-Upon-Tyne	4	4	2
HG	Harrogate	3	3	4
HX	Halifax	3	3	0
BB	Blackburn	2	2	2
UB	Uxbridge	1	1	0
OL	Oldham	0	1	0
CW	Crewe	0	1	0
	London	0	1	0
-	Missing data	0	1	0
	Totals	40	45	37

6.1.2.2 Summary Company Statistics

Summary statistics relating to company size, type and perceived performance relative to major competitors, are presented in tables 6.3a, 6.3b and 6.3c.

Table 6.3a: Company Size Statistics

ITEM	MEAN	MEDIAN	MINIMUM	MAXIMUM
Study Sample: (N=45)				
Number of Employees	438	280	25	3000
Annual Turnover (£m)	23.3	14.0	1.20	127.0
Cap. Exp. (£1000)p.a.	1408	500	20	15000
Main Sample: (N=40)				
Number of Employees	429	267	25	3000
Annual turnover (£m)	23.7	14.5	1.20	127.0
Cap. Exp. (£1000)p.a.	1466	500	20	15000

Table 6.3b: Company Type Statistics

ITEM	STUDY SAMPLE (N=45)	MAIN SAMPLE (N=40)
Company Ownership:		
United Kingdom	40	37
North American	3	2
West European	2	1
Independence of company:		
Fully Independent	14	13
Subsidiary	17	15
Division	8	7
Subsidiary of Divis'n	6	5
Industry Sector:		
Commercial Services	1	0
Capital Goods	12	11
Consumer Durable	9	9
Consumer non-durable	8	6
Producer Goods[1]	15	13
Product Diversity:[2]		
Single-Product	6	6
Single-Business	27	23
Multi-Business	12	11

1. Goods bought to assist in the manufacture of some other product.
2. These three items were defined as follows:
Single-Product: Dependent on one product for at least 95% of total company sales.
Single-Business: Dependent on one major area of related products (similar technology and markets) accounting for at least 70% of total company sales.
Multi-Business: Diversified into more than one major product area so that no single *business* accounts for 70% or more of total company sales.

Company performance was assessed by a four item question covering growth of, profits, sales volume, market share and return on investment, relative to each companies major competitors. The informant was asked to rate their company as being better, the same, worse or don't know, for each question. Each of these four responses was scored as +1, 0, -1 and 0 respectively and these scores summed to produce a nine point scale of perceived company performance ranging from -4 to +4. A company with an overall average performance would be expected to achieve a score of zero on this scale. The mean score for the companies in the total sample (after eliminating 4 cases giving two or more "Don't Know" responses) was 2.00 and the standard error 0.26. A t-test (N=41) to compare this observed mean score with a hypothesised zero mean is highly significant ($p<0.01$). This indicates that the companies within the sample perceive themselves to be better than their competitors, on average. This could possibly explain the companies willingness to participate in the study. Phillips (1981) observed a similar effect in a mailed questionnaire study of 506 wholesale distribution companies in the USA. Phillips found that companies participating in the study had, on average, higher sales volumes than the non-participating companies. However, commercial success was not a parameter of significant interest to the study, any bias from this source was not therefore judged to be a threat to the study.

The observed distributions of this study's overall company performance score is given in table 6.3c.

Table 6.3c: Overall Company Performances

SCORE	FREQUENCY STUDY SAMPLE (N=41)	FREQUENCY MAIN SAMPLE (N=36)
-4	0	0
-3	1	1
-2	1	1
-1	1	1
0	3	3
+1	7	6
+2	11	10
+3	9	7
+4	8	7
Missing	4	4

6.1.2.3 Summary Informant Statistics

Summary statistics on the status and functional responsibilities of the informants within the companies is given in table 6.4.

Table 6.4: Respondent Status and Responsibility

ITEM	STUDY SAMPLE No.	%	MAIN SAMPLE No.	%
Respondent Status:				
Director	32	71.1	27	67.5
Manager	13	28.9	13	32.5
Functional Responsibility:				
C.E.O.[1]	23	51.1	19	47.5
Production[2]	13	28.9	12	30.0
Technical[3]	6	13.3	6	15.0
Other[4]	3	6.7	3	7.5

Notes to table 6.4:
1 - Chairman, Chief Executive, Managing Director, General Manager.
2 - e.g. Production Director, Service Director, Plant Manager, Works Manager.
3 - e.g. Technical Services Director, Development Director, Project Engineer, Production Engineer.
4 - e.g. Director Computer Services, D.P. Manager.

6.1.2.4 Summary Project Statistics

Financial statistics on the projects covered by the study are given in table 6.5a. Categorisations of the projects are presented in tables 6.5b and 6.5c. Note, the definition of a capital project used within this study was any project which increased the company's fixed assets.

Table 6.5a: Project Costs. (£x1000)

ITEM	MEAN	MEDIAN	MINIMUM	MAXIMUM
Study Sample:				
Fixed Assets.	922	240	5	8000
Working Capital.	323	20	0	4000
Goodwill.	116	0	0	5200
Total.	1361	250	20	11000
Main Sample:				
Fixed Assets.	968	210	5	8000
Working Capital.	356	18	0	4000
Goodwill.	130	0	0	5200
Total.	1453	235	20	11000

Projects were categorised according to the nature of the inputs into the decision giving rise to the project. This is the "Decision Topic" categorisation used by Hickson *et. al.* (1986) in "Top Decisions" (see chapter 3). Dr. R.J. Butler, the originator of this scheme and co-author of "Top Decisions", acted as an independent judge to assist the author in categorising the projects according to this scheme. This categorisation was made using the description of the project supplied by the respondents in answer to the project title question in section 2 of the questionnaire (appendix A). In addition, question 2.7 of the questionnaire was constructed using the same decision topic categories. Each respondent was asked to identify the category that accounted for the major expenditure during the project. For the study sample only, the frequency of responses to each of these categories is also presented in table 6.5b.

Table 6.5b: Project Topic Categorisation

	SAMPLE		Q2.7
TOPIC	STUDY	MAIN	STUDY
Technology	22	19	29
Reorganisation	1	1	2
Control	6	6	4
Domain	1	1	1
Product	3	3	2
Boundary	2	2	2
Input	4	4	0
Location	5	4	5
Missing Data.	1	0	0

By comparing the study sample results, it will be observed from table 6.5b, that the project topic categorisation based on expenditure (Q2.7) is very similar to the categorisation based on project description. The notable exception is the Input category. In addition, we may use this data to test the correspondence between topic categories and the taxonomy of strategic decisions (Entity, Relational, Interface) developed in chapter 3. There it was asserted that Entity change decisions would tend to result in capital investment projects. All of the decisions studied here were capital investment projects, therefore only Entity change topics (Technology, Product, Boundary and Location) should be identified. The data in table 6.5b shows that, based on project description, 73% of the projects in the study sample were of the Entity type. This increases to 84% if the classification based on expenditure is used. The statistics for Relational and Interface topics are 16% and 11% respectively, based on project description and 13% and 2% based on expenditure. These statistics appear to provide further tentative evidence for the associations identified in chapter 3. Furthermore, most of the discrepancy with respect to the Relational categorisation occurs because five of the six Control topic projects involved the purchase of computer equipment.

In addition to the above an *ad hoc* categorisation of each project was made by the author. This categorisation scheme describes the aim or purpose of the project and is given in table 6.5c. These categories are not necessarily mutually exclusive, product and process developments can, and do, occur simultaneously.

Table 6.5c: Project Description Categories

CATEGORY	STUDY SAMPLE	MAIN SAMPLE
Process Development	18	14
Product Development	8	8
Market Development	3	3
Rationalisation	2	1
Expansion/Contraction	6	6
Managerial Information	7	7
Missing Data	1	1

Having summarised the sample on which the findings of this study are to be based, we now address the question of sampling bias.

6.2 SAMPLING BIASES

The issue we are addressing here is whether there is evidence (or not) to support the assertion that the study sample is free of bias. In other words, is the sample representative. This issue has two aspects. First, were those organisations participating in the study different from those that declined to participate? Second, what evidence is there that the study sample is representative of the U.K. manufacturing industry as a whole? Through necessity our arguments here will be based largely on secondary data drawn from the KOMPASS directory. The number of dimensions that we may use to draw comparisons between samples is therefore limited. In particular, we will use this secondary data to characterise the main and study samples. This secondary data can differ significantly from that obtained first hand, for the reasons stated previously.

6.2.1 PARTICIPANT AND NON-PARTICIPANT BIAS

The low response and sample size of the mailed pilot studies preclude their use for our current purposes. We focus therefore, solely on the participants and non-participants to the main study. That is, those 40 organisations that agreed and 37 that did not agree, to a request by the author for a 90 minute personal interview with a senior executive of that organisation.

In total 77 companies were contacted during the main study resulting in 40 interviews, a response rate of 52%. This response rate is misleading as an indicator of the willingness of companies to cooperate in the study. Ten companies failed to satisfy the basic criteria of having fully implemented a recent strategic capital project, or of having a suitable key informant. Most of these would have participated in the research if these criteria had been met. A more representative estimate of the response rate to the study is therefore in the order of 60%, a figure comparable to the two thirds response reported by Hickson *et. al.* (1986) in their study of strategic decision-making.

Table 6.6 below summarises reasons why 37 of the organisations contacted did not feel able to participate in this study. Note that where contact was made, these reasons were given by the CEO's of the organisations.

Table 6.6: Non-participation summary

REASON GIVEN	NUMBER
Failed to satisfy sampling requirements:	
No recent completed strategic capital projects.	6
Insufficient knowledge about projects. (Due to recent take over or reorganisation.)	4
Too busy:	
No time or not prepared to spend 90 minutes.	10
Cancellation:	
Interview arranged, subsequently cancelled.	5
Logistical:	
Unable to contact the CEO.	3
Interview schedule filled.*	2
Policy:	
Unable to assist for reasons of commercial confidentiality.	3
Company policy not to participate in surveys.	1
Miscellaneous:	
Did not wish to be involved.	2
Unconvinced about the worth of the research.	1
TOTAL:	37

* - This reason was applicable to the Newcastle and Sussex samples, where the interview had to fit within a five day period.

6.2.1.1 Ease of Contact

In terms of the number of telephone contacts made between participating and non-participating companies the following statistics are available. Participating companies (N=40), mean number of calls per company, 5.15, standard deviation, 2.81, modal number of calls, 5, range 1 to 14. Non-participating companies (N=34), mean number of calls per company, 4.15, standard deviation 3.15, modal number of calls, 1, range 1 to 14. A Chi-squared contingency test did not indicate a statistical difference in the number of calls between the two samples ($p^*>0.05$). In assessing the non-participating group, the three companies listed in table 6.3 under the "logistical" heading as, "unable to contact the CEO" were excluded. These three cases bias the statistics for this group, as the average number of calls made to each company was 17.3, range 16 to 22. In assessing whether a letter plus telephone approach was more (or less) effective than the telephone only approach, the following statistics are available. Seventeen participating companies (42.5% of this group) and thirteen non-participating companies (35.1% of this group) were sent request letters (Appendix C). The difference between these two proportions is not significant ($p>0.05$).

Overall therefore, the conclusion of this analysis is that, with the exception of a small proportion of companies (3 companies in 77, i.e. 4%) there is no evidence that the participating group of companies differs from the non-participating group in terms of ease (or difficulty) of contact. The one extra telephone call required on average to reach the participating companies (although not statistically significant) is explained by noting that in many instances the CEO was not the final person to be contacted in this group. Finally, the time required to make contact with a targeted person within a company was typically of the order of one week. However, it was not unusual to be attempting contact for a month or two. All of the abandoned group of companies were abandoned after more than two months of attempting contact.

6.2.1.2 Company Profiles

Here we compare the participating and non-participating groups of companies using secondary data taken directly from the KOMPASS directory. Note that for either groups to be included in the study they both must have satisfied the selection criteria described previously. Statistics on the two groups are summarised below in table 6.7.

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* The p-value is the value of the test significance level (α) at which the null hypothesis would be rejected (Mandenhall *et. al.*, 1986).

Table 6.7: KOMPASS Data on Responding, Non-responding Companies

	Participated (N=40)	Non-Participated[5] (N=35)
Company size[1*]	339	297
Overall business diversity[2]	2.0	3.2
Manufacturing diversity[3*]	1.7	2.3
% CBI members[4]	54	38

1 - Antilog of mean log., number of employees.
2 - Mean number of two digit product codes listed for each company.
3 - Mean number of two digit product codes listed in the range 11 to 49 for each company.
4 - The Confederation of British Industry. An industrial pressure group.
5 - The two companies identified in table 6.3 as non-participants due to the interview schedule being full were excluded from this analyses. Justified because these companies were not given an opportunity to participate in the sample.
* - These items were used to select companies for inclusion in the study.

Analysis of variance comparisons between the two groups on the first three criteria in the above table indicated no significant differences between the two samples ($p>0.05$). Note that the comparison of mean company sizes were performed using the logarithm of company size. This data transformation was made in order to satisfy the normal distribution assumption underlying the test method. A Chi-Squared test applied to the CBI membership data indicated no statistically significant differences between the two samples also ($p>0.05$). In addition, an ANOVA applied to the geographical distribution data in table 6.2 (excluding the pilot study sample) likewise showed no significant difference between the two groups. We again conclude, based on the above analyses, that the non-responding companies are not substantively different to the responding group of companies in the main sample.

6.2.2 STUDY SAMPLE AND NATIONAL INDUSTRY BIAS

Here we are concerned with a possible bias between all the organisations participating in this research (N=45) and U.K. manufacturing industry as defined in this study. The comparisons in this section are between the study sample and a national sample drawn from the KOMPASS directory.

We previously noted that practical considerations tended to result in an over representation within the study sample of companies within West Yorkshire. In an attempt to estimate the effect of this bias on the U.K. as a whole, a systematic sample was drawn manually from KOMPASS, by listing all manufacturing companies on every tenth page of the directory. This represented a sample of approximately 250 pages comprising 2343 separate companies with at least one two digit product code in the range 11 to 49. Of these 2343 companies, 857 (36.6%) were listed as employing 100 or more people. Some of these companies may have been distributors, not manufacturers. No attempt was made to identify and separate these companies from the sample.

Comparisons between the number of employees and number of product codes for the study sample (i.e., main and pilot studies) and the "national" sample are reported in table 6.8.

Table 6.8: Study and National Sample Comparisons of Means

	STUDY SAMPLE (N=43)+	NATIONAL SAMPLE (N=857)
Company size*	337	284
Manufacturing diversity*	1.72	2.17

+ - Missing data on two cases.
* - See table 6.7 for explanation.

A statistical comparison of the means of the above quantities (one way analysis of variance) indicated no difference between the two samples ($p>0.05$) for the logarithmic mean of number of employees or average number of manufacturing product categories covered by the firms.

Besides comparing the mean manufacturing diversity of the study and national samples, a Chi-Squared test was also used to compare the distribution of two digit manufacturing product codes. This comparison was based on data extracted from KOMPASS, not that obtained from the study. The distributions of manufacturing product codes between the study sample and the national sample are reported in table 6.9.

Table 6.9: Manufacturing Code Distributions between Study and National Samples

RANGE OF CODES	STUDY SAMPLE (N=43) Actual	Frequency(%)	NATIONAL SAMPLE (N=857) Frequency(%)
11...19	0	0	0.4
20...24	12	16.2	11.8
25...29	11	14.9	11.6
30...34	10	13.5	17.2
35...39	23	31.1	36.3
40...44	8	10.8	10.3
45...49	10	13.5	12.5

The national sample figures were used to calculate the expected frequency of product codes within a hypothetical representative sample of 43 companies. A Chi-squared analysis of the two distributions showed no statistically significant differences between the study sample and the national sample ($p>0.05$). Note that the expected frequency of observations within the 11 to 19 range of codes was less than 5. These codes were therefore excluded in the analysis, i.e., the degrees of freedom used in the analysis was 5 not 6.

6.2.3 CONCLUSIONS ON SAMPLE BIASES

In this section on sampling biases we have been able (using mainly secondary published data) to demonstrate that the responding and non-responding groups of companies contacted did not differ in terms of company size (mean number of employees) product diversity (mean number of all product codes covered by the company) manufacturing diversity (mean number of product codes in the range 11 to 49) or membership of a national industrial grouping (the CBI). In addition, it was shown that there were no significant differences between these two groups in terms of accessibility (number of calls per contact, use of letters etc.). Similarly, it was demonstrated that the study sample and a much larger (nominally 10%) national sample of U.K. manufacturing companies satisfying the sample selection criteria, did not differ in terms of company size or manufacturing diversity. Also, the study sample was comparable in terms of its distribution of manufacturing product codes to the national sample. The only evidence that exists for a bias within the study sample is that identified earlier as implying that the organisations studied performed better than their major competitors (section 6.1.2.2). The validity of assessing company performance by the method employed here has been supported by Dess and Robinson (1984). In addition, it is possible to control for the effects of industry-related factors on performance through the use of perceptual measures. In a cross industry study of the type reported here perceptual measures of performance may therefore be superior to objective measures. However, as we note previously, company performance was not a variable of interest to this study. Bias introduced from this source should not influence the validity of the findings, and we conclude that for the purpose of this study, the sample is representative of U.K. manufacturing companies.

6.3 <u>THE ASSESSMENT OF CONSTRUCT VALIDITY</u>

When discussing validity in chapter 5 it was noted that this chapter would be concerned with assessing the construct validity of the research instrument. In particular, the aspect of construct validity of concern was shown to be trait validity. (Domain validity was the concern of chapter 5, and nomological validity was not to be addressed explicitly as this is an exploratory study.) The particular items of trait validity to be assessed here are; (1) Factorial composition (2) Internal consistency and (3) Discriminant validity. (The research design precludes the assessment of convergent validity, as explained in chapter 5.) In addition, the statistical technique of factor analysis was identified as being capable of assessing factorial composition and internal consistency. We will therefore initiate our assessment of trait validity by reviewing factor analysis methodologies.

6.3.1 FACTOR ANALYSIS

6.3.1.1 <u>Methods of Factor Extraction</u>

The term "Factor Analysis" is used here to mean both principal components analysis and common factor analysis; some authors use the term to refer only to the common factor model. The models are similar in that they both allow for data reduction. They differ in that principal components analysis attempts to explain the variance structure of the data in terms of a linear combination of the observed data, whereas the common factor model accounts for the co-variance structure in terms of a hypothesised causal model (Kim and Mueller, 1978). The two models differ in another respect, which for our purposes is more important. As stated in the introduction to this chapter, the aim here is to construct measuring scales of the theoretical constructs. Factor analysis can produce such scales, called factor scores. Scores produced by the principal components model are exact, whereas scores produced by the common factor model are only estimates. The reason is that the common factor model is based on estimating more unobserved parameters than there are observed data points (Wilkinson, 1987) hence, there is insufficient information to directly compute the scores (Susmilch and Johnson, 1975). (This issue relates to the factor indeterminacy problem, see Rozeboom, 1982, for a general view of this issue.) For the common factor model there is no generally admissible statistical procedure for estimating the factor scores. Several procedures exist, each with its merits and demerits (see, Kim and Mueller, 1978; Susmilch and Johnson, 1975). However, within the principal components model this issue need not concern us as there is only one, exact, method for estimating the scores on subjects of the factors (Norusis, 1985,p.148-150). In analysing the factor structure of the data, principal components factoring was therefore employed; primarily because it produces exact factor scores, and also, to quote Wilkinson (1987,p.FACTOR-2) because, "principal component and common factor solutions for real data rarely differ enough to matter".

6.3.1.2 Factor Analytic Approach

Factor analysis can be applied to a data matrix in either a confirmatory or exploratory sense. Van De Ven and Ferry (1980,p.77) criticise the use of exploratory factor analysis for assessing trait validity (their Intrinsic Validity) in the following passage:

"*Factor analysis* is commonly used in test and instrument construction as a heuristic procedure for identifying orthogonal scales, selecting the best items within each scale, and thus imputing a *post hoc* theoretical meaning and definition to each scale. Although such a procedure is intuitively useful for identifying constructs and selecting items, it magnifies chance error and promotes a *post hoc* interpretation of the data."

Here the confirmatory approach adopted by Van De Ven and Ferry (1980) has been adopted. This involves deciding whether the observed data structure deviates "significantly" from that hypothesised. This is a matter of degree, ranging from simply specifying the number of factors to specifying the number, the variables which will load on each factor and the magnitude of these loadings (Kim and Mueller, 1978). In this study an intermediate hypothesis is used which only specifies the number of common factors and the variables which will load predominantly on these factors. The reason for adopting this level of hypothesis was that, in the absence of previous research results investigating the factor structure of the constructs used, no *a priori* estimates of factor loadings could be made. This approach also has the practical advantage of using essentially the same techniques and heuristics as are used in an exploratory factor analysis. Thus, general purpose factor analysis computer packages may be used, without recourse to the specialist software required to test more rigorous confirmatory hypotheses. In this study the FACTOR procedure within the SPSS-X V2.2 computer package running on a CDC CYBER main frame computer was employed.

A final technical issue within the subject of factor analysis concerns factor rotation. In this study, in order to aid the interpretation of the factor structures produced, the initial factor solution was rotated using the oblimin procedure. Oblique rotation was selected in preference to orthogonal rotation principally because the indices included in each factor analysis are hypothesised to be interrelated (Van De Ven and Ferry, 1980). Cattell (1966,p.211) identifies several other reasons why oblique rotation should be preferred to orthogonal rotations, one of which is, "that any oblique rotational resolution will permit orthogonality as a special case, but the converse is not true." Following oblique rotation the factor structure was interpreted from the structure matrix.

6.3.1.3 Possible Objections to the Factor Analysis Approach

6.3.1.3.1 Number of Cases

When performing factor analysis an heuristic commonly employed (due to Cattell circa. 1950) is the 4 to 1 rule of Cases to Variables in the data matrix being analysed. As far as the mathematics of factor analysis are concerned, the analysis will work provided the number of cases is not less than the number of factors hypothesised to exist within the data. Rummel (1970) suggests therefore, that, provided the approach adopted by the researcher is confirmatory, factor analysis can be performed on a data matrix in which the number of variables exceeds the number of cases. (Rummel cites several published analyses in which this has been the case; the most extreme being a study in which 236 variables were analysed on just 86 cases.) Where the researchers approach is exploratory the 4 to 1 rule should be adopted as a minimum, in order to mitigate against the risk of chance occurrences (random error) biasing the results and hence the inferences made. In terms of this study, a confirmatory approach using 45 cases will be sufficient to identify the factors hypothesised to exist within the data.

6.3.1.3.2 Type of Data

This issue was discussed in chapter 5 relating to the choice of scale metric to be used within the questionnaire. These arguments will not be reiterated here.

6.3.1.4 Heuristics for Assessing Factor Structures

Factor analysis can, to some extent, be referred to as more of an art than a science. In this sense one is guided by "best practice" rather than analytical rigour. What is thought of as best practice appears to be embodied within a number of heuristics; those used in the subsequent analysis are identified and explained here.

6.3.1.4.1 Number of Variables

Kim and Mueller (1978,p.77) address this problem with the following passage:

> "Thurstone suggests as least three variables for each factor, but this requirement need not be met if confirmatory factor analysis is used. In general, researchers seem to agree that one should have at least twice as many variables as factors."

6.3.1.4.2 Eigenvalue Criterion

Two criteria were used to identify the number of meaningful factors within the data matrix. The first of these is referred to as the Eigenvalue criterion. This criterion simply states that factors with Eigenvalues less than unity should not be interpreted as meaningful "when the correlational (not adjusted) matrix is used" (Kim and Mueller, 1978,p.43). The correlational matrix is used in the principal components factor model. The logic underpinning this heuristic is that a factor with an Eigenvalue less than unity is contributing less to an explanation of the variance in the data than that of a single variable. In this study, this criterion was used to establish a maximum value for the number of factors in the data.

6.3.1.4.3 Scree Plot

A further criterion used to establish the number of factors within the data is that of the scree test. This technique is based purely on observation and has no substantive theoretical basis. The heuristic operates on a plot of the Eigenvalue for each factor against the order in which the factor was extracted. The researcher then inspects this plot for a discontinuity. This discontinuity can be of two forms, either it appears as a bend in the plot separating it into two relatively smooth curves (Kim and Mueller, 1978; Rummel, 1970) or it appears as a step in what otherwise would be a smooth curve (Rummel, 1970). These discontinuities were only interpreted for factors satisfying the Eigenvalue criterion given above.

Note that the Eigenvalue and scree test heuristics are applied to the initial (un-rotated) factors.

6.3.1.4.4 Variable Loadings

In order to assess which variables are being associated with which factor some criterion for determining a "significant" loading is required. As the structure matrix loadings are correlation coefficients, no variable can load higher than |1.0|*. In addition the higher the loading the more significant that variable is to the interpretation of the factor. The problem arises in setting a minimum value for the loadings, bearing in mind that a loading of exactly zero is unlikely to be realised with real data. If one reviews the minimum values used by researchers when determining "significant" factor loadings, a wide range of values emerge. For example, Miller and Dröge (1986) selected |0.6|, Straub (1989) |0.5|, Van De Ven and Ferry (1980) |0.4| and Dess and Beard (1984) |0.3|. Carmines and Zeller (1979) viewed a loading of 0.376 as not significant, whereas in a second factor from the same analysis, 0.356 was viewed as significant. Clearly what constitutes "common practice" allows for a fair degree of leeway. In this study, minimum factor loadings from |0.3| to |0.5| were interpreted as significant, the actual value being selected to produce the clearest factor structure for the analysis in hand.

Note that generally it is the rotated factors that are being interpreted in this instance, not the initial factors.

6.3.1.4.5 Bartlett Test

Two statistical parameters can be calculated from the initial correlation matrix of variables to test whether the factor model is appropriate. The first of these is Bartlett's Test of Sphericity (Norusis, 1985). This tests the hypothesis that the correlation matrix is a unitary matrix, i.e. all diagonal elements are unity, all off-diagonal elements are zero. If the test statistic is small (insignificant) then the correlation matrix is close to being unitary, i.e. all the variables are uncorrelated with each other and each would be extracted as a separate factor. For factor analysis to be appropriate, the statistic needs to be large and significant.

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* The notation |x| means "the absolute value of x", i.e. the numerical value of x ignoring its sign.

6.3.1.4.6 Sampling Adequacy

The second parameter is the Kaiser-Meyer-Olkin "measure of sampling adequacy" (Norusis, 1985). The issue of sampling adequacy originates from the question "Is the given data (subset of variables) adequate for factor analysis"? (Kim and Mueller, 1978,p.53). More specifically, to what extent can differences between the observed data and hypothesised model be attributed to sampling variability? The Kaiser-Meyer-Olkin measure is a heuristic index which ranges between 0 and 1. In interpreting the index, values below 0.50 are generally viewed as unacceptable.

6.3.2 TRAIT VALIDITY

It was noted earlier that trait validity would be assessed in this study in terms of factorial composition, internal consistency and discriminant validity. The techniques for assessing factorial composition are indistinguishable from those of factor analysis and will not be discussed further here. Techniques for assessing internal consistency and discriminant validity are described below.

6.3.2.1 Internal Consistency

The assessment of internal consistency requires the appraisal of two parameters. The first is unidimensionality; the second, reliability. Carmines and Zeller (1979) suggest that the unidimensionality of a set of indicators may be determined if the first unrotated factor, extracted by principal components analysis, satisfies the following criteria:

1. The first extracted component should explain a large proportion of the variance in the items (say > 40%).

2. Subsequent components should explain fairly equal proportions of the remaining variance except for a gradual decline.

3. All or most of the items should have substantial loadings on the first component (say > 0.3).

4. All or most of the items should have higher loadings on the first component than on subsequent components.

For establishing the reliability of a set of indicators the most popular measure is Cronbach's alpha (Carmines and Zeller, 1979; Van De Ven and Ferry, 1980). Van De Ven and Ferry (1980) cite the following formula for calculating coefficient alpha:

$$\alpha = \frac{k.\bar{r}}{1 + (k-1).\bar{r}}$$

Where $\bar{r}$ is the average of the off diagonal elements in the correlation matrix of indicators, and k is the number of indicators in the matrix. For an interpretation of the meaning of the coefficient, see Carmines and Zeller (1979). For a unidimensional construct, Van De Ven and Ferry (1980) recommend that Coefficient alpha should have a value of between 0.7 and 0.9. Nunnally (1978) sets a less demanding criterion and suggested 0.6 as appropriate for exploratory research.

One of the assumptions underlying the assessment of reliabilities based on Coefficient alpha (and several other techniques, e.g. Alternative-Form, Split-Halves) is that the items in the scale are parallel. The Parallel-Measures model implies that each item in the scale measures a phenomenon equally. If the items measure a single phenomena unequally, or the items measure more than one concept, reliability assessments will be decreased. A technique designed to explicitly cope with both these violations of the parallel measures assumption is factor analysis (Carmines and Zeller, 1979). Hence, reliability coefficients based on factor analysis are not as restrictive as those methods assuming parallel measures. For factor scales produced using principal components analysis (as used in this study) the appropriate reliability coefficient for the scale is coefficient theta. This is calculated using the following formula:

$$\theta = \frac{k}{k - 1} . \left[1 - \frac{1}{L_1}\right]$$

Where k is the number of items in the scale and L_1 is the first (i.e., the largest) Eigenvalue. Carmines and Zeller (1979,p.61) suggest an interpretation of coefficient theta as follows:

> "...theta is the alpha coefficient for a scale in which the weighting vector has been chosen so as to make alpha a maximum. In other words, theta may be considered a maximised alpha coefficient".

It follows, therefore, that alpha will be smaller than theta. In this study theta is used to establish the reliabilities of the factor scales of the theoretical constructs.

6.3.2.2 Discriminant Validities

The approach used in this study to assess discriminant validity is median correlation (Van De Ven and Ferry, 1980). The median correlation is obtained by measuring the median off-diagonal correlation between "(a) items composing a given scale and (b) all of the other items which are scored on different scales" (Hackman and Oldham, 1975). An indication of discriminant validity for the given index is then shown when the median off-diagonal correlation of items in that index with items in other indices is low and smaller than the average inter correlation of items within the index.

6.3.3 METHODOLOGY

6.3.3.1 Post Coding and Data Aggregation

The first stage in any data analysis of this type is to post code the questionnaire data so that it is suitable for computer analysis. Post coding in this study was restricted to categorising responses to questions which listed an "Other" option, categorising question 1.1 "What is your job title?" and categorising the project description given at the beginning of section 2 of the questionnaire. The coding of the project title/description has been used to construct tables 6.5b and 6.5c. The coding of job title has been used in table 6.4. Of the 11 questions in the questionnaire offering an "Other" category, questions 2a.16, 2a.20, 2a.33, 2a.38 and 2b.20 had no responses to this category. Questions 2.6, 2.7 and 2a.28 had only one response in this category, and this response was therefore used in its place. The "Other" response to Question 1.2 was accommodated by a minor change to the original categorisation scheme and used in table 6.3b. The two responses to the "Other" category of question 2a.26b (referring to the use of contingency allowances when specifying the project) were seen as fall-back, or safety-net provisions and coded as such. Finally question 2.5 (referring to the stimuli giving rise to the project) had easily the largest number of "Other" responses. After eliminating those responses more accurately viewed as aims or goals of the project (i.e., question 2.6) and those appearing to be alternative forms of other categories within question 2.5, four responses remained. The common element to these four items appeared to be that the project was forced upon the company by its parent organisation. These responses were coded as "Strategic move/policy of parent organisation". The best example of this encountered during the study was the company forced to relocate, or cease trading, because its parent organisation sold the site it was currently occupying.

Subsequent to post-coding, the next operation was coding the questionnaires for input into the SPSS-X statistical package. Concurrent with this operation was scale reflection, for example the items within the Success/Expectations construct used to measure the Ease construct were coded to measure Difficulty. These items were therefore reflected to be congruent with the Accuracy and Satisfaction constructs. Similarly, those questions dealing with change were coded to yield a score ranging from -2 to +2, with the "no change" situation being represented by a score of zero. In addition variables defined in terms of other variables were computed and included in the data base. A number of methods were employed for computing new variables. The simplest method (applicable to interval scaled data) was to perform a simple arithmetic operation on the variables, for example, relative project cost was defined as the ratio of total project cost to the company's annual turnover at the time of project approval. Another technique used was to aggregate items, usually simply by summing several scales together. The overall measure of company performance defined previously and reported in table 6.3c is an example of this technique. When applying this technique it is important that each item to be aggregated is measured using the same scale. If not those items measured on extensive scales will dominate those on less extensive scales. If this is likely to be a problem it can be handled by standardising each item prior to aggregation. This is achieved by applying the transform:

$$(x_i - \bar{x})/\sigma$$

to each data point of each variable (x_i) to be aggregated. The transformed variables then have a mean of zero and standard deviation of unity across the sample (Manly, 1986).

6.3.3.2 <u>Analytical Procedure</u>

Following the necessary coding and aggregation of the data, the procedure outlined below was adopted.

1. Analyse the raw data (using the coefficient alpha model) to eliminate "noisy" variables from the data set.

2. Use principal components factor analysis to identify (if it exists) the hypothesised dimensionality of the theoretical constructs. This is a confirmatory approach.

3. Use median correlations to assess the discriminant validity of the constructs.

4. Calculate factor scores from step 2 for the theoretical constructs and assess the reliability of the constructed factor scales via the theta reliability model.

5. Assess the normality of the factor scales produced from step 4. Where significant deviations occur, transform scale items and iterate steps 1 to 4 until deviations are acceptable.

Step 5 of the above procedure was necessary to maximise the fit between the data and the mathematical assumptions and requirements of the analytical techniques employed. Rummel (1970,p.272) notes that failure to satisfy these requirements may produce substantive interpretations of the results at variance with their actual meaning "In order to realistically relate the empirical findings to the initial research question, the data and method have to be matched as perfectly as possible". A basic assumption of the factor model employed in this study is linearity in the bivariate interrelationships of the data (Rummel, 1970,p.275). The likelihood that two variables are linearly related is increased when the variables have univariate normal distributions. Hence the inclusion of step 5 in the above procedure. Rummel identifies a number of other reasons why transforming variable distributions to that of the normal distribution is desirable in factor analysis.

The major objection to the use of transformed data is that it weakens the correspondence between the analysis and the raw data. There is also the problem of interpreting the transformed variable. In deference to these objections the policy adopted here was that only generally accepted transformations would be used, and then only where the departure from the normal distribution appeared to be significant. Of the possible transformations suggested by Rummel only the logarithmic transformation was used. (This transformation was used earlier to transform company size data and is commonly employed for this purpose, see for example Miller and Dröge, 1986). The logarithmic transformation was applied to positively skewed scale items. The transformation applied to negatively skewed scale items consisted of reflecting the scale (to turn the negative skew into a positive skew) applying the log transformation and re-reflecting.

A further question was to determine the criterion by which a scale's distribution may be judged to be satisfactory, i.e., near enough to normal. One method would have been to use Lilliefors modification* of the Kolmogorov-Smirnov one-sample test (Wilkinson, 1987). This was a severe criteria and required (in some instances) several transforms to be applied, thus distancing the scales from the raw data. In the event, it was determined that typically, a single loga-

* The Lilliefors modification is necessary because factor scores are standardised variables.

rithmic transformation of selected scale items would reduce the level of skewness to less than ±1. Applying further transforms to reduce Skewness values below this level did not appear to significantly affect the correlation coefficients between scales. An individual scale was therefore judged to be "satisfactory" when further iterations through the steps outlined above did not significantly change its correlations with other scales. Thus no more than a single transformation of selected scale items was used.

In the remainder of this chapter sub-section we will present results from the final iteration of steps 1, 2 and 3. Step 4 will be treated separately in section 6.4. Appendix D lists correlation coefficients and skewness data for scales produced from transformed and untransformed (raw) data items. (The reader is advised to review chapter 7 before perusing this appendix as several of the scales presented have not yet been defined.)

6.3.3.3 Elimination of "Noisy" Variables

A "noisy" variable is defined in this study as a variable likely to reduce the reliability of a scale containing the variable. To identify such variables the RELIABILITY procedure within the SPSS-X computer programme was used. This procedure is capable of constructing scales of parallel measures and calculating the alpha reliability of the scale. In addition, it estimates the effect on the scale's alpha reliability if each item in the scale is deleted in turn. If deletion of a single variable increased the alpha reliability of the scale (an increase over the scale's alpha when containing the variable) then this variable was viewed as being "noisy" and eliminated from further analysis. In addition to the scale reliabilities this procedure also produces a correlation matrix for the items in the scale. Inspection of this matrix on rare occasions suggested items that should be placed in an alternative scale.

In summary this procedure was used to add and delete items to maximise the alpha reliability of the scale and the empirical discrimination among scales. However, the pursuit of reliability alone could generally only be achieved at the expense of the scales heterogeneity and "richness". This approach was not adopted, and efforts were made to keep the content of the items tapping a given construct consistent with the original theoretical basis of the scale (as outlined in chapters 4 and 5) thus preserving its heterogeneity and therefore the "richness" of the measures.

The scales and items relating to those scales, are outlined in the following tables. Note, the tables are given for secondary and tertiary constructs only (Chapter 4, tables 4.4, 4.5 and 4.6). Where quaternary etc. constructs are involved, the derivation of the construct and its alpha reliability (if appropriate) is given. The items composing a scale are summarised in the column headed "Questions". This column gives the number of the question from the questionnaire summarised in the form "Section.Number". In addition the symbol 'Σ' is used to denote the summation or averaging of the items within the question. The symbol 'Σ|xxxx|' indicates the summation or averaging of the module of the items within the scale; and where used refers only to items measuring a change. (Using the modulus focuses attention upon whether or not a change occurred, not upon the direction of any change.) Finally, an L placed before a question indicates that a logarithmic transform of the original data has been applied.

Note, the alpha reliability of individual sub-scales are given for interest only. These sub-scales are not used elsewhere within this analysis. In addition the overall reliabilities are presented principally for the purpose of comparison with the theta reliabilities of the factor scores to be presented later. They do however give an indication of the unidimensionality of the scales.

Table 6.10a: Uncertainty/Scope Construct

Code	Variable Description	Questions	α
	SIZE:		
USS01	Total project cost	LΣ2a.1	
USS02	Cost relative to annual turnover	L 2a.1÷2a.2	
USS03	Cost relative to annual capital budget	L 2a.1÷1.11a	
	SKILL USE:		
USK01	Comparative use of technical etc. skills	2b.14	
	STRATEGICALITY:		
UST01	Consequentiality	note 1	
UST02	Relative use of PCA techniques	note 2	
UST03	Number of goals set for project	Σ 2.6	
UST04	Normal fraction of capital projects approved	1.9	

Alpha reliability of 8 item Uncertainty/Scope scale = 0.677.

Note 1: A sum of Endurance, Seriousness, Radicality and Diffusion (Hickson *et. al.*,1986). Operationalised from questions 2a.11, 2b.36, 2c.1 and $\Sigma|2.4|$. (Coefficient alpha is 0.391, adequate for a construct composed of three or more distinct terms; Van De Ven and Ferry, 1980.)

Note 2: This variable was constructed from questions 1.8 and 2.8 to produce a nine point scale ranging from -4 to +4. A score of -4 implied that Post-Completion Audit (PCA) techniques were normally used, but not for the particular project under consideration. A score of +4 implied PCA techniques were not normally used, but were used in this particular instance. An intermediate score could be produced if PCA techniques were normally used and used in this instance, or, not normally used and not used in this instance.

Table 6.10b: Uncertainty/Novelty Construct

Code	Variable Description	Questions	α
UNX01	The type of site for the project	2.2	
UNX02	Changes to company products	2a.15	
UNX03	Source of the technology for the project	2a.16	
UNX04	Type of market to be served by the project	note 1	
UNX05	Process fit between project and department	L note 2	

Uncertainty/Novelty scale not constructed using parallel-measures model.

Note 1: The item was scored from question 2a.14 in a manner similar to Khandwalla's (1974) mass-production orientation construct.

Note 2: This single score was produced as the difference between the departmental and project mass-production orientations. In the case of a single department not being involved in the project, then the mass-production orientation of the whole firm was used. Khandwalla's (1974) scoring system was used on questions 2a.29a, 2a.29b and 2a.29c to produce the scale. The variable UNX05 is the modulus of the difference in the mass-production orientation scores.

Table 6.10c: Uncertainty/Urgency Construct

Code	Variable Description	Questions	α
	PRIORITY:		
UUP01	Relative time taken for project approval	2b.7	
UUP02	Rescheduling of other projects	2a.5	
UUP03	Opposition to project rescheduling	2a.9	
UUP04	Priority relative to other expenditures	2a.6	
	SURVIVAL:		
UUU01	Project's importance to firm's continuation	2a.13	
	SIMULTANEITY:		
UUS01	Time available for decision making	2b.8	
	WINDOW:		
UUW01	Effect of project delays on viability	2a.12	
	PRESSURE:		
UUR01	Ease of completing project on time	2a.7	
UUR02	Driven by technical/market considerations	2a.8	
	FINANCIAL ATTRACTIVENESS:		
UUF01	Yield of project relative to firm's standards	2a.18	
UUF02	Sponsoring managers acceptance of lower yield	2a.25	
UUF03	Approving authorities acceptance of lower yield	2a.25	

Alpha reliability of 12 item Uncertainty/Urgency scale = 0.421.

Table 6.10d: Uncertainty/Complexity Construct

Code	Variable Description	Questions	α
	PERCEIVED COMPLEXITY:		
UCC01	Technical complexity of the project	2a.27	
UCC02	Organisational complexity of the project	2a.27	
UCC03	Diversity of options for the project	2a.3	
	PERCEIVED RISK:		
UCR01	Financial risk	2a.26a	
UCR02	Technical risk	2a.26a	
UCR03	Organisational risk	2a.26a	

Alpha reliability of 6 item Uncertainty/Complexity scale = 0.746.

The secondary information construct, Flexibility, was measured using an 11 item scale (question 1.13). The alpha reliability of this scale was found to be unacceptably low at 0.164. To improve this reliability four of the eleven items were used to form a new scale, the remaining items being discarded. These four items were identical to four items of a five item Organicity measure used in a study by Covin and Slevin (1988). Their fifth item was not included in the original 11 item measure used here.

Table 6.11a: Information/Flexibility Construct

Code	Variable Description	Questions	α
	ORGANICITY:		
IFX01	Item 2	1.13	
IFX02	Item 4	1.13	
IFX03	Item 5	1.13	
IFX04	Item 7	1.13	

Alpha reliability of 4 item Information/Flexibility scale = 0.635[1].

1 - Covin and Slevin (1988) reported a reliability of 0.79 for their five item scale. This implies an average inter item correlation of 0.43 for their study; somewhat higher than the 0.30 observed here.

Table 6.11b: Information/Range Construct[1]

Code	Variable Description	Questions	α
	FAMILIARITY:		
IRF01	Standard capital project evaluation methods	1.7	
IRF02	Use of PCA techniques	1.8	
IRF03	New product/process capital expenditure	1.11ax1.11c(i)	
IRF04	New product/process revenue expenditure	1.11bx1.11c(ii)	
IRF05	Approach to new product development	1.5	
IRF06	Diversity of product base	1.6	
IRF07	Frequency of similar types of project	2.1(i)	
IRF08	Frequency of similar sizes of projects	2.1(ii)	
IRF09	Rapidity/intensity of industry change	Σ 1.12	0.646
	ABILITY:		
IRA01	Ability to managing complex projects	Σ2c.5[2]	
	SIZE:		
IRS01	Number of full time employees	L 1.14	

Alpha reliability of 11 item Information/Range scale = 0.586.

1 - Note, the single item measuring the Delegation dimension was eliminated as too noisy.
2 - This item not constructed using the parallel-measures model.

Table 6.11c: Information/Lubrication Construct

Code	Variable Description	Questions	α
	UNFREEZING:		
ILU01	Positive (6 items)	2b.6	0.371
ILU02	Negative (6 items)	2b.6	0.641
	MOVING:		
ILM01	Positive (7 items)	2b.6	0.410
ILM02	Negative (5 items)	2b.6	0.574
	REFREEZING:		
ILR01	Positive (7 items)	2b.6	0.430
ILR02	Negative (7 items)	2b.6	0.603

Alpha reliability of 6 item Information/Lubrication scale = 0.790.

Table 6.11d: Information/Activity Construct

Code	Variable Description	Questions	α
	ANALYSIS:		
IAA01	Sophistication of risk analysis procedures	L 2a.20	
IAA02	Sophistication of financial analysis	Σ 2a.24	0.801
IAA03	Extent of documentation produced	Σ 2a.36	0.666
	INFORMATION TECHNOLOGY:		
IAI03	Extent of computer use	LΣ2a.38	0.773
	COMMUNICATION:		
IAC01	Extent of support building	2a.4	
IAC02	Extent of formal discussion	L 2a.21x2a.22	
IAC03	Extent of informal discussion	2a.23	
IAC04	Use of communication methods	Σ 2a.34	0.623
	SEARCH:		
IAS01	Effort in collecting data	LΣ2a.30	0.900
IAS02	Internal information	Σ 2a.32	0.537
IAS03	External information	Σ 2a.33	0.550
IAS04	Data supplied from single person	2a.35	
IAS05	Data supplied from several people	L "	
IAS06	Data supplied from internal records	"	
IAS07	Data supplied from external records	"	
IAS08	Data supplied from tours/visits	"	
IAS09	Data supplied from survey/experiment/R&D	"	
	DESIGN RESOURCES:		
IAR01	Money spent on consultants	2a.31	
IAR02	Money spent on development, internally	2a.31	
IAR03	Managerial effort/time expended	Σ 2.7	0.543
	CONTINGENCIES:		
IAN01	Safety net provisions	LΣ2a.26b	0.672

Alpha reliability of 21 item Information/Activity scale = 0.824.

Items used to construct scales IAC04, IAS03 and IAR03 were drawn from a reduced set of items in the referred to questions. Items were deleted from the scales to improve reliability, commonly those items with low variance across the sample.

Table 6.12a: Success/Expectation Construct

Code	Variable Description	Questions	α
	EASE:		
SEE01	Overall problems with implementation	Σ 2b.20	0.844
SEE02	Unanticipated technical problems	2b.33	
SEE03	Unanticipated organisational problems	2b.34	
SEE04	Overall ease of implementation	2b.31	
SEE05	Extent of re-skilling, training etc.	2b.28	
	ACCURACY:		
SEA01	Time taken to reach expected performance	2b.30	
SEA02	Project completed to target	Σ 2b.3[2]	
SEA03	Extent f post-approval changes	2b.32	
SEA04	Adequacy of contingencies	2b.2[1]	
	SATISFACTION:		
SES01	Willingness to repeat the project	2c.4	
SES02	Satisfaction overall	L 2b.9	
SES03	Satisfaction technically	L 2b.12	
SES04	Satisfaction organisationally	L 2b.13	
SES05	A valid solution to the original stimulus	L 2b.10	
SES06	Achieving the financial returns expected	L 2b.11	

Alpha reliability of 15 item Success/Expectation scale = 0.836.

1 - This variable scored high for a mid score, low for an extreme.
2 - This item not constructed using the parallel-measures model.

Table 6.12b: Success/Changes Construct[1]

Code	Variable Description	Questions	α
	CULTURE:		
SCU01	Changes in behaviour	Σ |2b.4|	0.746[2]
SCU02	Changes in organicity	Σ |2b.5|	0.811[2]
	COMPETENCY:		
SCC01	Ability to handle complex projects	Σ 2c.6[3]	
SCC02	Time taken to handle complex projects	2b.29	
	SKILLS:		
SCS01	Changes to departmental procedures	Σ 2b.15	0.889
SCS02	Inadequacy of existing procedures	2b.35	
SCS03	Changes in the ways of doing business	2c.1	

Alpha reliability of 7 item Success/Changes scale = 0.634.

1 - The secondary concept of Applicability was eliminated as too noisy.
2 - Calculated using the Kuder-Richardson formula number 20. This is the appropriate form for coefficient alpha when using dichotomous data (Carmines and Zeller, 1979).
3 - This item not constructed using the parallel-measures model.

6.3.4 FACTORIAL COMPOSITION

6.3.4.1 Factor Composition of Secondary Constructs

In this stage of the analysis principal components factor analysis was used in a confirmatory sense to investigate the dimensionality of the scales identified in tables 6.10a to 6.12b above. The findings are reported in tables 6.13a to 6.15b below, and figure 6.2.

With reference to the summary statistics table contained on figure 6.2 it is observed that, with the exception of the Information/Range construct, all of the constructs have sampling adequacy values in excess of 0.5. Similarly the Bartlett sphericity tests are satisfactory, with the exception of the Uncertainty/Novelty construct. The value of 0.38 for this construct is evidence that the items constituting this scale are, as hypothesised, orthogonal. Factor analysis of this construct has not been attempted for this reason.

Inspection of the scree plots presented in figure 6.2, together with the Eigenvalue data on the summary statistics table, indicate the dimensionality of the constructs. Note, the following observations are derived from the original computer printouts reproduced in figure 6.2, not from inspection of figure 6.2 itself.

Figure 6.2: Factor Analysis Summary

Summary Statistics

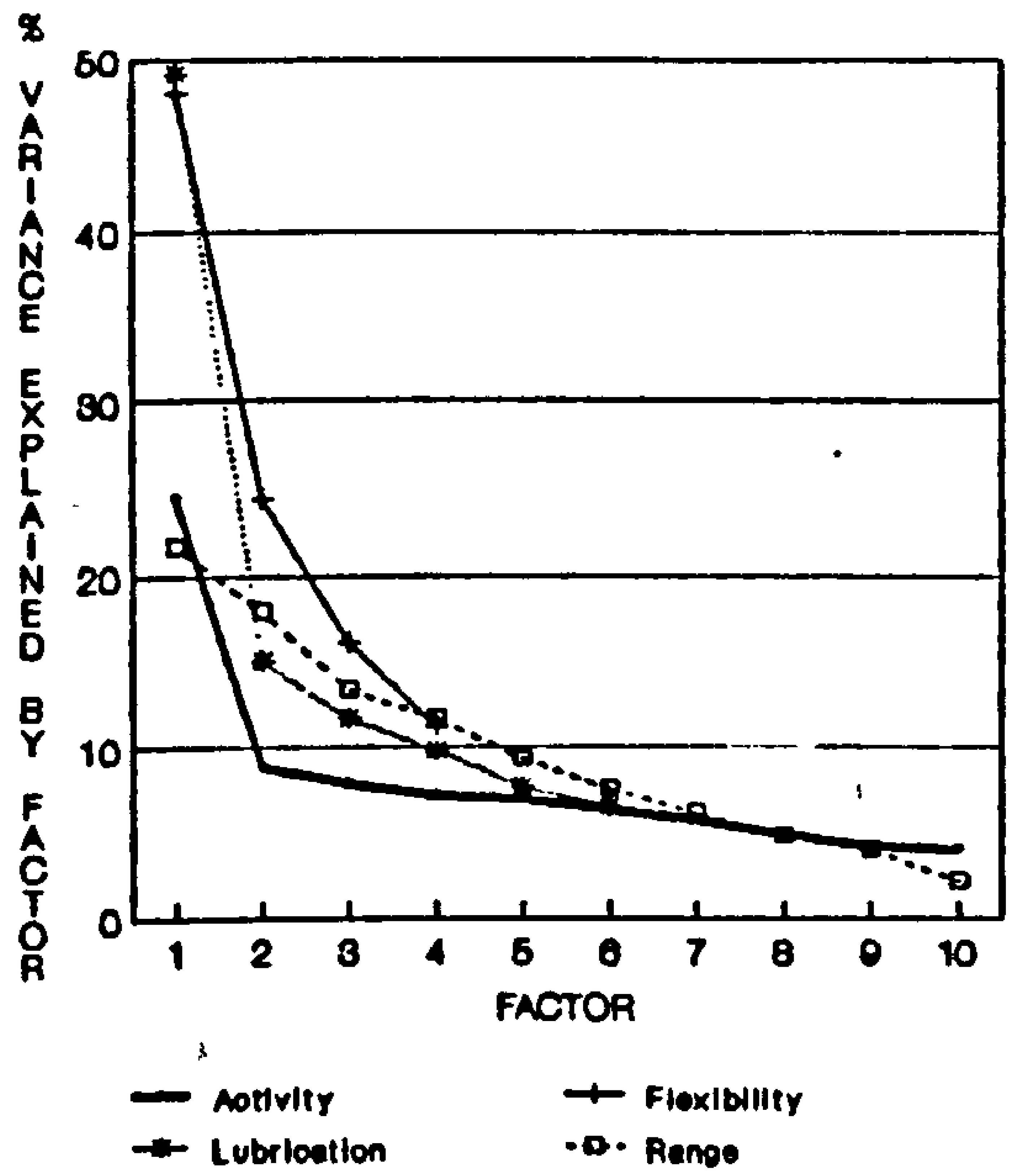
Construct	KMO	BART	EIGEN
• UNCERTAINTY:			
Scope	0.575	0.000	3
Novelty	0.588	0.380	-
Urgency	0.550	0.000	5
Complexity	0.631	0.000	2
• INFORMATION:			
Activity	0.545	0.000	8
Lubrication	0.804	0.000	1
Range	0.409	0.000	5
Flexibaility	0.624	0.000	1
• SUCCESS:			
Expectation	0.682	0.000	5
Changes	0.625	0.000	3

KMO - Kaiser-Meyer-Olkin measure of sampling adequacy.

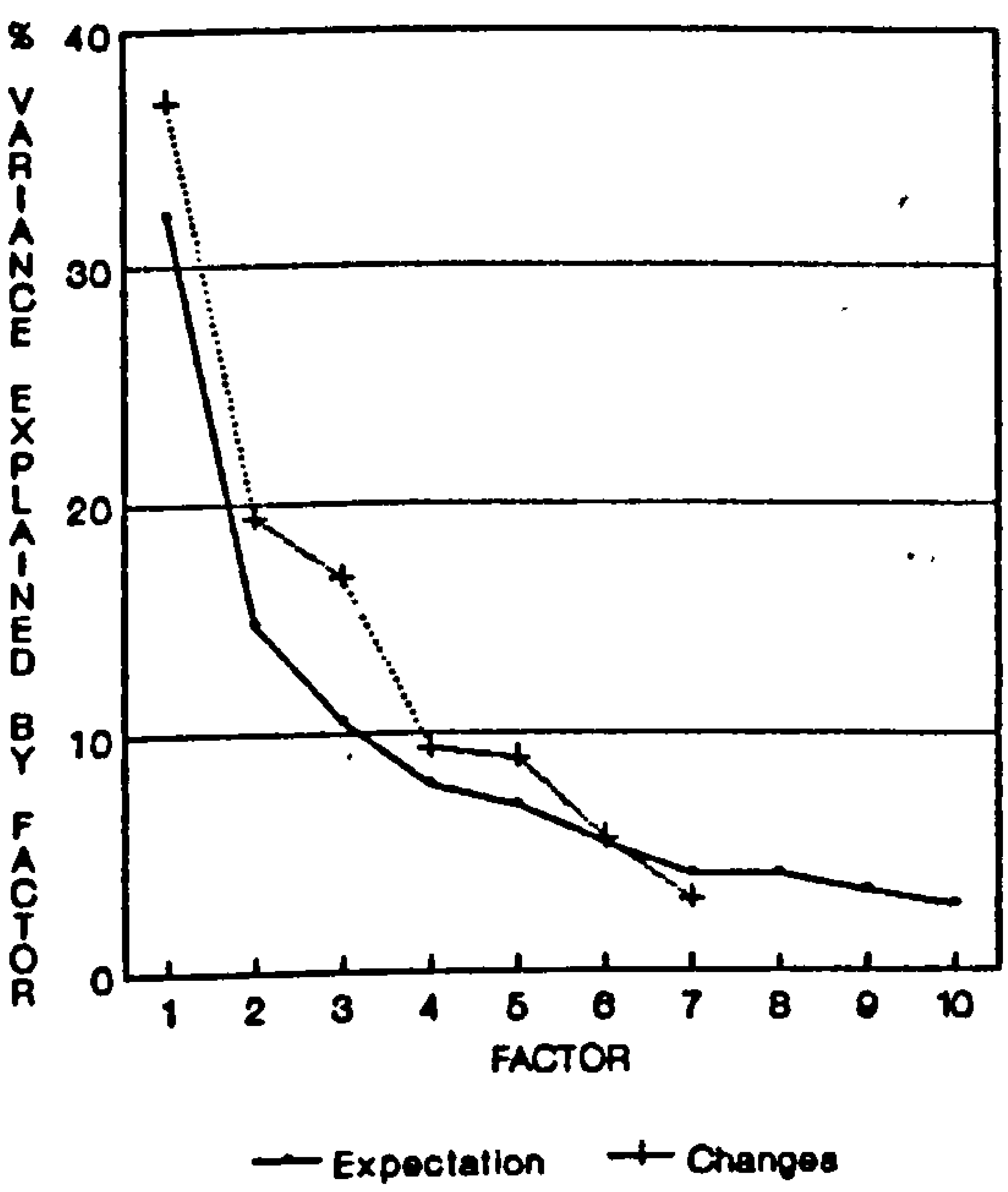
BART - Bartlett test of sphericity, significance level.

EIGEN - Number of factors extracted with Eigenvalues greater than or equal to unity.

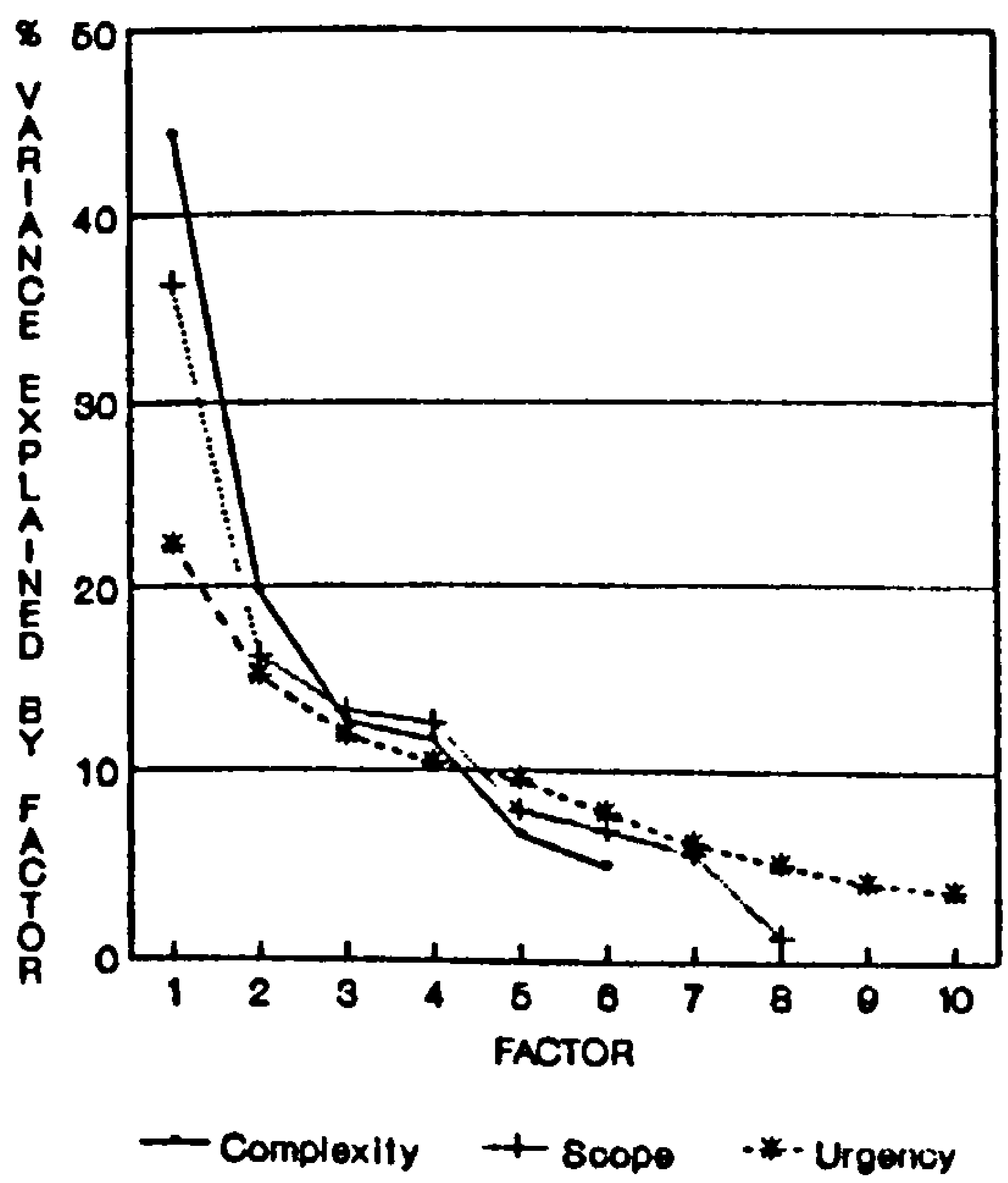
Scree Plots for Information Constructs



Scree Plots for Success Constructs



Scree Plots for Uncertainty Constructs



6.3.4.1.1 Uncertainty Constructs

As noted above, the factorial composition of the Uncertainty/ Novelty construct cannot be investigated as this item is not composed of items which are parallel measures to each other. This is demonstrated through the Bartlett Test of Sphericity being insignificant (figure 6.2). The remaining discussion therefore focuses only on Scope, Urgency and Complexity constructs.

The Uncertainty/Scope construct was originally hypothesised to be composed of three dimensions, Size, Skill Use and Strategicality. Factor analysis extracted three factors with Eigenvalues greater than unity. Table 6.13a below reproduces the structure matrix after oblique rotation of the first three factors. Note, correlations below |0.3| are not reproduced in the table. Correlations greater than |0.5| are entered in bold type and are the items principally used to interpret the factor structure; this convention will be followed in subsequent tables. The un-rotated Eigenvalue and cumulative percentage variance explained by each factor is presented at the base of the table.

Table 6.13a: Uncertainty/Scope Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
USS01	**0.813**		
USS02	**0.943**		
USS03	**0.974**		0.307
USK01		**0.701**	0.481
UST01	**0.635**		
UST02			**-0.784**
UST03	0.406		**-0.688**
UST04		**0.764**	
Eigenvalue.	2.904	1.297	1.059
Cum. % var.	36.3	52.5	65.8

1 - See table 6.10a for a description of the items listed.

The factorial composition of the Scope construct as revealed in table 6.13a, provides satisfactory confirmation of the hypothesised structure. Factor 1 is the Size construct, together with Consequentiality. Factor 2 is Skill Use together with "Normal fraction of capital projects approved". Factor 3 is the remaining Strategicality items. Factors 1 and 3 are negatively correlated (-0.212). Factors 1 and 2 and, 2 and 3 are uncorrelated (0.054 and -0.024 respectively).

The Uncertainty/Urgency construct was originally hypothesised to be composed of six dimensions; Priority, Survival, Simultaneity, Window, Pressure and Financial Attractiveness. Five factors with Eigenvalues greater than unity were extracted. Inspection of the Eigenvalue scree plot however suggests a three-dimensional construct. Table 6.13b below reproduces the structure matrix after oblique rotation of the first three factors. The interpretation of the table is the same as for table 6.13a above.

Table 6.13b: Uncertainty/Urgency Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
UUP01		0.481	0.441
UUP02		0.794	
UUP03	-0.500	0.474	
UUP04		0.315	
UUU01			-0.796
UUS01	0.432		-0.501
UUW01	-0.370		-0.436
UUR01		0.352	-0.511
UUR02		0.594	
UUF01	0.609		
UUF02	0.879		
UUF03	0.890		
Eigenvalue.	2.662	1.815	1.428
Cum. % var.	22.2	37.3	49.2

1 - See table 6.10c for a description of the items listed.

The factor structure illustrated in table 6.13b identifies Factor 1 as the Financial Attractiveness dimension. Factor 2 can be interpreted as principally the Priority dimension, combined with Pressure. Factor 3 is a combination of the remaining dimensions, Survival, Simultaneity and Window together with item UUR01, the "perceived ease of completing the project on time" and appears to be associated with time aspects of the project. Regarding the inter-correlation between items, Factor 1 is uncorrelated with either of the other factors, correlation coefficients of -.059 and -0.003 with factors 2 and 3 respectively. Factors 2 and 3 are inter-correlated to the extent of -0.151. In summary this structure is a reasonable confirmation of the construct and its theoretical basis.

The Uncertainty/Complexity construct was originally hypothesised to be composed of two dimensions; Perceived Complexity and Perceived Risk. Factor analysis extracted two factors with Eigenvalues greater than unity and inspection of the Eigenvalue scree plot also suggests a two-dimensional construct. Table 6.13c below reproduces the structure matrix after oblique rotation of the first two factors. The interpretation of the table is the same as for table 6.13a above.

Table 6.13c: Uncertainty/Complexity Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2
UCC01	0.790	
UCC02	0.355	0.821
UCC03	0.691	0.345
UCR01	0.786	
UCR02	0.721	0.438
UCR03		0.901
Eigenvalue.	2.657	1.184
Cum. % var.	44.3	64.0

1 - See table 6.10d for a description of the items listed.

The structure illustrated in table 6.13c does not correspond with the anticipated structure. However, inspection suggests interpreting Factor 1 as a dimension of "perceived uncertainty surrounding financial and technical aspects/consequences of the project". Factor 2 may be interpreted as "perceived uncertainty surrounding organisational aspects/consequences of the project". The observed structure therefore represents social and technical dimensions of project complexity, not the anticipated Complexity - Risk dimensions. However, socio-technical considerations were used to construct the scale items. The lack of correspondence with the Risk and Complexity structure is therefore not viewed as serious, because the analysis identified an alternative existing structure within the construct.

6.3.4.1.2 **Information Constructs**

Inspection of figure 6.2 indicates that both Lubrication and Flexibility constructs are uni-dimensional. It is not proposed therefore to investigate these constructs further at this stage. Here we focus only on the Range and Activity constructs.

The Information/Range construct was hypothesised to consist of three dimensions; Familiarity, Ability and Size, after eliminating Delegation (see the footnote to table 6.11b). Factor analysis extracted five factors with Eigenvalues grater than unity. Inspection of the Eigenvalue scree plot was less conclusive but showed a tendency to a three-dimensional construct. Table 6.14a below reproduces the structure matrix after oblique rotation of the first three factors. The interpretation of the table is the same as that for table 6.13a above.

Table 6.14a: Information/Range Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
IRF01	0.360	0.617	
IRF02		0.770	
IRF03			0.650
IRF04	0.518	0.374	
IRF05		0.600	0.330
IRF06		0.682	
IRF07	0.865		
IRF08	0.869		
IRF09			0.831
IRA01			
IRS01	0.492		0.581
Eigenvalue.	2.377	1.983	1.478
Cum. % var.	21.6	39.6	53.1

1 - See table 6.11b for a description of the items listed.

Inspection of table 6.14a does not indicate close agreement with the hypothesised structure. In particular the nine items measuring Familiarity have factored into three separate dimensions. While acknowledging the philosophy of the current analysis is confirmatory, an exploratory approach could be justified here as there is a satisfactory ratio between the number of the cases and variables of 5.4:1, i.e., greater than the 4:1 ratio usually considered to be acceptable. However, the Kaiser-Meyer-Olkin measure of sampling adequacy is unacceptable at 0.421, suggesting that differences between the factor model produced here and that hypothesised to underlie the construct can be attributed to sampling variability. From the available evidence it is not possible to produce a definitive explanation for this observation. Even a tentative explanation is difficult, although one such explanation may relate to Phillips' (1981) finding, that the use of multiple informants is preferable when investigating organisational concepts.

In conclusion, the theory requires that the Range construct be retained. The overall alpha reliability of the construct is low at 0.586, but close to the 0.6 considered adequate by Nunnally (1978). We will therefore retain the concept and accept as a limitation of the study the lack of congruence between the observed and theoretical factor structures.

The Information/Activity construct was hypothesised to consist of six dimensions; Analysis, Communication, Search, Information Activity, Design Resources and Contingencies. It was not claimed that the dimensions were mutually exclusive. For example, many of the Search items could equally well be defined as Analysis. Factor analysis extracted eight factors with Eigenvalues greater than unity. Inspection of the Eigenvalue scree plot indicated two factors underlying the construct. Table 6.14b below reproduces the structure matrix after oblique rotation of the first two factors. The interpretation of the table is the same as that for table 6.13a above.

Table 6.14b: Information/Activity Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2
IAA01		-0.672
IAA02	0.731	-0.527
IAA03	0.579	-0.662
IAI01		-0.767
IAC01	0.498	
IAC02	0.389	
IAC03	0.565	-0.313
IAC04	0.539	
IAS01		-0.705
IAS02		-0.605
IAS03	0.714	
IAS04		
IAS05		-0.364
IAS06		-0.398
IAS07	0.442	
IAS08		
IAS09	0.391	
IAR01	0.505	
IAR02		-0.474
IAR03	0.595	
IAN01	0.601	-0.517
Eigenvalue.	5.134	1.860
Cum % var.	24.4	33.3

1 - See table 6.11d for a description of the items listed.

Inspection of table 6.14b shows Factor 1 to be the Communication and Resources dimensions. Factor 2 is principally Analysis and a majority of the Search indicators. The documentation (IAA03) and Contingencies dimension (IAN01) are significantly correlated with both Factors 1 and 2. We may therefore identify Factor 1 as a Communication /Resources dimension and Factor 2 as an Analysis/Search dimension. The correlation between Factors 1 and 2 is -0.255.

An explanation of this factor structure is supplied by the study of Sharp *et. al.* (1989) (see also Sharp, 1991) into capital investment decisions. This study identified two principal dimensions subsuming the capital investment process and were labelled by them as Design and Support. The Analysis/Search dimension identified here (Factor 2) can be viewed as a dimension of Design, in a manner similar to the way this term was conceived by Sharp *et. al.* Similarly, the Communication/Resources dimension (Factor 1) is congruent with Sharp *et. al.*'s Support dimension. Indeed the specific item included within the questionnaire to measure Support (item IAC01) correlates significantly with Factor 1.

In summary, the factor structure of the Information/Activity construct is broadly in line with the hypothesised structure and is congruent with concepts existing in the literature describing key dimensions of the capital investment evaluation process. Where it is found to be convenient to refer to these two dimensions of the Information/Activity construct they will be referred to as the Design and Support dimensions.

6.3.4.1.3 Success Construct

The Success/Expectation construct was originally hypothesised to be composed of three dimensions; Ease, Accuracy and Satisfaction. Factor analysis extracted five factors with Eigenvalues greater than unity. Inspection of the Eigenvalue scree plot suggested a two-dimensional construct. The structure matrix produced after oblique rotation of the first two factors is reproduced in table 6.15a below. The interpretation of the table is the same as for table 6.13a above.

Table 6.15a: Success/Expectation Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2
SEE01		0.822
SEE02	0.493	0.552
SEE03		0.548
SEE04	0.590	0.704
SEE05		0.736
SEA01	0.470	0.492
SEA02	0.419	0.411
SEA03		0.660
SEA04		0.526
SES01	0.517	
SES02	0.872	
SES03	0.576	
SES04	0.645	0.410
SES05	0.772	0.349
SES06	0.655	
Eigenvalue	4.818	2.197
Cum. % var.	32.1	46.8

1 - See table 6.12a for a description of the items listed.

Inspection of table 6.13a suggests an interpretation of the factor structure in line with the hypothesised structure. Factor 1 is congruent with the hypothesised Satisfaction dimension (items SES01 to SES06) Factor 2 is a merged Ease (items SEE01 to SEE05) and Accuracy (items SEA01 to SEA04) dimension. The correlation between factors 1 and 2 is 0.244. This structure is a satisfactory confirmation of the construct and its theoretical basis.

The Success/Changes construct was originally hypothesised to be composed of three dimensions; Culture, Capability and Skills. Factor analysis extracted three factors with Eigenvalues grater than unity. Inspection of the Eigenvalue scree plot also suggests a three-dimensional construct. However, counter to previous practice, the factor matrix in table 6.15b below, reproduces the first three principal components of the data. This was done because the principal components were simpler to interpret than the rotated structure matrix. As oblique rotation of the factor solution was not attempted, the factors in table 6.15b are orthogonal.

Table 6.15b: Success/Changes Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
SCU01			0.838
SCU02	0.472	-0.538	0.378
SCC01	0.598	0.397	0.341
SCC02		0.864	
SCS01	0.923		
SCS02	0.732		-0.365
SCS03	0.770		
Eigenvalue.	2.587	1.358	1.168
Cum. % var.	37.0	56.4	73.0

1 - See table 6.12b for a description of the items listed.

Interpreting the above factor structure suggests that Factor 1 is congruent with the hypothesised Skill dimension (items SCS01 to SCS03). Factor 3 is dominated by the "changes in behaviour" scale (SCU01). Factor 2 is a polar construct contrasting "changes in the time taken to complete complex projects" with "changes to the organisation's culture" (SCU02).

Further investigation of the SCU01 scale dominating Factor 3 shows that most of the variance within this item is associated with three manufacturing process changes (machine downtime; net product rejects; under standard production). In addition these changes are predominantly positive; i.e., downtime etc., was reduced. Factor 3 is therefore interpreted as measuring "improvements to the manufacturing operations of the organisation" and not "extent of social/behavioural change" which this item was intended to capture.

Factor 2 is principally (55% of the factor's variance) associated with item SCC02, the "time taken to implement complex capital projects"; this item scored high if the time taken was low. 21% of Factor 2's variance is accounted for by item SCU02; "extent of cultural change associated with the project's implementation". That these two items are negatively associated is not surprising from a practical viewpoint, as the greater the cultural change required, the longer implementation will take. Factor 2 is therefore interpreted as an "ease of cultural change" measure; negative values implying difficulty. The Success/Change construct was designed to measure the extent of procedural Change. Factor 2 and item SCC02 is not therefore congruent with the theoretical basis of the Change construct.

In summary, while the hypothesised three dimensional structure to this construct is supported by the Eigenvalue and scree plot evidence, a closer inspection shows the two minor factors to be detrimental to the theoretical purity of the measure. The two items principally defining these two factors, items SCU01 and SCC02, were therefore discarded. Factoring the now five item Success/Changes scale yielded a solution with one Eigenvalue greater than unity and accounting for 51.5% of the variance; evidence of a unidimensional construct. Analysing the first three factors yielded a structure congruent with theoretical expectations, namely item SCU02, SCC01 and items SCS01..03 loaded as separate factors. The inter-correlations between factors was high, ranging from 0.169 to 0.336.

6.3.4.2 Factor Composition of Primary Constructs

It is only necessary here to demonstrate the composition of the Uncertainty and Information constructs, as the overall Success construct alone does not form part of the hypotheses.

6.3.4.2.1 Uncertainty Construct

The 31 items composing this scale were hypothesised to measure the four dimensions; Scope, Novelty, Urgency and Complexity. Factor analysis extracted 11 factors with Eigenvalues greater than unity. Inspection of the Eigenvalue scree plot suggests a three-dimensional construct. Table 6.16a below reproduces the factor loading matrix after oblique rotation of the first three factors. Note, the five Uncertainty/Novelty items are included here as they are hypothesises to be parallel to the overall Urgency construct; this does not contradict the previous assertion that the Uncertainty/Novelty indicators are orthogonal to each other. The interpretation of the table is the same as for table 6.13a above, with the addition that Factor/Item correlations between |0.2| and |0.3| are indicated with a period and a colon thus ".:" and correlations between |0.1| and |0.2| are indicated with a single period thus ".". Sign is indicated normally.

Table 6.16a: Uncertainty Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
USS01	0.708		
USS02	0.848		-.
USS03	0.742	.	
USK01	0.310		
UST01	0.635		.
UST02	.:	0.336	0.306
UST03	0.491	0.318	
UST04	.	-.	
UNX01	0.579	.	.
UNX02	0.590		
UNX03	.	-0.377	.:
UNX04	.:	-.:	
UNX05	0.331		.:
UUP01		0.422	-0.327
UUP02	0.425	0.470	
UUP03	.:	.:	-0.505
UUP04	.	.	
UUU01	.:	-.	
UUS01	.:	.:	0.357
UUW01	.:	.:	-0.487
UUR01	.:	.:	
UUR02	0.635		-.
UUF01	.	-.:	0.556
UUF02		.:	0.829
UUF03		.	0.849
UCC01	0.361	0.617	-.
UCC02		0.677	
UCC03		0.697	-.
UCR01	0.356	0.600	
UCR02		0.684	.:
UCR03	-.:	0.560	.
Eigenvalue.	5.218	3.363	2.797
Cum. % var.	16.8	27.7	36.7

1 - See tables 6.10a, b, c and d for descriptions of the scale items.

The Bartlett Test of Sphericity for this analysis was satisfactory. Sampling adequacy was suspect at 0.454, this value possibly reflects the low ratio of cases to variables in the analysis, i.e., 1.45:1. Accepting these limitations the above factor structure provides reasonable confirmation of the hypothesised structure. Factor 1 is composed of Scope and Novelty items, US?0? and UNX0?. Factor 2 is primarily the Complexity construct, items UC?0?. Interestingly, Factor

3 is not the Urgency construct but the Financial Attractiveness dimension of the Urgency construct, i.e., items UUF01 to UUF03. These three items account for 60% of Factor 3's variance. The remaining 9 Urgency indicators are distributed approximately evenly between Factors 1 and 2, typically with average loadings of 0.28 on Factor 1 and 0.22 on Factor 2. The correlations between the factors is reproduced below as table 6.16b.

Table 6.16b: Factor Correlation Matrix

	FACTOR 1	FACTOR 2	FACTOR 3
FACTOR 1	1.000		
FACTOR 2	0.079	1.000	
FACTOR 3	0.037	-0.031	1.000

This table shows that all three Factor 3 are approximately orthogonal to each other.

6.3.4.2.2 Information Construct

For purposes of hypothesis testing the Information construct was subdivided into Experience and Process dimensions. We will therefore look initially at the factor structure of the Experience dimension, defined by Flexibility and Range indicators.

Factor analysis of the 15 combined Flexibility and Range indicators extracted 6 factors with Eigenvalues greater than unity. To test the presumed dimensionality of the Experience construct the first two factors were extracted. The structure matrix produced by oblique rotation of these factors is reproduced in table 6.17a below. The interpretation of the table is the same as for table 6.16a.

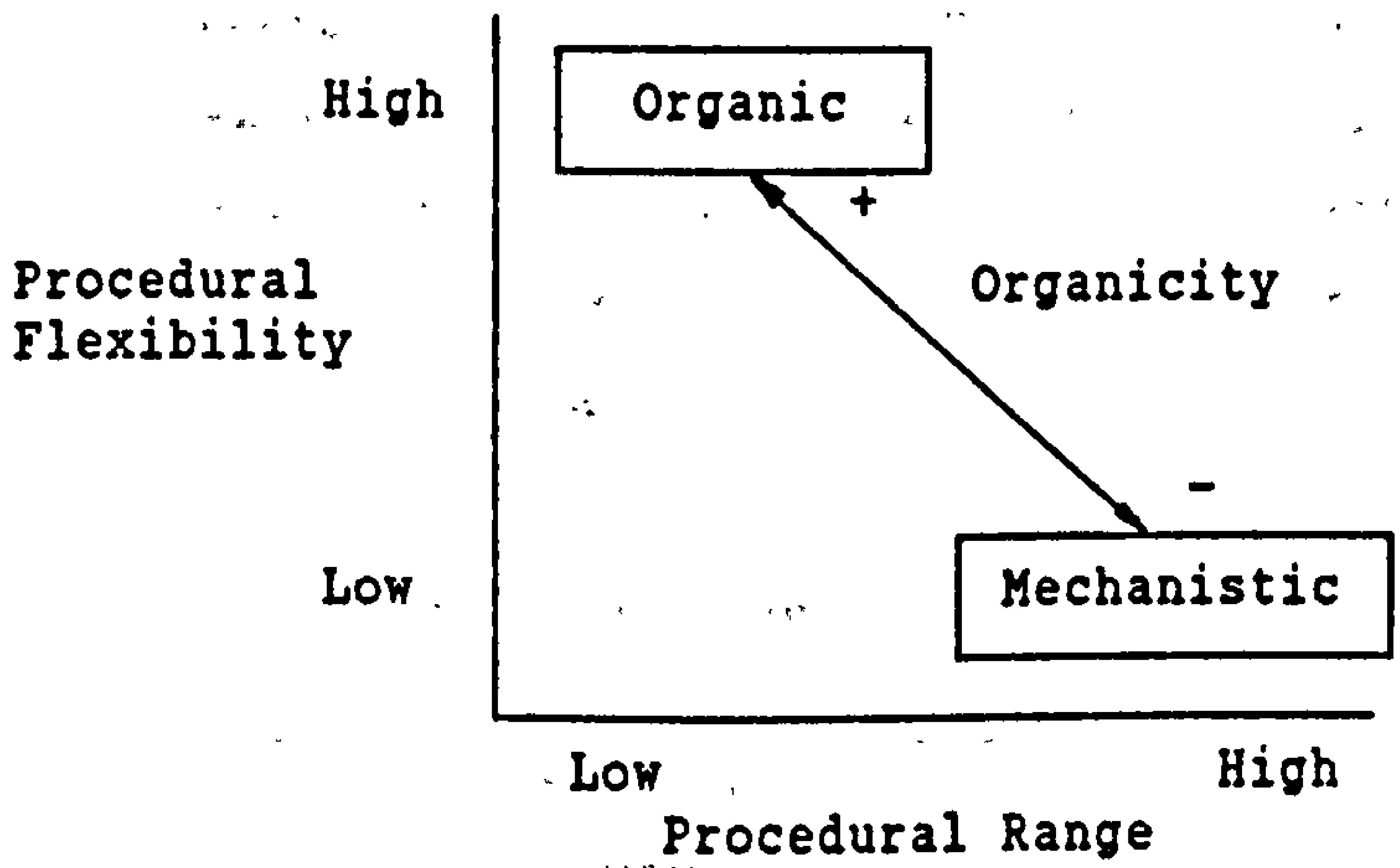
Table 6.17a: Information/Experience Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2
IRF01	0.535	.
IRF02	0.727	
IRF03	-.	.:
IRF04	0.336	0.601
IRF05	0.417	.
IRF06	0.633	
IRF07	-.	0.690
IRF08	-.	0.736
IRF09	.	0.477
IRA01		
IRS01	.:	0.684
IFX01	-0.373	-0.492
IFX02	-.	
IFX03	-0.705	
IFX04	-0.650	-0.403
Eigenvalue.	2.975	2.235
Cum. % var.	19.8	34.7

1 - See tables 6.11a and b for descriptions of the scale items.

The Bartlett test of sphericity for this analysis was satisfactory, sampling adequacy was disappointing at 0.454, and the correlation between the two factors was 0.116. The factor structure illustrated in table 6.17a is not the simple structure anticipated, i.e., Flexibility items loading only on factor 2 say, and Range items on factor 1. It is also noted that the Flexibility indicators are negatively correlated with the Range indicators. As the Flexibility indicators were derived from Burns and Stalker's (1961) Organic - Mechanistic polar organisational taxonomy, we may deduce that Organicity is negatively associated with procedural Range. In other words its polar opposite, Mechanicity, is positively associated with Range. It was noted in chapter 4 that, conceptually, procedural Flexibility and Range are orthogonal dimensions. The above factor structure indicate that the Organicity - Mechanicity dimension is not orthogonal to Range but in fact, Mechanicity is a measure *of* Range. The possible relationship of Burns and Stalker's Organic-Mechanistic forms to the procedural Range and Flexibility dimensions accounting for the observed factor structure is illustrated in figure 6.3.

Figure 6.3: Range, Flexibility and Organicity Dimensions



In terms of the cybernetic arguments developed in chapter 4 the interpretation illustrated in figure 6.3 of the association between Range, Flexibility and Organicity is reasonable. Both Range and Flexibility refer to ways in which an organisation can develop sufficient internal variety to match the environmental variety it is subjected to. This, it was argued, could be achieved through either a relatively small number of flexible procedures, or a larger number of more rigid procedures. Both solutions to the organisational design problem are cybernetically equally valid and satisfactory. Organic - Mechanistic forms therefore represent two successful organisational designs, but we conclude that the Organicity construct does not accurately measure Flexibility.

From this description it appears reasonable to argue that the Organicity measure used in this study was not a valid measure of the Flexibility concept. By reflecting the Organicity measure and describing it as a measure of Mechanicity, we have an indicator of the Range concept. These reflected Organicity measures will be referenced using the labels IMX01 to IMX04 and will replace IFX01 to IFX04 in the remainder of the thesis. Where it is necessary to refer to a combined Range - Mechanicity construct it will be identified as Information CAPACITY. Using Capacity in place of the previously defined Experience label highlights the notion that the full breadth of the procedural Flexibility construct has not been captured in this study. We now turn to the Information Process constructs.

Factor analysis of the 27 combined Lubrication and Activity indicators extracted 10 factors with Eigenvalues greater than unity. Scree plot inspection indicated three factors underlying the indicators. These were extracted and the structure matrix produced by oblique rotation of the three factor solution is reproduced in table 6.17b below. The interpretation of the table is the same as for table 6.16a.

Table 6.17b: Information Process Structure Matrix

ITEM[1]	FACTOR 1	FACTOR 2	FACTOR 3
ILU01	0.460		0.575
ILU02			0.839
ILM01	.	.:	0.561
ILM02	.:		0.745
ILR01	0.357	-0.434	0.505
ILR02	0.525	-.:	0.614
IAA01	0.774		.
IAA02	0.595	0.631	0.371
IAA03	0.697	0.501	.
IAI03	0.667	.	.
IAC01	.:	0.475	.
IAC02		0.407	
IAC03	.:	0.609	0.323
IAC04	0.309	0.513	.
IAS01	0.599		.:
IAS02	0.673		.:
IAS03	0.371	0.603	-.
IAS04		0.220	
IAS05	.	.	0.476
IAS06	.	.	.:
IAS07		0.541	.:
IAS08	0.354		
IAS09	0.326	.:	
IAR01		0.454	
IAR02	0.422	.:	.:
IAR03	0.497	0.383	
IAN01	0.556	0.584	
Eigenvalue.	5.795	2.968	1.827
Cum. % var.	21.5	32.5	39.2

The Bartlett test of sphericity for this analysis was satisfactory. Sampling adequacy was acceptable at 0.494, particularly in view of the low cases to variables ratio of 1.7:1. The above factor structure provides reasonable confirmation of the hypothesised Process construct. Factor 3 is the Lubrication construct. The Activity construct separates into Factors 1 and 2. Factor 1 may be interpreted as the Design dimension of Information/Activity, while Factor 2 is the Support dimension. These two sub dimensions were noted previously during the discussion surrounding table 6.14b. Finally we note that factors 2 and 3 are effectively uncorrelated (correlation coefficient 0.037). Factor 1 (Design) is correlated with Factor 2 (Support, r=0.207) and Factor 3 (Lubrication, r=0.248).

6.3.4.3 Summary

To summarise the above analysis and discussion it is seen that generally the data supports the factorial composition of the primary and secondary constructs suggested in chapter 4. Where analysis does not clearly support the theoretical structures the discrepancies were typically due to two sets of indicators defining a single dimension rather than one. Alternatively, explanations for the observed structures were found in terms of other structures within the construct. The main exception to this rule is the procedural Flexibility construct. This, it was argued, appears not to have been fully measured. It was therefore replaced by a Mechanicity construct which is positively associated with procedural Range. A new construct was defined consisting of Range and Mechanicity indicators and called Capacity. Capacity partially captures the Experience concept defined in chapter 4. Having established factorial composition (with minor modifications in places) we now look at the discriminant validity of the constructs.

6.3.5 DISCRIMINANT VALIDITY

Establishing the factorial composition of the primary constructs has established the discriminant validity within these constructs. Here we are interested in the discriminant validity between the primary constructs. As explained earlier, the method selected for this analysis was Median Correlation. However, medians are tedious to calculate (hand computation was necessary and several thousand data items are involved) and as the data scales were made to be approximately normal, the median will not differ greatly from the mean. The results presented below in table 6.18 therefore refer to mean correlations.

Table 6.18: Mean Inter- and Intra-scale Correlations

SCALE[1]	INTER-[2]	INTRA-[3]
UXX	0.034	0.112
ICX	0.033	0.113
IPX	0.052	0.141
SEX	-0.044	0.254
SCX	0.085	0.368

1. The scale items are:-
   UXX - Uncertainty
   ICX - Information Capacity
   IPX - Information Process
   SEX - Success Expectation
   SCX - Success Changes
2. Mean off-diagonal inter-scale correlation.
3. Mean intra-scale correlation.

The data in table 6.18 above presents satisfactory evidence of the discriminant validity of the constructs. All inter-scale correlations are small and less than the intra-scale correlations.

The remaining trait validity topic to be addressed here is internal consistency (i.e., unidimensionality and reliability). This topic is closely associated with the overall aim of this chapter to construct factor scales of the theoretical constructs. Hence, we will address this topic as part of the factor scale construction issue.

6.4 FACTOR SCALES CONSTRUCTION

The basis for constructing factor scales and assessing their unidimensionality and reliability has been set out in section 6.3.2.1 above. Briefly, this involves extracting the first factor from the principal components analysis, determining the extent to which it satisfies the criteria for uni-dimensionality specified by Carmines and Zeller (1979) and evaluating its theta reliability. As single factors cannot be rotated the factor weights presented here will differ from those presented previously during the discussion of factorial composition (Section 6.3.4). Interpretation of the weights is the same however, namely the contribution to the overall factor of a given scale item can be assessed from the magnitude of its weighting. Factor scales produced by this procedure are standardised. That is, each factor scale has a mean value of zero and unit variance across the sample of cases for which it was constructed. It should also be noted that factor scales are not constructed from factor loadings (which are correlation coefficients) but by regressing the factor with the scale items. These regression weights (or β coefficients) are not presented here as they are not particularly meaningful due to high multicollin-iearity between variables.

In the tables that follow, factor loadings for each scale are presented. In addition the Eigenvalue of the factor, the number of items in the scale and hence the theta reliability of the scale is given (based on the formula in section 6.3.2.1). For interest, alpha reliabilities are also indicated and placed in brackets. Finally, the variance explained by the factor is indicated.

The uni-dimensionality of a scale was assessed using the four criteria suggested by Carmines and Zeller (1979) (section 6.3.2.1). One problem when interpreting these criteria is in defining the word "most" (criteria 3 and 4). This word is interpreted here as meaning a simple majority, i.e., more than 50%. No doubt more demanding interpretations could be specified. A further problem stems from the requirement that 40% or more of the variance in the data should be explained by the first factor (criterion 1). While this may be a reasonable criterion for scales with fewer than 8 or 9 items, for scales with substantially more items it becomes unacceptably onerous. The policy adopted here has therefore been to reject this criterion if the scale achieves satisfactory theta reliability values, of say, greater than 0.7. Finally, this study has applied a policy of conservatism regarding the deletion or retention of scale items. In practice this means that if an indicator has survived all previous screening processes it will be retained in the final scales, unless there is a sound theoretical justification for deleting the item(s). This policy is derived from a desire to retain the "richness" of the data, and hence the scales. Factor loadings are shown in the following tables using the conventions developed in table 6.16a. Initially we look at the Uncertainty construct.

6.4.1 UNCERTAINTY SCALES

Four Uncertainty construct scales are presented in table 6.19 over. These are the overall Uncertainty scale (UXX) the Uncertainty/Scope (USX) Uncertainty/Urgency (UUX) and Uncertainty/Complexity (UCX) scales. Note that the Uncertainty/Novelty scale cannot be generated by this procedure and was generated by summing the five scale items and standardising across the sample. No reliability assessment for this measure can be made using the available data.

Table 6.19 indicates an adequate reliability for the overall Uncertainty scale UXX. The most notable feature of the scale is the effective exclusion of Financial Attractiveness (items UUF01 to UUF03) from its construction. This implies that considerations of future returns from the project were not contributing to the Uncertainty (variety) of the project in general and the Urgency of the project in particular. It was noted previously that Financial Attractiveness contributed substantially to the Uncertainty/Urgency scale (UUX). If this scale was to reflect the overall Uncertainty construct it was necessary to explicitly exclude items UUF01 to UUF03 from the scale's construction; as indicated in table 6.19. This change results in an Uncertainty/Urgency scale with a reliability indicative of a bi-dimensional construct. This supposition is supported by the earlier discussion on factorial composition, which identified three factors describing the Urgency construct, one of which was Financial Attractiveness. Hence, although the reliability of the Uncertainty/Urgency construct is relatively low, it is satisfactory for a moderately broad construct of two terms (Van De Ven and Ferry, 1980). Reliabilities of both the Uncertainty/Scope (USX) and Uncertainty/Complexity (UCX) scales are satisfactory.

Accepting the above discussion the unidimensionalities of the scales are satisfactory. Scale UUX has been discussed above and scale UCX unequivocally satisfies all of the criteria for unidimensionality. The reliability and unidimensionality of the Scope scale (USX) can be improved by explicitly omitting item UST04 (probability of approving a capital investment proposal). Retaining the item effectively means the calculated reliabilities are conservative.

Table 6.19: Uncertainty Scales

ITEM[1]	UXX	USX	UUX	UCX
USS01	0.634	0.788		
USS02	0.759	0.913		
USS03	0.721	0.802		
USK01	.:	.:		
UST01	0.520	0.578		
UST02	0.302	0.317		
UST03	0.557	0.562		
UST04				
UNX01	0.547			
UNX02	0.501			
UNX03				
UNX04	.			
UNX05	.:			
UUP01	.:		.:	
UUP02	0.568		0.649	
UUP03	0.356		0.556	
UUP04	.:		0.309	
UUU01	.		0.363	
UUS01	0.323		0.315	
UUW01	0.404		0.434	
UUR01	0.333		0.516	
UUR02	0.585		0.590	
UUF01			Omitted	
UUF02			Omitted	
UUF03			Omitted	
UCC01	0.601			0.655
UCC02	0.389			0.629
UCC03	.:			0.688
UCR01	0.584			0.700
UCR02	0.333			0.751
UCR03				0.552
Eigenvalue	5.218	2.904	1.905	2.657
No. items	31	8	9	6
Reliability	0.835	0.749	0.535	0.748
[θ and (α)]	(0.773)	(0.677)	(0.505)	(0.746)
% variance	16.8	36.3	21.2	44.3

1 - See tables 6.10a, b, c and d for item descriptions.

6.4.2 INFORMATION SCALES

The overall Information Capacity (ICX) scale is presented in table 6.20a together with the individual Range (IRX) and Mechanicity (IMX) sub scales. Range items are labelled as in table 6.11b. Mechanicity items are reflections of the Flexibility items identified in table 6.11a. In terms of mechanicity these items are:

IMX01 Insistence on a uniform managerial style throughout the firm.

IMX02 Emphasis on holding fast to true and tried management practices, procedures or principles.

IMX03 Emphasis on getting line staff personnel to adhere closely to formal job descriptions.

IMX04 Strict hierarchy of control and authority using sophisticated information systems.

Table 6.20a: Information Capacity Scales

ITEM	ICX	IRX	IMX
IRF01	0.477	0.431	
IRF02	0.512	.:	
IRF03	.	.:	
IRF04	0.608	0.654	
IRF05	0.399	0.411	
IRF06	0.404	.	
IRF07	0.304	0.580	
IRF08	0.331	0.636	
IRF09	0.372	0.444	
IRA01			
IRS01	0.574	0.704	
IMX01	0.569		0.769
IMX02	.		0.564
IMX03	0.501		0.662
IMX04	0.719		0.758
Eigenvalue	2.975	2.377	1.923
No. items	15	11	4
Reliability	0.711	0.637	0.640
{θ and (α)}	(0.657)	(0.586)	(0.635)
% variance	19.8	21.6	48.1

Table 6.20a shows that the unidimensionality of the Mechanicity scale is satisfactory and reliability is acceptable using Nunnally's

(1978) criterion. The reliability of the Range scale (IRX) is similar to that of Mechanicity, but the unidimensionality is poor. Indeed, of the four criteria for assessing unidimensionality, this scale only satisfies one; i.e., most of the item loadings are substantial. Accepting these observations, it is the author's judgment that in order to preserve the breadth of the Range construct, its original definition will be retained. Finally we note that the above comments about the Range scale also apply to the overall Information Capacity scale, although its reliability is more acceptable.

The overall Information Process (IPX) scale is presented in table 6.20b together with the individual Lubrication (ILX) and Activity (IAX) scales. Lubrication and Activity items are labelled as in tables 6.11c and 6.11d.

Table 6.20b: Information Process Scales

ITEM	IPX	ILX	IAX
ILU01	0.535	0.680	
ILU02	0.353	0.765	
ILM01	0.446	0.548	
ILM02	0.403	0.764	
ILR01	.:	0.682	
ILR02	0.503	0.746	
IAA01	0.604		0.567
IAA02	0.787		0.800
IAA03	0.735		0.780
IAI01	0.578		0.591
IAC01	0.390		0.433
IAC02	.:		.:
IAC03	0.532		0.562
IAC04	0.465		0.519
IAS01	0.504		0.470
IAS02	0.603		0.542
IAS03	0.437		0.552
IAS04			.
IAS05	.:		.:
IAS06	.:		.:
IAS07	0.350		0.376
IAS08	.:		.:
IAS09	0.300		0.342
IAR01	.		.:
IAR02	0.455		0.457
IAR03	0.485		0.544
IAN01	0.622		0.705
Eigenvalue	5.795	2.952	5.134
No. items	27	6	21
Reliability	0.859	0.794	0.845
{θ and (α)}	(0.815)	(0.790)	(0.793)
% variance	21.5	49.2	24.4

Table 6.20b provides satisfactory evidence of the reliability and unidimensionality of the Lubrication scale (ILX) the Activity scale (IAX) and the overall Process scale (IPX). We note also that it is the Design dimension of Activity that is primarily been highlighted in both the Activity and Process scales.

6.4.3 SUCCESS SCALE

Two Success construct scales are presented in table 6.21. These are the Success/Expectations scale (SEX) and the Success/Changes (SCX) scale. Individual scale items are labelled as in tables 6.12a and 6.12b.

Table 6.21: Success Scales

ITEM	SEX	SCX
SEE01	0.597	
SEE02	0.661	
SEE03	0.434	
SEE04	0.819	
SEE05	0.509	
SEA01	0.609	
SEA02	0.526	
SEA03	0.388	
SEA04	0.440	
SES01	0.345	
SES02	0.699	
SES03	0.432	
SES04	0.671	
SES05	0.715	
SES06	0.396	
SCU02		0.472
SCC01		0.578
SCS01		0.926
SCS02		0.737
SCS03		0.784
Eigenvalue	4.818	2.573
No. items	15	5
Reliability	0.849	0.764
{θ and (α)}	(0.836)	(0.708)
% variance	32.1	51.5

Table 6.21 indicates adequate reliability and unidimensionality of the Expectation (SEX) and Changes (SCX) scales.

6.5 CONCLUSIONS

This chapter has been concerned with the generation of valid and reliable measures of the theoretical constructs outlined in chapter 4, for use in hypothesis testing.

In section 6.1 a simple statistical summary of the data collected for analysis was presented. In section 6.2 focus was placed on sampling bias as a threat to the study's internal validity. In this discussion contrasts were made between companies participating in the study and those contacted but declining to participate. These two groups were compared using primary and secondary data and no statistically significant differences between the two groups were found at the 5% level. Next, the study sample was compared with a representative national sample of companies, again using secondary data. No statistically significant differences were identified at the 5% level between these two samples in terms of size (number of employees) industry sector or in terms of diversity of manufacturing activities. Some primary evidence pointed to the possibility that the study sample companies perceived themselves to be better than their major competitors. This would not however be a threat to the validity of the study and overall it was concluded that the study sample was representative of all companies contacted as part of the research and representative of companies on a national scale.

In section 6.3 the question of construct validity and its relevance to construct measurement was highlighted. Techniques for assessing trait validity in terms of factorial composition, discriminant validity, reliability and unidimensionality were discussed. Subsequently the factorial composition and discriminant validity of the primary and secondary constructs were investigated. Scale items were included or deleted if sound reasons could be proposed for such empirical adjustments. Factorial compositions were generally found to support the theoretical basis of the scales. One major change made here was to replace the Information Experience construct with an Information Capacity construct. This change was made because the Flexibility construct was not adequately captured using the Organicity measures employed in the study. Reflection of these measures defined a new construct, Mechanicity. Range and Mechanicity define Capacity. Finally discriminant validities were found to be satisfactory.

In section 6.4 the reliabilities and unidimensionalities of the primary and secondary constructs were determined. Again some modifications were required to the constructs, principally the exclusion of Financial Attractiveness from the Uncertainty and Uncertainty/Urgency constructs. Following such empirical adjustments to the scales reliabilities and unidimensionalities for the constructs were determined to be satisfactory, as all theta and alpha reliabilities are within ranges reported in the literature and claimed to be "satisfactory" (e.g., Miller and Dröge, 1986; Jenkins *et. al.*, 1975; Hackman and Oldham, 1975).

It could be argued that some of the scales reported here achieve their reliabilities more by the number of items composing the scale than by the inter-correlation between items. To some extent this is true but in defence of the study it is observed that many commonly used psychometric scale frequently employ tens of scale items. The most extreme case identified was a study by Lundstrom and Lamont (cited by Peter, 1981) to reduce a 173 item "Consumer discontent" scale to 82 items! It would have been possible in a number of instances to improve scale reliabilities and unidimensionalities further by deleting items. This approach has been avoided however, as the automatic pursuit of maximising reliability (beyond a reasonable minimum) can only be achieved by reducing the "richness" of the measures and therefore the breadth of the construct. How the researcher optimises this trade-off is largely a matter of personal preference. In this study the tendency was to preserve the "richness" of the data.

The evidence presented in this chapter indicates that the study sample is representative of the total sample of companies contacted for interview and representative of manufacturing companies within the U.K. employing 100 or more people. In addition the scales developed for the theoretical concepts have satisfactory trait validities. The next chapter will use these scales to test the hypotheses developed in chapter 4.

CHAPTER 7

DATA ANALYSIS

This chapter aims to utilise measures of the theoretical constructs developed in chapter 6 to investigate the hypotheses developed in chapter 4. It is broadly structured into two parts. Part one is methodological and sets out the chosen method of statistical analysis (Causal Modelling) and discusses the issue of statistical conclusion validity. Part two, the bulk of the chapter, investigates the relationships between the constructs.

7.1 STATISTICAL METHODOLOGY

7.1.1 CAUSAL MODELLING

Causal modelling is a method consisting of two related techniques. The first of these is the Simon-Blalock technique, the second is Path Analysis. Path analysis in turn is subdivided into Recursive and Non-recursive path estimation techniques. The Simon-Blalock technique is based on correlational methods, and Partial correlation in particular. Path analysis is based on the method of multivariate regression. However, the predictions of the Simon-Blalock technique also rest upon a regression justification (Asher, 1983).

7.1.1.1 Comparison with Other Techniques

Causal modelling differs from other multivariate techniques in that it assumes an ordering of the variables in a set (Van de Geer, 1971). This ordering represents causation. Most multivariate techniques assume independence between the individual explanatory variables (x1, x2, etc.) i.e., x1 and x2 say, are assumed to be orthogonal. Any observed association between x1 and x2 is therefore assumed to be due to some common association with an explained variable (regression) or latent variable (factor analysis, canonical correlation). In causal analysis this restriction is removed. By way of illustration, the hypotheses developed in chapter 4 predict that Change is dependent upon Uncertainty (Hypothesis 1) and Information Process (Hypothesis 7). If this was the extent of the hypotheses, Change could be regressed on Uncertainty and Information to establish the model. However, Hypothesis 3 posits that Information Process is in its turn also determined by Uncertainty. Therefore the assumption of no causal relation between the independent explanatory variables is violated for regression. Causal analysis enables this type of model to be tested.

As with any statistical technique, confidence in the results is dependent upon the reliability and validity of the indicators used (Asher, 1983). Causal modelling is, however, also dependent upon the use of sound theorising in order that the ordering of the variables can be attempted. As Asher (1983,p.10) states:

> "Probably the best advice that one could offer to someone contemplating the use of causal modelling is to begin with a model in which one has substantial confidence.... If one has some confidence in the basic model, then the admissible revisions in the model when the data analysis is not fully confirmatory (and it seldom is) are limited... One should not allow the testing and revision of models to become an enterprise completely determined by statistical results devoid of theoretical underpinnings."

Asher's comment would therefore indicate that Causal modelling is not a technique amenable to data exploration.

7.1.1.2 The Notion of Causality

Some of the philosophical problems associated with the word "Causality" were addressed in chapter 5 in relation to the discussion of validity (Cook and Campbell, 1979; Nunnally, 1967; Green and Tull, 1970). Similar comments are made by authors writing about the interpretation of statistical associations. For example, Van de Geer (1971,p.112) comments:

> "...let us state explicitly that correlations never *prove* causal relations. All they can do is to be consistent with some causal theory. ...formal analysis of data is only one way to arrive at an understanding of the real world, and formal analysis is not sufficient by itself. It should be guided by what is reasonably known about the content to which the data refer."

As the above quotation shows, demonstrating a statistical association (concomitant variation or co-variation) does not prove causality. Further evidence can be accrued if a temporal ordering between variables can be demonstrated, although Simon (1957,p.5) argues that the essential aspect of a causal relationship is that it is asymmetrical in nature and not that it always involves temporal sequences. A further condition requires the elimination of other possible causes. This condition can be problematical especially as there is a "potentially infinite universe of such variables and there is no statistical test or coefficient that can tell us whether we have made the correct decision" (Asher, 1983). The remainder of this study will proceed on an "as if" basis, i.e., as if no such confounding variables exist.

7.1.1.3 Assumptions

As justification of both the Simon-Blalock technique and Path Analysis rests on the basic regression model, the use of these techniques requires satisfaction of the assumptions of regression analysis. Asher (1983) discusses and summarises these assumptions, together with the assumption of a linear relationship between the variables and the assumption of data measured at the interval level. The last two assumptions are important to the use of the Simon-Blalock technique as they affect the computation of the Pearson product moment coefficient, "r". Asher advocates the use of scatter plots to visually inspect the nature of the associations between variables. This procedure was adopted here and indicated no noticeable non-linear associations to exist between variables used in the causal analysis.

We addressed the question of interval vs. ordinal level measuring scales in chapter 5. The conclusion was that the use of ordinal data in place of interval data to compute product moment coefficients would not be a serious problem. This is particularly true when, as in this study, scales are constructed by aggregating several ordinal measures together. Such scales will approach the interval measure assumption. A test of this assumption is provided by comparing the correlation matrix between major theoretical constructs calculated using Pearson's product-moment coefficient with the matrix of Spearman rank-order correlations; table 7.1. Pearson's coefficient assumes data measured at the interval level; Spearman is a non-parametric coefficient requiring only ordinal level data. If the two sets of coefficients are similar, then similar conclusions are likely regarding associations implied by the data (Sorensen and Zand, 1975).

Table 7.1: Comparison of Pearson and Spearman Correlations

SEMI-MATRIX OF PEARSON CORRELATIONS (Below diagonal)	SEMI-MATRIX OF SPEARMAN CORRELATION COEFFICIENTS (Above diagonal)						
	UXX	IRX	IMX	ILX	IAX	SCX	SEX
Uncertainty	-				0.622	0.615	-0.504
Range		-	0.296	0.112	0.190		
Mechanisity		0.282	-	0.159	0.363		
Lubrication		0.130	0.161	-	0.208		0.297
Activity	0.640	0.157	0.348	0.321	-	0.448	-0.242
Change	0.648				0.442	-	
Expectation	-0.433			0.149	-0.254		-

NUMBER OF OBSERVATIONS: 45

Note: All correlation of ±0.10 or less have been omitted from the table.
Minimum size for Pearson coefficient to be significant at p=0.10 is ±0.25.

Inspection of table 7.1 indicates similar signs and magnitudes for the majority of significant elements, hence it is concluded that the use of ordinal level data would not influence the analytical results. The linearity and interval level data assumptions of the analysis are therefore not violated to any significant extent.

With respect to the assumptions of regression analysis Asher (1983) concludes that the technique is "adequately robust" to the problems of heteroscedasticity and non-normality. In chapter 6 data transformations were used to minimise violations of the normality assumption. Asher further discusses the problem of multicollinearity, noting that this is not viewed as a problem by some analysts if the correlation level between variables does not exceed the 0.7 or 0.8 level. Finally, the t-test used within this study to test the significance of a correlation is also known to be robust, particularly for sample sizes of 20 or more (Manly, 1986).

In conclusion, the assumptions underpinning the causal modelling techniques and significance tests to be used in this study should not present serious problems to its validity.

7.1.1.4 Overview of Techniques

7.1.1.4.1 The Simon-Blalock Technique

This technique is based in Simon's work into spurious correlations. Specifically, what are the conditions under which a non zero correlation between two variables provides evidence for inferring the existence of a causal relationship between the two (Asher, 1983). Starting from a postulated causal model the researcher identifies the partial correlations which should vanish and which should not. In determining these partial correlations the researcher controls for "*all* variables which are either antecedent to, or intervening between, the particular variables being related, but they do *not* involve controls for variables taken to be dependent upon *both* of these variables" (Blalock, 1972,p.23).

Consider the formula for a first-order partial correlation between variables a and b controlling for variable c, viz.,

$$r_{ab.c} = (r_{ab} - r_{ac}.r_{bc})/\surd((1 - r^2_{ac}).(1 - r^2_{bc}))$$

For the partial to vanish r_{ab} must equal the product of r_{ac} and r_{bc} and be smaller in magnitude than either r_{ac} or r_{bc}. This relationship provides a quick test of the model and can be extended to higher order partial correlations. The major advantage, therefore, of the Simon-Blalock technique over Path Analysis, is that it provides a fairly rapid way of testing alternative models in order that those most compatible with the data may be selected (Blalock, 1972). The magnitudes of the correlation coefficients also provide data on the size of the associations between variables. The method is, however, restricted to recursive models only, i.e., models with no reciprocal association between variables. It also provides "very meagre" information about the strength of a linkage (Asher, 1983). Asher therefore recommends the use of path analysis to investigate the magnitude of the linkages between variables.

7.1.1.4.2 Path Analysis

The basis of Path Analysis is regression. For recursive models the simplest approach is to use ordinary least squares. For non-recursive models techniques such as two stage least squares are required. One of the debates surrounding the technique is whether or not to use standardised coefficients in the regression models. Asher (1983) summarises this debate and concludes that it is more appropriate to use standardised coefficients "if one wants to make statements about the relative importance of independent variables *within* populations". As this summarises the aim of this study, it justifies the use of scales derived from standardised factor scores.

The basic aim of Path Analysis is to specify a set of linear equations that are equivalent to a postulated causal diagram. The dependent variable in an equation is one of the variables in the model. If a variable is not determined by any other variable in the model it is referred to as an *exogenous variable*. If determined by other variables it is called an *endogenous variable*. The regression coefficients (β weights if the variables are in standardised form) are called *path coefficients*. The equations themselves are called *structural equations*. However, a model defined solely in terms of exogenous and endogenous variables is unrealistic as it implies complete determination of the whole model by only the exogenous variables (Van de Geer, 1971). Therefore, an unobserved or *residual* factor is included representing items not actually measured but which impinge upon the endogenous variables (Asher, 1983). The principal assumptions on which the Path Analysis technique is based (besides those mentioned previously as common to regression analysis in general) centre upon the residual terms. There are three such assumptions:

1. No residuals are attached to exogenous variables.
2. Residual terms are uncorrelated with each other.
3. Residuals are uncorrelated with any other variables in the model.

Solving a particular system of structural equations produces estimates for the path coefficients. These can be used to calculate the correlations between variables in the model by the application of what Duncan (1966) termed the "basic theorem of path analysis", i.e.,

$$r_{ij} = \sum_{q} p_{iq} r_{jq}$$

where i and j denote two variables in the system and q runs over all variables from which paths lead directly to variable i. 'p' are the estimated path coefficients and 'r' product moment coefficients. In addition the magnitudes of the path coefficients yield information on the change produced in one variable by a specified change in another (Asher, 1983).

In summary, this study will use (where appropriate) the Simon-Blalock technique to investigate the causal structure of a model and path analysis to investigate the magnitude of the linkages between variables.

7.1.2 STATISTICAL CONCLUSION VALIDITY

Cook and Campbell (1979,p.39) identify three questions associated with the statistical analysis of covariance structures. These were mentioned in section 5.1.1 and concern the issues of statistical power, statistical significance and Effect Size. While Cook and Campbell viewed statistical conclusion validity primarily in terms of statistical significance, a number of authors in the 1980's have focused attention on the issues of power and effect size; see Sawyer and Ball (1981) Mazen *et. al.* (1987) Baroudi and Orlikowski (1989). The principal comment made by these authors is that neglect of these issues has given rise to spurious and contradictory findings within their disciplines. In addition, many of these contradictory findings can be attributed to some of the studies having inadequate statistical power and by focusing only on the studies with adequate power levels, many of the contradictions disappear.

Briefly the "power" of a statistical test is the probability that the test will correctly reject the null hypothesis. This is given by $(1 - \beta)$ where β is the Type II error rate. The "significance" of a statistical test is the probability that the test will incorrectly reject the null hypothesis. This is given by α where α is the Type I error rate. Type I and Type II errors are discussed in most introductory statistical texts, e.g., Mendenhall *et. al.* (1986). Finally, "Effect Size" is a measure of the "*degree* to which the phenomenon under study is manifested" and is an "index of degree of departure from the null hypothesis" (Cohen, 1969,p.10). This statement is usually interpreted as meaning the proportion of variance explained by the proposed association. In the above discussion of causal modelling it was indicated that the product moment coefficient (r) was to be used to demonstrate causal associations. In this instance the effect size is simply determined by the value of r^2. (Methods for determining the effect size of other types of statistical test are given by Cohen, 1969 and 1977).

Effect Size is a property of the particular relationship under investigation; it is not determined by the size of the sample. The attained level of statistical significance is determined by the sample size and is not indicative of Effect Size (Sawyer and Ball, 1981). The statistical power attained is determined positively by the Effect Size and sample size and negatively by the chosen significance level. Cohen (1969,p.5) commenting on this last point, says:

> "An investigator can set the risk of false null hypothesis rejection at a vanishingly small level, say α=0.001, but in so doing, he may reduce the power of his test to 0.10" (i.e., β=0.90).

In this example the β/α ratio is 900 to 1. In other words this investigator is implicitly stating that a Type I error (mistakenly rejecting the null hypothesis) is 900 times more serious than a Type II error (mistakenly accepting the null hypothesis). While there is a case to be made in favour of the seriousness of the Type I error over the Type II error, Cohen suggests this should typically be in the order of 4 to 1 and recommends that experimental designs should aim to achieve an α level of 0.05 and a β level of 0.20, i.e., a power of 0.80. Using a less stringent significance level criteria than the "conventional" 0.05 can be justified, if so doing improves the power of the analysis. Sawyer and Ball (1981) for example, cite a study in which a significance level of 0.25 was adopted in order to mitigate the effects of low power. In addition these authors recommend that an investigator should aim for higher power in basic theoretical research than in applied research. It is not therefore necessarily detrimental to the conclusions of a study if a minimum significance level of 0.10 is adopted for these reasons. In the analysis that follows, a minimum significance criteria of 0.10 has been adopted. Finally, it is noted that a one-tailed significance test is more powerful than a two-tailed test. In terms of causal modelling, which aims to test directional hypotheses, one-tailed tests are justified.

The final question to be addressed in this section is, what Effect Size can this study measure? To assist with answering this question Cohen (1969) introduced a heuristic method of categorising Effect Size as being either Large, Medium or Small. A Large Effect Size is an association explaining approximately 25% of the variance. A Medium Effect Size accounts for approximately 9% and a Small Effect Size 1% of the variance. In terms of the product moment coefficient (r) these Effect Sizes translate as:

Table 7.2: Effect Size and Pearson's "r"

Effect Size	r
Large	0.50
Medium	0.30
Small	0.10

Cohen demonstrates that interpreting Effect Size in this way is meaningful in terms of the types of associations found within the behavioural sciences, and views the Medium Effects Size as a "very important" level as "Many of the correlation coefficients encountered in behavioural science are of this order of magnitude...".

7.1.2.1 Statistical Power Analysis

So what Effect Sizes can this study detect? The sample size is fixed at 45 cases. With reference to the tables presented by Cohen (1969,pp.81-92) for the significance of product moments the following data has been extracted. Table 7.3 indicates the product moment coefficients corresponding to three levels of Effect Size at three levels of statistical significance (p=0.10, 0.05 and 0.01) for both 1-tailed (α') and 2-tailed (α'') tests.

Table 7.3: Power (%) of t-test of Product Moment r

Effect Size	Equivalent r	α' 0.10	0.05	0.01	(N=45) α" 0.10	0.05	0.01
LARGE	0.50	99	97	90	97	94	84
MEDIUM	0.30	77	65	38	65	53	29
SMALL	0.10	26	16	5	17	10	3

Inspection of Table 7.3 indicates that the current study is capable of detecting "Strong" Effect Sizes with satisfactory power at significance levels of 1% and better. Medium Effect Sizes can be detected with satisfactory power at a significance level of 10% using a 1-tailed test and with reasonable power using a 2-tailed test. Small Effect Sizes cannot be detected with any confidence by this study.

It is possible using tables presented by Cohen to determine the sample size required to detect a specified Effect Size. Based on Cohen's recommendation of $\alpha=0.05$ and Power $(1-\beta)=0.80$ the sample size required to detect a small Effect is 618 for a 1-tailed test and 783 for a 2-tailed test. A comparison between the significance (α) and power ($1-\beta$) of the t-test to detect the hypothesis $r \neq 0$ is presented in table 7.4 below for 1- and 2-tailed tests and a sample size of 45 cases. In table 7.4 a single prime (') indicates a 1-tailed test, a double prime (") a 2-tailed test.

Table 7.4: Significance and Power of t-test.

α	Critical r r'	r"	% Power at critical r 1 - β'	1 - β"
0.10	0.19	0.25	53	51
0.05	0.25	0.30	51	53
0.01	0.35	0.38	48	50

The most striking feature of table 7.4 is that (within the accuracy of interpolation of the tables) the power of the t-test is constant at about 51% at the critical r value, irrespective of the significance level or direction of the test. Hence the minimum power achieved by any statistically significant correlation coefficient presented in this study will be better than 50%.

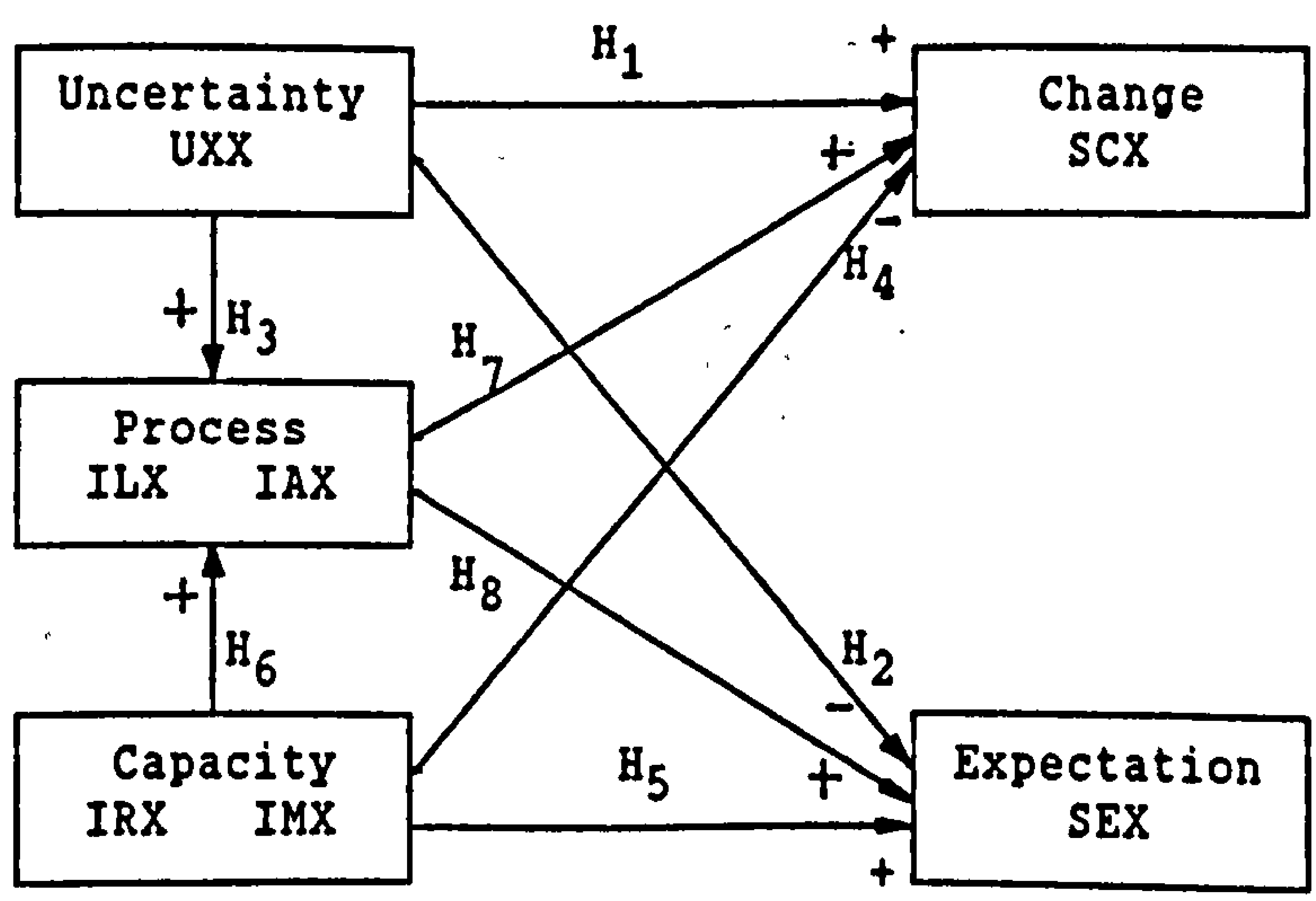
The above analysis has been based on the full sample size of 45 cases. This sample size is equivalent to performing a t-test with 43 degrees of freedom (d.f.). This in turn is equivalent to testing a zero order partial correlation coefficient. A first order partial correlation using this sample will have 42 d.f., with one d.f. being removed for each successively higher order of partial correlation. A fifth order partial correlation will therefore be performed with 38 d.f., which is equivalent to testing a zero-order partial with a sample size of 40 cases. A significant part of the following data analysis is based on partial correlations, hence it is necessary to determine the effect on the above power analysis of testing these higher order cases. Arbitrarily selecting a sample size of 40, then (with reference to table 7.1 above) the power of the t-test is decreased for large effects by 1 to 2 percentage points for α=0.05 and 0.10, and by 5 to 6 points for α=0.01, irrespective of direction. For medium effects the decrease in power is of the order of 4 to 5 percentage points and for weak effects one percentage point, irrespective of test α or direction. It is concluded, therefore, that the above analysis is robust to the use of partial correlations (up to order 5) and that the power of the analysis is satisfactory.

Finally it should be noted that power, significance and Effect Size are all basic aspects of statistical conclusion validity (Cook and Campbell, 1979). The above analysis indicates that this study will have satisfactory statistical conclusion validity for correlations of about 0.30 and above. Cook and Campbell (1979) identify a number of other threats to statistical conclusion validity, notably using measures of low reliability and violating the assumptions of statistical tests. Both of these issues were addressed and resolved in chapter 6.

7.2 DATA ANALYSIS

The starting point for this analysis is the system of hypotheses developed in chapter 4. Hypotheses 1 to 8 can be represented using a "path diagram". This path diagram, referred to as Model I, is illustrated in figure 7.1. In this diagram boxes represent primary constructs and hypotheses are represented by lines. The direction of the hypothesis (line) is indicated by the direction of the arrow. A positive association is represented by a "+", a negative association by a "-" symbol. The scales used to measure each primary construct are also indicated. These scales are defined in chapter 6. Note that figure 7.1 differs from figure 4.2 in that the Information Experience construct is replaced by an Information Capacity construct, and procedural Flexibility (IFX) is replaced by Mechanicity (IMX). The reason for these changes was given in chapter 6 as being due to the Flexibility construct not been fully measured. Note, however, that the hypothesised relationships involving Experience developed in chapter 4 also apply, without modification, to the Capacity construct. This change in definition does not therefore substantively effect any previous arguments.

Figure 7.1: Initial Hypotheses Path Diagram. (Model I)



Hypotheses 9 and 10 are implicit in figure 7.1 through the absence of paths between Uncertainty and Capacity, and between Change and Expectation.

7.2.1 MODEL I

The model illustrated in figure 7.1 was investigated using the Simon-Blalock technique. The specific predictions of the model are that the correlation between Uncertainty and Capacity and the third order partial correlation coefficient between Change and Expectation, controlling for Uncertainty, Capacity and Process (hypotheses 9 and 10) should be zero. The product moment and third order partial correlations for this model are presented below in tables 7.5a and 7.5b.

In tables 7.5a and b, and in subsequent tables, correlations in bold type are significant at the 0.01 level, in normal type at the 0.05 level and in italic type at the 0.10 level. Non significant correlations are enclosed in parentheses. If the correlation refers to a directional hypothesis the significance levels refer to one-tailed tests, else they refer to two-tailed tests. Note also that as Uncertainty and Capacity are both exogenous variables, their zero order correlations are also univariate β regression weights, i.e., standardised path coefficients. The correlations in table 7.5a therefore provide direct evidence for or against hypotheses 1 to 6 and 9.

Table 7.5a: Zero order partial correlations*, Model I.

Scale	UXX	ICX	IPX	SEX	SCX
UXX	1.000				
ICX	(0.008)	1.000			
IPX	0.550	0.387	1.000		
SEX	-0.433	(0.052)	(-0.172)	1.000	
SCX	0.648	(0.025)	0.343	(-0.037)	1.000

Table 7.5b: Third order partial correlations, Model I.

Controlling for UXX, ICX and IPX

Scale	SEX	SCX
SEX	1.000	
SCX	0.356	1.000

* The zero order partial correlation coefficient is the same as the Pearson product moment coefficient (r) between the two variables.

Focussing on associations with Uncertainty, inspection of table 7.5a provides confirmation of hypotheses one, two and three, namely that uncertainty is positively causal to Change, negatively causal to Expectation and positively causal to Information Process. Looking at the associations with Capacity, table 7.5a provides evidence in support of hypothesis 6 (accepting that hypotheses formulated in terms of Experience are the same when formulated in terms of Capacity). Table 7.5a also supports hypothesis 9, that Uncertainty and Capacity are uncorrelated (r=0.008). The correlations do not provide evidence in support of hypotheses 4 and 5 however. Indeed the association between Capacity and Change is not only statistically insignificant, but is in the opposite direction to that expected, i.e., positive instead of negative. This observation may be due to random error, so in future analyses we will dispense with Capacity and treat Mechanicity and Range as two separate exogenous variables. Note that the association between Capacity and Expectation is in the anticipated direction but is also statistically insignificant.

Superficially the correlation between Process and Change appears to confirm hypothesis 7. However, the correlation of 0.343 is approximately equal to the product of the correlation between Uncertainty and Process (0.550) and Uncertainty and Change (0.648) i.e., 0.356. Likewise the correlation between Process and Expectation is approximately equal to the product 0.550x(-0.433) i.e., -0.238. This indicates that both of these correlations are spurious, and that the second order partial correlation, controlling for Uncertainty and Capacity would vanish. Further analysis confirms this supposition. Finally, inspection of table 7.3b indicates that the third order partial between the two success indicators is significant at the 5% level and not negligible as predicted by hypothesis 10.

In summary, the basic causal model (Model I) satisfactorily accounts for the effect of Uncertainty on the system and Information Capacity on Process. The model however indicates a negligible influence for Capacity or Process on either Success measure, contrary to prediction. Uncertainty and Capacity are uncorrelated as expected, but the two success measures are positively associated, contrary to expectation. Next we will attempt to understand the failure of some of the hypothesised associations to be demonstrated, initially by focusing on hypothesis 10, the association between Change and Expectation.

7.2.2 MODEL II

Change and Expectation were conceptualised as orthogonal dimensions of implementation Success because they relate to two mutually exclusive forms of organisational adaptation or change. These two types of adaptation were illustrated in figure 4.1 and represent adaptation through extension of an existing procedure or creation of a new procedure. A single project would influence many of the organisation's essential variables and therefore both types of adaptation would occur. However, there is no basis for assuming that the extent of one type of adaptation would influence the extent of the other type. The constructs designed to measure these two types of adaptation, Change and Expectation, are therefore logically independent. Hence, the association observed above is likely to be a feature of the reification of these constructs.

A further review of the items composing the Change and Expectation scales, together with the evidence accrued from the factor analysis in chapter 6, suggests that the Expectation construct could be dichotomised into an Ease/Accuracy measure and a Satisfaction measure. This is demonstrated by the factor analysis presented in table 6.15a. This dichotomisation is further supported on substantive grounds by noting that the scale items loading predominately on factor 2 (Ease/Accuracy) are measuring technical aspects of success. Items on factor 1 (Satisfaction) could be interpreted as managerial measures of success (e.g., valid solution to the original stimulus for the project; achieved expected financial returns). To investigate the effect of dichotomising Expectation two new factor scales were constructed. These were a 9 item Success/Ease scale (SEE) and a 6 item Success/Satisfaction scale (SES). Ease was composed of the Ease/Accuracy items SEE01 to SEA04 (see table 6.12a) and Satisfaction from items SES01 to SES06. The factor loadings etc., for these two scales are presented in table 7.6. In table 7.6 the Eigenvalue and % variance refer to the first unrotated factor.

Table 7.6: Ease (SEE) and Satisfaction (SES) Scales.

ITEM	SEE	SES
SEE01	0.751	
SEE02	0.603	
SEE03	0.567	
SEE04	0.795	
SEE05	0.716	
SEA01	0.606	
SEA02	0.516	
SEA03	0.556	
SEA04	0.532	
SES01		0.475
SES02		0.885
SES03		0.608
SES04		0.713
SES05		0.823
SES06		0.593
Eigenvalue	3.620	2.915
No. items	9	6
θ Reliability	0.814	0.788
% variance	40.2	48.6
Skewness	-0.295	-1.526

It will be noted that the skewness of the Satisfaction scale is greater than unity. However, as the items composing the scale had been transformed once (the skewness of a Satisfaction scale based upon the raw data is -2.513) it was decided not to apply further transforms. In addition the pattern and magnitude of correlations involving the scale is not substantially effected by the transformation (appendix D) suggesting further transformation is unnecessary.

Having dichotomised the Expectation scale it is reasonable to expect the Ease and Satisfaction scales to be positively associated. It is also reasonable for Ease to take on the theoretical interpretation previously ascribed to Expectation, hence we expect Ease and Change to be uncorrelated. Change must be positively associated with Satisfaction to account for the observed correlation presented in table 7.5b above. This proposition appears to be plausible on the grounds that managerial satisfaction is likely to reflect the essentially technical criteria of Ease and also the social aspects of Change. In addition it is reasonable to presume that Satisfaction is causally dependent upon Ease and Change and not vice-versa.

The specific test of interest at this stage is that the fifth order partial correlation between Change and Ease controlling for Uncertainty, Range, Mechanicity, Process and Satisfaction, should vanish. However, as Satisfaction is dependent upon Ease and Change this partial cannot be calculated as the Simon-Blalock technique does not allow for the control of variables dependent upon the particular variables being related. Instead the fourth order partial between Change, Ease and Satisfaction, controlling for Uncertainty, Mechanicity, Range and Process, will be calculated and inspected to see if the correlation between Change and Ease is spurious. The correlation matrix is presented in Table 7.7a below.

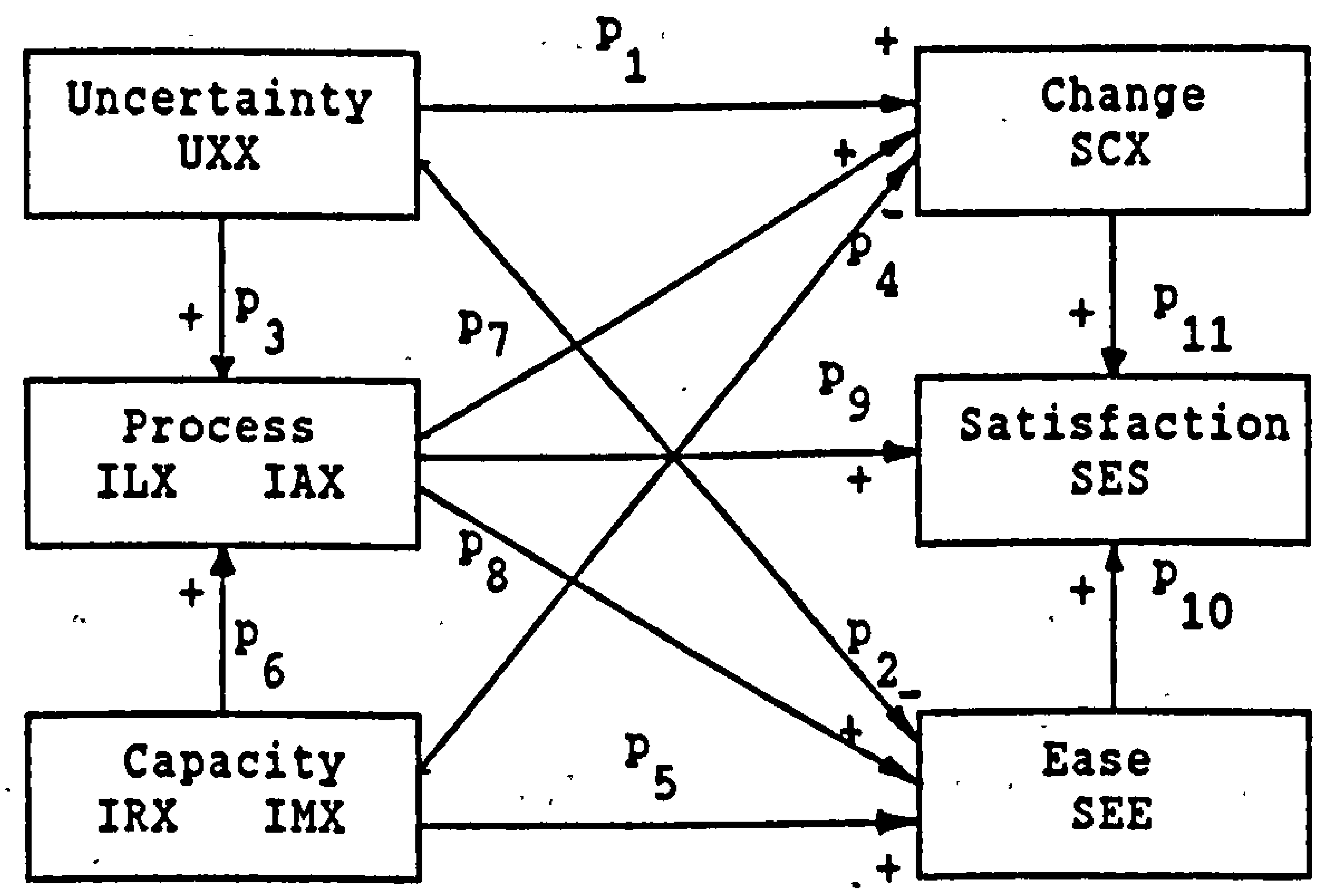
Table 7.7a: Fourth order partial correlations, Model II; Controlling for UXX, IMX, IRX and IPX

Scale	SCX	SEE	SES
SCX	1.000		
SEE	(0.226)	1.000	
SES	0.394	0.527	1.000

The correlation between Change and Ease (0.226) is approximately equal to 0.394x0.527, i.e., 0.208 and we conclude that the association between Change and Ease is spurious. Thus, accepting that Ease replaces Expectation, hypothesis 10 is demonstrated.

Having established the causal path between the (now) three Success constructs it is necessary to revise the paths between these constructs and Uncertainty and Information constructs. Substantively the only modification made to model I is to separate Satisfaction from Expectation. Hence the model I hypotheses still apply if Ease is substituted for Expectation. The question is then reduced to whether Uncertainty and Information constructs are causally related to Satisfaction. The Satisfaction concept was developed in chapter 4 as being related to a willingness to repeat the project and an overall sense of "a-job-well-done" (section 4.3.6). It appears reasonable to assume therefore, that Satisfaction will be influenced by what the organisation *did*. In other words by the Information Process constructs not by the exogenous constructs Uncertainty, Mechanicity and Range which represent what the organisation or project *is*. On the basis of this argument it is predicted that the exogenous variables Uncertainty, Mechanicity and procedural Range, will have no direct influence upon Satisfaction. Information Process, being behaviourally determined, would be expected to directly and causally, influence Satisfaction. In addition, Zand and Sorensen (1975) found that items subsumed within the secondary Process construct, Lubrication, were associated with success measures such as Satisfaction. In fact their success measures were used here as the basis for constructing Satisfaction (see chapter 5). Thus, we would expect there to be an association between Information and Satisfaction. These arguments lead us to the final form of Model II, which is illustrated in figure 7.2.

Figure 7.2: Revised Causal Model. (Model II)



For simplicity we have retained the Capacity construct in figure 7.2. In subsequent evaluations we will use the Range and Mechanicity constructs. Paths P_4, P_5 and P_6 will therefore be evaluated using subscripts 'r' and 'm' to denote Range and Mechanicity.

Using the Simon-Blalock technique the specific prediction of Model II is that the third order partial correlations between Uncertainty, Range, Mechanicity and Satisfaction, controlling for Process, Change and Ease, will vanish. The value calculated for these partial correlations are, 0.003 between Uncertainty and Satisfaction, -0.003 between Mechanicity and Satisfaction and 0.136 between Range and Satisfaction. These correlations are sufficiently close to zero to support the hypothesis of the non-existence of these paths.

The recursive causal model illustrated in figure 7.2 can be expressed in terms of the following structural equation system:-

$$IPX = p_3.UXX + p_{6r}.IRX + p_{6m}.IMX + p_P.e_P$$

$$SCX = p_1.UXX + p_{4r}.IRX + p_{4m}.IMX + p_7.IPX + p_C.e_C$$

$$SEE = p_2.UXX + p_{5r}.IRX + p_{5m}.IMX + p_8.IPX + p_E.e_E$$

$$SES = p_9.IPX + p_{10}.SCX + p_{11}.SES + p_S.e_S$$

Where e_i are standardised residuals and p_i (i = P, C, E and S) are path coefficients for the residuals. These residual path coefficients are not calculated as regression weights but are estimated from:-

$$p_i = \sqrt{(1 - R_i^2)}$$

where R_i^2 is the square of the appropriate multiple correlation coefficient (Asher, 1983).

The above system of structural equations was solved using the MGLH procedure within the SYSTAT computer package. The path coefficients are reported below in table 7.7d. Significance levels of the t-values for the coefficients are indicated as for table 6.5a.

Table 7.7b: Path coefficients, Model II.

	UXX	IRX	IMX	IPX	SCX	SEE	SES
UXX	-						
IRX	-	-					
IMX	-	-	-				
IPX	0.586	(0.103)	0.359	-			
SCX	0.667	(0.022)	(0.011)	(-0.031)	-		
SEE	-0.669	(-0.023)	(-0.038)	(0.074)	-	-	
SES	-	-	-	(0.117)	0.383	0.577	-
Residual	-	-	-	0.679	0.762	0.780	0.799

A '-' indicates a non existent path.

Inspection of figure 7.7b indicates no major departure from the significant paths previously identified using partial correlations. Specifically we note that dichotomising Expectation has strengthened the association between Uncertainty and Ease. The association between Information Process and Capacity (Hypothesis 6) is due almost entirely to Mechanicity. Finally, the associations between Information and Success measures are, as noted for Model I, not statistically significant; although there is weak evidence for the hypothesised link between Process and Satisfaction. Note that it is quite typical for residual path coefficients to be of the magnitude reported (see Asher, 1983; Blalock, 1972; Duncan, 1966).

Having amassed two items of evidence against the existence of direct causal links between exogenous Information variables and Success variables, a further test for these links was made using the technique of moderated regression analysis. This technique is summarised by Covin and Slevin (1988) as:

> "moderated regression analysis is an appropriate technique for testing hypothesised contingency relationships since it allows interaction effects, which are implied in all contingency relationships, to be directly examined. In moderated regression analysis, the statistical significance of interaction effects is tested by regressing the dependent variable on two (or more) main variables (one being the independent variable, the other the hypothesised moderator variable) and the cross-product of those main variables."

Specifically we will test to see if the exogenous Information variables Range and Mechanicity influences the relationship between Uncertainty and Success. As Uncertainty, Range and Mechanicity are all exogenous variables they do not violate the assumption of the regression model of independent regressors. The regression equations to be solved are:

$$Y = a + b1.U \qquad (1)$$

$$Y = a + b1.U + b2.X \qquad (2)$$

$$Y = a + b1.U + b2.X + b3.U.X \qquad (3)$$

Where, in equations (1) to (3) above, Y refers to Change or Ease, U to Uncertainty and X is Range or Mechanicity or Capacity. As we are using standardised variables the regression constants 'a' will all be zero and regression coefficients will be β's. We know from table 7.7b that the regression coefficients for U (β1) are significant and that those for X alone (β2) are not. The specific question being addressed here is whether the cross-product coefficients (β3) are significant or not. If they are significant then this is evidence that exogenous Information variables do influence Success. If not, we are forced to conclude that exogenous Information constructs do not effect Success. Performing the moderated regression analyses failed to identify any significant cross-product coefficients.

In summary, Model II appears to provide a satisfactory explanation of the Expectation - Change association identified in Model I but still no evidence to support the hypothesised Information - Success paths. In particular there is no evidence in support of the exogenous Information - Success paths. This is not to say such paths do not exist, but that this study does not have sufficient power to detect them. We conclude therefore that hypotheses 4 and 5 of chapter 4 are spurious and we will not actively pursue them further. However, it is unreasonable to assume that there are no associations between Information constructs and Success. We therefore focus our attention on possible reasons for not having detected evidence to support hypotheses 7 and 8, i.e., associations between Information Process and Success.

7.2.3 MODEL III

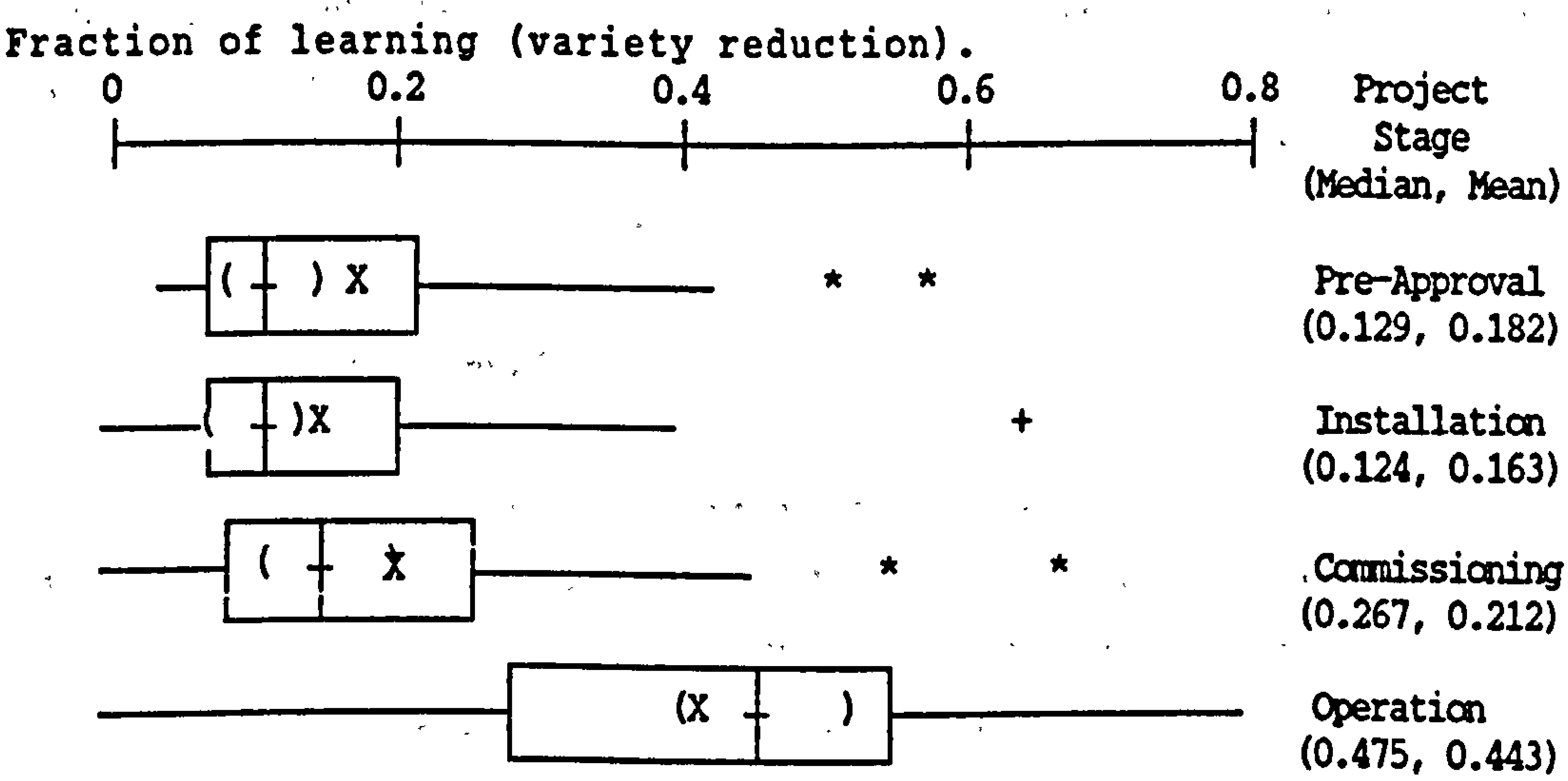
Before attempting to identify reasons for the absence of the hypothesised Information Process - Success paths, it will be instructive to review the assumptions underpinning the construction of the Information Process scale and see what evidence exists to indicate the strengths of likely associations.

7.2.3.1 Strength of Association

The basic idea underpinning the construction of the Information Process measure was, what activities did the organisation perform that would have contributed to variety reduction? As such, the construct was divided into two secondary constructs. First was Lubrication, a measure relating to the management and social/behavioural interaction carried out during the project. This measure was based in the Lewin-Schein theory of change and covered all stages of the project from pre-approval planning to final operation. Second was Activity. This measure was based upon indicators designed to capture the extent of formal analysis, the interaction or communication occurring and the search for information, from both internal and external sources. In order to preserve a temporal asymmetry and thereby preserve a causal direction, the Activity measures were restricted to the pre-approval planning phase of the project. These two secondary constructs were aggregated using factor analysis to generate an overall Information Process measure which, it turns out, is dominated by the Activity construct and the Design dimension of Activity in particular. (See discussion of table 6.20b, chapter 6). Before elaborating on this observation it will be instructive to review some additional data collected in the study and not used so far.

One of the questionnaire items was designed to measure (in relative terms) the stage of the project when maximum organisational learning occurred. The actual wording is "which [stage] made the greatest contribution to the reduction of uncertainty or resolution and identification of problems etc., with the project". The project was divided into the four stages (defined in chapter 5) of, Pre-approval, Installation, Commissioning and Operation. The question design was based upon the Analytic Hierarchy Process (Saaty, 1980) and was able to yield a ranking in terms of the relative importance of each stage. That is, not simply that A is greater than B, but what fraction of the total learning a particular stage accounted for. The learning contributed by all of the project stages was therefore unity. It should be noted that not all of the capital projects investigated conformed to this four stage model of a project; one for example never came into operation. If a stage was omitted, then it was simply assigned a value of zero. The analysis of this question is summarised in the Box plot illustrated in figure 7.3 below. For a description of the Box plot see Velleman and Hoaglin (1981). The Box plot in figure 7.3 differs slightly from the standard form in two respects. First, an "X" has been used to represent the mean of the data. Second, the parentheses indicate "notches" which define a simultaneous confidence interval around the *median*. If the intervals of two boxes do not overlap, then the two population medians are different, at about the 95% level of confidence. Finally grouping Box plots in the manner used in figure 7.3 provides a graphical analogue to the one way analysis of variance, using rank order statistics instead of means (Wilkinson, 1987).

Figure 7.3: Box chart for project Learning



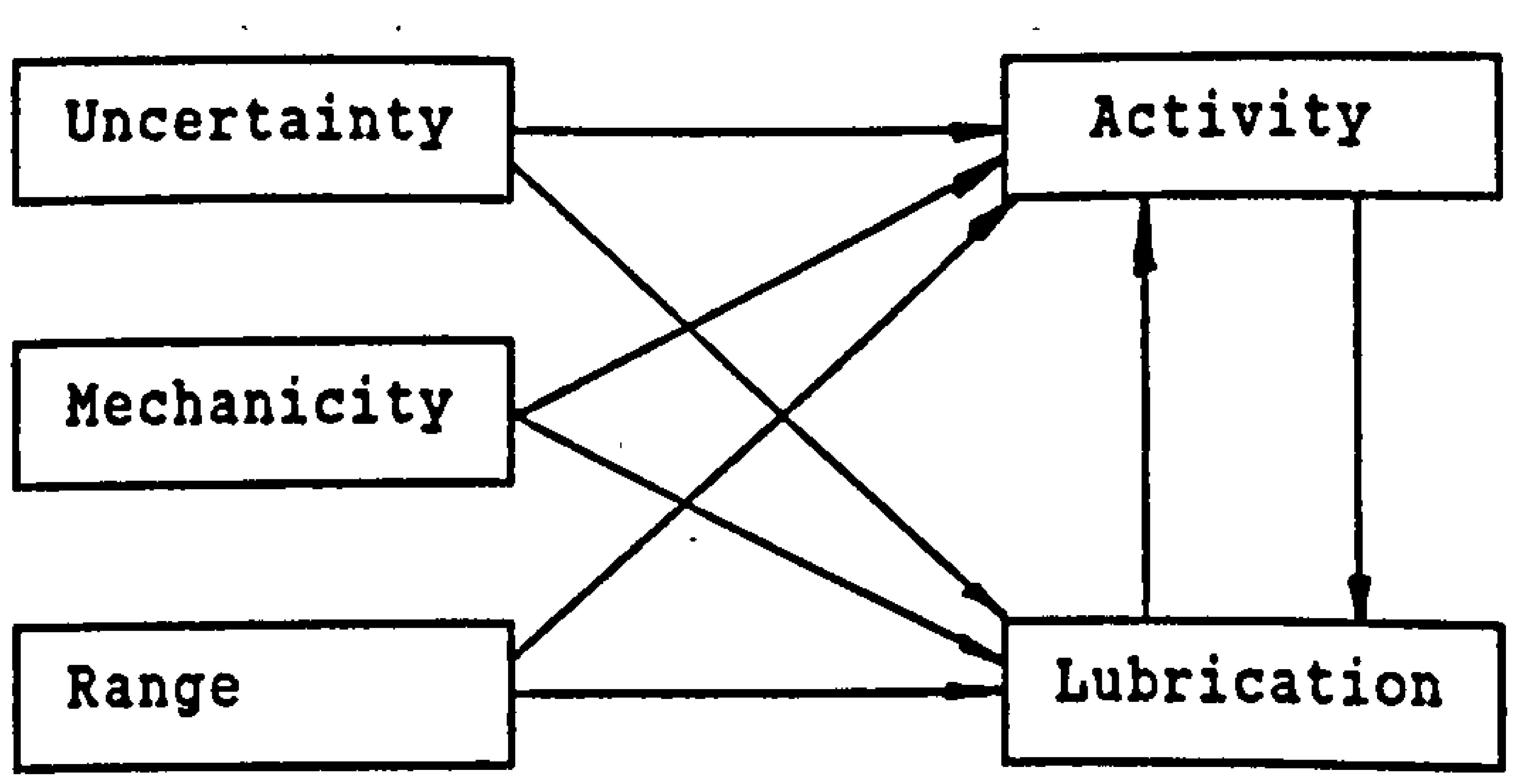
The major conclusion of this analysis is that organisational learning (as defined in this study, chapter 4) predominantly occurs after the project's planning or design stage. The two "hands-on" stages, commissioning and operation, contribute nominally two thirds of the organisational learning associated with the project. This finding is compatible with the finding of Burglman (1988) that organisations "learn by doing". Importantly, for the discussion at hand, the pre-approval stage learning (that measured by the Information Activity construct) accounts for less than 20% of the total project learning. This may be a fairly crude method of measurement but it suggests that in terms of variety reduction, the pre-approval stage only accounts for a small proportion of the total. This finding, taken together with the observation that Information Activity dominates the Information Process scale and only refers to the pre-approval stage of the project, would suggest that associations between Success and Information Process are more likely to be weak than strong. The Lubrication concept on the other hand was measured over the entire project, and the Refreezing stage refers specifically to the later commissioning and early operational stages. If strong associations are to be found between the Information Process and Success constructs, then perhaps the Lubrication concept in general, and the Refreezing stage in particular, would be most likely to yield significant associations.

The above argument suggests that the Information Process scale developed in chapter 6 (IPX) is too restrictive (crude!) a measure. It therefore appears reasonable to disaggregate this measure into Secondary and possibly tertiary constructs if significant associations are to be identified between Process and Success.

7.2.3.2 <u>Secondary Levels</u>

If the two secondary Information Process constructs are to be used to understand the effect of Information Process on Success, then a causal model of their individual effects is required. We hypothesised that Activity will influence Lubrication and vice versa. In other words Activity and Lubrication are reciprocally associated. It also appears reasonable from hypotheses 3 and 6 that the exogenous variables will influence both Activity and Lubrication. Substantive reasoning therefore enables a causal model like that illustrated in figure 7.4a to be drawn. Paths between Success constructs and residuals have been omitted for clarity.

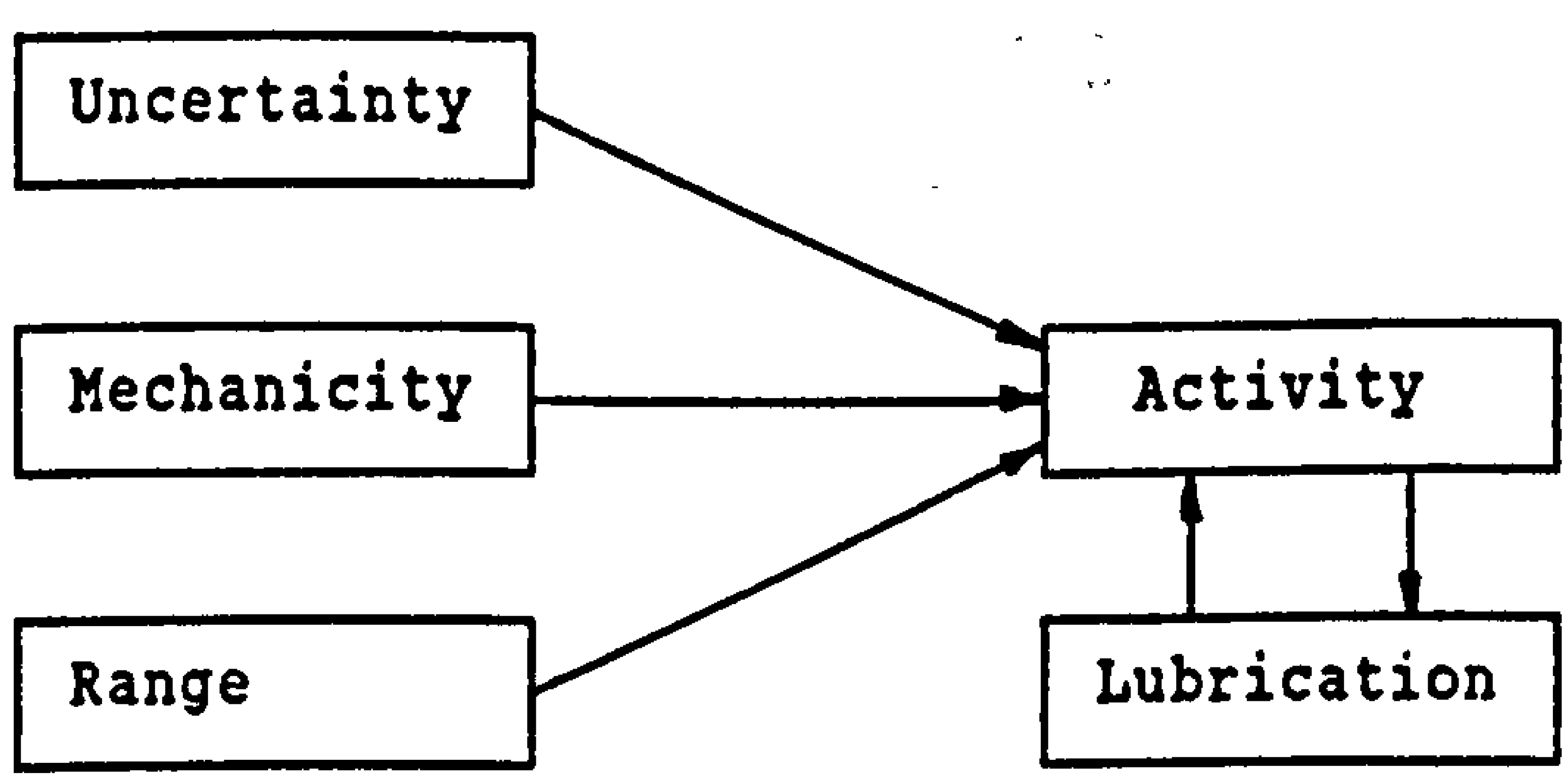
Figure 7.4a: Preliminary Information causal model.



The model illustrated in figure 7.4a is underidentified (see Asher, 1983 for a fuller description of the identification problem in non-recursive structural models). In other words the model has more unknown path coefficients than structural equations to solve for them. Hence, an analytical solution of the above model is not possible. The model can be just identified if each endogenous variable is independent of one but not the same, exogenous variable, i.e., the six paths between the exogenous and endogenous variables are reduced to four paths. Alternatively eliminating one of the non-recursive paths will identify the equations. If more than two exogenous-endogenous variable paths are eliminated the solution will be overidentified. Substantively there are no grounds for making these eliminations, hence a purely empirical, exploratory approach was adopted.

By inspection of correlation matrices, use of the instrumental variable* procedure (to solve just identified non-recursive structural equation systems; Asher, 1983) and regression (to solve for recursive equations systems) the most consistent causal path structure connecting the constructs in figure 7.5a was found to be that illustrated in figure 7.4b below (using the same simplification as for figure 7.4a). Note, this model is only partially based upon substantive theory.

Figure 7.4b: Final Information causal model



The only consistent result to emerge from the exploratory analysis summarised in figure 7.4b. is the absence of a path between Uncertainty and Lubrication. Hence, There is reasonable confidence in the statement that Uncertainty only acts upon Activity. The path coeffi-

* An instrumental variable is a variable uncorrelated with the residual terms in the equations in which they are used. Exogenous variables are instrumental variables, endogenous variables may also be, see Asher, 1983. To produce path coefficients which are regression coefficients the instrumental variables used should also appear in the structural equation for the dependent variable.

cient for this association is consistently determined to be about the same as that of the zero order partial correlation between the two constructs. A further finding of this analysis is that there is a so called "unanalysed correlation" between Mechanicity and Capability of magnitude 0.282. This correlation is to be expected as both concepts are measures of Capacity. A correlation of this magnitude will not cause multicollinearity problems in earlier regression analyses.

The remaining paths in figure 7.4b are quite tentative and their path coefficients are sensitive to changes in the model's definition. This sensitivity to model definition is well known, see for example Asher (1983,p.51) Duncan *et. al.* (1971,p.228). Finally, no path coefficients are given on the model because they cannot be simultaneously determined, as the model in figure 7.4b is also underidentified. This comes about because no exogenous variable is directly associated with Lubrication. By way of support for the above model, the zero order correlation matrix between the above constructs is reproduced in table 7.8.

Table 7.8: Information Construct Zero Order Correlations

Scale	UXX	IMX	IRX	IAX	ILX
UXX	1.000				
IMX	(-0.079)	1.000			
IRX	(-0.072)	*0.282*	1.000		
IAX	0.640	0.348	(0.157)	1.000	
ILX	(0.006)	(0.161)	(0.130)	0.321	1.000
SCX	0.648	(-0.046)	(-0.028)	(0.048)	(-0.116)
SEE	-0.624	(0.034)	(0.026)	(0.005)	(0.128)
SES	(-0.046)	(0.039)	(0.130)	(0.042)	(0.174)

Inspection of table 7.8 indicates that Range (IRX) is, at best, only weakly associated with the dependent constructs. The only significant associations are therefore the ones between Uncertainty (UXX) and Activity (IAX) Mechanicity (IMX) and Activity, and Activity and Lubrication (ILX).

Finally, inspection of the third order partial correlations (controlling for Uncertainty, Mechanicity and Range) between Success, Activity and Lubrication (the lower right hand box in table 7.8) do not yield significant associations between these constructs. Therefore, at the secondary construct level, no statistical evidence exists in support of hypotheses 7 and 8. For this reason associations at the tertiary construct level were investigated.

7.2.3.3 Tertiary Levels

Associations between tertiary level Information Process constructs, the exogenous constructs (Uncertainty, Mechanicity and Range) and three Success constructs were investigated using partial correlations. The tertiary constructs investigated are those identified in tables 6.11c (Lubrication) and 6.11d (Activity) the correlations are summarised in table 7.9a and 7.9b; note, the negative Lubrication constructs ILU02, ILM02 and ILR02 have been reflected and therefore represent the absence of these influences. The correlations associated with Uncertainty (UXX) Range (IRX) and Mechanicity (IMX) are zero order, those with Change (SCX) and Ease (SEE) are third order and those with Satisfaction (SES) fifth order partial correlations.

Table 7.9a: Tertiary Lubrication Constructs, Partial Correlations.

Control				UXX IRX IMX		+ SCX SEE
D.F.	43			40		38
Item	UXX	IRX	IMX	SEE	SCX	SES
ILU01	*0.227*	(-0.125)	(0.034)	(0.113)	*-0.243*	(0.126)
ILU02	(-0.071)	(0.164)	(0.085)	(-0.006)	-0.299	(0.163)
ILM01	(0.179)	(-0.149)	(0.012)	(-0.098)	(-0.043)	(-0.063)
ILM02	(-0.049)	*0.225*	(0.104)	(-0.056)	(-0.100)	(-0.035)
ILR01	(-0.181)	*0.225*	(0.122)	0.300	(0.197)	0.477
ILR02	(-0.025)	(0.134)	0.294	0.279	(0.024)	(0.152)

D.F. - Degrees of Freedom.

Table 7.9b: Tertiary Information Activity Constructs, Partial Correlations.

Control				UXX IRX IMX		+ SCX SEE
D.F.		43		40		38
Item	UXX	IRX	IMX	SEE	SCX	SES
IAA01	*0.232*	(0.089)	0.420	0.268	(-0.110)	(0.066)
IAA02	0.466	(0.085)	0.270	(0.130)	(0.052)	(-0.050)
IAA01	0.448	(0.191)	0.320	(0.095)	(-0.011)	(0.119)
IAI03	0.383	(0.145)	*0.204*	(0.085)	(0.051)	(0.040)
IAN01	0.511	(0.030)	0.271	(-0.019)	(-0.010)	(0.004)
IAC01	0.318	(0.017)	(0.085)	(-0.089)	(0.129)	-0.315
IAC02	*0.236*	(0.098)	(-0.097)	(0.062)	(0.092)	(-0.092)
IAC03	0.503	(0.126)	(0.051)	-0.358	*-0.235*	*-0.228*
IAC04	0.370	0.256	(0.122)	*-0.213*	*-0.234*	(0.121)
IAS01	(0.145)	(0.107)	0.279	0.393	(-0.007)	(0.094)
IAS02	0.379	(0.005)	(0.137)	(0.094)	(-0.001)	0.366
IAS03	(0.423)	(-0.160)	(0.167)	(0.026)	0.361	(0.169)
IAS04	(0.109)	(-0.043)	0.277	(-0.183)	(-0.106)	(0.034)
IAS05	*0.221*	(0.062)	(-0.061)	(0.063)	-0.264	(-0.040)
IAS06	(-0.092)	(0.179)	0.276	(0.035)	(0.040)	(0.010)
IAS07	(0.113)	(0.077)	(0.011)	-0.260	*0.239*	(-0.206)
IAS08	*0.195*	(-0.001)	(0.072)	(-0.035)	(0.103)	(-0.191)
IAS09	(0.031)	0.275	0.527	-0.280	(0.091)	(-0.086)
IAR01	*0.227*	(-0.063)	(0.050)	(-0.184)	(0.118)	(0.193)
IAR02	*0.195*	0.266	(0.014)	(-0.125)	(-0.041)	*0.061*
IAR03	0.674	(-0.002)	(0.122)	(0.115)	*0.230*	(0.040)

D.F. - degrees of freedom.

7.2.3.3.1 Tertiary Lubrication Constructs

With reference to table 7.9a (Lubrication correlations) we observe that the three exogenous constructs (Uncertainty, Mechanicity and Range) are generally not associated with tertiary Lubrication indicators. To qualify this observation, there does appear to be a moderate association between Mechanicity and the absence of negative Refreezing behaviour (ILR02). However, these correlations are in general agreement with previous findings based on secondary constructs. Focusing on the associations with the three Success constructs, we observe that both Unfreezing indicators (ILU01 and ILU02) are moderately negatively associated with Change. That Moving (ILM01 and ILM02) is unassociated with Success and that Refreezing is moderately associated with Ease and positive Refreezing is strongly associated with Satisfaction.

Partial corroboration of the observed Satisfaction associations comes from the study by Zand and Sorensen (1975) if we assume that the Satisfaction measure used here is equivalent to their "Level of Success Index", the LSI. This is a reasonable assumption as both indicators are substantially based upon measures of satisfaction, although here we are measuring satisfaction with the implementation of a capital project, they were interested in the implementation of management science projects.

Using fifth-order partial correlations Zand and Sorensen investigated the associations between the six change measures (subsumed here under the name of Lubrication) and their LSI. With a sample of 280 cases they were able to claim statistical significance for partial correlations as low as 0.10, i.e., "weak" effects. However, even with this sample size they only had adequate power to detect correlations of about 0.16. Furthermore they only identified three "strong" effects. These were between positive Unfreezing and positive Moving (partial r=0.51) between negative Unfreezing and negative Moving (partial r=0.46) and between positive Refreezing and LSI (r=0.67). The next largest correlation identified in their study was -0.23 between positive and negative Unfreezing. They reported a further two correlations of 0.23 and -0.21 and seven below 0.2 in magnitude. The lowest correlation was 0.08 between positive moving and positive Refreezing.

Duplicating Zand and Sorensen's (1975) method of analysis with the data reported here (i.e., the six positive and negative Lubrication measures and Satisfaction) we find generally similar results are obtained. The strongest association is between positive Refreezing and Satisfaction (r=0.58, c.f. 0.67 in Zand and Sorensen's study). The correlation between negative Unfreezing and negative Moving is 0.38 (c.f., 0.46). In this study the next largest correlation is 0.29 between positive and negative Unfreezing (c.f., -0.23; the change in sign is due to the use in this study of reflected negative scales). The major difference between this study and Zand and Sorensen's is the absence of an effect between positive Unfreezing and positive Moving, 0.06 compared to their 0.51. Most of the remaining associations are comparable, and too weak to be detected with confidence by this study.

To summarise this discussion, associations between the tertiary Lubrication concepts and other exogenous constructs are in agreement with the associations identified for the secondary constructs. Only positive Refreezing is strongly associated with a success construct, this being Satisfaction; a finding in agreement with that of Zand and Sorensen (1975). A moderate association is also identified between positive and negative Refreezing and Ease and a moderate negative association between positive and negative Unfreezing and Change.

7.2.3.3.2 Tertiary Activity Constructs

We now consider the associations between the tertiary Information Activity constructs given in table 7.9b. Inspecting these correlations suggests that a focus on the success associations alone is most instructive. Furthermore, there appear to be nominally four patterns of association. These are defined below.

Pattern 1. Activity item exhibits little or no significant association with success measures. This pattern is typified by the Analysis indicators IAA02 and IAA03, the Information Technology (IAI01) and Contingencies (IAN01) indicators.

Pattern 2. Activity item primarily exhibits negative associations with Success indicators. The strongest item of this type is IAC03, the Informal discussion indicator. Other indicators of the Communication concept exhibit similar patterns. This pattern of association is also exhibited by the Unfreezing measures of Lubrication.

Pattern 3. Activity item primarily exhibits positive associations with Ease and Satisfaction measures. Only two items exhibit this pattern, items IAS01 and IAS02. Both are associated with the collection of information, IAS02 specifically with information from within the organisation. This pattern is also exhibited by the Refreezing measures of Lubrication.

Pattern 4. Activity item primarily exhibits a positive association with the Change measure. This pattern is typified by item IAS03, a measure of the extent of information collected from sources external to the organisation.

Comparing the items exhibiting these four patterns of association with the factor analysis of all Activity items reported in table 6.14b, suggests that the above patterns could have been obtained simply by dichotomising each of the previously identified Design and Support factors. Specifically the Design factor is dichotomised into pattern 1 and 3 items; Support into pattern 2 and 4 items.

7.2.3.4 Information Process Sub-Scales

Analysis of the tertiary Information Process items suggests that the information contained in the construct will be better utilised if Lubrication is disaggregated into its three constituent sub-scales and Activity into four new sub-scales. The 38 items of the Lubrication construct were subdivided in accordance with the original construction of the concept (see Appendix A, question 2b.6). Items measuring a negative attribute were reflected. Factor scales of each set of items were then produced using the methodology of chapter 6. The resulting scales were, Unfreezing (ILU) Moving (ILM) and Refreezing (ILR). Factor loadings of items on these scales are reported in table 7.10a, together with Eigenvalues, % variance explained of the first unrotated factor and theta reliabilities for the scales. Guided by a factor interpretation and with reference to the original conceptual framework of the Activity construct, the tertiary Information Activity items were placed into four groups, each representing nominally one of the four patterns of association identified above. The final categorisation of items and factor loadings of the four scales is reported in table 7.10b, together with the usual statistics. The factor scales were labelled in accordance with the author's interpretation of each set of items as follows:

IAF - Information Activity Formal analysis.
IAM - Information Activity Meetings.
IASI - Information Activity Search Internal information.
IASE - Information Activity Search External information.

Scales IAF, IAM and IASE are constructed using the tertiary Activity items. This yields scales based on 9, 6 and 4 items respectively. Scale IASI constructed using the two tertiary items had a low theta reliability of 0.45. The final scale was based upon the 9 quaternary items used to construct scales IAS01 (2 items) and IAS02 (7 items).

Table 7.10a: Information Lubrication Sub-Scale

ITEM[1] Scale:	ILU[2]	ILM[3]	ILR[4]
TM initiated	-0.385		
TM did not feel too big	0.308		
TM became involved	0.322		
TM & UM felt important	0.614		
TM & UM open and candid	0.603		
UM revised assumptions	-.		
UM could state problems	0.689		
UM recognised need	0.746		
UM did not feel threatened	0.751		
UM not resentful	0.786		
UM not able to do design			
UM confident in E	0.634		
TM helped develop design		-.	
TM advised of options		0.350	
UM helped develop design		0.679	
UM reviewed alternatives		0.722	
UM understood project		0.776	
UM & E gathered data jointly		0.836	
E felt had enough time		.	
E could educate the UM		0.530	
Alternative forms devised			
Designs improved sequentially		-.:	
Needed data available		0.444	
Data was accessible		0.401	
TM encouraged adoption			0.509
TM accepted recommendations of E			
UM operated project			.:
UM were satisfied			
E initiated positive feedback			0.518
E supported new behaviour			0.539
E helped after commissioning			0.373
Project accepted			0.584
Performance of unit increased			0.397
Project successful			0.605
Results measurable			0.576
Standards for evaluation existed			0.577
Similar projects proposed			.:
Compatible with needs of unit			0.679
Eigenvalue	3.776	3.145	3.092
No. items	12	12	14
θ Reliability	0.802	0.744	0.729
% variance	31.5	26.2	22.1

1 - See appendix A question 2b.6 for a full description of individual items. Note that here negative items (and their descriptions) have been reversed.
2 - Unfreezing.
3 - Moving.
4 - Refreezing

TM - Top Managers; UM - Unit Managers; E - Engineers.

Table 7.10b: Information Activity Sub-Scale

ITEM[1]	Scale: IAF[2]	IAM[3]	IASI[4]	IASE[5]
IAA01	0.633			
IAA02	0.716			
IAA03	0.721			
IAI01	0.689			
IAN01	0.769			
IAS04	.:			
IAS06	0.371			
IAS08	.:			
IAR02	0.547			
IAC01		0.541		
IAC02		0.496		
IAC03		0.723		
IAC04		0.647		
IAS05		0.492		
IAS09		.:		
IAS01(Collection)			0.815	
IAS01(Validation)			0.777	
IAS02(Marketing)			0.349	
IAS02(Personnel)			0.321	
IAS02(Production)			0.639	
IAS02(Technical)			0.378	
IAS02(Planning)			0.600	
IAS02(Accounting)			0.463	
IAS02(Board)			.:	
IAS03				0.837
IAS07				0.413
IAR01				0.532
IAR03				0.747
Eigenvalue	3.239	1.794	2.665	1.712
No. items	9	6	9	4
θ Reliability	0.778	0.532	0.703	0.554
% variance	36.0	29.9	29.6	42.8

1 - See tables 6.11d for item descriptions. For IAS01 see appendix A questions 2a.30 and for IAS02 question 2a.32.
2 - Information Activity Formal analysis.
3 - Information Activity Meetings.
4 - Information Activity Search Internal information.
5 - Information Activity Search External information.

Having redefined the Lubrication construct in terms of its constituent concepts and Activity in terms of four new sub-scales, it now remains to more explicitly define the interaction between these constructs and the Model II constructs of Uncertainty, Range, Mechanicity, Change, Ease and Satisfaction.

7.2.3.4 <u>A Definitive Model</u>

Having disaggregated Information Process into seven sub-scales presents problems in handling this number of variables. This complexity together with the lack of any substantive theory as to how many of the Process sub-scales are causally related and, if reciprocal relations are assumed the lack of methods for estimating the resulting underidentified model, all contributed to the decision to abandon formal path analysis as the technique for analysing the current problem. Instead, a combination of partial correlation and multivariate linear regression was used. Specifically partial correlation was used to investigate the associations between Information constructs and regression to investigate the relationships with success. At each stage the results of the analysis were checked for consistency against previous findings and discussions of likely associations (or lack of association) between constructs. In other words the models needed to be plausible and consistent with previous findings.

7.2.3.5.1 Information Process Associations

Ginzberg's (1978) description of the Lewin-Schein model presented in chapter 4 suggests a correspondence between the three stages of the model and the four stages of the project model identified in chapter 5. Specifically, Unfreezing is associated with the pre-approval stage of the project model, Moving with Installation and Refreezing with Commissioning and Operation. Because the Activity constructs were measured during the pre-approval stage of the project we may infer that Activity and Unfreezing are coincident, whilst Moving and Refreezing are both associated with the post-approval stages of the project. Substantively ,therefore, Moving and Refreezing are causally dependent upon Unfreezing and Activity. The pattern of associations between the four Activity and Unfreezing constructs may be determined using third order partial correlations; controlling for Uncertainty, Range and Mechanicity. These third order partial correlations, together with the zero order partial correlations between exogenous variables and the pre-approval Process constructs, are reported in table 7.11. Interpretation of the significance levels of these correlations are the same as for table 7.5a.

Table 7.11: Information Construct Associations

	UXX	IRX	IMX	IAF	IAM	IASI	IASE
IAF	0.513	(0.171)	0.391	1.000			
IAM	0.560	(0.223)	(0.118)	*0.280*	1.000		
IASI	*0.259*	(0.122)	*0.271*	0.378	(0.100)	1.000	
IASE	0.599	(-0.080)	(0.153)	(0.102)	(0.227)	(0.050)	1.000
ILU	(-0.065)	(0.168)	(0.028)	(0.109)	0.337	*0.270*	(-0.083)
ILM	(0.009)	(0.222)	(0.118)				
ILR	(-0.075)	(0.129)	*0.295*				
D.F.	43			40			

D.F. - Degrees of Freedom.

The correlations reported in Table 7.11 are largely consistent with previous findings. The three exogenous variables are by and large not associated with Lubrication, although there is tentative evidence that Mechanicity is associated with Refreezing. Uncertainty is associated with all Activity sub-scales, although the link with Internal information is tentative. Mechanicity is strongly associated with Formal analysis and tentatively associated with Internal information. Range just fails to be tentatively associated with Meetings. Focusing on the third order partial correlations we identify a moderate association between Formal analysis and Internal information, a result consistent with factor analysis of the Activity construct. Based on the same factor analysis we would anticipate an association between Meetings and External information. In fact this correlation just falls below the 0.25 figure required for statistical significance at the 10% level. The other associations worthy of note are a moderate one between Meetings and Unfreezing and two tentative associations, one between Formal analysis and Meetings, the other between Unfreezing and Internal information. These partial correlations are stable at higher orders, such as those obtained by applying additional controls for Meetings, Formal analysis etc.

With respect to estimating the associations between Moving and Refreezing (which follow Unfreezing and Activity) we would, on substantive grounds, anticipate that Unfreezing was a determinator of Moving, and Moving and Unfreezing were determinators of Refreezing. However, as the four Activity sub-scales are co-incident with the Unfreezing process, it is probable that these are also determinants of

Moving and Refreezing.

To estimate these influences, stepwise regression followed by multivariate regression on the selected predictors was used. The regression approach was considered appropriate as none of the correlations observed in table 7.11 exceeds 0.6 and Asher (1983) notes that multicolliniarity is unlikely to be a problem provided correlations between independent variables are less than 0.7 to 0.8. The stepwise regression technique employed was that implemented in the SYSTAT computer package (Wilkinson, 1987). This package estimates the predictor set of variables independently of the parameter estimates. The parameters are estimated by a separate multiple regression procedure. If the t-test of a predictor's coefficient (or 'β') in the initial multivariate model had low significance, the model was reestimated without this predictor and the process iterated until only those predictors with coefficients significant at, or better than, 10% remained. Predictors were also excluded (or retained) if their retention (or exclusion) violated a previously established theoretical or substantiated model of the data. Wilkinson (1987,p.MGLH-20) also sounds a further cautionary note when he writes:

> "For a given set of data, an automatic stepwise programme cannot necessarily find a) the "best" fitting model, b) the "real" model, or c) alternative "plausible" models. Furthermore, the *order* variables enter or leave a stepwise programme is usually of no theoretical significance...It should never be used without cross validation".

In this study the cross validation methods used were substantive reasoning and partial correlation. It was found that the stepwise regression procedure just described tended to produce more parsimonious models than those produced by partial correlation.

The first model tested regressed Moving (ILM) on the exogenous variables (UXX, IMX, IRX) the Activity variables (IAF, IAM, IASI, IASE) and Unfreezing (ILU). The selected predictors of Moving were Unfreezing and Formal analysis (IAF). The regression model using these two predictors of Moving is presented in table 7.12 below. Note that the convention established for representing the significance of correlation coefficients is also used in table 7.12 and subsequent tables.

Namely, coefficients significant at or above the 1% level are in bold type, significant at or above the 5% level, in normal type and significant at or above the 10% level, in italic type.

Table 7.12: Regression Analysis for Moving

N: 45 MULTIPLE R : 0.739 MULTIPLE R^2: 0.546
ADJUSTED MULTIPLE R^2: 0.535 STANDARD ERROR OF ESTIMATE: 0.682
NO CONSTANT ESTIMATED F-RATIO: 25.827 (p=0.000)

VARIABLE	STANDARDISED COEFFICIENT (β)	STD ERROR	TOLERANCE	T	P(2 TAIL)
IAF	*0.206*	0.103	.995	2.002	0.052
ILU	0.695	0.103	.995	6.744	0.000

DURBIN-WATSON D STATISTIC : 1.994
KOLMOGOROV-SMIRNOV ONE SAMPLE TEST: 0.084 (LILLIEFORS)

Inspection of table 7.12 indicates that both Formal analysis (IAF) and Unfreezing are predictors of Refreezing. The high tolerance values (i.e., close to unity) indicate little multicollinearity between the predictors and is calculated as one minus the squared multiple correlation between each predictor and the remaining predictors in the equation. Values close to zero are problematical (Wilkinson, 1987). The remaining statistics show that the model does not violate assumptions concerning the distribution of the residual terms and therefore it is appropriate to use the regression model. The Durbin-Watson statistic indicates how independent the cases are from one another. Values in the range 1.5 to 2.5 are generally viewed as acceptable (McLagan, 1973). The Lilliefors probability of the Kolmogorov-Smirnov test indicates that the residuals are normally distributed, at the 95% confidence level.

The second model regressed Refreezing (ILR) on the eight variable noted above, plus Moving. The stepwise procedure extracted three predictors of Refreezing, which were Meetings (IAM) Internal information (IASI) and Moving (ILM). Statistics on this model are presented in table 7.13 above. Note that the above stepwise regression does not corroborate the tentative correlation between Mechanicity and Refreezing found in table 7.11.

Table 7.13: Regression Analysis for Refreezing

N: 45 MULTIPLE R : 0.613 MULTIPLE R^2: 0.376
ADJUSTED MULTIPLE R^2: 0.347 STANDARD ERROR OF ESTIMATE: 0.808
NO CONSTANT ESTIMATED F-RATIO: 8.448 (p=0.000)

VARIABLE	STANDARDISED COEFFICIENT (β)	STD ERROR	TOLERANCE	T	P(2 TAIL)
IAM	*-0.250*	0.128	.908	-1.953	0.058
IASI	0.469	0.129	.895	3.637	0.001
ILM	0.347	0.126	.940	2.762	0.008

DURBIN-WATSON D STATISTIC : 1.718
KOLMOGOROV-SMIRNOV ONE SAMPLE TEST: 0.133 (LILLIEFORS)

Having estimated the most significant associations between Information Process construct measures, the remaining task is to estimate how these interact with the success measures and thereby determine the influence of Information Process on Success.

7.2.3.5.2 Predictors of Success

The same stepwise regression procedure just described was used to determine the predictors of implementation success. In this model there are three success measures to be estimated (Change, Ease and Satisfaction) and ten possible predictor variables, three exogenous variables, four Activity variables and three Lubrication variables. In addition, based on arguments that lead to the determination of Model II, Satisfaction is also predicted by Change and Ease and therefore there are twelve possible predictors for this concept. Previous analysis has indicated certain "allowed" predictors of each success measure. It has also indicated certain disallowed predictors. The result of each stepwise procedure were therefore compared with results of prior analyses and adjusted if necessary.

The variables retained by the three stepwise regression procedures (from ten predictors for Change and Ease, twelve for Satisfaction) are listed below.

SCX = f(UXX, IMX, IASE, ILU, ILR)

SEE = f(UXX, IAM, ILR)

SES = f(SCX, SEE, ILM, ILR)

Initially it is observed that the above models are consistent with earlier models of the data with respect to the appropriate inclusions of Uncertainty, Change and Ease. With reference to the earlier discussion concerning which stage of the project organisational learning occurred, the above models appear reasonable in including Refreezing. The models are also consistent with respect to the exclusion of procedural Range. The inclusion of Mechanicity as a predictor of Change is interesting and is the only evidence so far obtained for the efficacy of hypothesis 4. The inclusion of the remaining variables also appears reasonable based upon the analysis of partial correlations reported in tables 7.9a and 7.9b. However, this same analysis would indicate that Moving should not be retained as a predictor of Satisfaction. Moving was therefore explicitly excluded from the stepwise procedure and the model for Satisfaction reestimated. No substitute variable was added, hence the final model for Satisfaction used Change, Ease and Refreezing only as predictors. The results of the analyses are reported in tables 7.14, 7.15 and 7.16.

Table 7.14: Regression Analysis for Change

N: 45 MULTIPLE R : 0.834 MULTIPLE R^2: 0.695
ADJUSTED MULTIPLE R^2: 0.665 STANDARD ERROR OF ESTIMATE: 0.579
MODEL CONTAINS NO CONSTANT. F-RATIO: 18.254 (p=0.000)

VARIABLE	STANDARDISED COEFFICIENT (β)	STD ERROR	TOLERANCE	T	P(2 TAIL)
UXX	0.413	0.112	.611	3.701	0.001
IMX	*-0.169*	0.095	.846	-1.776	0.083
IASE	0.371	0.113	.595	3.282	0.002
ILU	-0.408	0.095	.845	-4.291	0.000
ILR	0.371	0.099	.778	3.747	0.001

DURBIN-WATSON D STATISTIC : 1.610
KOLMOGOROV-SMIRNOV ONE SAMPLE TEST: 0.468 (LILLIEFORS)

The analysis of table 14 appears to provide tentative evidence in support of hypothesis 4, namely that an organisation with a large range of procedures (Mechanicity was identified as a measure of procedural range in chapter 6) can absorb variety without Change. In other words, Change does not occur because the organisation does not *need* to. However, the association is weak. Also, the specific variable measuring procedural Range (IRX) is not extracted, nor is the Capacity construct if substituted in place of Mechanicity and Range. In addition Mechanicity could be removed from the predictor variable set by excluding certain single cases from the data, five of the 45 cases caused this effect. The remaining 4 variables were not so effected by single cases.

Table 7.15: Regression Analysis for Ease

N: 45 MULTIPLE R : 0.721 MULTIPLE R^2: 0.520
ADJUSTED MULTIPLE R^2: 0.497 STANDARD ERROR OF ESTIMATE: 0.709
MODEL CONTAINS NO CONSTANT. F-RATIO: 15.186 (p=0.000)

VARIABLE	STANDARDISED COEFFICIENT (β)	STD ERROR	TOLERANCE	T	P(2 TAIL)
UXX	-0.459	0.129	.684	-3.552	0.001
IAM	*-0.255*	0.129	.686	-1.977	0.055
ILR	0.291	0.107	.994	2.717	0.010

DURBIN-WATSON D STATISTIC : 1.856
KOLMOGOROV-SMIRNOV ONE SAMPLE TEST: 0.414 (LILLIEFORS)

Table 7.16: Regression Analysis for Satisfaction

N: 45 MULTIPLE R : 0.660 MULTIPLE R^2: 0.436
ADJUSTED MULTIPLE R^2: 0.409 STANDARD ERROR OF ESTIMATE: 0.769
MODEL CONTAINS NO CONSTANT. F-RATIO: 10.817 (p=0.000)

VARIABLE	COEFFICIENT (β)	STD ERROR	TOLERANCE	T	P(2 TAIL)
SCX	0.340	0.124	.872	2.739	0.009
SEE	0.421	0.131	.784	3.213	0.003
ILR	0.319	0.127	.832	2.514	0.016

DURBIN-WATSON D STATISTIC : 2.101
KOLMOGOROV-SMIRNOV ONE SAMPLE TEST: 0.331 (LILLIEFORS)

Based upon the above analysis Model III can be defined and is illustrated here in figure 7.6a and 7,6b. Figure 7.6a shows the correlations between Range, Mechanicity, the four Activity variables and three Lubrication variables. Figure 7.6b illustrates the associations between the three Success variables, Uncertainty, Mechanicity and Information Process variables. It was felt that subdividing the overall model in this way would make clearer the associations between constructs.

In figures 7.6a and 7.6b a two headed arrow signifies an association between two variables. The magnitude and direction of this association is indicated by the attached (partial) correlation coefficient. These coefficients are taken from table 7.11. Single headed arrows indicate presumed causal relationships, the arrow indicating the direction of causation. The magnitude and sign of the relationship is taken from the regression analyses summarised in tables 7.12 through 7.16. The weight of a line (correlation or path) signifies the statistical significance of the association, not Effect Size. Light lines represent tentative associations and are (generally) significant at or above the 10% level. In figure 7.6a the third order partial correlation between Meetings and External Information is not significant at the 10% level. It has been included in the figure because of the evidence provided by factor analysis of the Activity construct, that items composing the Meetings and External Information constructs are indicators of Support. A heavy line indicates correlations or paths significant at or above the 5% level. In fact the majority of these associations are significant above the 1% level. Finally figure 7.5 summarises the stages of disaggregation of the Information Process construct carried out during the development of Model III, and is given to assist the reader in interpreting figure 7.6a. In arriving at the Information Activity measures identified in figure 7.5 it was necessary to redefine several of the measures originally envisaged as constituting this construct. Hence, the correspondence between the dimensions of the Information Activity construct illustrated in figure 7.5 with those of table 4.5 is not great.

Figure 7.5: Information Process Construct Disaggregation

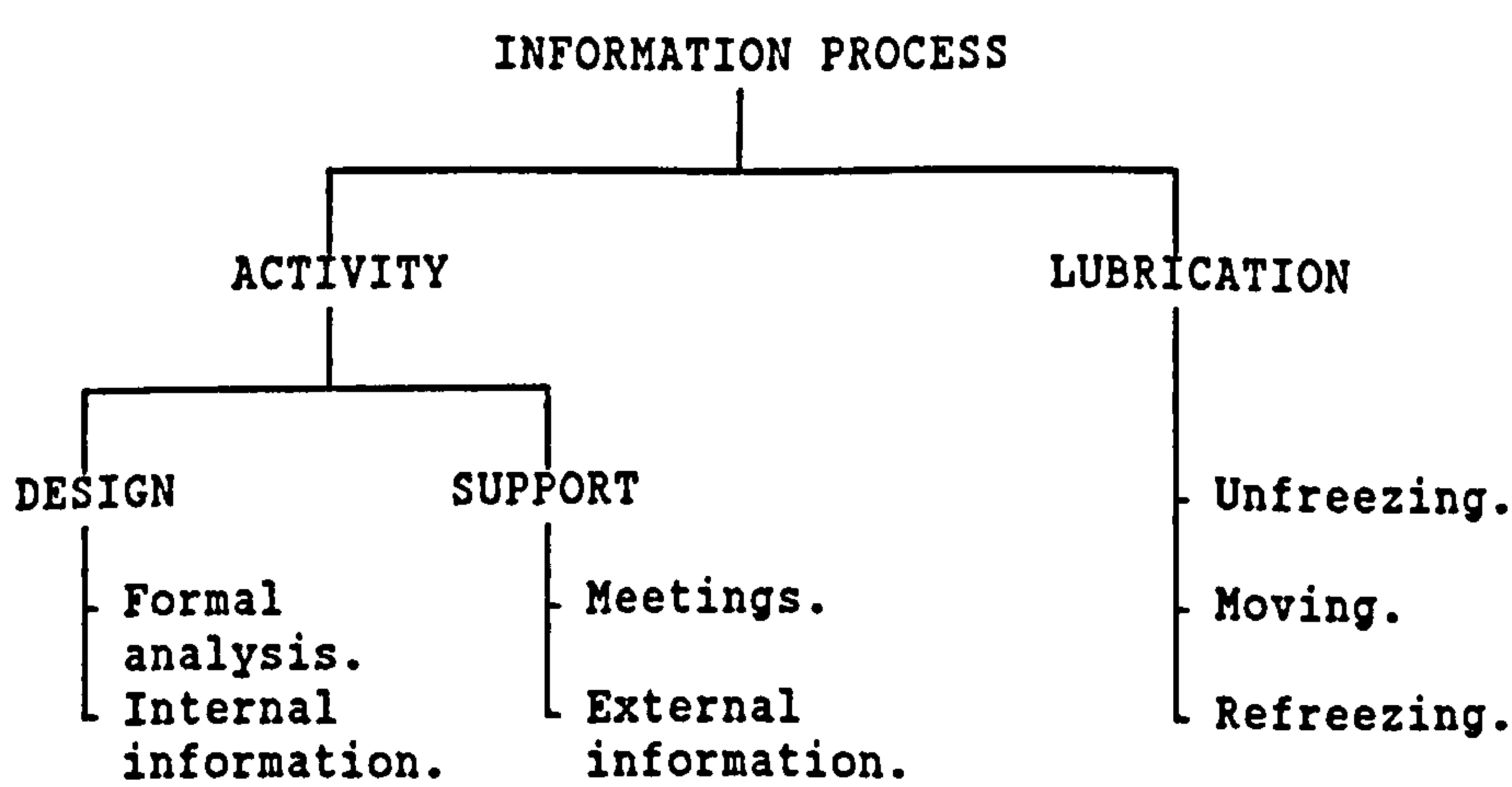


Figure 7.6a: MODEL III - Information Construct Associations

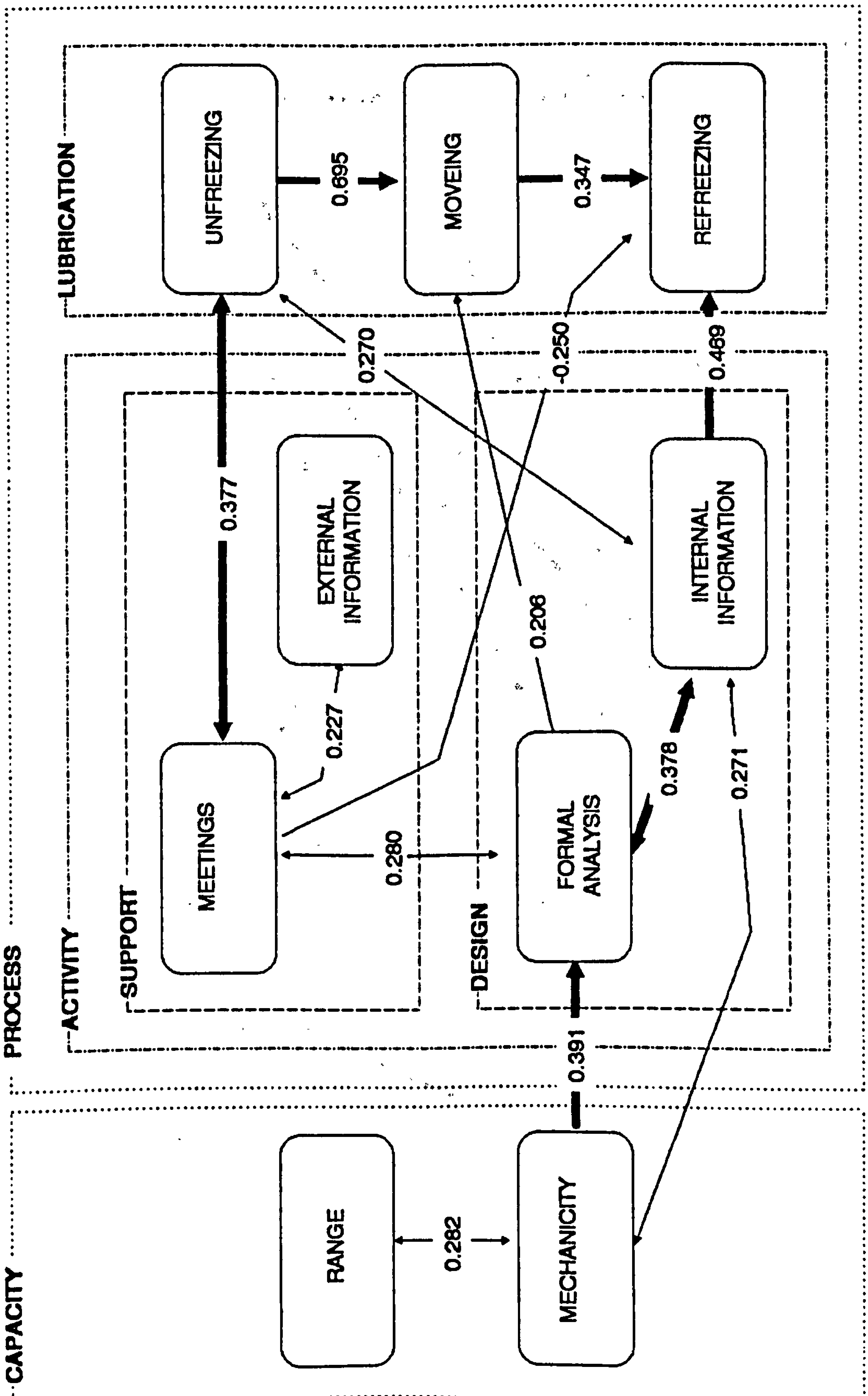
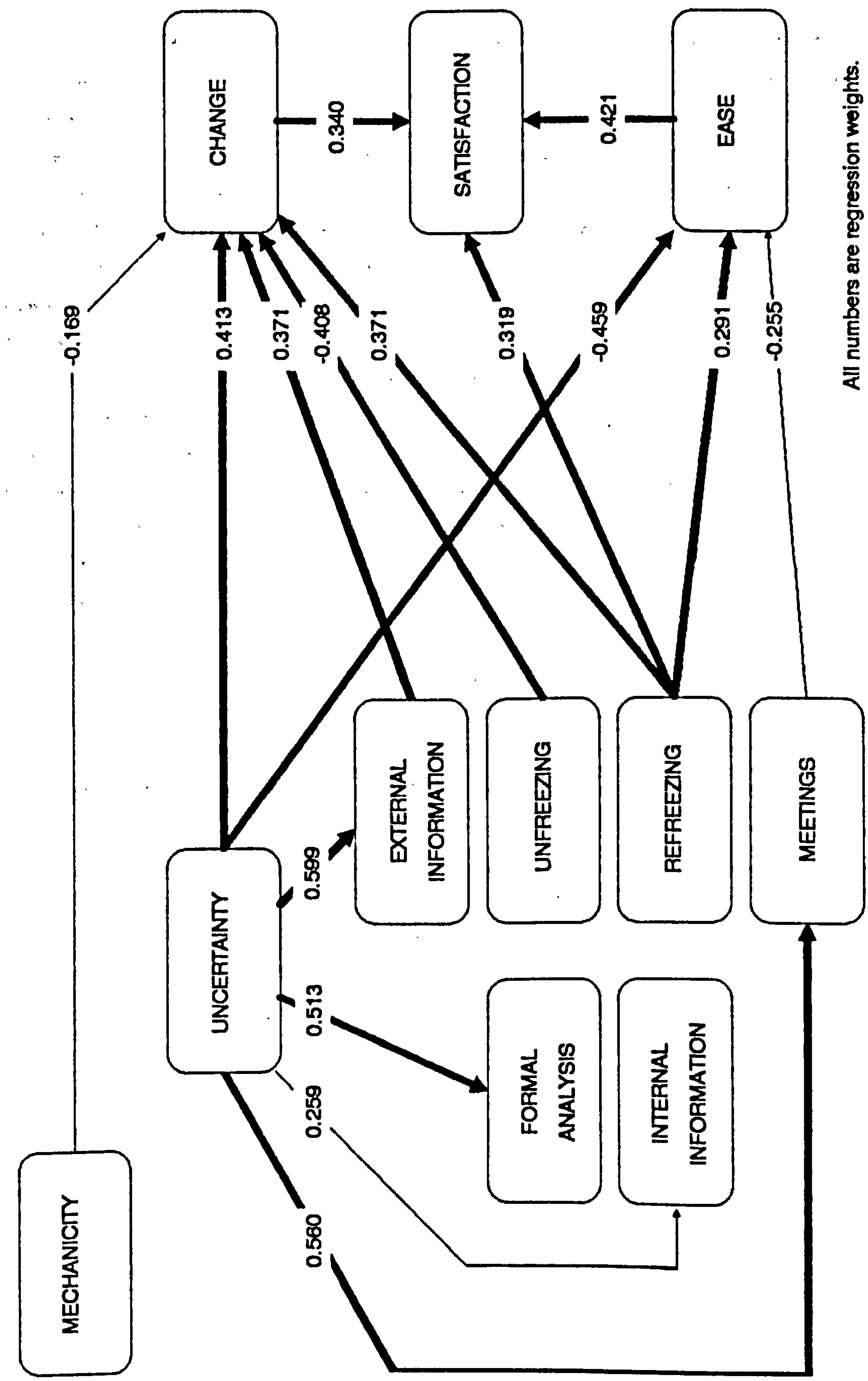


Figure 7.6b: MODEL III - Determinators of Implementation Success



7.3 CHAPTER SUMMARY

Scales developed in chapter 6 were initially used to test the evidence in support of the ten hypotheses developed in chapter 4. This original set of hypotheses, after replacing the exogenous Information Experience construct by Information Capacity to reflect the incomplete capture of the Experience construct by the research instrument, was referred to as Model I. Initial analysis supported hypotheses 1, 2 and 3, namely that Uncertainty gave rise to Change, was detrimental to Expectation and stimulated Information Process. Support was also found for hypothesis 6, that Information Capacity is a causal determinant of Information Process, and hypothesis 9, that Uncertainty and Capacity are orthogonal. The initial analysis did not however find evidence in support of hypotheses 4 and 5, that Information Capacity influenced Change and Expectation. Nor was evidence found in support of hypotheses 7 and 8, that Information Process influenced Change and Expectation. Finally, the evidence did not support hypothesis 10, that Change and Expectation were orthogonal.

In an attempt to account for the absence of the Change - Expectation orthogonality hypothesis, Model II was developed. This dichotomised Expectation Success into Ease and Satisfaction constructs, thus generating three implementation Success measures. Analysis showed that Change and Ease were orthogonal, thus demonstrating the efficacy of hypothesis 10. Analysis further demonstrated that Change and Ease were causal determinants of Satisfaction. The interpretation being that successful social/procedural Change, together with technical Ease of implementation lead to managerial Satisfaction with the project. Positive associations between the success constructs adequately accounted for the observed association between Change and Expectation identified in Model I. However Model II still did not account for the failure to detect hypotheses 4, 5, 7 and 8. In an attempt to detect evidence in support of hypotheses 4 and 5 the Capacity construct was disaggregated into its component Mechanicity and Range constructs. Still no associations between Success and these measures could be detected, either by the use of path analysis or moderated regression analysis. It was therefore concluded that the exogenous Information constructs of Mechanicity and procedural Range did not directly influence implementation Success. Their influence would be indirect and operate through the observed association with Information Process, assuming evidence could be found to connect Information Process with Success.

To understand the influence of Information Process upon Success, it was first demonstrated that the final stages of the project were most likely to yield significant associations. Only the tertiary concept of Refreezing within the secondary concept of Lubrication was associated with these stages of the project. The bulk of the Information Process measure developed in chapter 6 was associated with the earliest stages of the project and it was reasoned that these were unlikely to yield strong associations with Success. By analysing the associations between individual indicators of the Information Process measures (Activity and Lubrication) a number of patterns were identified. These patterns were found to be congruent with other analyses of the data and indicated that Activity is subsumed by four interacting processes labelled, Formal Analysis, Meetings, Internal Information search and External Information search. The original conceptual structure of the Activity construct came from a taxonomy of information occupations within the U.S. information industry sectors. For the purpose of this study these "occupations" were labelled, Analysis, Communication, Search and Information Technology. Two further components, Design Resources and Contingencies, were included for reasons given in chapter 4. The correspondence between the four Information Activity constructs identified in this chapter and the six constructs identified in chapter 4 is as follows. The Formal Analysis construct incorporates the Analysis, Information Technology and Contingencies dimensions of chapter 4, together with some indicators of the Search and Design Resources dimensions. The Meetings construct incorporates the Communication dimension of chapter 4, together with some of the Search indicators. Internal Information search is composed of two multi-item measures of Search, and External Information search is composed of a third multi-item measure of Search, together with the bulk of the Design Resources dimension indicators. Besides sub-dividing Activity in the way outlined above, Lubrication was also sub-divided into its three component stages of Unfreezing, Moving and Refreezing. Using these seven (four Activity and three Lubrication)

Information Process variables significant associations with the Success constructs were identified. These are summarised as Model III, figures 7.6a and 7.6b.

Model III provides support for hypotheses 7 and 8, primarily through the Refreezing construct but with respect to Change, also through the External Information search construct. However, the Ease and Change success constructs were also negatively influenced by the variables, Meetings and Unfreezing. Failure to detect associations between Success and Information Process constructs in earlier models can therefore be attributed to two causes. Firstly, the Refreezing and External Information constructs were "swamped" by other measures in the highly aggregated Information Process construct used when testing these models. Secondly, the existence of negative paths or correlations between the Information Process and Success constructs will tend to cancel the positive associations resulting in weak net associations.

The correlation and regression coefficients shown in figure 7.6a and 7.6b are indicative of the relative influence of one variable on the other. Considering the associations with Success variables, inspection of figure 7.6b shows that Uncertainty has the greatest positive effect on Change, the greatest negative effect on Ease and no direct effect on Satisfaction. The next largest influence on Change is the negative effect due to Unfreezing. Unfreezing also indirectly positively influences Change through its influence on Refreezing via Moving. Refreezing is positively related to all three Success measures and is in its turn principally determined by Internal Information search, Moving and negatively by the Meetings construct. The Meetings construct also has a direct negative effect on Ease. Negative Information Process - Success influences were not anticipated from the theoretical formulation of chapter 4. We therefore require further evidence in support of these phenomena if they are not to be viewed as just artifacts of the data, or method of analysis. This evidence and other topics will be discussed next in chapter 8.

CHAPTER 8

DISCUSSION AND LIMITATIONS

This chapter addresses a number of unresolved issues within the thesis to present. Initially we seek to identify explanations of the unanticipated negative associations identified in Chapter 7 between Meetings, Refreezing and Ease, and between Unfreezing and Change. Next, certain limitations of the methodological approach adopted will be discussed. Finally, a model will be developed illustrating how some of the ideas underpinning this thesis may be expanded with a view to identifying sources of strategic advantage for an organisation.

8.1 UNANTICIPATED ASSOCIATIONS

Analysis of the experimental data reported in chapter 7 identified two unanticipated and negative associations between Information Process and Success constructs not predicted by the theoretical development of chapter 4. A third negative association within the Information Process construct was also identified. These associations imply that certain activities performed during the pre-approval stage of the project were detrimental to the outcome of the project. That organisations should undertake actions whose effects are counter to the aim of the organisation, namely to implement a capital project, appears to be non-rational; nor was it predicted by the cybernetic theory used. We propose to consider explanations of these associations under three headings. First, are the associations simply artifacts of the method of analysis, and therefore not due to any causal phenomena. Second, are they artifacts of the data, and finally does their existence imply that the theory adopted is not able to provide an explanation of the implementation phenomena. The theory, therefore, may requires modification or replacement. A number of alternative explanations and theories existing within the literature will be reviewed to determine whether they are better able to account for the observed phenomena.

8.1.1 STATISTICAL ANALYSIS

Initially we seek to account for the unanticipated associations identified in Model III as due to the violation of an assumption of the statistical techniques employed. Standardised regression weights for the associations were evaluated as -0.41 between Unfreezing and Change (table 7.14) -0.26 between Meetings and Ease (table 7.15) and -0.25 between Meetings and Refreezing (Table 7.13). All of these associations are statistically significant at or above the 6% level and the analysis had sufficient statistical power (at least 51%, table 7.4) to detect effect sizes of this magnitude. In addition, assumptions underlying the stepwise regression analysis technique used were not violated. In particular, tolerances for the predictors were high hence muilticollinearity is not implicated. The Durbin-Watson statistics were also within acceptable ranges (as would be expected for this type of data) hence autocorrelation is not implicated either. In conclusion, assumptions of the regression technique were satisfied and the associations are unlikely to be due to sampling theory type I and II errors. We therefore preclude the associations from being spurious for analytical reasons.

8.1.2 RELIABILITY

If the unanticipated associations are not artifacts of the method of analysis, then are they artifacts of the method of measurement? In other words, were the theoretical concepts measured with adequate validity. We will return to the question of validity later in this discussion. Here we focus on the related issue of reliability, as noted in chapter 5, reliable measures are not necessarily valid but valid measures need to be reliable. The question we address here is therefore, were the measures of Meetings, Unfreezing, Refreezing, Ease and Change, sufficiently reliable to enable the analysis to reasonably detect the reported negative influences? The reliability of the Change construct was established in chapter 6 as 0.76. Reliabilities of Unfreezing (0.80) Refreezing (0.73) Meetings (0.53) and Ease (0.81) constructs were established in chapter 7. With the possible exception of the Meetings construct, all reliabilities are adequate for an exploratory study of this type (Van de Ven and Ferry, 1980). Therefore, could the observed negative association between Meetings and Ease be attributable to the use of a Meetings measure of low reliability and be spurious? This does not appear to be the case. It is, for example, possible to construct a ten item Support measure using items from the Meetings and External Information scales (the actual items are defined as Factor 1 in table 6.14b, excluding items IAA03 and IAN01 which load heavily on both the Design and Support factors). The theta reliability of this Support scale is a satisfactory 0.76, yet a statistically significant ($p<0.10$) negative association between Support and Ease exists. This suggests a certain stability to the negative association between Ease and a social dimension of Information Process incorporating the Meetings construct items. We therefore conclude, that the reliability of measures issue is not implicated as a possible explanation of the observed negative associations.

8.1.3 ALTERNATIVE THEORIES

In view of the above discussion it appears that questions of analysis and measurement reliability do not account for the unanticipated associations identified in chapter 7. Accepting that the associations are real, a substantive finding of the study is, that while the cybernetic theory adopted was successful at predicting many of the observed associations, it does not provide a complete explanation of the observed phenomena. The theory, therefore, requires modification or replacement. A large number of possible explanations, models and theories exist within the management literature and need to be reviewed. To help focus the discussion and reduce the size of this initial candidate set of theories, a closer look at the component constructs of Information Process is justified.

First we note that the two Information Process constructs from which the negative associations are presumed to emanate are themselves positively associated, the third order partial correlation being +0.34 (Table 7.10). This implies some common basis for the negative associations. Inspection of the Meetings construct shows it to be tapping into the extent of formal and informal (toing and froing) interaction and communication between people and the reliance of the decision on data gathered from several people. Unfreezing is associated principally with measures of unit manager involvement/commitment (e.g., "Top and Unit managers were open and candid", "Unit managers [did not] resent having to deal with the project"). In relation to other pre-approval stage Process variables identified in chapter 7 (Formal Analysis, Internal and External Search) the two constructs Meetings and Unfreezing appear to be related to a social dimension associated with pre-approval stage processes. Thus, it appears reasonable to identify the observed negative associations with social, behavioural, aspects or effects of the project.

In an attempt to gain further insight into the characteristics of this social dimension a number of the tape recordings made during the data collection interviews were selected for analysis. The cases investigated were chosen on the basis of exhibiting extreme scores on the Unfreezing, Meetings, Change or Ease scales. It must be remembered that the data collection interviews were highly structured and furthermore, the information being sought here was not part of the formal research design. Any information to be gleaned from the interview tapes would therefore be unsolicited and serendipitous, hence meagre and anecdotal. The information obtained will be reported where appropriate. We now review a number of possible explanations for the unanticipated negative associations identified from the literature.

8.1.3.1 <u>Politicality</u>

If we identify the pre-approval stage of the project as a decision making stage, then perhaps decision theory is capable of providing an explanation of the observed correlations. One of the most recent and comprehensive studies into organisational decision making is that reported by Hickson *et. al.* (1986). When identifying an "explanatory theory" of their three fold taxonomy of decision making processes (see Chapter 3 for a fuller description of this study) Hickson *et. al.* (1986,p.241) write:

> "Decision-making processes are therefore explicable first and foremost by the complexity and politicality to which they are a response."

This statement identifies two dimensions of interest, a Complexity dimension and a Politicality dimension. Complexity may be equated with the Uncertainty concept used in this study (several of Hickson *et. al.*'s Complexity indicators were used as indicators of item UST01 within the Uncertainty/Scope construct). Politicality was identified by Sharp *et. al.* (1989) with their Support dimension. Support in turn was identified as one of two factors accounting for the factor structure of the Information Activity construct, the other factor being Design (table 6.14b). As the Meetings construct is formed by effectively dichotomising the Support dimension (the other component being External information, see chapter 7) then Meetings may represent a partial capture of a Politicality dimension.

The question we need to address here is whether there is evidence to suppose that Politicality, or political action, is functional or dysfunctional to the decision making process. On this latter point Hickson *et. al.* (1986,p.256) report that there is just a "slight inclination to be less content" with decisions typified by high complexity and politicality. This description does not convey a strong sense of politicality having been dysfunctional to the decision-making process. Unfortunately, as far as this study is concerned, no mention is made as to whether politicality is dysfunctional to the implementation process; although it would appear reasonable to assume that the research methodology adopted by Hickson *et. al.* would have identified such effects if managers had perceived them to have been present. The study by Sharp *et. al.* (1989) into managerial behaviour during capital investment decisions provides a further perspective on the dysfunctionality, or not, of political action. (Note that a third activity, Authorisation, is also included in the model developed by Sharp *et. al.* This variable is of less interest to us here and will not be considered further.) By assuming that managerial time spent upon Design and/or Support will increase project value (directly or by reducing project uncertainty) incur costs and decrease project Net Present Value (due to delay) Sharp *et. al.* found that the decision-making process is optimised if:

> "effort expended on the Design, Support Generation and Authorisation activities ... is either the maximum permitted by staff constraints or no effort is expended on an activity at all."

Now, consider the implications of this finding for a project in which the required Design effort is initially underestimated. Using the above finding we reason that such an underestimation would be reinforced, with the result that only minimal design effort is undertaken for the project. This lack of design effort would then reasonably lead to problems during the post-approval stages of the project. Furthermore, if some Support activity is perceived as necessary, then, if managers optimise their time in the way suggested by Sharp *et. al.* this activity would be reinforced and be carried out with maximal effort. In other words, we are considering a situation in which Support activity drives out Design activity due to the extent of Design activity required being initially underestimated. Such a mechanism could account for the negative association between Design and Support factors reported in chapter 6, (correlation coefficient -0.26). Hence, we have a mechanism by which political action during a project (Support) drives out design effort, resulting in a low Ease score for the project.

8.1.3.2 Underestimating Design Effort

It was argued above that effective managers, seeking to optimise their time and minimise opportunity costs, could find themselves in a situation in which political action reinforces an initial underestimation of the Design effort required on a project. This lack of early Design effort will become evident later on in the project leading to unanticipated difficulties and thus lowering the Ease score for the project. This argument suggests a mechanism where Politicality (measured to some extent in this study by the Meetings construct) acts as an "amplifier" to an initial mistake of underestimating the Design effort required on a project. Politicality is not, however, an explanation of how or why such a mistake came to be made in the first instance. Before seeking to address these how and why questions though, we need to review the evidence that underestimating Design effort is a plausible explanation of the observed negative associations between Ease and Meetings.

Investigating cases with very low Ease scores did identify failure to preplan, through a tendency to oversimplify, as an identifiable cause of implementation problems in two instances. Quotations from the interviews illustrating this point are given below.

> "We could have substantially preplanned the project more effectively, which would have greatly assisted in the installation and commissioning after. ... Really it was a lack of understanding of new technology and a new manufacturing technique and its complexities. A tendency to oversimplify."

> "We took an optimistic view and expected too much and failed to achieve what we expected."

This second example was, nevertheless, judged to have been successful, "We achieved 90% of what we expected to achieve by the time we expected to achieve it - it was a very good performance."

In contrast to these examples other explanations of low Ease scores are not difficult to find. For example, the project in which a dramatic change in the target market for a new product occurred which was outside the company's control and the instance where new equipment failed to meet its agreed performance specification. However, as the informants to these two examples noted during the interviews, a more rigorous sensitivity analysis in the first example and more equipment trials in the second could have ameliorated the later problems.

Further evidence in support of the "underestimation of Design effort" hypothesis comes directly from the study. Question 2b.20 of the questionnaire (Appendix A) was a 20 part question designed to measure the extent and type of problem encountered during the project's implementation. (This question was used to construct the Ease indicator SEE01.) Each question was scored on a 1 to 5 scale, with 1 representing "Little or none". The first item of this question was, "Underestimating the complexity of completing the project..." and achieved a score of 2 or more in over 70% of the cases studied. Its mean score of 2.444 was the highest of any single indicator in the question. Underestimating project complexity was seen, therefore, as the most frequent and serious threat to ease of project implementation.

The above discussion suggests that the underestimation of design effort is a plausible reason why projects achieve low Ease scores. How and why might this situation come about? It was suggested above that political action was not a direct cause of underestimation, but that it may act to moderate the effect of more direct causal influences. The first quotation above suggests one causal reason as the "lack of understanding". We will refer to this as "Lack of Prior Knowledge". As we are investigating strategic decisions and these are defined in terms of concepts such as "novelty", then it follows that a "lack of prior knowledge" is a feature of such decisions which has to be taken as given. A more interesting question is therefore, what can an organisation do to counter its lack of prior knowledge? Again, it was noted from one of the interviews that a more rigorous sensitivity analysis might have better prepared the organisation to deal with subsequent implementation problems. This suggests that quality of the organisation's planning system is another potential factor. Evidence for this supposition is supplied by analysis of the 20 items in question 2b.20.

An exploratory factor analysis of the 20 items measuring problems encountered during implementation was made to gain insight into underlying causes of the reported difficulties. As this question was only one indicator of implementation Ease its factor structure was not investigated in chapter 6, only its alpha reliability; a satisfactory 0.844. It must be noted that factoring 20 variables with only 45 cases in an exploratory analysis is technically a dubious procedure. The relatively small number of cases to variables precludes the use of split half confirmation of the factor structure for example. However, the results appear to make sense and so have been used in this discussion. Principal components factor extraction was used and inspection of the resulting Eigenvalue scree plot indicated an underlying structure consisting of four factors. The varimax rotated loadings of the items on these four factors is reproduced in table 8.1 below. As has been the convention in this study, loadings above 0.5 are in bold type, loadings less than 0.3 are not recorded.

Table 8.1: Implementation Difficulties Factor Structure

ITEM	FACTOR 1	2	3	4
Underestimate complexity	0.592		0.453	
Lack of confidence	0.595			
Uncoordinated responses		0.836		
Inexperience in planning	0.681		0.371	
No learning system	0.651			0.529
Objectives not defined	0.724			
No commitment to plan			0.733	
Sub-contractor control	0.640			-0.352
Management controls		0.772		
Unrecorded knowledge	0.618			0.353
Lack of training		0.405	0.494	
Role definition poor			0.651	
Late changes			0.709	
Not allowing for changes			0.797	
Authority in wrong hands		0.609		0.379
Other crises	0.319			0.674
Insufficient support				0.659
Insufficient finance				0.656
Reluctance to use specialists		0.773		
Assuming designs work	0.472			
Eigenvalue (unrotated)	5.508	2.424	1.804	1.744
% variance explained	27.5	39.7	48.7	57.4

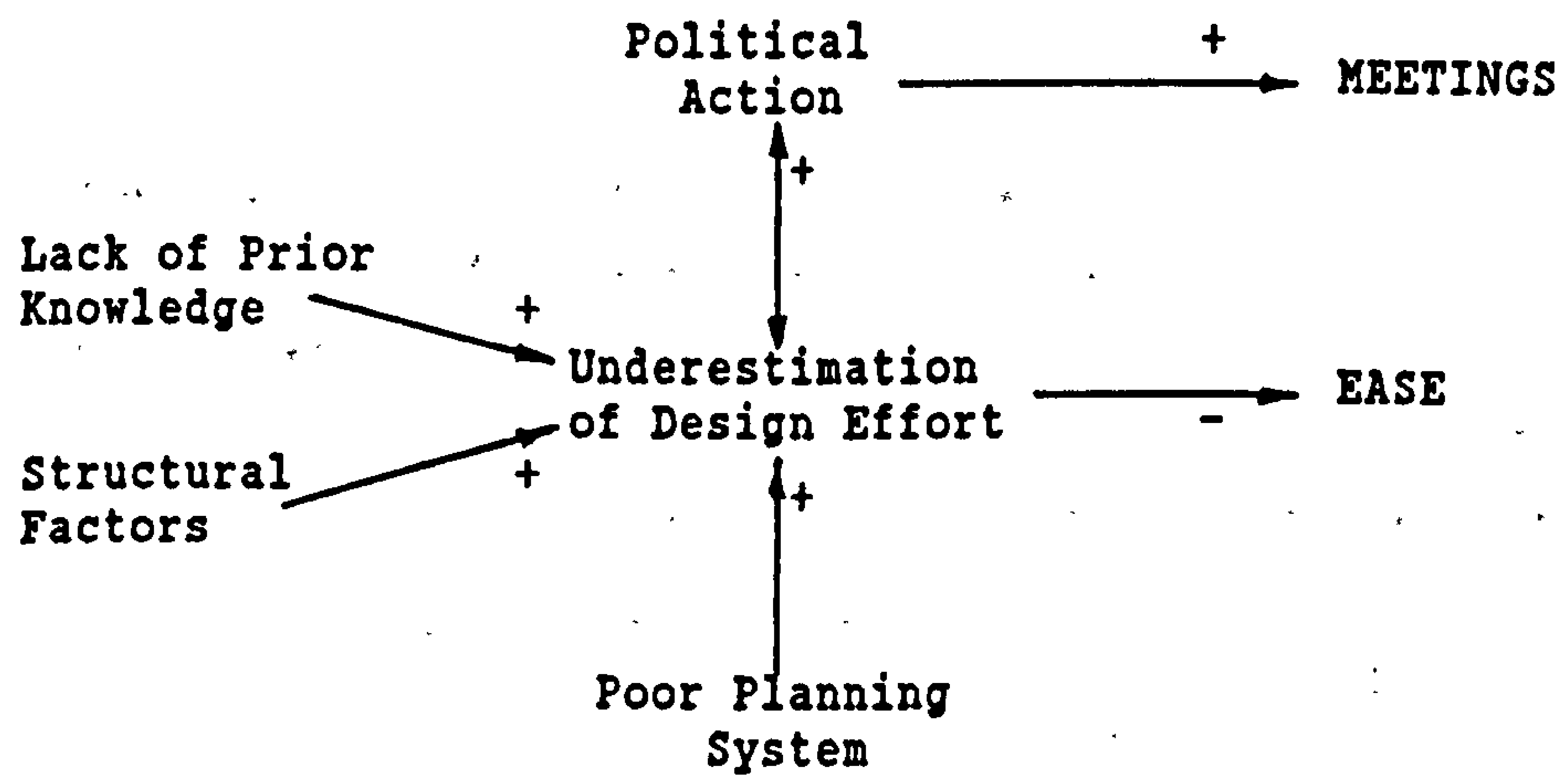
Interpreting factors in terms of those items with loadings above 0.47 it is seen that all items in the question contribute to a factor. Only the item "Not having a system for learning from experience..." contributes significantly to more than one factor. In addition, assigning a rank to each item based on its overall mean score and averaging the resulting ranks for each factor, identifies factor 1 as the most important factor. Factor 3 ranks second in overall importance, followed by factor 4 and finally factor 2. The same importance ordering is obtained if actual means are used in place of ranks. Factor 3 refers to training and also making, or having to make, late changes to the project. This factor is strongly correlated with the overall effort and time expended by management on the project (item IAR03 of the Design Resources dimension of Information Activity, table 6.11b; $r=0.465$, $p<0.01$). Factor 4 appears to be a collection of items signifying a lack of support or priority being given to the project. Factor 2 refers to a lack of project control systems, both technical (information systems) and human (not having the correct people in charge).

Finally, factor 1 is seen to contain the "underestimation of complexity" item, and also items referring to a lack of confidence in planning, inexperience in planning, not gaining commitment to the plan and the most dominant single item in the factor, failure to define key tasks and set objectives. These items (and others) point to an association between poor planning and the underestimation of project complexity. Thus, quality of the organisation's planning system is implicated as a probable cause of underestimating design effort.

Finally we note structural explanations of how design effort is underestimated. March (1981) comments on a number of these. One such structural factor of particular relevance here is investigated by Harrison and March (1984). They observe that the technique of assessing capital projects as the difference between a high income and low cost requires two stochastic estimates to be made. Although each estimate may be unbiased, because the final choice is likely to be made for the project with the highest difference between these two estimates, the effect of statistical regression to the mean results in a biased estimate of net return. Thus the expected return is optimistic and the project fails to achieve target. Such an effect would directly influence Ease as the Accuracy concept within Ease related to the achievement of anticipated, targeted returns.

To summarise the above arguments, we started from the need to account for the observed negative association between the Meetings and Ease constructs. This became a question of understanding the reasons why the Design effort required on a project may be underestimated. It was suggested that such an underestimation could be the result of a lack of prior knowledge, inadequate planning and structural properties of the way projects are evaluated. In addition, the political action surrounding a project would act to "crowd out" Design effort following an initial underestimation of Design needs. Furthermore, we note that political action was probably measured in this study by the Meetings construct. This sequence of arguments is summarised in the causal model illustrated in figure 8.1 below:

Figure 8.1: Causality Underlying the Meetings - Ease Association



The effect of the relationships identified in figure 8.1 is a spurious negative association between Meetings and Ease. The above model could therefore account for one of the associations identified in chapter 7. A further negative association was noted in chapter 7 involving the Meetings construct. This was internal to the Process measure and involved Refreezing. Refreezing entails the stabilisation of social change and some of the indicators of this measure refer to the success of the project. The negative association between Meetings and Refreezing is therefore possibly due to the same causal processes that influence Ease and Meetings.

Could the arguments used so far be reversed and thereby account for the negative association between Unfreezing and Change? It appears reasonable that a low Success/Change score could be attributable to a failure to devote sufficient resources to the political aspects of a project. However, it does not seem reasonable that "over designing" a project could be associated with the essentially social process of Unfreezing. Indeed we would expect any such negative association to be between Design items, such as Formal analysis (IAF) or Internal Information Search (IASI). No such negative associations were identified in the data analysis. Hence, we conclude that over designing, at the expense of Support generation, is an inadequate explanation of the negative association between Unfreezing and Change. However, an alternative explanation for this association is available from a secondary analysis of the interview tape recordings. We review this evidence below.

8.1.3.3 Resistance to Change

In the preceding discussion the academic notion of politicality was discussed. Only in one of the interview tapes studied was politicality mentioned. The following comments were made during questions about problems encountered during implementation and specifically reasons why one individual, the Shop Manager, was resistant to the project. An extract of the interview transcript is reported here:

> "Basically he didn't want to know until it was properly commissioned. You have to know the organisation. It was a very political organisation and they were all suspicious of anything research and development did, both in management and in the shop floor...I think previously [new technology] had been thrust upon them without any consultation what so ever. 'Here is a new piece of plant, this is what it will do, get on with it.' which isn't the proper way to introduce it. That's probably why there was the scepticism and reluctance...They knew we were doing something but they didn't know what and we weren't allowed to tell them what."

This extract associates the "political organisation" with ideas of "suspicion" and "secrecy", and is similar to MacMillan's (1978) definition of political action as the action taken by an actor against other actors "to ensure that its own goals are achieved" ("actor" is synonymous with Hickson *et. al.*'s (1986) "interest unit"). This is not the implicit interpretation of politicality used in this study. Here, politicality was equated with ideas of developing consensus. Indeed the question specifically measuring consensus building in the questionnaire (question 2a.4, item IAC01) only scored 1 (little or none) for this particular project and the overall Meetings score for the project was the sixth lowest in the entire study. In addition the organisation was viewed as having a "highly restricted access to information", item 1 of the organicity measure, question 1.13. The picture of this "political organisation" is of a rather paternalistic organisation. This may be accounted for by noting that the company was owned by its founder. However, the major conclusion of this evidence is that resistance came from a single individual, the Shop Manager, and reflected a lack of prior consultation and involvement of this individual in the earlier pre-approval stages of the project. Indeed the respondent noted that involvement of the line management at the pre-approval and design stage of the project would have been a good thing. It is interesting, therefore, that the only place in which politicality is mentioned by (in this instance) a senior manager, is in connection with the failure of the organisation to use procedures involving line management in the pre-approval decision-making stage of the project.

The study included a number of indicators designed to assess the use of procedures to involve line management in the project from its earliest stages. These measures were subsumed within the Behavioural Lubrication construct, the Unfreezing and Moving items of this measure being particularly relevant to unit (or line) management involvement. Hence, it is not surprising that the above case had a very low Unfreezing score. The Lubrication construct was included in the questionnaire in recognition of the "resistance to change" phenomenon; the existence of which, its behavioural and/or organisational basis and methods for circumventing or minimising its effects has been documented in the strategy and other literatures since the 1960's and earlier (see for example Ansoff, 1984; Steiner and Cannon, 1966). The precise formulation of the Lubrication concept was adapted from the study of Zand and Sorenson (1975) who in turn based their conceptualisation of the measures on the Lewin-Schein theory of change. Superficially the measures looked adequate. Measures relating to Unfreezing, for example, measured aspects of senior manager commitment and unit manager involvement during the pre-approval stage of the project. Both aspects have been identified within the strategy literature as making major contributions to overcoming the resistance to change phenomenon. It is interesting, therefore, that the scale constructed from these measures is the source of the direct negative (dysfunctional) association with the Success/Change construct. (Note, Unfreezing has a beneficial indirect effect on Change through the association with Refreezing.)

The Lewin-Schein theory of change is described in Sorensen and Zand (1975,p.218). The Unfreezing stage is associated with:-

> "...encouraging dissatisfaction with current behaviour in order to unlearn this current behaviour and create a desire to learn new behaviour."

Thus, Unfreezing aims to create a sense of the need for change. If we look at the variables associated with Unfreezing we observe positive associations with Meetings, Moving and Internal information search. The association with Moving is expected, as both are components within the Lubrication concept. However, the association with Internal information and Meetings suggests the possibility that Unfreezing may have measured the mechanism by which information was collected from within the organisation, rather than the intended generation of commitment to the project.

A feature of some of the projects studied was that resistance to the project was identified as coming from a single individual. The instance cited above of the Shop Manager is a case in point. Here resistance was due to a lack of prior involvement of the manager during the early stages of the project. Another case in point comes from the pilot study reported in chapter 4. Here a major problem with the implementation of the project (from the managers perspective, not the engineers) was the need for close liaison with the customer. This was a new (to this company) requirement and the problem was only solved when the individual responsible for operating the liaison procedures was replaced. No formal measurement of the Unfreezing construct was made during the pilot study. However, judging from the interviews and the detail contained within the Capital Application document, the author's assessment is that most of the Unfreezing procedures would have been followed in this instance. Two further examples of single individual resistance can be cited. In one instance the introduction of a computer controlled (CNC) machine was resisted by the skilled craftsman who would be responsible for operating the new equipment. The motive behind the craftsman's resistance was, the de-skilling of his job, loss of bonuses etc., resulting from the introduction of the new technology. However, this was not seen as a major obstacle to the project's implementation. We "managed around him" was the respondents' comment. Eventually the craftsman left the company. This project achieved a quite large negative Unfreezing score. The last case for which data of specific resistance exists also relates to the first introduction of CNC machinery. Here the resistance came from the works engineer. The precise nature of the resistance was to do with the engineer's perception of how long it would take to commission and integrate the new machine into the factory's operations. Essentially the engineer took a very pessimistic view as compared to the CEO. The CEO's problem was solved, rather tragically, when the engineer died. The project was then successfully completed to the CEO's schedule. In contrast to the previous case, this project achieved a quite large positive Unfreezing score.

It would be dangerous to read too much into an analysis of these cases, particularly as they represent only some ten percent of the total sample. However, they do represent instances in which "resistance to change" can be clearly identified and therefore supports a "resistance to change" hypothesis. One feature of these examples is that the "power" of the individual to resist the project affects the perception of the severity of the resistance; in the absence of a measure of "power" it is equated here with "authority". For example, the craftsman was in a less powerful position than the Shop Manager and appears to have had less of an impact on the project. A second tentative observation is the lack of correspondence between the Unfreezing measure and the existence of resistance. This lack of correspondence may be further illustrated with a case also involving the first introduction of CNC machinery. This project obtained the lowest Unfreezing score of any project studied; "didn't bother" was the response to some of the questions used to assess Unfreezing. However, the project had a quite large Change effect on the organisation. It also achieved the second highest Ease of implementation score and the lowest Meetings score. In other words the project was successful, yet very little consultation occurred, as measured by Meetings and Unfreezing. The only implementation problem identified was a slight increase in grievances due to shop floor workers wanting an increase in pay to operate the machine. This grievance was dismissed as a minor irritation; nor was it equated with resistance to the project.

To attempt a summary of the arguments presented above to account for the negative association between Unfreezing and Change we note the following. Firstly, Unfreezing is a measure associated with the behavioural, social phenomenon of "resistance to change". Secondly, Unfreezing could be measuring a "collection of internal information" process, as well as the intended "generating commitment" process. Thirdly, "resistance to change" by individuals was identified within a number of the cases studied. Fourthly, the "Power" of the individual could affect the severity of the resistance offered and finally, there was little correspondence between the incidence of these cases and the Unfreezing measure. From these arguments it is concluded that the a possible explanation of the observed negative association between Unfreezing and Change is "resistance to change". We also conclude that the measurement of "resistance to change" must take into account the power of individual actors to offer effective resistance.

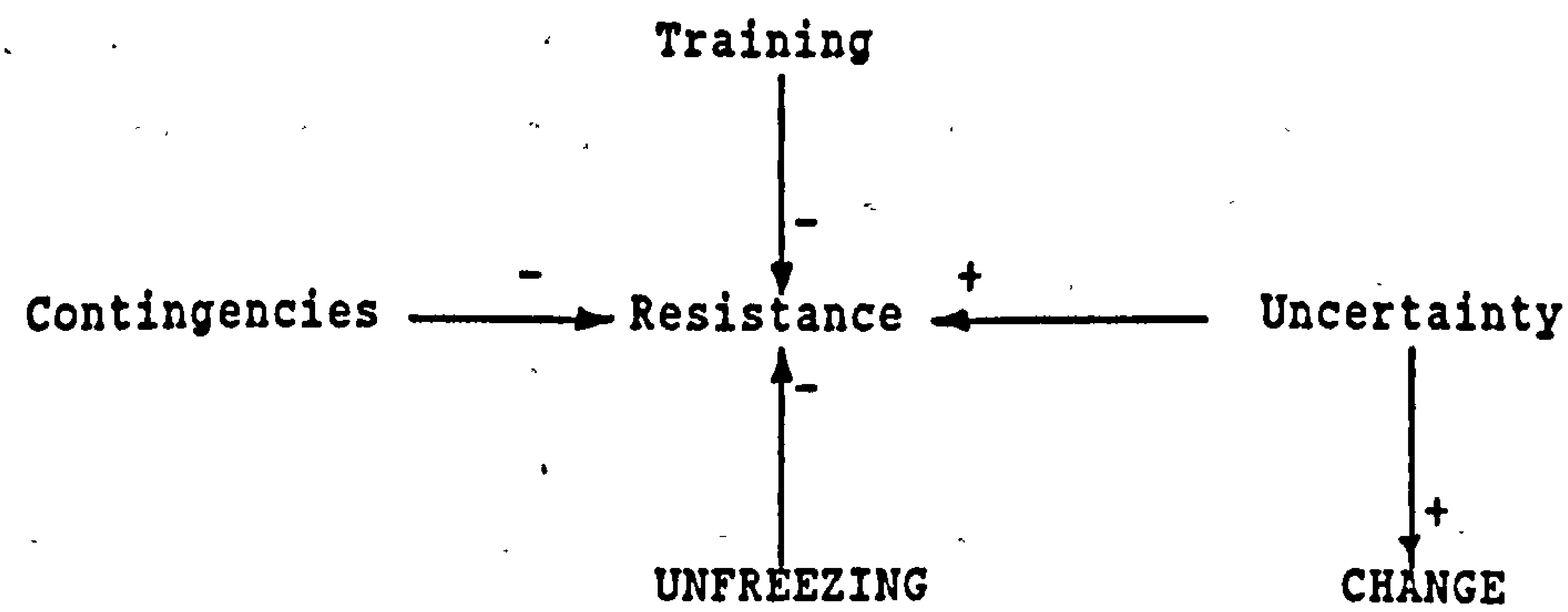
Looking at the evidence available from the study to account for observed cases of resistance we identify a lack of involvement in the decision (i.e., poor Unfreezing) inability (or unwillingness) to learn new working procedures, beliefs about what was feasible, and negative effects on personal skills and pay. The importance of personal issues in determining resistance to change was noted by Woodward (1965). Indeed Woodward notes that resistance to change was almost completely lacking from the cases they studied and that where it did occur it was associated with threats to pay levels or employment. We may also posit that training would assist in overcoming resistance based on the need to learn new working procedures. Indeed the specific item measuring lack of training in question 2b.20 (see discussion associated with table 8.1) had the highest mean (1.933) of any item not significantly associated with the "quality of planning" factor. Thus, lack of training is identified as an important cause of implementation difficulties. The issue of beliefs about feasibility raises an interesting point relating to the discussion in chapter 4 about contingency allowances. Adapting arguments proposed by Galbraith (1969) it was noted that slack resources reduce the need to process information and are therefore a method of variety absorption. In the context of a project, slack resources were equated with contingencies. The resistance of the works engineer to the new CNC machine could be interpreted as a desire to generate a time contingency sufficient to cover any imagined difficulties. This accords with Ansoff's (1987,p.239) view that resistance is inversely proportional to the time for implementation.

To summarise the above reasoning, it is suggested that the level of organisational resistance to a project may be determined by summing over all interest units (N) involved in or influenced by the project, the net negative personal effect ($P^{-} - P^{+}$) of the project on the interest unit, weighted by the interest unit's power. In symbolic form, Resistance may be defined as follows:

$$\text{Resistance} = \sum_{i=1}^{N} \text{Power}_i . (P_i^- - P_i^+)$$

Resistance may be reduced through Contingency allowances, Training and Involvement. Involvement was measured in this study by Unfreezing. Finally we suggest that organisational change will tend to generate more negative personal threats (P^-) than positive personal benefits (P^+) and that the level of both will be determined by the Uncertainty associated with the project. In other words, Uncertainty will be positively associated with organisational Resistance. It has been demonstrated in this study that Uncertainty is positively associated with procedural Change. Hence, we are able to account for a spurious negative association between Change and Unfreezing operating because of the pattern of associations between Change, Unfreezing, Uncertainty and an unmeasured concept, organisational Resistance. This pattern is illustrated in figure 8.2 below.

Figure 8.2: Causality Underlying the Unfreezing - Change Association



The above model suggests that the observed unanticipated association between Unfreezing and Change is spurious, and originates through a presumed association with the unmeasured concept Resistance. However, this association is the strongest observed in the study between any of the Information Process and Success measures. It is judged unlikely therefore, that this model fully accounts for the association. It was noted previously that the Unfreezing measure was suspect at measuring what was intended (generating commitment to the project) and may have also measured a process by which information and data were collected from within the organisation. That is, the particular construction of the Unfreezing measure may not have measured the success of generating commitment, just the presence or absence of some consultation process. In other words, the validity of the Unfreezing construct is suspect. Such an explanation may also help to account for the observed unanticipated association between the Unfreezing and Change constructs.

8.1.3.4 Summary

The cybernetic theory developed in chapter 4 identified organisational procedures as the proper focus for the study of the implementation phenomenon. In particular the theory identified two modes of organisational adaptation as the outcome or "Success" of the implementation effort, and identified the contingent dimensions of the implementation question as Uncertainty and Information. From this perspective hypotheses were developed and tested. Of ten hypotheses, six were successfully demonstrated after making only minor changes to the operationalisation of one of the Success constructs. In particular the hypotheses linking Uncertainty to Success and Information constructs were found to be strong. The four hypotheses not demonstrated related Information constructs to Success. Two related dimensions of organisational structure to Success, the others related processes used during the pre-approval design stage of the project to Success. In the final analysis tentative evidence was found in support of one of the hypotheses connecting a dimension of organisational structure to one of the Success concepts. The inability to identify an association between Information Process and Success constructs implies that these associations are weak. In other words, pre-approval design and decision making does not assist the subsequent post-approval implementation effort to any great extent. In fact, to demonstrate any link between the two stages required a close examination of each separate indicator used to operationalise the Information Process concept. Under such close scrutiny evidence was found to support the two original hypotheses linking Information Process and Success. However, unanticipated, significant and negative associations were also identified. It has been suggested here that these associations may be explicable in terms of a social or behavioural theory of information processing.

The question posed at the beginning of this discussion of alternative theories was, are these theories as good or better at accounting for all of the observed associations? In view of the success of the cybernetic approach at providing a coherent framework and perspective for this study, and the successful demonstration of the majority of the anticipated associations, then the authors judgment is that the cybernetic theory should, by an large, be accepted and retained. In addition, it is not obvious to this author how some of the behavioural explanations posed above could be adapted to account for the associations most clearly explained by the cybernetic model. In other words, the cybernetic approach used in this study was quite successful at predicting what happens during implementation, but to predict process, or how it happens, an explicitly social or behavioural dimension is also required. This suggests that adaptation, not rejection, of the cybernetic approach is in order. One possible adaptation or extension to the theory which may prove beneficial in future studies is based on cognitive theory, and will be reviewed next.

8.1.4 COGNITIVE THEORY

The following discussion is based on Steinbruner (1974). Trained as a Psychologist but writing as a Political Scientist about the nuclear sharing issue among NATO allies in the period 1954 to 1964, Steinbruner argues that many of the issues surrounding this complex decision cannot readily be explained by a rational, analytic theory of decision-making. Steinbruner then argues that a cybernetic theory of decision-making is able to readily account for many of the issues found to be most perplexing when viewed from a rational perspective. However, he identifies certain limitations to current cybernetic theory when applied to complex decision situations. At the risk of over simplification, for cybernetic principles to operate constraints have to be established for the decision. In the case of simple decisions these constraints will be identifiable within the decision's environment. However, for complex decisions in complex environments explaining how these constraints are established poses a major problem and is one not addressed by cybernetic theory. Steinbruner argues that an appropriate source of supplementary information regarding the source of decision-making constraints can be found within cognitive theory.

Steinbruner continues by elaborating four axiomatic principles of cognitive theory. Two of these are the "Consistency" and "Economy" principles, Economy being subdivided into "Simplicity" and "Stability" principles. Consistency refers to the mind's tendency to keep internal belief relationships consistent with one another. It influences both how memory is organised and how new information is processed. Economy refers to the fact that "perception and attention are selective", that is "the mind remembers some things of importance but forgets a great deal and never even attends to most of the information it physically receives". This selection is achieved through the operation of the simplicity principle - keeping beliefs simple - and the stability principle - resisting change to the core structure of beliefs.

Steinbruner's contribution is interesting from the perspective of the present study. It suggests modifications to cybernetic theory which introduces an explicitly human dimension into the theory. Further, it achieves this in a highly consistent manner; the economy principle for example is "in accord with a fundamental proposition of the cybernetic paradigm". This extension could therefore provide a basis for explaining the nature of the behavioural dimension identified as the source of the unanticipated associations between Information Process and Success constructs. The stability principle is consistent with a "resistance to change" effect, and consistency and simplicity principles may help account for the "underestimation of design effort" issue discussed above. Cognitive theory, therefore, provides a basis and explanation of the two concepts identified here as being potentially responsible for the observed negative associations between Information Process and Success measures.

8.2 LIMITATIONS

8.2.1 EXTERNAL VALIDITY

It was noted in chapter 5 that a discussion of external validity would be deferred until this chapter. It was also noted in section 5.1.4 that external validity was the least important validity type in the current study.

Broadly, external validity is concerned with the extent to which a particular study's results may be generalised to other times, settings, people etc. There is no objective measure of external validity, it has to be established by deduction (Cook and Campbell, 1979). Two broadly based threats to the external validity of a study can be identified. The first comes from the specificity of the theory used and the second from the operationalisation of this theory. The theoretical perspective of this study was developed in chapters 2, 3 and 4. This development and the hypotheses derived from it, was not restricted to particular times, settings etc. and was therefore entirely general; within the overall constraint that the study applied to the implementation phenomenon. Subsequent results indicated anomalies between theory and findings. To account for these anomalies, Cognitive theory was proposed as an extension to the Cybernetic perspective adopted. The extensions proposed using Cognitive theory are, in turn, non specific to times, settings etc. Hence, we conclude that the theoretical perspective adopted in the study and the proposed modification to this perspective, does not present a threat to the external validity of the study.

Operationalisation of the theoretical perspective adopted was the subject of chapter 5. This process was based on two major constraints. These constraints determined the breadth of study being undertaken and related to the type of organisation and decision to be investigated. The rationale for selecting these two constraints was derived from arguments presented in chapter 3 and resulted in the selection of capital investment projects (because they were seen as the most strategic) within manufacturing organisations (because capital investments were most frequent within such organisations). This selection represented one of nine possible selections derived from the three fold categorisation of organisations (Manufacturing, Commercial Service and Non-commercial Service) and projects (Capital, Revenue and Social) identified in that chapter. Arguments used to derive the threefold taxonomy of project types were entirely general and should not pose a threat to external validity. The organisational taxonomy was empirically derived and will reflect limitations of the data used. As noted in chapter 3, this data, although very broadly based, did not include, for example, decisions from within construction companies, or voluntary organisations. The organisational taxonomy is therefore restricted to a subset of organisations and is probably incomplete.

In the light of the constraints imposed, two questions are pertinent to a discussion of the effect of operationalisation upon external validity. Can the study's results be extended to other project types? Can the results be reasonably extended to other, non-manufacturing organisations? If we are more focused in our questioning, two further questions can be addressed. How representative was the sample of manufacturing organisations studied? How representative was the sample of capital investments? It will be convenient to address these four questions in reverse order. The data required to address the second pair of questions is contained in chapter 6. In table 6.5b projects were categorised using Hickson *et. al.*'s (1986) "Decision Topic" scheme. Of the ten categories in this scheme the current study identified projects in eight of them. In addition Technology topics dominated the sample, a finding in broad agreement with Hickson *et. al.*'s study. Product classification data was presented in Table 6.9. This data showed the sample companies to be distributed in a manner similar to the national distribution. In summary, the findings of chapter 6 present reasonable evidence for the external validity of the study in terms of types of capital projects and manufacturing organisations studied.

Turning to the first pair of questions asked above, we consider the applicability of the study to non-manufacturing organisations. As the study did not address the question of implementation within non-manufacturing organisations little can be stated concerning this question. One commercial service company did enter the sample and the project studied was a Control topic decision. The implementation of this topic was not noticeably different to similar decisions in manufacturing companies. This may indicate that capital investment projects are treated similarly in different organisational types. However, this conclusion is highly tentative and the most appropriate conclusion would be that the external validity of the study with respect to non-manufacturing organisations is indeterminate from the available data. The situation concerning the first question (extension of findings to other project types) is a little more certain. To see why we need to reiterate some of the conclusions of chapter 3.

8.2.1.1 Extension to Other Project Categories

Viewing the capital project as a surrogate for an Entity change decision and noting that an Entity change cannot be a pure type as an Entity change also requires a Relational change (see chapter 3, section 3.1.1.2) it is reasoned that capital projects are likely to also include elements of social and possibly revenue projects. Strictly, therefore, the unit of analysis used within the study was probably a programme of projects with a predominantly capital project component. From the internal validity perspective this 'lack of purity' represents a threat, it is however beneficial to the study's external validity. During a number of interviews it appeared to the author that the projects being described, and previously identified as being capital, were more akin to social projects. Two such cases were identified, a project to implement BS 5750 Part 2 and a project to reorganise the shop floor work flow arrangement. The first project was subsequently categorised as a Control topic, the second as a Reorganisation topic in table 6.5b. Both topic categories were identified with Social projects in chapter 3. A further interesting observation regarding these cases relates to the analysis of question 2b.17 of the questionnaire. This question was analysed in chapter 7 (see Figure 7.3) and captured the relative 'learning' or 'variety reduction' occurring during the project. The finding summarised in chapter 7 was that learning occurred predominantly during the project's final Operation stage. Indeed, on the average nearly as much learning occurred during this stage as occurred during the other three stages (Design, Installation and Commissioning) combined. The interesting feature of the two cases quoted above was that the initial Design stage accounted for most of the "learning". Two other cases were identified from the main sample which exhibited a similar pattern, both were control topic decisions and of three other Control topic decisions within the sample, all ranked Design or Installation as contributing the most or second most to Learning. This indicates that cases associated with social project topics tend to exhibit a markedly different "Learning" pattern than do the vast majority of capital investment projects studied.

A further comparison between revenue and capital project types is possible by comparing this study with those of Ginzberg (1978) and Zand and Sorensen (1975). These studies looked at the implementation of Management Science/OR projects (e.g. the implementation of a new stock control model) and provide examples of what we call revenue project. In addition, the two studies cited above both employed the Lewin-Schein model as their basic theoretical perspective. This enables a reasonably direct comparison between their findings and some of this study's to be made. Importantly, both of the above studies found that Refreezing contributed most to project success; where success was measured as user satisfaction, a concept similar to our managerial Satisfaction. This finding is similar to one of our findings. However, a point of departure between this study's findings and those of Zand and Sorensen (1975) concerns the important interconnections between the Unfreezing, Moving and Refreezing stages of the Lewin-Schein model. In particular Zand and Sorensen found a strong association between positive Unfreezing and positive Moving constructs. This study identified only a weak association, a result pointing to a possible difference between capital and revenue project types. Other associations identified by Zand and Sorensen (using fifth order partial correlations, see next chapter section) were similar.

Thus, in terms of the stages of the Lewin-Schein change model we observe that for capital and revenue projects it is the final Refreezing stage that is primarily determining satisfaction. Observing that the Unfreezing stage of the Lewin-Schein model is associated with the pre-approval stage of a project, our earlier discussion provides evidence to suppose that the Unfreezing stage primarily predicts project satisfaction for social projects. Finally, this study indicates that the pattern of associations between the three precepts of the Lewin-Schein model are different for capital and revenue projects. An important rider to these speculations is that a different set of indicators would be used to measure the theoretical constructs of an instrument specifically designed for Social or Revenue projects. This may also affect the pattern of associations between constructs. In summary, the evidence is that the findings and conclusions of this study do not readily apply to projects other than capital investment projects.

8.2.1.2 <u>A Methodological Note on the Zand and Sorensen Study</u>

This note represents a digression from the main issues of this chapter but is necessary to account for an apparent contradiction in the argument of the previous section. In discussing Zand and Sorensen's (1975) findings it was noted that they identified a strong association between their positive unfreezing and positive moving constructs, whereas this study identified only a weak association between these constructs. Both these findings are derived from an analysis using fifth order partial correlations. That is the correlation between positive Unfreezing and positive Moving say, controlling for negative Unfreezing, negative Moving, positive and negative Refreezing and success (the LSI in Zand and Sorensen; Satisfaction, SES in this study). This discrepancy is unlikely to be due to the operationalisation of these constructs as this study used a parsimonious set of Zand and Sorensen's indicators.

The regression results reported in chapter 7 (table 7.12) identifies a *strong* association between Unfreezing and Moving, a result in apparent contradiction with the *weak* association noted above based on partial correlation. The reason for this apparent contradiction is not due to the aggregation of positive and negative indicators of Unfreezing etc., but because it is not appropriate to use fifth order partial correlations to explicate the key associations between constructs in which causal order can be established. This is the essence of Blalock's (1972) statement reported in chapter 7, that in using the Simon-Blalock technique in causal modelling one does not control for variables that are dependent upon the variables being analysed. Dependent variables cannot be influencing the association being studied and therefore should not be controlled. In the case of the Lewin-Schein change model a causal order can be established. This runs from Unfreezing through Moving and Refreezing to success and was noted in chapter 7. It is therefore inadmissible to control for Refreezing and success when analysing the association between Unfreezing and Moving. If such controls are applied, the results are frequently misleading and contradictory.

In conclusion, the difference in the pattern of fifth order partial correlations reported for this study and Zand and Sorensen's is indicative of a true difference between the two sets of findings. The actual values reported however are likely to be artifacts of the analytical technique (fifth order partial correlation) and not represent real associations. So, of the associations reported by Zand and Sorensen (1975) it is only the correlations between the two refreezing constructs and their level of success index (the LSI) that represent "real" associations, the other reported associations are likely to be artifacts of the analysis.

8.2.2 INFERRED CAUSALITY

In chapter 5 (section 5.2.3) we noted that three criteria needed to be established for causation to be inferred. These were (1) associative variation, (2) sequence of events and (3) absence of other possible causal factors (Green and Tull, 1970). There are a number of points within this study where associative variation has been established but where the other two criteria have been assumed, not demonstrated. In this section we will specifically investigate the evidence in support of criteria 2 and 3 above.

The negative associations between Meetings and Unfreezing, and Change, Ease and Refreezing identified in chapter 7 were assumed in the construction of figures 7.6a and 7.6b, to be causal. Because Meetings and Unfreezing relate to the pre-approval stage of the project it is possible to establish a sequence of events from these constructs to Change, Ease and Refreezing. However, the discussion in the first part of this chapter attempted to explain these negative associations in terms of other possible causal factors. Accepting the existence of these factors means that the negative associations referred to above are spurious, not causal. To represent this using the constructs identified in chapter 7, figures 7.6a and 7.6b need to be corrected by replacing the single headed paths with double headed arrows showing association.

The Process construct principally associated with Success was Refreezing. This association is unlikely to be spurious based on the evidence presented within this study. However, Refreezing refers to late stages of the project just as do the Success constructs. Is it reasonable to argue that this represents a sequence of events? Inspection of the items composing the Refreezing measure (table 7.10a) shows it to contain a measure of project success which accounts for about 11% of the variance of the scale. As managerial Satisfaction (SES) also was composed of items measuring project success, some of the association between these two items is to be expected. These comments accepted, the remaining 89% of the Refreezing measure's variance is composed of items measuring aspects of Engineering support, objectivity and availability of performance standards and top management encouragement of adoption. The vast majority of the Refreezing indicators are not dependent upon success, and we conclude that the inferred causal order between Refreezing and Success constructs is valid.

The research instrument was specifically designed to generate a sequence of events between Uncertainty and Information constructs and Success constructs (chapter 5). With the exception of the associations noted above there is no difficulty inferring causality between these constructs. There is a potential problem with the inference of causality between the Uncertainty and Information constructs. Specifically, hypotheses 3 and 6 in chapter 4 stated that Uncertainty and Information Experience caused Information Process. There is little difficulty with the causal order between Experience and Process measures, as Experience relates to parameters determined by the pre-project history of the organisation. The causal order between Uncertainty and Information Process is more problematical however. For example, an important indicator of Uncertainty was project cost. This would not be known until some design effort had been expended in determining cost. Design effort is associated with the pre-approval stage of the project, which in turn was measured by Process. Therefore, if many of the Process measures were temporally precedent to the Uncertainty measures, how can causality be inferred as being from Uncertainty to Information and not vice versa? At the very least it would appear that a reciprocal (non-recursive) relationship would exist between the two constructs.

The fallacy of the foregoing argument is the presumption that an indicator _is_ the concept. This is not so. In measurement theory an indicator is _caused by_ a concept (figure 5.3) and in this instance it is the Uncertainty associated with a project that causes the cost. The concept underpinning both Uncertainty and Information is Variety. Variety was defined in Chapter 3 and conceptualised in chapter 4 as a property of a project. Models developed in chapter 2 identified the inception of a project with "Goal recognition" (Goals originate in response to a changed strategic objective of the organisation). Therefore, as a goal defines a project and a property of the project is variety, it follows that the goal must also determine variety. Hence, we are able to equate a project's variety (i.e., Uncertainty) with the very start of the implementation process and consequently Uncertainty must precede all project specific Information. In other words, Information Process is a response to Uncertainty, as stated in hypothesis 3 of chapter 4. Furthermore, Uncertainty is an exogenous variable, as assumed throughout the study.

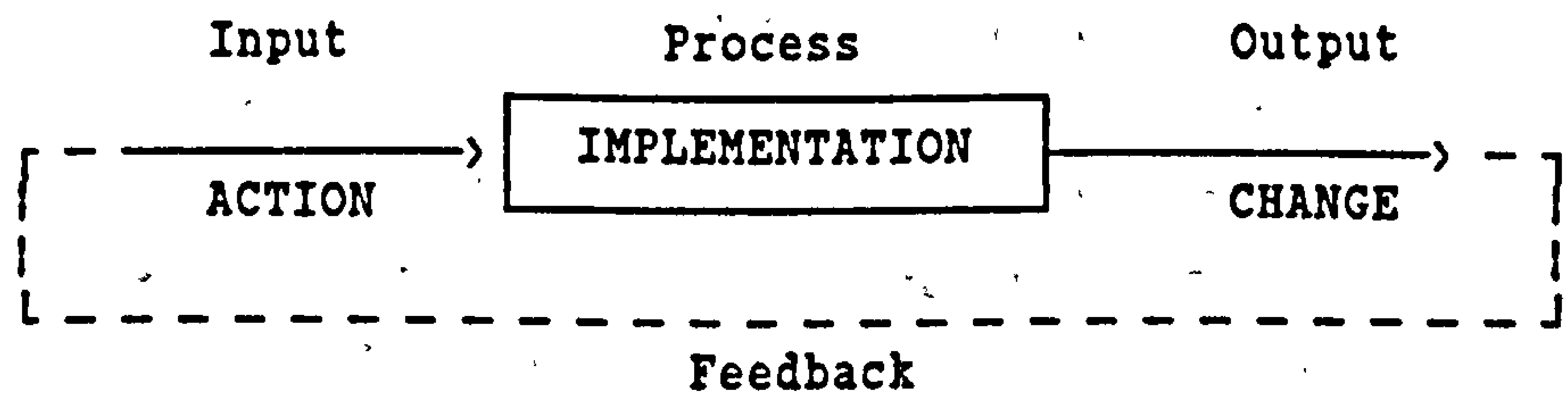
Following from the above discussion an interesting question is, can project Information affect the goals and objectives which created the project? The answer must be, yes. For example, it is not difficult to imagine a scenario in which subsequent information, on cost say, leads to a project being abandoned. In terms of the logical models used above this implies a redefinition of an organisation's strategic objectives. However, as the change in critical success factors that stimulated the changed objective will still be present, the organisation is still constrained to implement a change of some type. One way could be by redefining its business environment, effectively replacing a capital project by a revenue project. This study did not investigate scenarios of this type, although they were observed to occur by Hickson *et. al.* (1986) and have been commented on in chapter 3.

8.2.3 LEARNING AND COMPETITIVE ADVANTAGE

In chapter 2 we noted that the focus of this thesis would be on strategic change. In figure 2.10 we indicated that such change would influence an organisation's internal resources directly, where internal resources is taken to include procedural techniques. The basis for this assertion was identified in chapter 4 through the argument that strategic change represented changes to an organisation's standard operating procedures and this reflected "Organisational Learning". It was further argued in chapter 4 that such changes could represent a source of competitive advantage to an organisation in a manner similar to the *Gateway Capacity* concept identified by Zaltman *et. al.* (1973). Gateway Capacity was defined by Zaltman *et. al.* as the "extent that the adoption of an innovation can open avenues to the adoption of other innovations". Such Gateway Capacity effects may be overt or covert; covert in the sense that the project may spin-off unintentional benefits. Question 2a.28 of the questionnaire (Appendix A) was designed to measure a projects overt Gateway Capacity. Projects undertaken for these reasons typically involved the purchase of computer controlled machinery (see chapter 9 for a fuller discussion). Here, our aim is to discuss and develop the covert Gateway Capacity arguments, to identify how these may enable an organisation to develop competitive advantages and to identify limitations to this competitive advantage argument.

It will be instructive in developing the following arguments to view implementation as a simple process with inputs and outputs. In chapter 3 we identified change as the output of implementation. March (1981) argues that organisational change follows from organisational action and comments that "Action can be seen as stemming from past learning". This statement serves two purposes, first it identifies action with a learning concept and secondly it implies that learning is cyclical through time. In other words, learning involves feedback. An initial model of organisational learning would be as follows.

Figure 8.3: Organisational Learning - Initial Model.

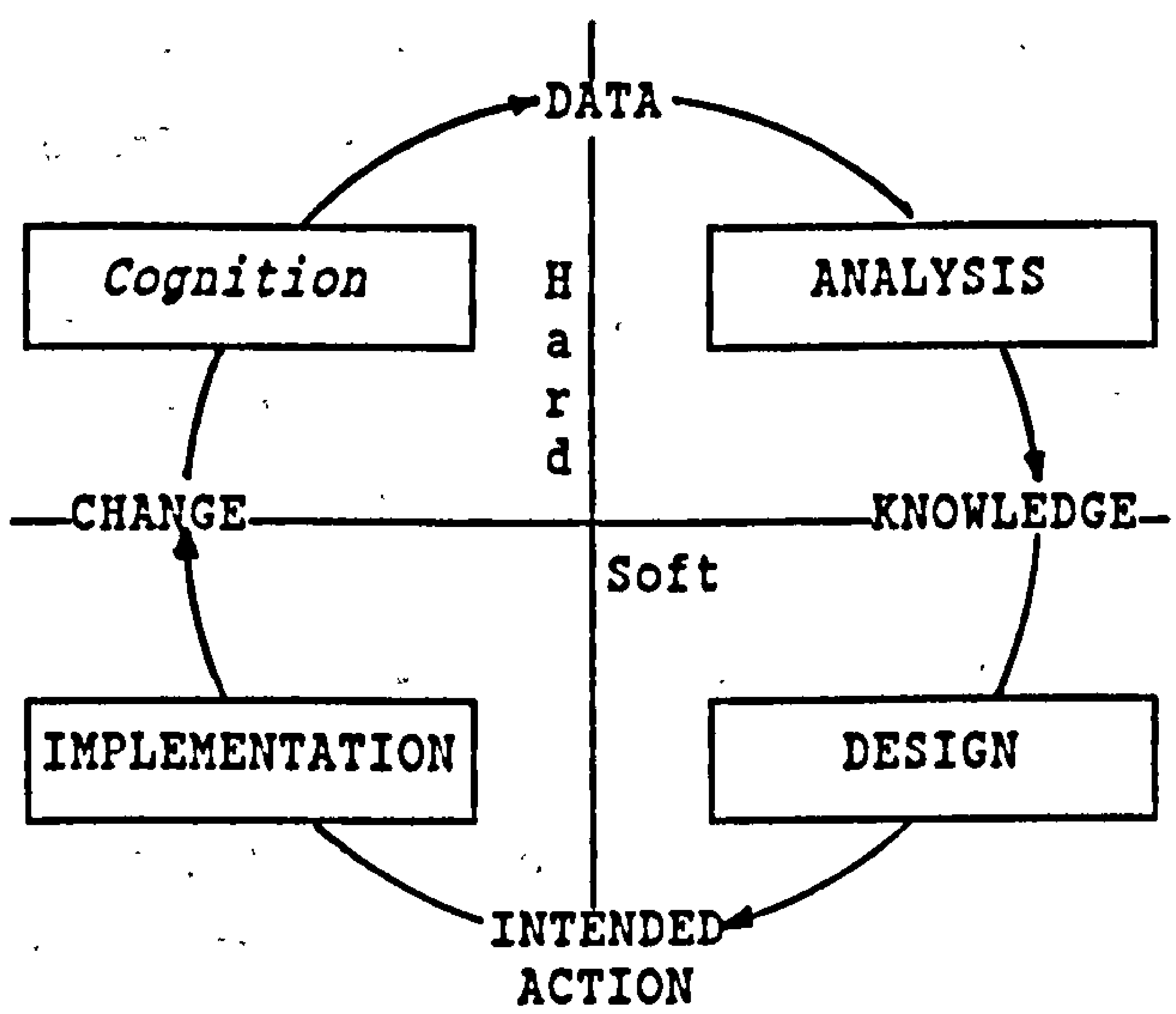


To extend the above model a process is required whose output is action. Mintzberg *et. al.* (1976) define a decision as a commitment to action, and in chapter 2 it was noted that planning and decision-making are synonymous in a managerial context. Thus, we see planning as a precursor to action. In turn, internal and external data *or* information was identified in chapter 2 as inputs to the planning process (e.g., figure 2.1). There is however a problem with this view and it relates to the use of the word <u>or</u>. Data is not information and the input to planning has to be one or the other. Computer scientists and accountants (Higgins, 1985) draw a distinction between the two. Woodhouse *et. al.* (1982) for example define data as "unorganised facts which appear as a collection of numeric and/or alphabetic and/or other characters in some representation". Information, on the other hand, is defined as "the meaning attached to data". This definition of information implies an inferential process which converts data into information (Tsichritzis and Lochovsky (1982). We will refer to this process as "analysis". However, the word Information has been used elsewhere in this thesis to refer to Variety Reduction and to avoid confusion with this meaning the word "knowledge" will be used in the current context. Analysis is therefore a process which converts data into knowledge.

To complete the connection between data and action a second process is required that converts knowledge into action. We will refer to this process as "design". Planning is therefore a combined analysis and design process. Analysis is concerned with "what" questions (what does this data mean?) and design with "how" questions (how do we use this knowledge?) (Gane and Sarson, 1979). This description of planning is in reasonable agreement with Anthony's (1965) definition as "deciding what to do". Finally we note that planning is identified by some authors with learning (e.g., De Geus, 1988).

By splitting planning into a two stage process two dimensions appear. One is associated with data and action. It is associated with concrete, specific items, such as facts and objectives. This could be referred to as a "Hard" dimension. The other dimension, in contrast, is associated with items like knowledge and with reference to figure 8.3 above, change. These items define a "Soft" dimension, in the sense that knowledge and change items have less clearly defined attributes, such as time and place, whereas data and action have more clearly definable attributes. These Hard and Soft dimensions provide a structure on which an extended version of the model in figure 8.3 above can be constructed. This model is illustrated in figure 8.4, and is a model of experiential organisational learning. It is experiential because it includes an implementation stage and is therefore a model of "learning by doing". Note that the focuses of this model is on the standard operating procedures of an organisation.

Figure 8.4: A Model of Organisational Learning



8.2.3.1 Implications of the Organisational Learning Model

As previously stated, implementation in this study is seen as a process which changed standard operating procedures. Chapter 4 identified the standard operating procedures of an organisation with its skills. A change to these procedures is therefore equated with an adaptation, or extension, of the organisation's skills/distinctive competency. Thus, the process connecting change to data in figure 8.2 is a process leading to the recognition and identification of these skills. To paraphrase Theodore Levitt's seminal contribution, the question being asked during this process is "What organisational skills do we really have?". For this reason the process connecting change to data in figure 8.2 will be referred to as "Organisational Cognition". The questions then being addressed during the planning stages of the model relate to "What new or additional opportunities do these skills open up?" and subsequently "How can we capitalise on these opportunities?".

With this interpretation of organisational learning we are able to understand how implementation can lead to competitive advantage. Implementation leads to competitive advantage (in a not directly economic sense) if the skills the organisation acquires as a result of the implementation can be recognised and subsequently used. Implementation drives the organisational learning process but of itself is not sufficient for the full benefits, if any, to be realised. That such "spin-off" can occur was demonstrated in the case study described in chapter 4. This concluded that a procedural change adopted to eliminate a liaison problem encountered during the project was in fact a core skill required by any organisation wishing to become a Just-In-Time supplier. At the time of the study there was no indication that the organisation wished to capitalise on this skill. An example of where spin-off effects may have directly lead to new business opportunities for an organisation is found within the Mail Order catalogue industry. Many companies within this industry possess subsidiary companies providing credit worthiness information to lending institutions, e.g., Grattan, Empire Stores. The data required by these subsidiary companies is provided by the core business which supply goods on credit to a large number of households within the U.K.

Adopting this perspective indicates that the best time for an organisation to review its competitive skills is following the implementation of a strategic decision. Such a review suggests the idea of a formal "Organisational Skills Audit". This idea appears to be superficially similar to certain procedures already used by some organisations, e.g., the Personal Skills Audit, the Post Completion Audit. The Personal Skills Audit focus on such skills as fluency in a foreign language, or ability to use a PC. The Post Completion Audit seeks to identify improvements to capital expenditure planning and budgeting procedures (Neale and Holmes, 1988) in order to improve the quality of existing and future investment decisions (Pike, 1988). These two examples would need considerable modification if they were to fulfil the aims of the proposed Organisational Skills Audit, which is to identify organisational skills with potential for creating future innovative opportunities. Such an audit could start by asking the question "What skill do we really have?", a question initiating the Organisational Cognition process of figure 8.2 above. However, to ask the next question proposed above, namely "What opportunities do these skills present?", requires access to data that will probably be external to the organisation. This point was noted above and is supported by many studies into the innovation process, whether at the national, industry or organisational level (see Cohen and Levinthal, 1990; for a review). It is also suggested by the findings of this study. Model III in chapter 7 identified a statistically significant path between External Information (IASE) and Success/Change (SCX) constructs. Indeed this was the only significant and <u>positive</u> association identified between pre-approval and success variables.

The paper by Cohen and Levinthal (1990) cited above, is relevant to the present discussion of how an organisation may identify and further utilise skill changes that "spin-off" from strategic projects. They argue that the level of prior related knowledge possessed by a firm is critical to its ability to exploit new, external knowledge and thus its innovative capability. Their thesis focuses on a firm's ability to recognise new information, assimilate and apply it. They identify this ability with the concept of "Absorptive Capacity". The concept of Absorptive Capacity appears to be congruent with the three processes of figure 8.4 identified here as, "organisational cognition", "analysis" and "design". A further point of congruence between this study and Cohen and Levinthal's relates to the sources of Absorptive Capacity. They note that it may be a by-product or spin-off from R & D investment, a firm's manufacturing operations or more directly through sending staff on training programmes. The congruence is suggested by noting that R & D investment is frequently ongoing, budgeted revenue expenditure and the Absorptive Capacity spin off may therefore be equated with spin off from Revenue projects as defined in chapter 3. Similarly, spin off from manufacturing operations is similar to the arguments proposed here, that Capital projects have potentially beneficial side effects. Finally, their personnel training programme is an example of a Social project. Thus, we identify an organisation's Absorptive Capacity as a major constraint on its ability to identify covert Gateway Capacity benefits. Absorptive Capacity is in turn, according to Cohen and Levinthal, determined by the level of prior related knowledge, the Absorptive Capacity of individual members of the organisation, the communication structure (both internal and external) and the path or history of the organisation. These factors are therefore even more basic constraints on the ability of an organisation to reap the incidental benefits resulting from the implementation of a strategic decision.

8.3 CHAPTER SUMMARY

This chapter has sought to address a number of issues. The first was to elicit possible explanations for the negative associations identified in chapter 7 between Information Process and Success constructs. Initially we discussed Politicality as a possible explanation but found little evidence for supposing this to be directly dysfunctional to the implementation process. However, Politicality was indirectly implicated as an "amplifier" of underestimating the design effort required on a project. This argument suggests that the negative association between Meetings and Ease (and also Meetings and Refreezing) could be due to an initial underestimation of the true complexity of the project. Possible reasons how such underestimation might occur were identified as, quality of the organisations planning system, lack of prior knowledge and structural factors relating to the method of project assessment. It was then proposed that the observed association between Meetings and Ease (and also Refreezing) was spurious and due to the pattern of associations illustrated in figure 8.1.

Turning to the association between Unfreezing and Change, the phenomenon of resistance to change was considered. By assessing possible causes and effects of this phenomenon it was proposed that associations between Unfreezing, Resistance to change, Uncertainty and Change could result in the observed association being spurious. However, this was viewed as only a partial explanation, and a validity argument based on the inadequacy of the Unfreezing measure was also invoked. Theoretically the Unfreezing construct was intended to measure the effectiveness with which the need for the project was instilled into various organisational actors. It was suggested that the Unfreezing measure used may have measured a process by which internal information was obtained for use in designing the project, not the effectiveness of reducing social resistance to the project.

The next major issue addressed in this chapter was the question of external validity. Here it was argued that the theoretical basis of the study (and subsequently proposed modification of this theory) would not threaten external validity. In addition the study covered a wide range of Capital project and its findings should be quite general. However, there is tentative evidence to suggest that these conclusions will not be applicable to projects other than Capital investments. Finally, there is the question of the study's applicability to non-manufacturing organisations. A wide range of manufacturers were covered in the study and shown to be representative of the national distribution. The study's finding are therefore probably representative of most of the U.K.'s manufacturing sector. Whether the implementation of Capital projects in manufacturing organisations is any different to their implementation in Service organisations this study cannot say.

Following the discussion on external validity we reviewed issues of inferred causality. With some minor provisos, assumptions made during the study were held to be valid. Finally, we sought to identify some limitations to the theoretical assertion made in chapter 4 that implementing strategic decisions would lead to unintentional, or indirect, competitive advantages for an organisation. It was proposed that, following the final implementation of a strategic project, an "Organisational Skills Audit" should be performed to identify any new skills capable of being used as a basis for future innovative developments. The key questions to be asked during such an audit were identified as "What skills do we really have?" and "What opportunities do these skills present?". The answers to these questions probably depend upon access to relevant external information and the organisation's

Absorptive Capacity. This in turn will be a function of the organisation's prior related knowledge, communication structure and history (Cohen and Levinthal, 1990).

This, and the previous two chapters, have been concerned with analysing the experimental data on implementing capital projects collected from 45 U.K. based manufacturing organisations. In the remaining chapter we aim to summarise the study's findings, present its conclusions and address its further implications.

CHAPTER 9

SUMMARY AND CONCLUSIONS

The previous chapters have detailed the theory, methodology and analysis of the data employed in this study. This concluding chapter presents a summary of the research, its findings and their implications. It also discusses the limitations of the research and recommends areas for further research directed towards a greater understanding of the implementation of strategic decisions and the implementation of strategy in general.

9.1 <u>OVERVIEW</u>

9.1.1 AIMS AND BACKGROUND TO THE STUDY

This study did not set out to solve a particular practical problem in the implementation of strategy. The study is therefore not of the Evaluation, Applied or Action research forms. It is of the Basic objective research form, which is concerned with tackling a general problem of the application of knowledge (Bennett, 1986). This is not to say that the findings of this study are of no or little practical benefit to practising managers (such benefits are addressed in section 9.3) but that consideration of the practical application of any findings did not form part of the research approach or methodology adopted during the study.

In keeping with this research approach the questions addressed by this study are of a general nature, seeking to investigate the broad structure of the phenomenon in the context of the individual organisation. These questions aim to clarify and explain. Examples are; What is implementation? What are the principal contingent dimensions of the phenomenon? What happens to an organisation when a strategic decision is implemented? What is implementation success? Answers provided to these questions and other questions raised by these answers, will be discussed and summarised here.

Literature in the Business Policy/Strategic Management area dealing with the topic of strategy implementation is not, as yet, very extensive; certainly in comparison with the writings on strategic analysis, planning and formulation. What has been written in the strategy literature primarily dates from the early 1980's. One reason for this lack of interest is that many aspects of implementation (e.g., control) were seen as the domain of other subjects (e.g., Management Accounting). In addition, prior to the 1980's much of the strategy literature took the view that decision making was more important than implementation. Make the right decisions and implementation will follow automatically, was one of the underlying assumptions of strategy formulation (Ansoff, 1984; Stonich, 1982). However, by the early 1980's this assumption was no longer held as tenable, prompting interest in the subject over the last decade.

While the strategy literature has been relatively silent on the implementation question, other subjects have a longer history of research in areas which can contribute to its study. The economic literature dealing with technological change and innovation (stemming principally from the work of Schumpeter, *circa* 1940) is relevant. Another important source is the organisational theory literature dealing with organisational change (dating from the work of Trist and Bamforth; see Trist *et. al.*, 1963) decision making (e.g., March and Simon, 1958) and in particular studies of strategic decision making (e.g., Hickson *et. al.*, 1986; Mumford and Pettigrew, 1975). The "Project Management" and some psychological literatures are also of value in providing concepts and perspectives on the phenomenon. However, these literatures tend to address questions different to those asked of this study, nor do they provide a coherent theoretical structure from which to start an investigation of strategy implementation. In this study such a coherent theoretical framework was provided by the systems theory and cybernetics literatures.

9.1.2 REVIEW OF PERSPECTIVE AND THEORY

The first question asked of this study was "What is implementation? In point of fact several alternative, but complementary, definitions were identified. The first of these was developed in chapter 2 by consideration of the "classic" (or at least common) model of strategy implementation as a process intermediate between strategic planning and control. If implementation is intermediate then it should be possible to identify a start and an end to the process, thus logically separating it from the planning and control activities. By reviewing the meanings attached to strategy, strategic planning and operational planning, a model of organisational information flows was developed. Strategic planning was viewed as a process of continuous monitoring of various strategic variables against the predetermined set-points, or objectives, for these variables. Using this model it was determined that implementation started when objectives were changed, i.e., strategic decisions were made. This change in organisational objectives generated short term goals, the purpose of which was to achieve the new objective. The start of the implementation process was therefore referred to in the study as "goal recognition". By considering the operational planning/control function of an organisation (centring on the budgeting activities) it was determined that implementation ended with task definition. These were the day-to-day tasks that the organisation would have to perform in order to accommodate, or satisfy, the changed objective.

This model leads to the view that strategy implementation is a temporary bridge joining the strategic and operational activities of the organisation. From a decision making perspective implementation was defined as "Programming", viz:

> "Implementation is the process of interfacing an 'unprogrammed' decision making process to the organisation's 'programmed' decision making processes."

Viewing implementation as a temporary phenomenon causes the study to concentrate on the implementation of strategic decisions. As a result the concept of organisational change is important in developing the study. Through a combination of arguments derived from systems theory and cybernetics, together with a secondary data analysis of a major U.K. study into strategic decision making (Hickson *et. al.*, 1986) a framework for categorising strategic decisions was developed. This framework was further developed to argue that strategic decisions are implemented through a programme of projects. Projects are therefore the atomic unit of analysis for studying implementation. Furthermore it was determined that projects are principally of three kinds. These were labelled the Capital project, the Revenue project and the Social project. Of these the Capital project was found to be the most consequential, on average, for an organisation.

A number of conclusions can be drawn from the conceptualisations just described. Some are practical, some theoretical. The practical considerations are that the study should focus on Capital investment projects. It was further concluded that, as this type of project is most common within manufacturing organisations, this class of organisation should be the basic type of organisation studied. Together these two considerations determine the sub title of this thesis. In relation to the question "What happens to an organisation when a strategic decision is implemented?" the substantive answer is that it is changed. The framework for categorising strategic decisions was based on the idea of change in the structure of the organisation. This idea was subsequently developed to mean changes in the repertoire of standard operating procedures employed by the organisation in its day-to-day activities. From this perspective such change is seen as being indicative of organisational learning, in the sense that extensions of this repertoire confer on the organisation the ability to absorb a greater degree of environmental variety. This in its turn represents a strategic advantage for the organisation over and above the specific financial or marketing advantage anticipated for a project in the first instance.

In adopting this approach the question "What is implementation success?" is interpreted as organisational learning, i.e., the ability of the organisation to absorb a greater degree of environmental variety, or uncertainty. The principal contingent dimensions of the implementation phenomenon are therefore external variety injection (Uncertainty) and internal variety absorption (Information). Uncertainty is a property of the particular project being implemented and as such is determined by the strategic goal and changed objective initiating the project. Programming is therefore a process for absorbing a project's (or strategic decision's) variety by changing the organisation's standard operating procedures by task definition. It was convenient to subdivide the Information construct into Experience and Process dimensions. Experience referred to preexisting organisational procedures that would give the organisation an innate capacity for variety absorption. Process referred to the activities performed by the organisation to absorb the variety injected by the project. Implementation success, seen in terms of organisational learning, also has two components. One of these views success as the ability of the organisation to achieve the intended aims of the project. This view of success looks at the ability of existing procedures to absorb the variety injected into the organisation by the project and is reflected in the absence of problems etc., during implementation. This concept was referred to during the thesis as Ease. The other dimension of success refers to the extent of adaptation of procedures required to finally implement the project. This concept was referred to as Change. Change is associated with organisational learning and success because it may confer "Gateway Capacity" (Zaltman *et. al.,* 1973) benefits on an organisation. Gateway Capacity is the extent to which the adoption of one innovation can open up avenues to the adoption of other innovations. The utility of this approach and conceptualisation was illustrated by the analysis of a case study conducted as part of the research. This study indicated how unanticipated problems encountered during the implementation of a capital project gave rise to procedural changes of potential future strategic advantage.

The five concepts outlined above of Uncertainty, Information Experience, Information Process, Ease and procedural Change and ten hypotheses connecting them, constitute the principal structure describing the implementation phenomenon and investigated in this study. We now turn to a summary of these investigations.

9.2 SUMMARY OF FINDINGS

9.2.1 METHODOLOGY

The theoretical variables outlined above were investigated using a highly structured questionnaire instrument consisting of closed questions (Appendix A). Questions were asked retrospectively about objective events relating to two units of analysis; a particular strategically important capital investment project and the organisation. The instrument had to be amenable to numerical analysis and consisted, in the main, of questions scored on a five point scale ranging from "Little or none" to "A great deal". The actual instrument required some 400 separate responses for completion and was administered during a personal interview lasting nominally 90 minutes. This interview was frequently tape recorded.

This research methodology was adopted following a pilot study to test response rates to a mailed survey. This pilot study indicated a probable response rate to a mailed survey of less than a minimally acceptable 20 per cent. Through the use of personal interviews a response of 52% was achieved, considerably increasing the study's internal validity. Whilst the interviewing approach substantially restricted the distribution and number of cases for analysis, reducing to some extent the study's external and statistical conclusion validities, it was possible to control for certain biases, e.g., non-response bias. In addition, for an exploratory theoretical study of the type reported here, threats to internal validity were seen as being the most serious to the study's overall validity.

9.2.2 THE SAMPLE

Interviews were conducted with single key informants from U.K. based manufacturing companies. These informants needed knowledge of the project from its initial goal recognition phase, through authorisation to final operational integration into the day-to-day activities of the organisation. In addition the informant needed to possess knowledge of the organisational parameters of interest. Informants were therefore directors or senior managers of the organisations studied. Chief executive officers comprised the largest single grouping, at 51% of the total sample.

Manufacturing organisations for inclusion in the study were selected from the 1988 KOMPASS directory. Companies were selected, principally, on the basis of number of employees (100 or more) and product area (two digit product group classifications 11 to 49, see Appendix B). From nominally 30,000 companies listed in the KOMPASS directory, these criteria reduced the available sample frame to an estimated 8500 companies.

The results reported in this thesis are based on a sample of 45 cases obtained between March and August 1989. The majority of the sample consists of 40 main study cases obtained by personal interview and are mainly concentrated in the West Yorkshire area of England. The remaining 5 cases came from early pilot study work on the research instrument. Attempts using secondary published data and data obtained directly from the study, failed to identify bias between the main sample and 37 non-responding organisations contacted, or between the study sample and a nationally representative sample of 857 U.K. manufacturing companies drawn from the KOMPASS directory.

One statistic derived from the study was the informants' perception of the position of their organisation relative to their major competitors. This measure indicated that the participating companies were better than expected for an average organisation. Interpretation of this finding is problematical however, as it is not objective and comparable data could not be obtained from non-participating organisations. Whether the result is due to bias in the sample, or bias in the response to the question cannot therefore be ascertained. However, commercial success was not a parameter of significant interest to the study, hence, any bias from this source was not judged to threaten the study.

Eight of the ten strategic decision "Topic" categories used by Hickson *et. al.* (1986) were investigated during the study. These were concentrated in those topic categories anticipated to be typical of strategic capital investments. The investments studied are therefore judged to be representative of strategic capital investment decisions in general.

9.2.3 CONSTRUCT VALIDITY

Construct validity was determined in the study through the assessment of trait validity, using the technique of principal components factor analysis. Factor analysis was used to assess both the reliability of composite multi-item scales and the factorial composition of these scales. After elimination of a number of "noisy" indicators the multi item scales of the theoretical constructs were adjudged to be satisfactory with theta reliabilities in the range 0.66 to 0.86. Results of the factorial composition analysis of the scales were generally satisfactory. Where the factor structure did not correspond with the theoretically anticipated structure, alternative plausible explanations for the observations were relatively easy to identify. These came either from the literature or from other theoretical structures underlying the scales. Finally, discriminant validities were assessed using the technique of median correlation. These were also judged to be satisfactory.

9.2.4 HYPOTHESIS TESTING

Ten hypotheses were identified from the theoretical discussion of chapter 4. These may be summarised as:

1. Uncertainty and Change will be positively associated.
2. Uncertainty and Ease will be negatively associated.
3. Uncertainty and Process will be positively associated.
4. Capacity and Change will be negatively associated.
5. Capacity and Ease will be positively associated.
6. Capacity and Process will be positively associated.
7. Process and Change will be positively associated.
8. Process and Ease will be positively associated.
9. Uncertainty and Capacity will not be associated.
10. Change and Ease will not be associated.

The hypotheses summarised above are those tested in chapter 7 of this thesis. They differ from those formulated in chapter 4 in two respects. First, Information Capacity was used in place of Experience because of a failure to adequately measure one of the dimensions of the Experience concept. Capacity and Experience have the same interpretation within the hypotheses. The motivation for and discussion of this adaptation is contained in chapter 6. The second change to the above hypothesis summary is that the original formulation of the hypotheses involved a success concept entitled Expectation. During analysis (chapter 7) this concept was dichotomised into two of its component dimensions, Ease and Managerial Satisfaction. Here we have only referred to the Ease concept, as this encapsulates the original interpretation of Expectation. In the discussion that follows we will consider the analysis from the point at which Satisfaction was identified as a third dimension of implementation success.

The above hypotheses were investigated (initially) using the causal modelling techniques of partial correlation and path analysis. With a sample of 45 cases the power of the analysis enabled large effect sizes (Pearson and or partial correlations of about 0.50) to be satisfactorily identified (power 0.84 at a significance level of 0.01). Moderate effect sizes (r about 0.30) could also be detected with reasonable power at a significance level of 0.10.

The analyses presented in chapter 7 identified strong effects supporting hypotheses 1, 2, 3, 6, 9 and 10 above. No evidence in support of hypotheses 4, 5, 7 and 8 could be found at the high level of construct aggregation used. Moderated regression analysis also failed to provide evidence in support of hypotheses 4 and 5. It was therefore concluded that Information Capacity only affected implementation success indirectly through its influence on Process. In subsequent analyses the single Capacity measure was replaced by its two constituent measures, procedural Range and Mechanicity.

In order to explain the lack of statistical support for hypotheses 7 and 8, the Information Process construct was disaggregated into a total of seven sub scales. Three of these (Unfreezing, Moving, Refreezing) corresponded to the three stages in the Lewin-Schein change model used to construct a social measure of Information Process labelled Lubrication. The remaining four measures were constructed from the second Information Process dimension labelled Activity. Under factor analysis the indicators of the Activity construct formed a two factor structure, the factors being interpreted as Design and Support. The four scales were then produced by dichotomising the Design factor items into Formal Analysis and Internal Information search measures and the Support factor items into Meetings and External Information search measures. The items contained in each of these four Activity sub-scales were characterised by exhibiting a distinctive, and different, association with the three implementation Success measures.

Causal modelling is not suited to exploratory analysis of the associations between variables. The disaggregation of the Process construct into a large number of separate variables (with no clear theoretical basis for determining which of a large number of possible paths would be the significant ones) required the causal modelling approach to be abandoned. As none of the associations determined by causal modelling had exceeded 0.7, multicollinearity between variables was not likely to be a serious problem. Hence an exploratory approach based on stepwise regression was adopted for this stage of the analysis. The investigation of the relationships between Uncertainty, the two Capacity measures of Range and Mechanicity, the seven Information Process variables and the three Success variables was based on this technique. However, a further analytical problem remained in identifying the associations between the four Information Activity measures; Analysis, Meetings, Internal and External information search and the first stage of the Lubrication concept, Unfreezing. Because these five variables all referred to the pre-approval stage of the project, no variable was obviously dependent upon the others. Investigation of the structure of associations between these five variables was therefore based on partial correlation. Wherever possible the results obtained by stepwise regression or partial correlation were compared with the results of other analyses. If contradictions occurred then the substantive or causal modelling results were used as the final arbiter.

Results of the analyses will be summarised here using the following nomenclature. Firstly, no association or path with a standardised regression coefficient, or β coefficient of less than 0.2 was considered. As stated above, weak associations could not be detected by this study. A regression or β coefficient in the range 0.2 to 0.4 is referred to here as a "Moderate" association. Strictly, correlations below 0.25 are not statistically significant on a 2-tailed t-test, although 0.20 is significant at the 10% level using a 1-tailed test. Partial correlations below 0.25 were not therefore included unless supported by either substantive reasoning or alternative analyses. Regression β's below 0.25 were included if significant at the 10% level. Associations or path coefficients above 0.40 are referred to as "Strong". This nomenclature is based on Effect Size, not statistical significance (see chapter 7 for a discussion of Effect Size).

9.2.4.1 Associations Between Information Measures

Here we will summarise the associations between the nine Information measures. These are the two Information Capacity measures, the four Information Activity measures and the three Information Lubrication measures. In total thirteen substantive associations or paths were identified. All were of Moderate strength, except for two Strong associations, one between Unfreezing and Moving, the other between Internal information search and Refreezing. The associations are summarised diagrammatically in figure 7.6a. Note that in figure 7.6a, and 7.6b, correlations or paths significant at or above the 5% level are shown using heavy lines, those significant between the 10% and 5% level are shown by light lines.

Apart from a moderate association between the two Experience measures of Mechanicity and Range, the only other associations between Capacity and other Information variables in the study were moderate paths between Formal Analysis, Internal Information Search and Mechanicity. Formal Analysis was itself moderately associated with the Activity measures of Internal Information Search and Meetings and with the Lubrication measure, Moving. Moving refers to the action phase of a change effort and requires the presentation of information necessary for the change (Ginzberg, 1978). It was reasonable therefore to assume that Formal Analysis would be a likely source of such information. Another determinant of Moving was a strong path with Unfreezing. Unfreezing refers to a process congruent with the four Information Activity measures and is concerned with establishing a "felt need" for change. It was moderately associated with Meetings and Internal information search. Refreezing refers to the stabilisation phase of a social change and was strongly associated with the Internal information search variable. Refreezing was also moderately negatively associated with Meetings. One other association remains and this is between the Activity variables, Meetings and External information search. This association was not statistically significant but was justified on the basis that these two variables combined constituted Support. Support was identified as one of the two factors describing the structure of the Information Activity construct, the other factor being Design.

9.2.4.2. <u>Associations between Uncertainty, Information and Success</u>

Here we will summarise the associations between Uncertainty, the four Information Process measures exhibiting associations with Success and the three Success constructs of Change, Ease and Satisfaction. Fifteen statistically significant ($p<0.10$) regression β's were identified. Eight were of Moderate strength, seven were Strong. The associations are summarised diagrammatically in figure 7.6b.

Of seven Information Process measures, Uncertainty was only associated with the four Information Activity measures, not the Lubrication measures. Three regression coefficients were strong, the one between Uncertainty and Internal Information, moderate. The overall path coefficient between Uncertainty and Activity was strong, thus supporting hypothesis 3. As anticipated, Uncertainty was not associated with any of the Information Capacity measures. Path analysis had confirmed and stepwise regression also indicated, that Uncertainty was positively and strongly associated with Change and strongly negatively associated with Ease. These results confirm hypotheses 1 and 2.

Using causal modelling techniques we were unable to find evidence in support of the hypothesised association between Capacity, or its components, and success (hypotheses 4 and 5). However, stepwise regression did provide tentative evidence in support of hypothesis 4. Specifically, a weak (but statistically significant at the 10% level) path was identified between Mechanicity and Change. This association was negative, as anticipated, but relatively unstable, i.e., deleting certain single cases from the study's data base caused the association to disappear.

Of seven Information Process sub-measures, four were found to be associated, strongly or moderately, with success measures. Refreezing was moderately associated with all three success measures and this result is similar to the findings of Sorensen and Zand (1975) and Ginzberg (1978); two studies investigating the implementation of Management Science/OR projects. External information search was moderately associated with procedural Change. Taken together these findings appear to confirm hypotheses 7 and 8. A possible explanation as to why these associations did not appear when using the more aggregated Information Process construct would be that the relatively small number of indicators within this overall measure which exhibited significant associations were "swamped" by those showing no or little association of the anticipated kind. A further reason however is supplied by noting that the Unfreezing and Meetings measures both exhibit negative associations with Success. Specifically, Unfreezing was strongly negatively associated with Change, and Meetings moderately negatively associated with Ease. Negative associations between success measures of these indicators would act to cancel out the positive associations just noted. The net effect was the observed very weak associations between Information Process and Success.

The appearance of negative associations between certain Information Process indicators and Success constructs was not anticipated by the theoretical development underpinning this study. We how summarise the speculative arguments accounting for this observation.

9.3 DISCUSSION AND IMPLICATIONS OF THE STUDY

The implications of this study will be discussed here under two main headings. Those implications derived directly from the theoretical model and those from observations not conforming to the theoretical model. This last section basically summarises and discusses the material contained in chapter 8 of this thesis. In both instances, it will be the practical managerial consequences that are emphasised.

9.3.1 THE THEORETICAL MODEL

9.3.1.1 Change and Ease

The concept of implementation success developed during this study was based on the concept of organisational learning. This was contrary to a more "conventional" approach based on financial criteria of success, e.g., profitability. The reasons for rejecting this approach were twofold. First, many financial measures of project success are likely to depend upon the planning and formulation stages prior to project implementation, not just upon the implementation stage and methodologically it is difficult to separate the two effects. The second reason is that profitability is an aggregated surrogate measure of a large number of processes and activities performed by an organisation, the focus of this study was upon these basic activities, not their aggregate.

Implementation success was shown to have three components, Ease, measuring the achievement of expected outcomes, goals, lack of problems etc. Procedural Change, which may (if made explicit) form a basis of future strategies and projects, and finally, Managerial Satisfaction. Satisfaction was shown to be dependent upon Ease, Change and Refreezing. Satisfaction will therefore tend to be high where Ease and Change are high and need not concern us further.

The strongest relationships identified in the theoretical model were between Uncertainty, Ease and Change. Specifically, the greater the Uncertainty, or variety a project injects into an organisation (relative to its current experience) the greater the Change to existing procedures and the lower the Ease of implementation. This conclusion may appear axiomatic stated as it is here, but note that one of the assumptions traditionally held of strategic planning (Stonich, 1982; Ansoff, 1984) was that existing operations-implementation systems and procedures would translate a plan into action. The findings reported here show this not to be the case. This finding may be expanded using control theory concepts. Much of control theory is based on models in which it is assumed that the system under control is a "black box". Output levels depend only upon input levels and time. The processes contained within the black box are assumed to be fixed. The finding of this study in effect states that implementing a strategic decision will change the contents of the black box. Classical control theory is therefore not applicable to the problem of strategy implementation in the sense of effecting strategic change. Where it is applicable is in the subsequent maintenance of strategy, essentially an operational concern. Also, the theory used here predicts how the black box will change; it will change so as to exhibit greater variety than previously. In summary, the implementation of a strategic decision cannot be done entirely using existing operating procedures. In addition the final organisation will be more complex than the initial one, implying the need for new operational control systems. Finally, the magnitude of these effects directly depends upon the variety injected by the project, as does the extent of problems likely during implementation. Practising managers should recognise these effects.

9.3.1.2 Contingency Allowances

One possible consequence of not adequately anticipating or estimating the extent of problems when implementing a strategic decision, is to overrun budgets, schedules etc. Contingencies are occasionally used to compensate for the unexpected. But are these contingencies adequate? The pilot study reported in chapter 4 investigated the use of contingencies in greater depth than in the main study. In the case of this particular organisation contingencies were officially only considered for certain items, such as currency fluctuations on imported equipment. They were not allowed to compensate for potential unanticipated problems with the project. (This rule did not prevent some unofficial contingency allowances being made, e.g., presenting volume estimates believed to represent reasonable minima of what could be achieved.) One informant gave the following response to a question probing the anticipation of problems and the use of contingencies to compensate:

> "We thought we would have horrendous problems. What they are, what form they'll take, we didn't know...except that we knew the return was satisfactory to cover [the risk]."

This quotation suggests that, provided the return on a project is high enough, the assessed risk associated with it will be acceptable. This implies that this organisation carried out some form of risk-benefit analysis on this project. However, because risk was seen in terms of unanticipated difficulties and because the extent of these difficulties could only be subjectively assessed, it is reasonable to assume that if the return had been lower, but still attractive, a point would have been reached where a profitable project would have been foregone. At the other extreme, incorrectly assessing risk too low may involve a company in serious financial loss. In either instance a less subjective method of risk assessment would be beneficial. It may be possible to construct such an indicator using some of the Uncertainty indicators identified in this study. The measure so obtained may be valuable in setting contingencies for projects, thus keeping them within budget.

9.3.1.3 Organisational Structure

Two organisational parameters were identified from the theoretical basis of the study to be of interest in understanding implementation. These were Procedural Flexibility and Range. We attempted to measure Flexibility using the Burns and Stalker (1961) Organic - Mechanistic dichotomy. This proved to be an unsatisfactory formulation as the Organic - Mechanistic dimension appeared to be measuring both Flexibility and Range. In particular Mechancity was identified as a indicator of Range.

Mechanicity was found to be weakly and negatively associated with Procedural Change. This association was hypothesised (see above). Mechanicity was also associated with the Design activities of Information Process, i.e., Formal Analysis and Internal Information Search.

Neither of these variables is associated directly with success variables. Finally, Range was not associated with any variable other than Mechanicity. From the available evidence organisational structure (measured as Mechanicity and Range) does not have a significant impact on an organisation's ability to implement capital investment projects.

9.3.1.4 <u>Social Change</u>

We will focus here on the influence of the three stages of the Lewin-Schein change model on implementation success. The single variable directly and positively associated with all three implementation success measures was identified by this study (and others, Sorensen and Zand, 1975; Ginzberg, 1978) as Refreezing. The conclusion of this finding is that attention to the items constituting the Refreezing measures will contribute to successful projects. These items are listed in question 2b.6 (Appendix A) and in table 7.10a. Focusing on items in table 7.10a with factor loadings above 0.3 we see that Refreezing is enhanced if the engineers support the project into the operational phase, if benefits from the project are seen quickly, and if standards and results for assessing the project are available. Top management encouragement is also seen to be important to Refreezing.

Noting that Refreezing is directly influenced by Moving and indirectly by Unfreezing we see from table 7.10a that both of these stages are dominated by items involving the unit managers. This centres on their involvement in the project, their recognition of the need for the project and their being reassured that the project is not a threat to them. In contrast to Refreezing we see that the engineers and top management have only minor influence on these stages. When these actors are important it is in association with the unit managers. We specifically note that top management initiation of the project has a negative influence on Unfreezing. This suggests that projects imposed from the top are to be avoided.

The negative effect of senior management initiation of projects on implementation success was also noted by Lockett and Polding (1978). Lockett and Polding, in a study of the implementation of Operations Research/Management Science projects, cite one project which was initiated by a senior manager, technically solved, but never implemented. They noted that the senior manager "left the problem" once a manager and a "modeller" had apparently started to make progress. When the project's budget allocation was used up, the project was discontinued without implementation. Lockett and Polding attribute the failure of this project to the manager's suspicion of the modellers role in policy recommendation, which he felt was his prerogative. They finally make the observation that, "The high involvement of top management, which is often thought to be necessary for implementation was here, but was not sufficient to achieve successful implementation." Features of the Lockett and Polding case support some of the findings of this study. The project was initiated by a senior manager. We noted above that this is negatively associated with Unfreezing and therefore ultimately project success. The unit manager involved perceived the project as a threat, again this would be a negative indicator of Unfreezing. Finally we note that the senior manager left the project in its early stages. We noted above that senior manager involvement is most beneficial to a project in its final, Refreezing stage. So, taking evidence from this study into the implementation of capital projects, and Lockett and Polding's (1978) study into the implementation of a type of revenue project, we observe that senior manager involvement "which is often thought to be necessary for implementation" must be of a supportive nature, not of a compelling nature, if it is to be of benefit to the successful implementation of a project.

One final result of the study is the importance of external information in effecting successful procedural change. This item will be discussed in some detail below.

9.3.2 EMPIRICAL OBSERVATIONS

9.3.2.1 Complexity and Planning

Turning now to the more speculative findings of the study, it is apparent that if implementation processes are to be improved then attention has to be paid to the factors giving rise to the observed negative associations between Success and Information Process. Three associations were observed, all from an underlying behavioural or social dimension to the Information Process construct. The discussion in chapter 8 identified the negative association between Meetings, Refreezing and Ease to be ultimately due to an underestimation of project complexity. Some experimental evidence in support of this hypothesis was available from the study. Question 2b.20 listed 20 possible problems with project implementation and the first item was the underestimation of project complexity. This item achieved the highest mean score of any of the 20 questions, identifying it to be the most serious cause of implementation difficulties.

A number of suggestions were put forward in chapter 8 as to why project complexity is underestimated. One possible explanation is a lack of prior knowledge. However, projects with a great deal of prior knowledge would, by definition, not be classed as strategic - they are programmed operational projects. This lack of prior knowledge could be corrected by the use of external consultants. It would also be dependent upon factors identified by Cohen and Levinthal (1990) as contributing to an organisation's "Absorptive Capacity". These are, the communication structure between the organisation and its external environment and between its internal sub-units, the absorptive capacity of its staff, access to critical knowledge (including the awareness of where useful experience can be found) and the history of the organisation. Structural explanations were also noted (March, 1981; Harrison and March, 1984). Finally, a third determinant was derived from a factor analysis of question 2b.20 and identified as Quality Of The Organisation's Planning System.

The factors identified above leads to the hypothesis that the negative associations with the Meetings construct were probably due to failure to recognise the project's true complexity. This tendency may be ameliorated by paying attention to the three factors identified here as contributing to it. For example, the structural bias identified by Harrison and March (1984) in the method of capital project assessment may be overcome by the use of more sophisticated capital project risk assessment techniques, e.g., Monte Carlo simulation. This study suggests that better planning systems may also help prevent this problem. Finally, there is the lack of prior knowledge and Absorptive

Capacity explanation. Ways to help overcome this difficulty will be returned to later.

9.3.2.2 Resistance and Power

The remaining negative association identified was between Unfreezing and Change. It was argued in chapter 8 that probably this association reflected a resistance to change effect not adequately compensated for by the Lubrication measure in general, and Unfreezing in particular. Notably, Unfreezing may have measured a process for collecting internal information for planning or evaluation purposes and that perhaps organisations went through the processes of Unfreezing (i.e., generating a felt need for the project) without being effective. Examining instances of resistance to a project identified no clear correlation between these instances and Unfreezing (and other measures). This was accounted for by noting that resistance came predominantly from an individual and that the seriousness of this resistance depended on the "power" or authority of the individual. The axiomatic belief held by several authors that resistance to change will be automatic is therefore brought into question. Woodward (1965:47-48) found resistance to change to be relatively uncommon:

> "Moving from one factory to another...the research workers obtained an impression of the way that people reacted to change. The surprising thing was the almost complete lack of resistance."

Woodward goes on to note some tentative reasons for this lack of resistance, such as the change not been seen as a threat to employment or pay levels and factory manager skills in presenting the change. In view of Woodward's finding and those of this study, it appears to be questionable as to whether what appears to be resistance is in fact resistance, or is simply due to people not knowing what they have to do; in other words a lack of training.

Lack of training was identified from question 2b.20 as important. Ranking the mean scores for all 20 items in this question rated lack of training as the fourth most important source of implementation difficulties. It was also the only item in the top quartile of difficulties not associated with the poor planning quality problems noted above. Therefore, next to planning system quality, lack of training is identified as the most serious difficulty encountered during implementation. Summarising these findings, the available evidence suggests that firstly, resistance is not *a priori* present, what looks like resistance may be a lack of training. Secondly, if resistance is a problem it is likely to come from key individuals. Therefore, identify those individuals (probably those with the most to lose in terms of increased work load, reduction in pay etc.) and target them for special consideration, involvement in the decision processes etc. Finally, contingencies (i.e., slack resources) may be useful as a means of overcoming resistance, e.g., by giving people time to adjust.

9.3.2.3 Dimensions of Implementation Difficulties

We previously noted that factor analysis of the "implementation difficulties" question used in the study (question 2b.20) produced a four factor solution, see table 8.1. Factor 1 was identified with the quality of the organisation's planning system and was the most important factor in determining implementation difficulties. Factor 3 refers to training and also making, or having to make, late changes to the project. This factor is strongly correlated with the overall effort and time expended by management on the project ($r=0.465$, $p<0.01$) and is the second most important factor of implementation difficulties. This finding, that making late changes to the design of a capital project incurs considerable expense in terms of managerial time and effort, appears to echo a comment made by Martin (1984,p.56). Martin observed that errors in the initial specification (the requirements specification) of an Information Systems project are "much more time consuming and expensive to correct than those in coding". This suggests that Factor 3 may be an important factor of implementation difficulties in, not only capital projects, but also revenue projects; to use the nomenclature of chapter 3. Factor 4 is the third most important factor and appears to be a collection of items signifying a lack of support or priority being given to the project. Finally, factor 2 refers to a lack of project control systems, both technical (information systems) and human (not having the correct people in charge).

Overall, therefore, these four factors appear to refer to specific points noted elsewhere in this thesis. Factors 1 and 2 suggest that organisations with sound planning and project control systems will experience fewer problems than otherwise. Factor 3 says, don't make late changes to a project, it is very expensive in time and effort. In other words make allowances for the unexpected and assess training needs at the outset. Formal risk assessment or contingency planning may also help overcome problems associated with this factor. Finally, factor 4 echoes the need for support and priority to be given to the project.

9.3.2.3 <u>Gateway Capacity</u>

One of the primary deductions stemming from the theoretical development underpinning this thesis is the idea that implementation of strategic decisions changes an organisation by extending its available set of standard operating procedures. The greater the set of operating procedures available to an organisation, the greater its ability to absorb variety from its environment and the more likely it is to be successful, in the long term. This mechanism was seen as similar to what Zaltman *et. al.* (1973) called Gateway Capacity. Gateway capacity was defined by them as the tendency of an innovation to open up avenues to other innovations in the future. If these effects exist they raise questions of organisational attitudes to risk and innovation, e.g., is risk aversion necessarily a good thing? Risky projects were identified in this study with Uncertainty through the Complexity construct. So if organisations are to actively search for new business opportunities (i.e., innovate) and if recognition of such innovative opportunities depends, as Cohen and Levinthal (1990) propose, on the level of prior knowledge, then implementing high variety projects, but preferably not financially risky projects, may be helpful to long term organisational success.

We identified two forms of Gateway Capacity, overt and covert. Overt Gateway capacity would simply be projects implemented for the specific reason to gain experience with a new technology etc. The existence of this type of Gateway Capacity was measured in the research using question 2a.28 which asked the extent to which the project was initiated for the purpose of acquiring new skills etc. along four dimensions of information technology, production/manufacturing, marketing/Sales and technology. An "Other" category was not used by any respondent. In total 17 projects (45%) achieved some score on this question (This is out of 38 cases. Cases 1 to 7 were excluded as there was some doubt about how the question was interpreted by these respondents.) Five of these cases (13%) achieved scores of 4 or more on at least one dimension. This suggests that a reasonable number of organisations specifically seek out opportunities for the application of new technology in order to gain experience with it. The correlation matrix between the scores for the 17 cases produced only one statistically significant association above the 10% level. This was between the production and technology dimensions ($r=0.554$; $p<0.05$) and indicates that these organisations were primarily looking for production experience with new technology, not for marketing or information technology experience.

The covert Gateway Capacity effects have not been investigated in this study, although this hypothesis is potentially useful as a topic for future research. However, this study has shown that procedural changes do occur when strategic decisions are implemented. Further, it has shown that the greater the project Uncertainty or variety, the greater the procedural change. Having demonstrated that these changes occur, the next question is how can an organisation reap the Gateway capacity benefits, if any? In chapter 8 it was suggested that some process of Organisational Cognition is required and this should be directed at answering the question "What skills do we really have?". The answer to this question then feeds into an analysis process asking "What opportunities do these skills present?". It was further suggested that these questions would be asked as part of a formal "organisational skills audit" carried out following the implementation of a strategic decision, notably by focusing attention on the organisational changes that had occurred during project implementation.

The ability of an organisation to answer the two questions posed above was seen as dependent upon its Absorptive Capacity (Cohen and Levinthal, 1990) and on access to suitable external information. This study identified a significant positive association between external information and procedural change, thus external information was important in achieving implementation success. Absorptive Capacity and the factors contributing to it have been addressed above and will not be reiterated here but we note that knowing where to find relevant external information is an important aspect of an organisation's Absorptive Capacity.

The value of external information has been noted by several authors and at several junctures during this study. A principal indicator of the External information search construct was the multi item question 2a.33. Analysis of the 12 external sources listed in this question (no "Other" source was suggested by respondents) identified the most valuable source, by far, to be equipment suppliers (mean score 4.000 on 1 to 5 scale). This source was followed by Customers/ Clients, Competitors (via a comparative analysis) Technical Consultants and Material Suppliers with scores in the range 2.333 to 2.000. These results are interesting as they suggest a strong technical bias to the external information sought, yet it was also valuable in achieving procedural changes with its social implications. Whereas equipment suppliers are demonstrably valuable to an organisation in assisting a given project, the extent to which this source of information will assist in what has been termed organisational cognition or, in a broader sense, Absorptive Capacity is questionable. A role for information systems is suggested here. Indeed Woodward (1965,p.73-74) makes a related comment:

> "The fact that organisational change brought about by technical change resulted in modifications to structure in line with the results of this survey, suggests that facts and figures of the kind given in this report could help the individual manager to foresee the organisational results of any technical change he contemplates. Thus, no problems need arise from technical change to which at least partial solutions cannot be found from the accumulated experience of manufacturing industry. This implies, of course, that such experience must be adequately documented and systematised information made available. There is a pressing need for more factual description of manufacturing situations. Information of this kind would also be helpful if amalgamations or takeovers were contemplated, enabling the parent company to understand the organisational problems of any subsidiaries that were concerned with production processes different from its own."

The work on which this passage was based was completed over three decades ago. It is questionable how far the systemisation of experience has advanced in that time. Certainly today the information technology hardware exists to enable the extraction and dissemination of such knowledge. But, although such knowledge would be of value in designing projects to determine training needs say, of value in assessing the opportunities created in the manner suggested here by covert Gateway Capacity, a systemised information base of the type proposed by Woodward does not exist. We will look at implications for information system design next.

9.3.2.4 Information System Implications

This study found existing information technology use to be associated with internal data search only, as evidenced by the associations of the value of computerised systems with items of analysis and also of internal information (see factor analysis findings chapter 6 and items making up the Formal Analysis scale table 7.10b). During the study respondents were asked to assess the contribution to the project's design stage of four of the dimensions used to construct the Information Activity construct. The question was constructed using the analytical Hierarchy process of Saaty (1980). The results are presented below in the form of box plots as used in chapter 7 figure 7.3.

Figure 9.1: Box Chart for Information Activity

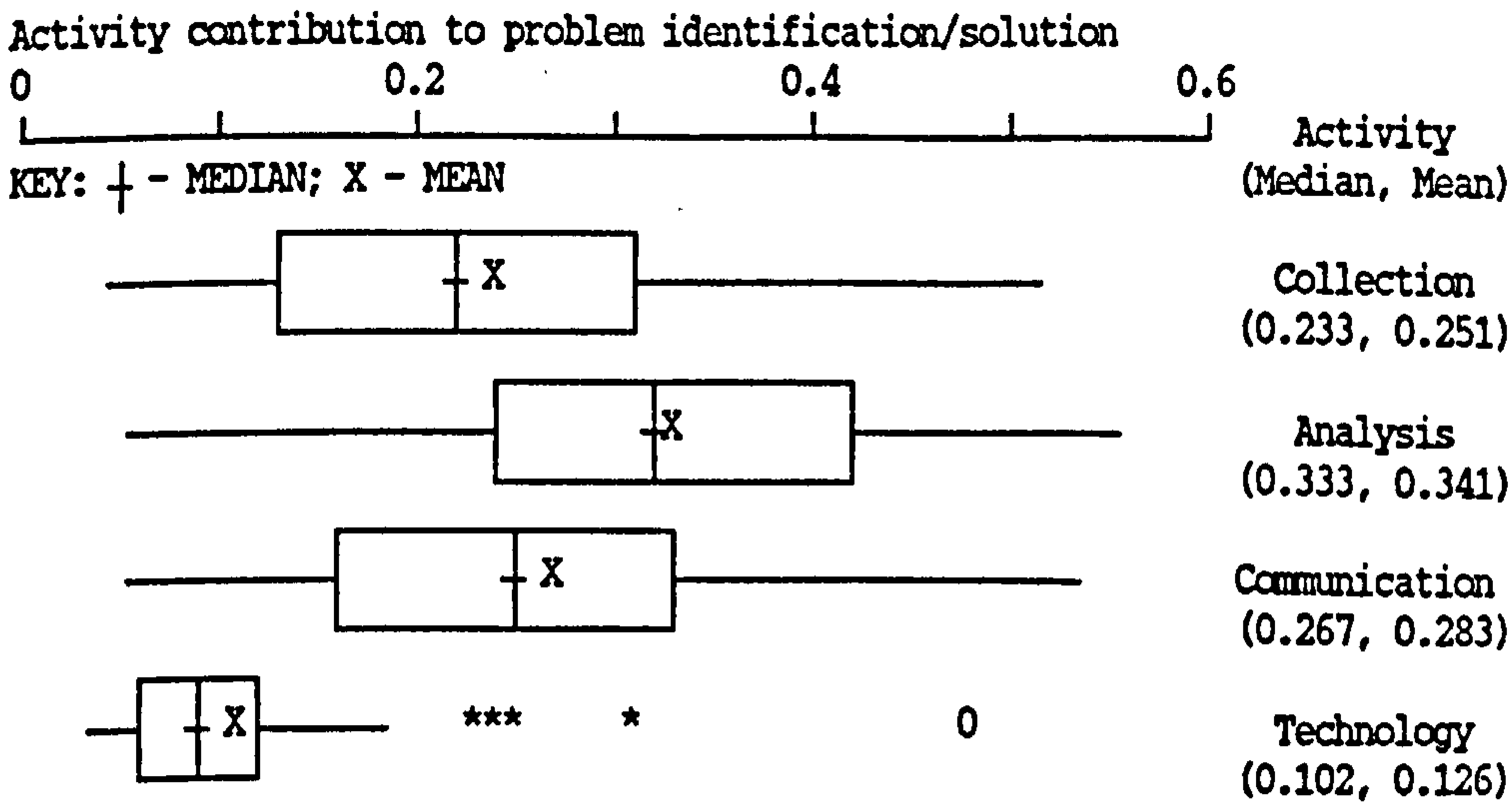


Figure 9.1 indicates that information technology was generally seen as contributing little to the overall identification of implemen-

tation problems or their solution during the project. There are some exceptions to this rule however, indicated above as outliners (* and 0 symbols). In one case information technology contributing about half of the overall project difficulty identification and problem resolution. This particular project involved the licensing of Japanese technology. The reason for the high score in this case was expressed by the respondent in the sentence, "We couldn't have done the project without a FAX." The success of this project was therefore critically dependent upon communications technology to an outside source.

A possible explanation of the above finding, that information systems are of limited benefit when implementing strategic decisions, follows. By definition strategic decisions are novel. Hence, the requisite knowledge or data is unlikely to exist 'in-house', and the only other source for this knowledge will be external to the organisation. Existing information systems appear to concentrate upon internal information needs, witness the observed association between Formal Analysis (containing the Information Technology indicator) and Internal information search. Hence, if information systems concentrate upon internal information, but external information is important to the implementation of strategic decisions (Change in particular) then it is not surprising that these systems are seen as being of little benefit.

This discussion suggests that information systems, to be of real strategic benefit to an organisation, have to contain external information of the type proposed by Woodward. This will assist organisations to identify the training needs and procedural changes necessary to implement a project and thus avoid later difficulties. In addition, such a system would assist organisations to critically assess the covert Gateway Capacity effects of new innovations and projects. The design of such systems no doubt presents significant problems, not least with schemes for codifying and systematising the required knowledge. However, the potential benefits of such a system, as outlined here, suggests that the effort would be worthwhile. This points to an area of further research and poses a major challenge to information system design.

9.4 LIMITATIONS

Limitations to the study will be discussed here as limitations to the theoretical basis of the study and limitations to validity. Validity limitations will be discussed in terms of the four main validity types identified by Cook and Campbell (1979) of, internal validity, construct validity, statistical conclusion validity and external validity.

9.4.1 LIMITATIONS TO THEORY

The theoretical basis of this study was grounded in the Cybernetic literature and in particular on deductions derived from the proof of the Law of Requisite Variety (Ashby, 1956). This law is entirely general in its formulation and will therefore not pose a limitation to this study. Furthermore the deductions made, although applied to business organisations, could be applied to other types of organisation.

Analysis of the research data identified associations between constructs not anticipated from the theoretical development based on Cybernetic theory. It was proposed that these findings could be contained within an overall Cybernetic theory by combination with concepts derived from Cognitive theory, as suggested by Steinbruner (1974). Such a modification would add to the theory an explicitly human dimension, the dimension apparently responsible for the observed unanticipated negative associations. However, making this adaptation would only limit the theoretical basis of the study to human systems. In summary, Cybernetic theory (and Cognitive theory) is broadly based and well established. Adopting this theoretical basis would not be a serious limitation to the study. If limitations exist they are most likely to be associated with the operationalisation of the theory, not with the theory itself. We will discuss these below.

9.4.2 LIMITATIONS TO VALIDITY

9.4.2.1 Internal Validity

Issues of internal validity are concerned with the elimination of alternative causes for observed relationships. Limitations to internal validity therefore refers to the extent to which such alternative causes were not eliminated. Cook and Campbell (1979) identified some 13 specific threats to internal validity. Most were not applicable to this study because they refer to test-retest research designs. Of the listed items the most serious to this study were selection effects. Bernstein *et. al.* (1975) discuss selection bias in research designs and conclude that "selection by expedience" (i.e., "Observational units are chosen solely because of availability") is one of the least serious as far as sources of bias are concerned (c.f., self-selection and selection by excellence). In this study selection by expedience was used. However, in order to control this source of bias a research methodology was adopted (personal interviewing) which maximised response to the chosen sample. Although there was some evidence to infer that companies responding to the research were commercially more successful than non-respondents, this conclusion could not be verified from objective data and should not pose a threat to the study. Measures based on objective secondary data indicated no differences between the two groups. Selection threats to internal validity are not therefore viewed as a serious limitation to this study. In addition the personal interviewing approach enabled a number of other internal validity threats to be controlled. The use of a questionnaire constructed of closed questions was a further control.

The problem of inferring causation can also be a threat to internal validity. As this study proposed a number of specific causal hypotheses, threats here would be particularly problematical. Again, in recognition of this limitation, the research instrument was designed to minimise these problems. Success measures referred to points in time after the Uncertainty and Information constructs were measured. Inferring causality between Uncertainty and Information constructs was more difficult. However, it was argued, based on measurement theory, that Information Process logically followed Uncertainty.

This was even though the specific indicators used in the study to measure Uncertainty were obtained as part of the information gathering activities of the organisation. In summary, the substantive threats and therefore limitations to internal validity have been addressed in the study and controlled for.

9.4.2.2 <u>Construct Validity</u>

Construct validity refers to the truth of stating that a given construct measures an intended concept. Of the threats to construct validity identified by Cook and Campbell (1979) most were adequately controlled for in the research design. One threat not controlled for is mono-method bias. This refers to relying on a single method of data collection and as such refers to the issue of convergent validity. For reasons discussed in chapter 5 it was decided to accept the possibility of mono-method bias as a distinct limitation on the study. This was principally to enable the study to collect a large enough sample so that statistical conclusion validity would not be too seriously threatened. In the study, construct validity was assessed using factorial composition and internal consistency measures, and was shown to be adequate. In conclusion and accepting that mono-method bias may limit the study's findings, the remaining evidence implies that construct validity was adequate for an exploratory study of the type reported here.

9.4.2.3 <u>Statistical Conclusion Validity</u>

Statistical conclusion validity was interpreted in this study as ensuring adequate power and significance to the statistical tests and in ensuring the statistical procedures used were appropriate to the data at hand. With a sample size of 45 cases it was shown that strong effects could be detected with adequate power and significance levels. The majority of associations identified in this study were of moderate effect size. The power of these associations was reasonable at a significance level of 10 per cent. Weak effects could not be detected with this size of sample. This study found only meagre evidence in support of the theoretical associations between Information Experience and Success constructs. If these associations exist at least a ten fold increase in sample size will be required to detect them with adequate levels of statistical power and significance (see Cohen, 1969,p.84).

9.4.2.4 External Validity

External validity concerns the confidence with which the study's conclusions can be applied to other samples, times etc. The sample frame adopted poses one threat to external validity. Here the sample frame used was manufacturing companies listed in the 1988 KOMPASS directory with 100 or more employees. This was estimated to be some 8500 companies. This sample frame contains several sources of bias. For example, it tends to exclude companies registered outside of the U.K., hence it contains a U.K. ownership bias. A further bias comes from its tendency to contain single entries for large divisionalised companies, or incomplete entries for their subsidiaries or divisions. Some attempts were made during sample selection to control for these biases (by using other directories and personal contacts) and a small number of such subsidiaries were sampled. However, in defence of the sampling procedure, it should be noted that the KOMPASS directory is one of the most complete and comprehensive available and its use should not represent a serious limitation to the study.

As the primary objective of the study was to investigate the implementation of strategic decisions, the primary limitations to the study's external validity come from its focus on manufacturing companies and on capital investment projects. To a lesser extent the study is limited by a focus on companies of 100+ employees. This last limitation was not viewed as serious because the directory was inaccurate in a number of instances with respect to this criterion. Hence, a number of companies were included in the sample with less than 100 employees. However, very small companies of 20 or less employees were not encountered and the study cannot be said to apply to them.

Concerning the selection of manufacturing companies, it was shown in chapter 6 that the sample was not statistically different from the population satisfying the sampling criteria. However, the extent to which the findings of this study only apply to manufacturing organisations, as opposed to non-manufacturing organisations, the evidence reported here cannot answer. Finally, there is the question of how well the study's findings may be extended to the implementation of strategic decisions not involving Capital investment projects, i.e. how applicable are the study's findings to Revenue and Social projects? The review of the evidence relating to this question given in chapter 8 indicated that different patterns of association would be found if other project types were investigated. The study's results may not therefore be applicable to Revenue and Social projects. However, partially countering this argument is the identification during the discussions in this chapter of a number of parallells between some of the findings of this study and findings reported in the literature dealing with the implementation of Operations Research/Management Science projects (see for example, Ginzberg, 1978; Martin, 1984; Lockett and Polding, 1978). Such projects are examples of Revenue projects. Hence, the findings of this study may be applicable to projects in general, not just Capital projects. The extent to which each of the above arguments prevails cannot be determined from this study and must be left as a topic for further research.

9.4.2.5 Summary

The limitations to this study fall into two categories. Those surrounding the theoretical model tested and those specific to the particular operationalisation of the theoretical model. The theoretical model was highly general so far as the implementation of strategic decisions is concerned. It is not therefore viewed as representing a limitation to the study. As far as the operationalisation of the theory is concerned, some limitations can be identified. Selection bias may be a problem to the internal validity of the study, but is not seen as serious. Indeed it is difficult to see how it could be further reduced as many of the commonly used alternative data collection methodologies suffer more from this problem than the one adopted here. Mono-method bias may have limited construct validity but the instrument design attempted to control this problem and other assessments of construct validity were satisfactory. Statistical conclusion validity could be enhanced through the use of a larger sample, but some of the theoretically interesting associations would require a very much larger sample if they are to be confidently established. Finally there is external validity. Threats to external validity probably represent the most serious limitations to the study, if we interpret it as an investigation of the implementation of strategic decisions in general. However, external validity was deliberately given a low priority in order that internal, construct and statistical conclusion validities were not seriously compromised. This priority ordering of validity types is that recommended by Cook and Campbell (1979) for an exploratory study of the type reported here. Indeed, one of the most interesting areas for further research would be the extension of the theory and ideas reported here to other organisational and project types. We will discuss this possibility and others next.

9.5 AREAS FOR FURTHER RESEARCH

Three broad areas of further research can be identified which relate to ideas, questions and perspectives developed during this study. Firstly there are a number of questions raised, or unresolved, by the particular focus of this study on capital investment projects. Secondly there are topics broadening the organisational and project basis of the study; that is topics to correct the accepted limitations to its External validity. Finally there are questions raised by the study which extend it beyond the confines of the implementation question and relate it to the pre-implementation area of decision making and the post-implementation area of organisational cognition and innovativness. We address these issues in turn.

9.5.1 FURTHER TOPICS ON CAPITAL INVESTMENT PROJECTS

We noted in chapter 5 that a single study cannot answer all the validity questions surrounding it. Replication is necessary if confidence in the findings reported here is to be increased (Bernstein *et. al.*, 1975). However, replication without taking into account possible improvements to this study would be ill-advised. For example, if a replication study is to contribute to an understanding of the research questions, then as Sawyer and Ball (1981) have noted, the study would need greater statistical power than achieved here. Hence, such a study would have to be based on a larger sample than 45 cases and if a significant improvement in power were to be achieved some one to two hundred analysable cases would be required. The most practical way to collect this quantity of data is by postal questionnaire. However, this study reported low response rates to such an approach. If low response were not to be seen as a serious limitation, the questionnaire employed in the replication study would need to be less exhaustive than the one employed for this research. This consideration raises a further topic, namely the design of parsimonious and valid measures of the critical concepts identified in this study.

Inspection of the factor analysis results reported in chapters 6 and 7 would be a reasonable starting point for the construction of parsimonious measures of the constructs. For example, exclusion of the Complexity concept indicators within the Uncertainty construct would not seriously damage the construct validity of this measure. Further, we note that where objective indicators could not be used, then a multiple respondent study would be advised to improve construct validity. A replication study would further need to take into account some of the conceptual issues identified in this study as possibly upsetting construct validity. The dimensions underlying the Information Experience concept were Flexibility and Range of standard operating procedures. It has been noted that Flexibility was possibly not measured in this study, only Range. A replication study may therefore choose to use other validated measures of organisational structure, such as Integration, Formalisation or Centralisation (Miller and Drôge, 1986) in place of Mechanicity and Range. Further work on the behavioural measure of Unfreezing would also be advised. In particular, it was recommended that the power of individuals to resist a particular project's implementation should be explicitly measured in connection with such a scale.

Finally, the study highlighted the complexity of associations between various sub-scales within the Information Process construct. Why are so many dimensions important? Why is one of the sub-scales most associated with achieving a satisfactory procedural change outcome for the project (External Information Search) only relatively weakly associated with any of the other process measures? and Why is Refreezing so important? Answers to these questions would probably only be possible if the dynamics of the implementation process are investigated. This suggests the need for longitudinal studies of the processes involved during the implementation of strategic decisions to help explain these associations.

9.5.2 FURTHER TOPICS ON IMPLEMENTATION

The broad area of study addressed by this thesis was the implementation of strategy. This was early refined to a question of the implementation of strategic decisions and further refined to the implementation of capital investment projects within manufacturing companies. At each stage of topic refinement a different approach could have been taken, leading to a different study. A natural extension of this study is therefore to apply its theoretical basis to Revenue and Social projects and organisations other than manufacturers. While the theoretical basis of the study could be applied without adaptation, the operationalisation of the theory was relatively specific to Capital investment projects. Thus, new constructs of the theoretical concepts would be required to extend the study in this way. For example, the mass-production orientation measure used as an indicator of Novelty is not reliable when applied to some service organisations (Khandwalla, 1977,p.661).

Finally, it would be recommended that the theoretical basis of these studies should first be extended in the manner suggested by the application of concepts from Cognitive theory. This recommendation applies also to the studies suggested in the above section. However, we believe that this theory (adapted or not) is unlikely to be of great utility in a study of strategy maintenance, the other aspect of strategy implementation. The recommendations above are therefore strictly limited to a study of the implementation of strategic decisions, not strategy maintenance.

9.5.3 BROADER ISSUES

Whereas this study has nothing to say about strategy maintenance issues, it does naturally extend to the strategy formulation and innovativeness surrounding the implemented project. Chapter 3 outlined a parsimonious classification of strategic decisions with some utility for predicting decision process. One of the issues identified as being of interest in understanding the decision making process (and we may view strategy formulation as decision making) was why and how a decision changes topic, i.e., an Entity change topic can become an Interface decision. This effect was noted in the study by Hickson *et. al.* (1986). The decision framework developed in chapter 3 is associated with organisational change and in particular each change exhibited a different level of variety absorbing capability. If we accept the view that change is resisted (a belief held as axiomatic by some authors, e.g., March, 1981; Sorensen and Zand, 1975; Ansoff, 1987) we may infer that the typical "decision trajectory" would be from large change (e.g., Entity decision) to less change (e.g., Interface decision). The extent to which this could occur however, would be constrained by the nature of the environmental threat to the organisation. The law of Requisite Variety would still have to be satisfied and if the threat was large then an Entity change may be the most effective way to meet it. Conversely, small environmental threats may be most effectively dealt with by a low change Interface decision. In truth a single threat would probably require a number of responses consisting possibly of Entity, Relational and Interface changes. In effect this argument would seek to explain a decision's trajectory in terms of variety avoidance. This study and in particular the framework of decision types developed in chapter 3, was based on a variety absorption hypothesis. Studies exploring these ideas could be proposed. A further concept noted in chapter 3 as an explanatory variable of decision making process was "decision reversibility". Above we suggested that the motive for changing a decision topic was a desire to minimise the need, hence resistance, to change. An alternative explanation may be that decision topics change to maximise the reversibility of the decision. Whatever the motive for the change, the outcome would be variety avoidance. Again studies could be proposed to investigate these hypotheses.

A further area of research identified here as important to the implementation issue, is in understanding why organisations intuitively underestimate the complexity of decisions. This phenomenon was implicated as a possible cause of the observed negative association between the Meetings, Refreezing and implementation Ease constructs. The development of an objective measure of project complexity may therefore be of some assistance to practising managers. Such a measure, to be useful, would have to rely on data available at the project design stage. Novelty and some of the Scope indicators used to construct the Uncertainty measure in this study, may serve as a useful launching platform to such a study. There is also the issue, mentioned above, of the design of information systems containing data on the types of procedural changes needed to implement certain types of decision. Not only would such a system assist in the design of specific projects, but it would also be of assistance in recognising the unintentional Gateway Capacity consequences of a project. An organisational skills audit following a project's implementation may be substantially assisted by such an information base. The system would therefore be central to the organisational cognition process necessary to assimilate any indirect Gateway Capacity benefits from a project into the organisation.

Finally, an implication of the study was that risk aversion was not necessarily a good thing, as it excluded the possibility of incidentally acquiring new skills thus opening new business opportunities for an organisation. A testable hypothesis would be that risk averse organisations do less well in the long run than companies showing a measure of risk taking. Certainly this study identified companies undertaking projects to overtly acquire the Gateway capacity benefits of a new technology. The covert benefits proposed in this study would necessarily be dependent upon what Cohen and Levinthal (1990) have referred to as the organisations "Absorptive Capacity" a component of which we call Organisational Cognition. Many other constraints would also be identifiable in such a study. For example, the nature of the organisation's environment may restrict new business opportunities for a given organisation. It should also be noted that Gateway Capacity effects were hypothesised from the theory developed in this study and therefore should be apparent from all projects undertaken by an organisation, not just capital projects.

9.5.4 CONTRIBUTION

This study has sought to explain an important aspect of strategy, namely the implementation of strategic decisions. The theoretical basis of this study has shown that organisations must match the complexity of change (threat or opportunity) in their environment with equivalent complexity of response. If their environment changes, they must change and strategic decisions are the organisational instrument of change. Thus, the successful implementation of strategic decisions is crucial to the success and survival of an organisation. In fact, it has been argued that making the correct decision is less important than the satisfactory implementation of the decision (Bonoma, 1984).

The process of implementing a strategic decision was described here as "programming". The atomic unit of a programme was in turn identified as the project. Therefore, at a pragmatic level of analysis we determine that the vehicle (or medium) for implementing a strategic decision is the project. The importance of successfully implementing projects is highlighted if we adopt the view of Hawthorne (1978,p.103):

> "If we regard a firm in its totality as in a state of development, it may be described as being composed of a variety of projects with time-scales of different length."

In other words, at any one point in time, an organisation is a collection of projects. Hence, the perspectives and theory developed here on the issue of project implementation has considerable generality and applicability too, not just Business Policy but organisational studies in general.

The theory developed in this thesis related the size and complexity of a particular project, aspects of the organisation's structure and decision making and design processes, to the magnitude of changes in the standard operating procedures of the organisation, and the ease of the project's implementation. Empirically, it was also found that managerial satisfaction with the project was primarily dependent upon the procedural change and ease outcomes mentioned above. The organisational structure and decision making components of the theoretical model were seen as being two aspects of an Information construct. Specifically, the structure component (labelled Information Experience) was viewed as representing a pool of standard operating procedures at the disposal of the organisation and from which it could draw in order to implement the new project. The decision making component (labelled Information Process) represented a second pool of procedures used for choosing from existing procedures and or designing new procedures. This dichotomisation of the information concept represents the difference between an organisation having a pool or repertoire of procedures that it uses from day-to-day, and having a "higher level" set of procedures which it uses, as required, to extend or adapt this repertoire to new situations.

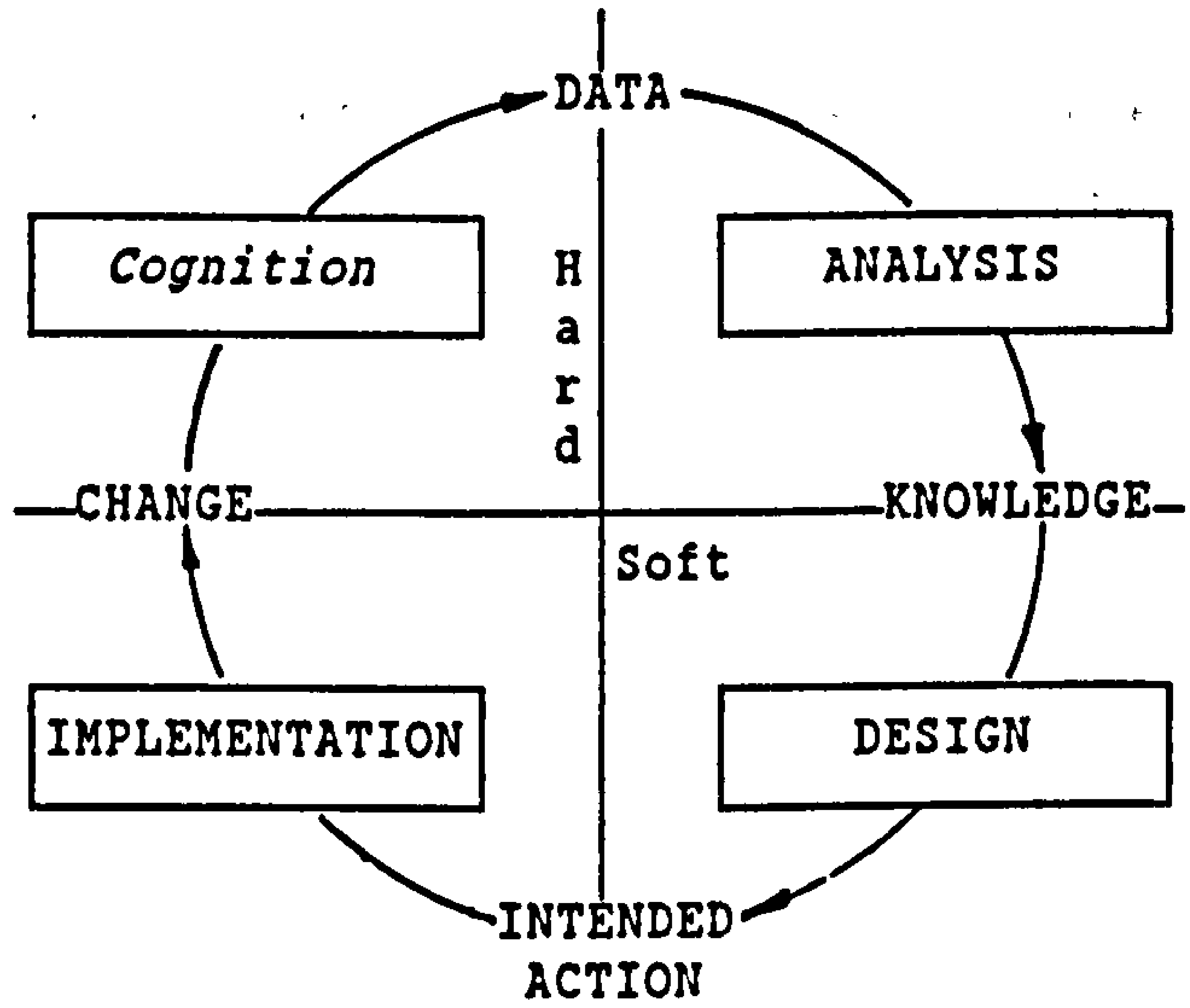
In measuring the Information Process concept it was decided, for methodological reasons, to primarily restrict the measure to the stage of the project prior to formal authorisation or approval. This is the stage at which most research on decision making stops. A major finding of the study was that, the processes carried out during this pre-approval stage of a capital investment had very little influence upon the final project success. The only indicator from strictly this stage of the project that was significantly and positively associated with implementation success, was the measure of External Information search. But this was the only indicator to be loosely connected with any of the other Information Process measures. In other words, External Information is associated with the success of a project, but is apparently not associated with the pre-approval decision making process. On the other hand, the Information Process indicator designed to measure the effort expended on project design was Formal Analysis. This indicator was strongly associated with most other Information Process measures, but not directly associated with implementation success. An explanation for this could be, that during the pre-approval decision making stage of a capital project, the decision makers are preoccupied with satisfying a narrow set of procedures aimed at identifying the financial costs and returns from the project, sufficient to satisfy some approval criteria. As financial success was not an indicator of implementation success within this study (budgeted cost was used as an indicator, but overall profitability was not) then the absence of a strong association between success and Information Process measures could be accounted for.

If the above observations and explanations are valid, then it suggests that capital project pre-approval decision making is governed by some threshold criteria. In other words, the process continues until it is clear whether the threshold can, or cannot, be attained. Also, because of the narrow financial focus of this process, the actual procedural design questions that this thesis was primarily concerned with, will not be asked, and may not be faced by the organisation at all until problems are being encountered with the project's acceptance or operation. This is likely to occur late in the project's history, after approval and installation of the capital equipment say. Thus, the finding that only Refreezing (the Information Process measure most associated with the late stages of the project) shows significant associations with <u>all</u> of the implementation success measures, is perhaps not surprising. In view of these findings, and speculations, it is recommended that future research on this topic be directed towards longitudinal studies of the design and decision processes carried out over complete projects.

A substantive finding of this study was that certain associations involving the Information Process construct, were not successfully predicted by the cybernetic theory used. Further research involving this concept should therefore take into account possible modifications to the theory suggested in chapter 8, by including concepts from cognitive theory into the research design.

A further theme of this thesis was that changes to an organisation's procedures are indicative of organisational learning, and learning confers on an organisation a potential strategic advantage. As procedural change was demonstrated not to occur until late in a projects history, then learning is also primarily associated with the later stages of a project. Furthermore, these late stages are the time when action is being taken. In other words, organisations learn by doing. The longitudinal research strategy mentioned above could be used to investigate these predicted effects, based on the organisational learning model developed in chapter 8 (figure 8.4) and reproduced over as figure 9.2.

Figure 9.2: A Model of Organisational Learning



The time frame required to study the entire learning cycle would be much greater than that required for a single project. Rather than use a longitudinal study to investigate the entire learning cycle therefore, a less expensive research strategy would be to focus on the process in this cycle that is the most speculative, the process of Organisational Cognition. Demonstrating that Organisational Cognition occurs, that it draws on the procedural changes induced in an organisation by the implementation of strategic decisions, and that it gives rise to new strategic opportunities for the organisation, would establish the learning model and one of the untested theoretical predictions of this thesis.

The contribution of this work is seen by the author primarily in terms of the development of a general and demonstrably effective, theoretical basis for the study of project implementation and strategic change. Major questions were posed at the beginning of the study; what is implementation? What are the principal contingent dimensions of the phenomenon? What happens to an organisation when a strategic decision is implemented? What is implementation success? These have been answered, at least partially and some from several perspectives. In addition, problems stemming from the underestimation of project complexity, the correct assessment of training needs, the idea of an organisational skills audit following project completion, and the need for information systems containing appropriate external information on procedures needed for successful implementation of new technologies, point to areas and ideas of benefit to practising managers.

The aim of this study was to help understand the implementation of strategic decisions. It is hoped this thesis offers a useful step towards that goal.

APPENDIX A

SAMPLE RESEARCH QUESTIONNAIRE

A survey of
capital investment projects
in
U.K. manufacturing companies.

UNIVERSITY OF BRADFORD

MANAGEMENT CENTRE

INSTRUCTIONS

This questionnaire is being administered as part of a study of how British manufacturing firms implement capital investment decisions. The questionnaire is designed to gather information about your firm's organisational structure, its environment, and the planning, installation and subsequent operation of a specific capital investment decision. This project should have been seen as important, that is, having a long-term impact on your company's goals, profitability and/or growth. It is further suggested that this project should have been in regular day-to-day operation for at least six months.

The questionnaire is broadly structured in two parts. Section 1, seeks information relating to your business as a whole. Section 2, seeks information specifically about the capital investment project that you have identified. Because of this, *the questionnaire is to be filled out only by a senior executive who has adequate familiarity with your firm's operations, its business and the specific project.* No questions of a personal nature are asked, nor is it a test; there are no right or wrong answers.

The *firm* in this questionnaire means the entity of which you are a senior executive, whether it be a division, a subsidiary, or an independent company. All questions, unless otherwise stated, refer to this entity's operations, environment, etc. The word *organisation* refers to any parent company of your firm. If you are fully independent, then *organisation* refers to your firm also.

To answer the questionnaire you, in the main, need only place a tick in a box or circle a number on a rating scale that seems closest to describing the reality as you perceive it. To correct or change your answer, simply place a line through the incorrect tick or circle. Feel free to make any additional explanatory or qualifying comments anywhere on the questionnaire, as your candid opinions are very important to the success of the study.

Please answer all the questions as incomplete questionnaires create severe problems in data analysis. After completing the questionnaire, please check to see that no questions are left unanswered.

The information supplied in this questionnaire will be kept in the strictest confidence, and will not be divulged to anyone except in aggregated form and for bona fide research purposes. To this end, we have not asked for the identification of respondents. Only those who are interested in further work are asked to supply their names and addresses in section 3 of the questionnaire.

Thank you, your co-operation is sincerely appreciated.

University of Bradford,
Management Centre,
Emm Lane,
Bradford,
West Yorkshire,
DB9 4JL.

SECTION 1. YOUR FIRM

1. What is your job title?

____

2. What is the principal ownership of your firm?
TICK ONE BOX ONLY.

United Kingdom owned [ ]
North American owned [ ]
Japanese owned [ ]
European owned [ ]
Other ______________ [ ]

3a. What is the status of your firm?
TICK ONE BOX ONLY.

A fully independent/autonomous organisation [ ]
A subsidiary of a larger organisation [ ]
A division of a larger organisation [ ]
A subsidiary of a division of a larger organisation [ ]

IF YOU ARE FULLY INDEPENDENT, DO NOT ANSWER QUESTION 3b.
3b. In relation to your nearest parent organisation, what degree of control has the parent over your activities?
TICK ONE BOX ONLY.

We operate as an independent/autonomous organisation, although part of a larger group. [ ]
We are effectively under the control of a larger group. [ ]

4. Which part of the manufacturing sector does your firm occupy?
TICK ONE BOX ONLY

Capital Goods Manufacturing. [ ]
Consumer Durable Good Manufacturing. [ ]
Consumer Non-Durable Good Manufacturing. [ ]
Producer goods (i.e. goods bought to assist in the manufacture of some other product). [ ]

5. Which of the following best describes your firm's approach to developing and marketing new products?
TICK ONE BOX ONLY.

We don't do any new product development. [ ]
We watch the competition and if their new products are successful then we imitate. [ ]
We actively develop and market new products ahead of the competition. [ ]

6. Which of the following best describes your firm?
TICK ONE BOX ONLY.

Single-Product Dominated [ ]
(Dependent on one single product for at least 95% of total company sales.)

Single-Business dominated [ ]
(Dependent on one major area of related products [similar technology and markets] which accounts for at least 70% of total company sales.)

Multi-Business [ ]
(Diversified into more then one major product area - so than no single *business* accounts for 70% or more of total company sales.)

7. Are the techniques to be used in evaluating capital project proposals formally documented and standardised?
TICK ONE BOX ONLY.

Yes [ ]   No [ ]

8. Does your organisation carry out post-completion audits of capital investment decisions?
(Post-Completion Audit (PCA) is, primarily, an internal process for reviewing the success or failure of a project <u>once it has been completed</u>. PCA is not simply capital budget monitoring or control.)
TICK ONE BOX ONLY.

Routinely [ ]   Frequently [ ]   Occasionally [ ]   Rarely [ ]   Never [ ]

9. What proportion of major capital proposals would you say are normally accepted by your firm?
TICK ONE BOX ONLY.

%	below 10%	10-24%	25-49%	50-74%	75-89%	90-100%
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

10a. Is your C.E.O. the owner or majority share holder of your firm?
(C.E.O. - chief executive officer, the managing director, general manager etc. primarily responsible for the running of your firm.)
TICK ONE BOX ONLY.

Yes [ ] No [ ]

IF YOU ANSWERED 'NO' TO THE ABOVE QUESTION THEN:

10b. What is the maximum capital expenditure that can be authorised by the C.E.O. of your firm, without making any reference at all to a higher internal or external authority e.g. board of directors, external owner/board?

£ [__________]

When answering these questions, please give an approximate annual figure averaged over the last three years.

11a. What is the approximate total annual capital expenditure budget for your firm?

Approximate annual capital expenditure £ [__________]

11b. What is the total revenue expenditure budget of your firm on R & D and/or Development and/or Design and/or Technical and/or Engineering? (Exclude expenditure on plant maintenance.)

Approximate annual revenue expenditure. £ [__________]

11c. Considering the above two figures, then, what percentage of each figure is directed towards developing entirely new (to your firm) products or processes?
(Note. Minor or routine technical or design changes are not seen here as new.)

Percentage of capital spent on new products or processes [______] %

Percentage of revenue spent on new products or processes [______] %

Please answer the following questions for the *industry* that accounts for the largest % of the sales of your firm (in other words your principal industry as defined by your major competitors).

12. How *rapid* or *intense* is each of the following in your main industry?
READ BOTH STATEMENTS AND CIRCLING ONE NUMBER ONLY FOR EACH SCALE. (1 REPRESENTS THE STATEMENT ON THE LEFT AND 5 THE STATEMENT IN THE RIGHT.)

Our firm rarely has to change its marketing practices to keep up with the market and competitors.	1	2	3	4	5	Our firm must change its marketing practices extremely frequently (e.g. semi-annually).
The rate at which products services are getting obsolete in the industry is very slow (e.g., basic metals like copper).	1	2	3	4	5	The rate of obsolescence is very high as in some fashion goods.
Actions of competitors are quite easy to predict (as in some primary industries).	1	2	3	4	5	Actions of competitors are unpredictable.
Demand and consumer tastes are fairly easy to forecast (e.g., for milk companies).	1	2	3	4	5	Demand and tastes are almost unpredictable (e.g., high-fashion goods).
The Production technology is not subject to very much change and is well established (e.g., in steel production).	1	2	3	4	5	The modes of production change often and in a major way (e.g., semi-annually).

The following questions refer to the operating management style and philosophy of senior management within your firm. It does not refer to any one person's style, but to the general atmosphere within your firm.

13. An operating top management philosophy of:
READ BOTH STATEMENTS AND CIRCLING ONE NUMBER ONLY FOR EACH SCALE. (1 REPRESENTS THE STATEMENT ON THE LEFT AND 5 THE STATEMENT IN THE RIGHT.)

[MECHANISTIC TYPE]						[ORGANIC TYPE]
A highly restricted access to important financial and operating information.	1	2	3	4	5	Important financial and operating information flow quite freely throughout the firm.
Strong insistence on a uniform managerial style throughout the firm.	1	2	3	4	5	Managers' operating style allowed to range freely from the very formal to the very informal.
Strong emphasis on giving the most say in decision-making to formal line managers.	1	2	3	4	5	Strong tendency to let the expert in a given situation have the most say in decision-making, even if this means temporary by-passing of formal line authority.
A strong emphasis on holding fast to true and tried management practices, procedures or principles despite any changes in business conditions.	1	2	3	4	5	A strong emphasis on adapting freely to changing circumstances without too much concern for past practices, procedures or principles.
Strong emphasis on getting line staff personnel to adhere closely to formal job descriptions.	1	2	3	4	5	Strong tendency to let the requirements of the situation and the individual's personality define proper on-job behaviour.
Specific definition of responsibility that is attached to individual's functional role only.	1	2	3	4	5	Broader acceptance of responsibility and commitment to the firm that goes beyond individual's functional role.
Strict hierarchy of control and authority using sophisticated information systems.	1	2	3	4	5	Loose informal control; heavy dependence on informal relationships and norm of co-operation for getting work done.
Personal communication is through highly structured channels and is mainly vertical between superiors and subordinates.	1	2	3	4	5	Communication is through open channels and lateral, between people of different ranks and resembles consultation rather than command.
Content of communication is instructions and decisions.	1	2	3	4	5	Content of communication is information and advice.
Loyalty and obedience to firm and superiors is highly valued.	1	2	3	4	5	Commitment to tasks and progress and expansion of the firm is highly valued.
Importance and prestige attached to identification with firm itself.	1	2	3	4	5	Importance and prestige attached to affiliations and expertise in larger environment.

14. Approximately how many full time employees are there in your firm?

Full time employees. [__________]

15. What was the approximate turnover of your firm in the last financial year?

Annual turnover. £ [__________]

16. In the last financial year how did your firm perform relative to your major competitors?
CIRCLE ONE NUMBER PER LINE.

	Better	The same	Worse	Don't know
In growth of profit terms.	1	2	3	4
In growth of sales volume terms.	1	2	3	4
In growth of market share terms.	1	2	3	4
In terms of return on investment.	1	2	3	4

SECTION 2. THE PROJECT

Please focus on a CAPITAL INVESTMENT project that is now fully commissioned and an integrated part of your everyday activities. In addition, this project would have been seen at the time of it's inception by those involved as playing a bigger rather than a smaller part in shaping what happens within your organisation for a long time afterwards, i.e., it was seen as being IMPORTANT to the future course of your organisation. Important may be defined in terms of the amount of expenditure involved, or that new businesses, markets or new products or new technologies were being sought, developed or used.

Please indicate, if you wish, a simple title for the capital project.

Title: ______________________________

1. How often do investment decisions for projects of this size and type arise?
PLEASE INDICATE THE NUMBER PER YEAR (USE FRACTIONS IF NECESSARY).

Frequency of decisions of similar *size* (in expenditure terms) per year [______]

Frequency of decisions of similar *type* per year. [______]

2. Where was the project (plant, equipment etc.) physically located within your firm?
TICK ONE BOX ONLY.

Installed on a new site. [ ]
Became the primary business area of the existing site. [ ]
Integrated into the primary business area of the existing site. [ ]
Became a new smaller business area or department on the existing site. [ ]
Integrated into an existing smaller business area or department on the existing site. [ ]

3a. Was the project entirely self contained, or part of a larger programme of activities, perhaps involving other projects, or organisational changes?
TICK ONE BOX ONLY.

Self contained/independent. [ ]
Part of larger programme. [ ]

IF PART OF A LARGER PROGRAMME THEN ANSWER PART 7b BELOW.

3b. Approximately what percentage of the total *expenditure* (capital and revenue) involved in the programme did this project account for?

Approximate % of programme due to project [_____] %

4. Which of the following were effected (positively or negatively) by the project?
CIRCLE ONE NUMBER ONLY PER LINE.

	Positive effect		Not affected		Negative effect
Profit	1	2	3	4	5
Quality	1	2	3	4	5
Output volume	1	2	3	4	5
Costs	1	2	3	4	5
Service rendered	1	2	3	4	5
Morale	1	2	3	4	5
Personnel benefits	1	2	3	4	5
Image	1	2	3	4	5
Sales	1	2	3	4	5
Market Share	1	2	3	4	5
Return on investment	1	2	3	4	5

5. To what extent did the original stimulus for the project come from?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Need to acquire new skills.	1	2	3	4	5
A market opportunity or customer enquiry.	1	2	3	4	5
Worker, shareholder or other stakeholder pressure.	1	2	3	4	5
The action of competitors.	1	2	3	4	5
Governmental or Social action.	1	2	3	4	5
New external technological development.	1	2	3	4	5
New internal technological development.	1	2	3	4	5
A need to protect sources of supply.	1	2	3	4	5
Increase loyalty of existing customers.	1	2	3	4	5
A need to preserve a market position or presence.	1	2	3	4	5
Other (specify)________________	1	2	3	4	5

6. To what extent was the project undertaken to achieve the following specific goals/aims/purposes?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
To reduce the variable costs of manufacture.	1	2	3	4	5
To reduce the fixed costs of manufacture.	1	2	3	4	5
To increase the volume of manufacture.	1	2	3	4	5
To improve the quality of manufacture.	1	2	3	4	5
To improve worker skills, morale, environment.	1	2	3	4	5
To simplify the manufacturing process.	1	2	3	4	5
To satisfy statutory requirements (Safety, pollution etc.).	1	2	3	4	5
To enter a new market.	1	2	3	4	5
To foster or promote a company image.	1	2	3	4	5
Other(specify) ________________	1	2	3	4	5

7. To achieve the goals identified above, how much effort was required/expended on the following activities? In addition, tick the activity which best accounts for the capital expenditure.
CIRCLE ONE NUMBER ONLY PER LINE, AND PLACE ONE TICK ONLY IN THE COLUMN OF BOXES TO REPRESENT THE MAIN CAPITAL EXPENDITURE ITEM.

	Expenditure item	Little or none	Some	Slight-ly	Quite a lot	A great deal
Obtaining/developing new technologies, equipment and/or premises.	[ ]	1	2	3	4	5
Internal restructuring/reorganisation.	[ ]	1	2	3	4	5
Developing new business plan or budget, or data-processing equipment facilities.	[ ]	1	2	3	4	5
Develop new Marketing and/or distribution capabilities.	[ ]	1	2	3	4	5
Developing new products.	[ ]	1	2	3	4	5
Improving personnel facilities and/or training.	[ ]	1	2	3	4	5
Purchasing and/or merging with organisations belonging to your parent.	[ ]	1	2	3	4	5
Purchasing and/or merging with organisations other than your parent.	[ ]	1	2	3	4	5
Obtaining finance and/or other supplies, e.g. raw materials.	[ ]	1	2	3	4	5
Developing or disposing of a new or existing site.	[ ]	1	2	3	4	5
Other (specify)________________	[ ]	1	2	3	4	5

8. Was a post-completion audit carried out for this project?
(Post-Completion Audit (PCA) is, primarily, an internal process for reviewing the success or failure of a project once it has been completed. PCA is not simply capital budget monitoring or control.)
TICK ONE BOX ONLY.

Yes [ ] No [ ] Don't Know [ ] In progress [ ]

SECTION 2a. THE PROJECT - From inception to approval.

Considering the time when final approval for the capital expenditure to implement the project was received, then:

1. What was the anticipated capital expenditure for the project?

Fixed assets (Equipment)	£ [__________]
Working capital (Store items etc.)	£ [__________]
Goodwill	£ [__________]

2. What was the annual turnover of your organisation at this time?

Annual T/O at time of authorisation	£ [__________]

3. To what extent was there a clear design or option for the project from its inception, (e.g. a single supplier only being available, extensive R&D already done)?
CIRCLE ONE NUMBER ONLY.

Few options available or few considered. 1 2 3 4 5 Many options available and considered.

4. To what extent did various people need convincing that the project was worthwhile?
CIRCLE ONE NUMBER ONLY.

Very little effort required, seen as the "right thing to do". 1 2 3 4 5 Considerable consensus building had to take place.

5. To what extent were other projects and activities re-scheduled to accommodate this project?
CIRCLE ONE NUMBER ONLY.

Little or none 1 2 3 4 5 Extensive re-scheduling

6. On a hypothetical priority list, what was the priority given to this project at the time of approval against other expenditures?
CIRCLE ONE NUMBER ONLY.

			Average			
Very Low	1	2	3	4	5	Very High

7. Was the agreed project completion date stated in the capital application document seen by most parties as being difficult or easy to achieve?
CIRCLE ONE NUMBER ONLY.

Very difficult 1 2 3 4 5 Very easy

8. Were technical/production considerations, or marketing/sales considerations seen as primarily determining the estimated project completion date?
CIRCLE ONE NUMBER ONLY.

			Both equal			
Technical	1	2	3	4	5	Marketing

9. How much opposition to project re-scheduling was there/would there have been?
CIRCLE ONE NUMBER ONLY.

		Little	Some	A lot		
No opposition	1	2	3	4	5	Great opposition

10. To what extent were external agencies (e.g. customers, equipment suppliers) responsible for setting the anticipated final completion date?
CIRCLE ONE NUMBER ONLY.

		Little	Some	A lot		
No extent	1	2	3	4	5	Great extent

11. What was the project's planning horizon, i.e. how far ahead did people look when evaluating the project?
TICK ONE BOX ONLY.

Less than 1 year	[ ]
1 to 2 years	[ ]
2 to 5 years	[ ]
5 to 10 years	[ ]
More than 10 years	[ ]

12. For how long could implementation of the project have been delayed without any significant effect (other than inflationary effects) on the project's viability?
TICK ONE BOX ONLY.

Less than 1 year [ ]
1 to 2 years [ ]
2 to 5 years [ ]
5 to 10 years [ ]
More than 10 years [ ]

13. How long would your organisation have remained in business *if it had done nothing* at the time final approval for this project was sought?
TICK ONE BOX ONLY.

Less than 1 year [ ]
1 to 2 years [ ]
2 to 5 years [ ]
5 to 10 years [ ]
More than 10 years [ ]

14. Please indicate on the following grid the type of MARKET and CUSTOMER being served by the project?
TICK AS MANY BOXES AS REQUIRED.

MARKET(S)	CUSTOMER(S) Existing	CUSTOMER(S) New
Existing.	[ ]	[ ]
New related.	[ ]	[ ]
New unrelated.	[ ]	[ ]

15. Which of the following best describes how the project affected or related to the PRODUCT(S) produced by your firm?
TICK ONE BOX ONLY.

Introduced no change (effect). [ ]
Introduced a minor improvement or modifications. [ ]
Introduced a major enhancement. [ ]
Introduced a new but related product. [ ]
Introduced a new unrelated product or invention. [ ]

16. Which of the following best describes the source of the TECHNOLOGY employed in the project?
TICK ONE BOX ONLY.

Own Research and Development. [ ]
Own research. [ ]
Own development. [ ]
Licence or patent agreement - own implementation. [ ]
Contractor supplied technology, few similar products in existence. [ ]
Contractor supplied technology, many similar products (i.e. a well proven off-the-shelf technology.) [ ]
Not a technical project. [ ]
Other (specify) ______________________ [ ]

17. At what level was final authorisation sought for approval to spend the required capital and to proceed with the project?
TICK ONE BOX ONLY.

Below divisional level or equivalent. [ ]
Divisional level or equivalent. [ ]
Chief executive. [ ]
Chief executive and ratified by board. [ ]
Board or equivalent top governing body. [ ]
Board and ratified at higher external level. [ ]
Outside and above your firm. [ ]

18. In relation to the standard payback, NPV, yield or other financial criteria used by your firm in assessing capital investment decisions where on the following scale was this project thought to fall at the time formal approval was given?
TICK ONE BOX ONLY.

Much worse than standard [ ]
Worse than standard [ ]
Same as standard [ ]
Better than standard [ ]
Much better than standard [ ]

19. Two definitions of project *risk* are given below. How was the *risk* of this capital investment project defined? Was it:
TICK ONE OR BOTH BOXES.

Defined as "potential variations in key assumptions/outcomes". [ ]
Defined as "potential negative outcomes", e.g. the chance of the project making a financial loss. [ ]

20. How was the *risk* of this project assessed?
TICK AS MANY BOXES AS REQUIRED.

a. Ignored or not assessed explicitly [ ]
b. Assessed subjectively as Low, Medium, High, etc. [ ]
c. Assessed in terms of "what-could-go-wrong" and contingency plans. [ ]
d. Analysed via formal "What-If" sensitivity analysis by giving a % change of each key factor one at a time. [ ]
e. Other (specify) ______________________________ [ ]

21. How many formally arranged meetings per month, on average, were there during the pre-approval stage of the project?

Number of pre-arranged meetings per month [__________]

22. How many people would there have been at these meetings?

Typical number of people at a pre-arranged meeting [__________]

23. How much discussion, toing and froing, or argument took place during the pre-approval stage of the project?
CIRCLE ONE NUMBER ONLY.

	Little or none	Some	Slightly	Quite a lot	A great deal
Extent of discussion etc.	1	2	3	4	5

24. How many times were separate estimates/analyses made of each of the following during the pre-approval stage of the project?
CIRCLE ONE NUMBER PER LINE.

	None	Once	Few	Several	Many
Capital cost of project.	1	2	3	4	5
Simple Payback Period.	1	2	3	4	5
Expected Productive Life.	1	2	3	4	5
Discounted Net Present Value of all Returns and/or Expected Rate of Return.	1	2	3	4	5
Cost and Risk of Failure.	1	2	3	4	5
Risk in not making the investment, or deferring it.	1	2	3	4	5
Opportunity cost. (ie., Possible failure to make profits etc. from alternative projects as a result of using resources on this project.)	1	2	3	4	5

25. To what extent at the time, could a *worse* payback, NPV etc. have been accepted without the project undergoing a substantial change, or cancellation?
CIRCLE ONE NUMBER PER LINE.

	Extent of worse payback etc.				
	Little or none	Minor	Moderate	Substantial	Major
By the sponsoring managers	1	2	3	4	5
By the approving authority	1	2	3	4	5

26a. During the *pre-approval stage*, how risky, or difficult to implement, was this project perceived as being, in the following terms?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slightly	Quite a lot	A great deal
Financially risky	1	2	3	4	5
Technically risky	1	2	3	4	5
Organisationally risky (ie. effects on working arrangements, management systems etc.)	1	2	3	4	5

IF YOU CIRCLED "1" TO <u>ALL</u> PARTS OF THE ABOVE QUESTION, THEN DO NOT ANSWER 26b BELOW.

26b. To what extent were contingencies of time, money etc. allowed in the pre-approval of the project to compensate for any perceived risk with the project?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slightly	Quite a lot	A great deal
Contingencies of money.	1	2	3	4	5
Contingencies of time.	1	2	3	4	5
Other (specify) ______________________	1	2	3	4	5

27. To what extent was the project seen as being of a technical and/or organisational complexity? (Organisational complexity refers to the projects effects on working arrangements, management systems etc.)
CIRCLE ONE NUMBER PER LINE.

	Little or none	Minor	Mod-erate	Sub-stantial	Major
Technical Complexity	1	2	3	4	5
Organisational Complexity	1	2	3	4	5

28. To what extent was this project initiated for the *purpose* of acquiring new skills (managerial, operational etc.) in the following areas?
CIRCLE ONE NUMBER PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Information processing/handling	1	2	3	4	5
Production/Manufacturing	1	2	3	4	5
Marketing/Sales	1	2	3	4	5
Technology	1	2	3	4	5
Other (specify) ____________	1	2	3	4	5

The three parts to this question refer to the type of manufacturing processes used within your firm. The item 'Custom' to 'Continuous process' technology refers to the degree of production continuity, i.e. the frequency with which plant or machinery is stopped/started, reset etc. during its normal operation. 'Custom' technology requires very many stop/starts, resets; 'Continuous process' technology requires very few.

29a. Before the project came into operation, then, to what extent did the following production techniques contribute to the value added by operations within the major part of your FIRM?
CIRCLE ONE NUMBER PER SCALE.

	Little or none	Some	Slight-ly	Quite a lot	Over 70%
'Custom' technology. (e.g. prototypes)	1	2	3	4	5
'Small batch, job shop' technology. (e.g. tools, dies).	1	2	3	4	5
'Large batch' technology. (e.g. drugs, chemicals, parts, cans).	1	2	3	4	5
'Mass production' technology. (e.g. cars, standard textiles).	1	2	3	4	5
'Continuous process' technology. (e.g. oil refining).	1	2	3	4	5

29b. To what extent do the following production techniques contribute to the value added by operations within the PROJECT?
CIRCLE ONE NUMBER PER SCALE.

	Little or none	Some	Slight-ly	Quite a lot	Over 70%
'Custom' technology. (e.g. prototypes)	1	2	3	4	5
'Small batch, job shop' technology. (e.g. tools, dies).	1	2	3	4	5
'Large batch' technology. (e.g. drugs, chemicals, parts, cans).	1	2	3	4	5
'Mass production' technology. (e.g. cars, standard textiles).	1	2	3	4	5
'Continuous process' technology. (e.g. oil refining).	1	2	3	4	5

IF THE PROJECT WAS INSTALLED OR INTEGRATED INTO AN ALREADY EXISTING SMALLER PART OR DEPARTMENT WITHIN YOUR FIRM THEN ANSWER QUESTION 29c. BELOW. ELSE TICK AS 'NOT APPLICABLE' HERE ----------------) [ ]

29c. Before the project came into operation, then, to what extent did the following production techniques contribute to the value added by operations within the DEPARTMENT?
CIRCLE ONE NUMBER PER SCALE.

	Little or none	Some	Slight-ly	Quite a lot	Over 70%
'Custom' technology. (e.g. prototypes)	1	2	3	4	5
'Small batch, job shop' technology. (e.g. tools, dies).	1	2	3	4	5
'Large batch' technology. (e.g. drugs, chemicals, parts, cans).	1	2	3	4	5
'Mass production' technology. (e.g. cars, standard textiles).	1	2	3	4	5
'Continuous process' technology. (e.g. oil refining).	1	2	3	4	5

30. During the pre-approval stage of the project, how much effort was expended on collecting and checking the information used?
CIRCLE ONE NUMBER PER LINE (CIRCLE '1' IF DON'T KNOW).

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Collection of information	1	2	3	4	5
Checking/Validation of information	1	2	3	4	5

31. Relative to similar projects, how much money was spent by your firm during the pre-approval stage of the project?
CIRCLE ONE NUMBER PER LINE.

	Much less	Less	About same	More	Much more
Paid to external agents e.g. consultants.	1	2	3	4	5
Spent on internal development budgets salaries etc. of own personnel.	1	2	3	4	5

The next few questions ask you to estimate the VALUE, as you see it, of the information used during the pre-approval stage of the project. We are not interested in the extent of the use of information. we are only interested in its value or contribution in helping to solve problems or in selecting a particular course of action or enquiry.

32. How would you rate the *value* of the information etc. supplied from within the following functional areas of your firm during the pre-approval stage of the project?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slightly	Quite a lot	A great deal
Marketing/Sales.	1	2	3	4	5
Personnel/Training.	1	2	3	4	5
Production/Manufacturing/Operations.	1	2	3	4	5
Technical/Engineering/R & D/Design.	1	2	3	4	5
Planning/Scheduling/Purchasing/Stores and other "Operational Support" activities.	1	2	3	4	5
Accounting/Finance/Data Processing/Legal and other "Senior Management Support" activities.	1	2	3	4	5
Board/General Manager/Head Office.	1	2	3	4	5

33. How would you rate the *value* of the information etc. supplied to your firm by people or agencies from outside your organisation during the pre-approval stage of the project?
CIRCLE ONE NUMBER PER LINE (CIRCLE "1" IF THE AGENCY WAS NOT INVOLVED).

	Little or none	Some	Slightly	Quite a lot	A great deal
Auditors	1	2	3	4	5
Trade associations	1	2	3	4	5
Shareholders	1	2	3	4	5
Trade Unions	1	2	3	4	5
Suppliers of materials	1	2	3	4	5
Suppliers of finance	1	2	3	4	5
Suppliers of equipment	1	2	3	4	5
Competitors (comparative performance)	1	2	3	4	5
Customers/clients	1	2	3	4	5
Government departments and agencies	1	2	3	4	5
Business consultants	1	2	3	4	5
Technical consultants	1	2	3	4	5
Others (Specify)________________	1	2	3	4	5

34. During the pre-approval stage of the project, how *valuable* were each of the following communication methods?
CIRCLE ONE NUMBER PER LINE (CIRCLE "1" IF DON'T KNOW).

	Little or none	Some	Slightly	Quite a lot	A great deal
Informal meetings	1	2	3	4	5
Formal Meetings	1	2	3	4	5
Post office Mail	1	2	3	4	5
Telephone	1	2	3	4	5
Fax or Telex	1	2	3	4	5
Video conference systems	1	2	3	4	5
Electronic Mailing systems	1	2	3	4	5

35. During the pre-approval stage of the project, how *valuable* were each of the following information gathering methods?
CIRCLE ONE NUMBER PER LINE (CIRCLE "1" IF DON'T KNOW).

	Little or none	Some	Slightly	Quite a lot	A great deal
Judgment of one person	1	2	3	4	5
Judgment of several people	1	2	3	4	5
Searching internally available data	1	2	3	4	5
Searching externally available data	1	2	3	4	5
Observational tours/visits	1	2	3	4	5
Survey/Experiment/R&D	1	2	3	4	5

36. During the pre-approval stage of the project, how *valuable* was the production of written documentation, in the form of:
CIRCLE ONE NUMBER PER LINE (CIRCLE '1' IF DON'T KNOW).

	Little or none	Some	Slightly	Quite a lot	A great deal
Minutes of meetings	1	2	3	4	5
Internally produced reports/memos.	1	2	3	4	5
Reports etc. from external agencies	1	2	3	4	5
Standard computer generated reports	1	2	3	4	5
Non-standard computer reports from specific analysis or enquiries.	1	2	3	4	5

37. Were computers used at all by your firm during the pre-approval stage of the project?
TICK ONE BOX ONLY.

Computers were not used. [ ]
Computers were used. [ ]

IF COMPUTERS WERE NOT USED THEN GO TO SECTION 2b. OF THE QUESTIONNAIRE.

38. What type of computer was used, and how *valuable* were each of the following types of computer programme (software) to you during the pre-approval stage of the project?
(NOTE: Information *value* is seen here as the contribution it made in solving identified problems, or in helping to select a particular course of action/enquiry.)
TICK AS MANY BOXES AS REQUIRES AND CIRCLE ONE NUMBER PER LINE.

	Type of Computer.			Value of use.				
	Micro-	Mini-	Mainframe	Little or none	Some	Slightly	Quite a lot	A great deal
Word/Text processing/publishing.	[ ]	[ ]	[ ]	1	2	3	4	5
Spreadsheet.	[ ]	[ ]	[ ]	1	2	3	4	5
Dedicated Graphics package.	[ ]	[ ]	[ ]	1	2	3	4	5
Critical path analysis / Project management.	[ ]	[ ]	[ ]	1	2	3	4	5
Data storage and retrieval systems. (i.e. Data Bases.)	[ ]	[ ]	[ ]	1	2	3	4	5
Other (specify) ________________	[ ]	[ ]	[ ]	1	2	3	4	5

39. During the pre-approval stage of the project, which of the following types of information were drawn from computer based files, and what was it's source?

In relation to data sources, the following definitions are made:
<u>Local</u> - from a department or personal data base.
<u>Central</u> - from a central source within your firm, e.g. the data processing department.
<u>Corporate</u> - from the D.P. department of a parent or subsidiary company.
<u>External</u> - from an external, public data source, e.g. PRESTEL, EXSTAT etc.
TICK ONE NUMBER PER LINE.

	Not Used	Source of data files. Local	Cent.	Corp.	Ext.
Scientific/Technical/Laboratory Information	1	2	3	4	5
Planning information (schedules, forecasts etc.)	1	2	3	4	5
Marketing Information	1	2	3	4	5
Financial (Accounting) Information	1	2	3	4	5
Production Information	1	2	3	4	5
Personnel Information	1	2	3	4	5
Top management Information (e.g. Share prices, exchange rates)	1	2	3	4	5

SECTION 2b. THE PROJECT-From approval up to the present

1. How many other major and important projects have there been in the department since this project was brought into operation?
(Note: "department" refers to the area of the site in which the project was installed, whether seen as a department or not.)

Number of projects [__________]

2. How adequately did contingencies of money, time etc. (if any) compensate for actual cost and time overruns (if any) experienced with the project?
CIRCLE ONE NUMBER ONLY

			About right			
Wholly inadequate	1	2	3	4	5	Far too generous

3. To what extent was the project completed to budget and to schedule, and has it achieved the specification originally given in the capital application documentation in terms of product quality and/or volume?
CIRCLE ONE NUMBER PER LINE.

	Much below	Below	About Same	Above	Much above
Budget	1	2	3	4	5
Schedule (time)	1	2	3	4	5
Specification	1	2	3	4	5

4. Since the project came into operation, to what extent have you experienced changes in the area or department where the project was installed, in the following listed items?
CIRCLE ONE ITEM PER LINE. (CIRCLE 3 IF YOU DON'T KNOW).

	Decreased (improved)		No change		Increased (worsened)
Absenteeism	1	2	3	4	5
Staff/worker turnover	1	2	3	4	5
Grievances	1	2	3	4	5
Accidents/illnesses	1	2	3	4	5
Machine downtime	1	2	3	4	5
Net product rejects	1	2	3	4	5
Under standard production (i.e. lower quality than desired but nor rejected).	1	2	3	4	5

As a result of this project some relatively subtle changes may have occurred within your firm. Please read the following statements and indicate whether, as a result of this project only, you are able to agree or disagree with the statement.
Note. Some of these questions require you to think in terms of double negatives.

5. With hindsight, to what extent can you agree or disagree with the following statements?
CIRCLE ONE NUMBER ONLY PER LINE.

	Agree		N/A or Neither		Dis-Agree
o Important financial and operating information has become less accessible.	1	2	3	4	5
o Managers are freer to adopt their own individual management style.	1	2	3	4	5
o Expertise rather than formal authority is now more recognised and used for decision-making.	1	2	3	4	5
o Past practice is now more of a barrier to adopting new ideas etc.	1	2	3	4	5
o Getting things done is now more important than "following the book".	1	2	3	4	5
o Informal relationships and controls are now more widely used for getting the job done.	1	2	3	4	5
o The individual now has less of a say in how they get their work done.	1	2	3	4	5
o Individual responsibility is now more orientated towards the firm as a whole than to functional role.	1	2	3	4	5
o Tasks are now more rigidly defined.	1	2	3	4	5

6. While considering only the project in question, decide to what extent you are able to agree or disagree with each of the following statement.
The following terminology is defined to better understand these statements.
Top management - C.E.O., Chairman, G.M., M.D., Board etc. of the firm.
Unit manager - person in charge of the day-to-day running of the department in which the project was installed.
Engineers - the person or people most directly responsible for the design, installation and commissioning of the project.
Use the scoring system explained in the previous question.
CIRCLE ONE NUMBER ONLY PER LINE (CIRCLE "3" OF YOU DON'T KNOW).

	Agree		Neither		Dis-agree
Unfreezing, Favourable.					
Top managers initiated the project.	1	2	3	4	5
Top managers became involved with the project.	1	2	3	4	5
Top and unit managers felt the project was important to the company.	1	2	3	4	5
Top and unit managers were open, candid.	1	2	3	4	5
Unit managers revised some of their assumptions.	1	2	3	4	5
Unit managers recognised the need for the project.	1	2	3	4	5
Unfreezing, Unfavourable					
Top managers felt the project was too big.	1	2	3	4	5
Unit managers could not state their problems clearly.	1	2	3	4	5
Unit managers felt threatened by the project.	1	2	3	4	5
Unit managers resented having to deal with the project.	1	2	3	4	5
Unit managers felt they could do the project design study alone.	1	2	3	4	5
Unit managers lacked confidence in the engineers.	1	2	3	4	5
Moving, Favourable					
Top managers helped develop the project design.	1	2	3	4	5
Top managers were advised of options.	1	2	3	4	5
Unit managers reviewed and evaluated alternatives.	1	2	3	4	5
Unit managers and engineers gathered data jointly.	1	2	3	4	5
Alternative ways to carry out the project were devised.	1	2	3	4	5
Designs were improved sequentially.	1	2	3	4	5
Relevant data were accessible, available.	1	2	3	4	5
Moving, Unfavourable					
Unit managers did not help develop the project design.	1	2	3	4	5
Unit managers did not understand the project as proposed by the engineers.	1	2	3	4	5
Engineers felt the design study was concluded too quickly.	1	2	3	4	5
Engineers could not educate the unit managers.	1	2	3	4	5
Needed data were not made available.	1	2	3	4	5
Refreezing, Favourable					
Unit managers operated the project.	1	2	3	4	5
Unit managers were satisfied.	1	2	3	4	5
Engineers initiated positive feedback after early use.	1	2	3	4	5
Project was widely accepted after initial success.	1	2	3	4	5
The project improved the performance of the unit.	1	2	3	4	5
Operation showed the success of the project.	1	2	3	4	5
Similar projects have/are been proposed for other areas.	1	2	3	4	5
Refreezing, Unfavourable					
Top managers did not encourage other units to adopt similar projects.	1	2	3	4	5
Top management ignored the solution recommended by the engineers.	1	2	3	4	5
Engineers did not try to support new managerial behaviour after the project was in operation.	1	2	3	4	5
Engineer did not try to re-establish stable operations after the project was commissioned.	1	2	3	4	5
Results were difficult to measure.	1	2	3	4	5
Standards for evaluating results were lacking.	1	2	3	4	5
The project was incompatible with the needs and resources of the unit.	1	2	3	4	5

7. How much time, relative to projects of similar size (if any) did *final approval* for this project take?
CIRCLE ONE NUMBER ONLY.

			Average			
Much less	1	2	3	4	5	Much more

8. To what extent did *this project* require:
CIRCLE ONE NUMBER ONLY.

Decisions and activities being performed at the same time.	1	2	3	4	5	Decisions and activities being performed one after the other.

9. Overall, what is your *current* opinion of the success of the project?
CIRCLE ONE NUMBER ONLY.

Highly unsatisfactory	1	2	3	4	5	Highly satisfactory

10. Is the project seen as a valid solution to the original stimulus/opportunity that arose?
CIRCLE ONE NUMBER ONLY.

Highly unsatisfactory	1	2	3	4	5	Highly satisfactory

11. Is the project *now* achieving the financial returns expected from it?
CIRCLE ONE NUMBER ONLY.

Highly unsatisfactory	1	2	3	4	5	Highly satisfactory

12. From a purely technical/engineering perspective, how satisfactory was the project?
CIRCLE ONE NUMBER ONLY.

Highly unsatisfactory	1	2	3	4	5	Highly satisfactory

13. From a managerial/organisational perspective, how satisfactory was the project?
CIRCLE ONE NUMBER ONLY.

Highly unsatisfactory	1	2	3	4	5	Highly satisfactory

14. To what extent did *this project's* use of previous experience, technical and other skills, compare to other capital projects carried out within your organisation?
CIRCLE ONE NUMBER ONLY.

			Average			
Much less	1	2	3	4	5	Much more

15. To what extent have *new skills*, ways of working or doing business been introduced or developed as a result of this project in the following functional areas of your firm? (We are not interested in whether you are now doing more or less of an activity, but the extent to which your firm now performs these activities differently.)
CIRCLE ONE NUMBER PER LINE. (CIRCLE '1' IF DON'T KNOW).

	Little or none	Some	Slightly	Quite a lot	A great deal
Marketing	1	2	3	4	5
Sales	1	2	3	4	5
Advertising/Public Relations/Promotion	1	2	3	4	5
Market research	1	2	3	4	5
Customer relations/Complaints/Liaison	1	2	3	4	5
Personnel	1	2	3	4	5
Training	1	2	3	4	5
Welfare/Security/Social services	1	2	3	4	5
Production	1	2	3	4	5
Production engineering	1	2	3	4	5
Maintenance/Engineering	1	2	3	4	5
Planning/Scheduling	1	2	3	4	5
Quality Control/Inspection	1	2	3	4	5
Work Study/Operations Study	1	2	3	4	5
Design	1	2	3	4	5
Research and/or Development	1	2	3	4	5
Transport/Distribution	1	2	3	4	5
Purchasing/Procurement/Stock Control	1	2	3	4	5
Accounting/Finance	1	2	3	4	5
Data Processing/Statistics	1	2	3	4	5
Legal/Insurance	1	2	3	4	5
Senior management	1	2	3	4	5

In the following questions the project is seen as passing through four stages. These are labelled and defined as follows:

PRE-APPROVAL - The design or planning stage, ending with formal approval to make the capital investments necessary for the project to be implemented.
INSTALLATION - The construction/installation stage ending with the start of commissioning of the project.
COMMISSIONING - The technical proving time involving the bringing of the project plant or equipment up to its design etc. capacity.
OPERATION - The final integration of the project into the normal day-to-day operations of the organisation, perceived as starting at the same time as commissioning.

16. Please give approximate dates to the following questions.
ANSWER ALL QUESTIONS.

	Month	Year
a) When did commissioning of the project end?	[____]	[____]
b) When did commissioning of the project start?	[____]	[____]
c) When was final approval for the capital expenditure given?	[____]	[____]
d) When was the stimulus that gave rise to the project first identified?	[____]	[____]

Use the following scale to answer the next two questions.

Equal - Equal value or contribution.
Mod. - Moderately more valuable of one over the other.
Ess. - Essentially or strongly more valuable.
Dem. - Demonstrably more valuable.
Abs. - Absolutely more valuable.

17. Listed below are six questions obtained by pairing off the four project stages given above. Please indicate by a tick, which of the pair you consider made the greatest contribution to the reduction of uncertainty or resolution and identification of problems etc. with the project as it stands NOW. In addition, indicate on the adjacent scale (defined above) to what extent the ticked item made the greater contribution.
TICK ONE ITEM [✓] AND CIRCLE ONE NUMBER PER LINE.

			Equal	Mod.	Ess.	Dem.	Abs.
Pre-approval [ ]	vs.	Installation [ ]	1	2	3	4	5
Commissioning [ ]	vs.	Pre-approval [ ]	1	2	3	4	5
Pre-approval [ ]	vs.	Operation [ ]	1	2	3	4	5
Operation [ ]	vs.	Installation [ ]	1	2	3	4	5
Installation [ ]	vs.	Commissioning [ ]	1	2	3	4	5
Commissioning [ ]	vs.	Operation [ ]	1	2	3	4	5

18. Listed below are six questions obtained by pairing off four underlying activities performed during the *design stage* of the project. The four activities are:
1. The gathering or collection of facts and figures.
2. The analysis of this data, particularly in relation to sophisticated calculations.
3. The effective communication of data and conclusions drawn from the data.
and 4. The use of tools such as computers and the like, used to aid data gathering, analysis and communication.

Please indicate by a tick, which of the pair you consider made the greatest contribution to the reduction of uncertainty or resolution and identification of problems etc. with the project as it stands NOW. In addition, indicate on the adjacent scale (defined above) to what extent the ticked item made the greater contribution.
TICK ONE ITEM [✓] AND CIRCLE ONE NUMBER PER LINE.

			Equal	Mod.	Ess.	Dem.	Abs.
Gathering [ ]	vs.	Analysis [ ]	1	2	3	4	5
Communication [ ]	vs.	Gathering [ ]	1	2	3	4	5
Gathering [ ]	vs.	Tools [ ]	1	2	3	4	5
Analysis [ ]	vs.	Communication [ ]	1	2	3	4	5
Tools [ ]	vs.	Analysis [ ]	1	2	3	4	5
Communication [ ]	vs.	Tools [ ]	1	2	3	4	5

19. How effectively has the new and unique experiences gained by your firm during the whole of this project been transferred to other parts of your business?
CIRCLE ONE ITEM PER LINE. (CIRCLE "1" IF NOT APPLICABLE)

	Little or none	Some	Slightly	Quite a lot	A great deal
In the immediate working area (department) around the project.	1	2	3	4	5
Throughout other areas of your site.	1	2	3	4	5
Between other subsidiaries or divisions of your organisation.	1	2	3	4	5

20. To what extent do you feel that problems with the project were caused by the following?
CIRCLE ONE NUMBER PER LINE.

	Extent of problem				
	Little or none	Minor	Moderate	Substantial	Major
o Underestimating the complexity of completing the project by concentrating on immediate commercial and technical decisions and making optimistic assumptions about the consequential effects.	1	2	3	4	5
o Having a lack of confidence in planning.	1	2	3	4	5
o By making slow or unco-ordinated responses to changes or problems affecting objectives after starting the project.	1	2	3	4	5
o Having inexperience in planning or controlling contracts.	1	2	3	4	5
o Not having a system for learning from experience, particularly a reluctance to analyse successful and unsuccessful past decisions.	1	2	3	4	5
o A failure during planning to define key tasks and objectives, or to provide sufficient detail with adequate design reviews or to anticipate possible faults.	1	2	3	4	5
o By failure to secure commitment to the plan.	1	2	3	4	5
o By failure to control sub-contractors adequately or specify responsibilities and acceptance criteria in contracts.	1	2	3	4	5
o By failure to provide or use appropriate management controls, information systems, or detailed data analysis methods during the project.	1	2	3	4	5
o Too great a dependence on individuals' unrecorded knowledge of plant, services, operating principles etc.	1	2	3	4	5
o A lack of prior training of operators and supervisors.	1	2	3	4	5
o By failure to clearly define changes in roles and responsibilities, provide adequate rewards and incentives, or anticipate anxieties of persons affected by the project.	1	2	3	4	5
o Making late changes to the project's design or programme.	1	2	3	4	5
o By failure to allow for changes in the "environment" (markets, government policies etc.) that were beyond the control of your firm.	1	2	3	4	5
o By failure to vest authority for and over all parts of the project with people of sufficient seniority and experience.	1	2	3	4	5
o through competing activities and crises distracting attention from the project.	1	2	3	4	5
o Having insufficient support during implementation from top management, key formulators or advocates of the project.	1	2	3	4	5
o Financial resources made available were not sufficient.	1	2	3	4	5
o Through a reluctance to consult specialists.	1	2	3	4	5
o Assuming that licensed or patented designs will work without checking or testing.	1	2	3	4	5
o OTHER (specify) ______________________	1	2	3	4	5

21. Would you please describe how the major *managerial problems* (if any) encountered in integrating the project into the organisation, were resolved.

____
____
____
____
____
____

22a. To what extent do you feel this project could have been handled *more* successfully during the four stages listed below?
CIRCLE ONE NUMBER PER LINE.

	Little or none	Minor	Mod-erate	Sub-stantial	Major
Pre-approval.	1	2	3	4	5
Installation.	1	2	3	4	5
Commissioning.	1	2	3	4	5
Operational.	1	2	3	4	5

22b. Please describe in what way you feel the project could have been handled differently.

____
____
____
____
____
____

23. To what extent did your firm delegate responsibility for the *management* of the project to an outside agency, consultant or contractor at each of the following stages?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Pre-approval stage	1	2	3	4	5
Installation stage	1	2	3	4	5
Commissioning stage	1	2	3	4	5
Operation stage	1	2	3	4	5

24. How much of the *new and unique* experience gained by your firm during the four stages of this project would be lost if certain key individuals were to leave the firm?
CIRCLE ONE NUMBER PER LINE (CIRCLE "NONE" IF DON'T KNOW)

	Little or none	Some	Slight-ly	Quite a lot	A great deal
New Pre-approval experience	1	2	3	4	5
New Installation experience	1	2	3	4	5
New Commissioning experience	1	2	3	4	5
New Operational experience	1	2	3	4	5

25. To what extent has the *new and unique* experience gained by your firm during the four stages of this project been transferred from the heads of individuals onto written records/manuals/reports?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Pre-approval experience	1	2	3	4	5
Installation experience	1	2	3	4	5
Commissioning experience	1	2	3	4	5
Operation experience	1	2	3	4	5

26. To what extent has the *new and unique* experience gained by your firm during the four stages of this project been transferred from the heads of individuals onto computer based data bases?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Pre-approval experience	1	2	3	4	5
Installation experience	1	2	3	4	5
Commissioning experience	1	2	3	4	5
Operation experience	1	2	3	4	5

27. To what extent has the *new and unique* experience gained by your firm during the four stages of this project been transferred from the heads of individuals onto computer based expert systems?
CIRCLE ONE NUMBER ONLY PER LINE.

	Little or none	Some	Slight-ly	Quite a lot	A great deal
Pre-approval experience	1	2	3	4	5
Installation experience	1	2	3	4	5
Commissioning experience	1	2	3	4	5
Operation experience	1	2	3	4	5

28. To what extent were personnel hired, trained, re-skilled to solve any of the problems encountered with the project?
TICK ONE BOX ONLY.

Not significantly [ ]
Slightly [ ]
To some extent [ ]
Greatly [ ]
To a very great extent [ ]

29. Has the time taken to handle similar decisions and projects changed over the years?
TICK ONE BOX ONLY.

Much less time than in the past. [ ]
Takes less time on average than in the past. [ ]
No significant or noticeable change. [ ]
Now seem to take longer than in the past. [ ]
Much longer than in the past. [ ]

30. How much time after commissioning did it take for the project to achieve the performance and/or returns expected from it?
TICK ONE BOX ONLY.

Much less than expected. [ ]
Less than expected. [ ]
About the same as expected. [ ]
Longer than expected. [ ]
Much longer than expected. [ ]

31. In relation to what was originally expected to occur, do you feel the implementation of this project to be:
TICK ONE BOX ONLY.

Much easier than expected. [ ]
Easier than expected. [ ]
About as expected. [ ]
Less easy than expected. [ ]
Much less easy than expected. [ ]

32. Did this project undergo any changes in product market, design capacity, specification etc. between approval and final use of the capital item?
TICK ONE BOX ONLY.

Not significantly	[ ]
Slightly	[ ]
To some extent	[ ]
Greatly	[ ]
To a very great extent	[ ]

33. To what extent were unanticipated technical problems encountered with the project during and after it was commissioned?
TICK ONE BOX ONLY.

Not significantly	[ ]
Slightly	[ ]
To some extent	[ ]
Greatly	[ ]
To a very great extent	[ ]

34. To what extent were unanticipated non-technical (organisational, personnel) problems encountered with the project during and after it was commissioned?
TICK ONE BOX ONLY.

Not significantly	[ ]
Slightly	[ ]
To some extent	[ ]
Greatly	[ ]
To a very great extent	[ ]

35. To what extent were existing standard procedures and practices found to be *inadequate* to finally implement the project?
TICK ONE BOX ONLY.

Not significantly	[ ]
Slightly	[ ]
To some extent	[ ]
Greatly	[ ]
To a very great extent	[ ]

36. If things had gone wrong with the project, how serious would it have been for your firm?
TICK ONE BOX ONLY.

Not at all	[ ]
Slightly	[ ]
Quite	[ ]
A great deal	[ ]
A very great deal.	[ ]

SECTION 2c. THE PROJECT - What about the future?

1. To what extent have the consequences of the project changed the way you do business?
TICK ONE BOX ONLY.

Not at all	[ ]
A little	[ ]
Quite a lot	[ ]
Substantially	[ ]
Radically	[ ]

2. How wide a general applicability do you feel any changes in operating procedures, new skills or ways of working etc. have to other parts of your firm?
TICK ONE BOX ONLY.

Not significantly	[ ]
Slightly	[ ]
To some extent	[ ]
Greatly	[ ]
To a very great extent	[ ]

3. Are there or have there been any plans to duplicate or repeat a similar type of project within your firm?
TICK ONE BOX PER LINE.

At your site		Yes [ ]	No [ ]
At some other site (if applicable)	Not applicable [ ]	Yes [ ]	No [ ]

4. In view of the experience gained during this project, if an *identical project* were to be proposed now, how willing do you think your firm would be to undertake it?
CIRCLE ONE NUMBER ONLY.

			The same			
Very unwilling	1	2	3	4	5	Very willing

5a. How do you now rate your firm's ability to implement important capital projects which are technically <u>simple</u> and have only <u>minor</u> organisational effects or consequences?
(Note. Organisational effects refer to the effect on managerial or operational working systems and practices.)
CIRCLE ONE NUMBER ONLY.

		Poor	Fair	Good		
Very Poor	1	2	3	4	5	Excellent

5b. How do you now rate your firm's ability to implement important capital projects which are technically <u>complex</u>, but have only <u>minor</u> organisational effects or consequences?
CIRCLE ONE NUMBER ONLY.

		Poor	Fair	Good		
Very Poor	1	2	3	4	5	Excellent

5c. How do you now rate your firm's ability to implement important capital projects which are technically <u>simple</u> but which have <u>major</u> organisational effects or consequences?
CIRCLE ONE NUMBER ONLY.

		Poor	Fair	Good		
Very Poor	1	2	3	4	5	Excellent

5d. How do you now rate your firm's ability to implement important capital projects which are technically <u>complex</u> and also have <u>major</u> organisational effects or consequences?
CIRCLE ONE NUMBER ONLY.

		Poor	Fair	Good		
Very Poor	1	2	3	4	5	Excellent

6. To what extent has this project affected your attitude to your firm's ability to handle the technical and organisational complexities of capital investment projects which are?
CIRCLE ONE NUMBER ONLY PER LINE.

	Reduced (decreased)		No change		Enhanced (increased)
Technically and organisationally simple.	1	2	3	4	5
Technically complex but organisationally simple.	1	2	3	4	5
Organisationally complex but technically simple.	1	2	3	4	5
Both technically and organisationally complex.	1	2	3	4	5

SECTION 3. FURTHER INTEREST

Please check through the questionnaire to ensure you have completed all the questions, as incomplete data presents major problems in subsequent analysis.

Place a tick in the box at the end of this line if your company would be interested in taking part in follow-up research. [ ]

Place a tick in the box at the end of this line if your company would be interested in a copy of the report summarising the findings of this study, when available. [ ]

If you ticked either of the above, then please complete.

Name: ______________________________

Company: ______________________________

Address: ______________________________

____

____

Tel. No. ______________________________

Thank you for your time and co-operation with this project.

APPENDIX B

KOMPASS MAIN INDUSTRIAL GROUPS

01	Livestock.
02	Agricultural Products.
03	Horticulture, Aquatic Plants.
04	Agricultural Services.
08	Forestry.
09	Fresh Fish and other Sea Products.
11	Coal and Peat.
12	Ores.
13	Crude Petroleum and Natural Gas.
14	Quarrying.
16	Precious and Semi-precious Stones, Uncut.
19	Minerals.
20	Food and Tobacco.
21	Beverages.
22	Leathers, Furs and their products, Footwear.
23	Textile Industry.
24	Wearing Apparel and Make-Up Textile Goods, Umbrellas etc.
25	Wood and Cork Products.
26	Furniture.
27	Cellulose, Paper and Board Industry.
28	Printing and Publishing.
29	Rubber Products.
30	Plastic Products.
31/2	Chemical and Oil Industry.
33	Non-Metallic Mineral Products.
34	Basic Metal Industry.
35/6	Metal Industry.
37	Electrical, Electronic, Data Processing and Nucleonic Equipment.
38	Precision Equipment; Measuring, Testing, Optical, Photographic, Cinematographic, Medical and Surgical Equipment.
39	Transport Equipment, Infrastructure.
40	Hydraulic and Pneumatic Equipment, Pumps, Compressors, Refrigerators, Heating and Air Conditioning Equipment.
41	Agricultural, Horticultural and Forestry Equipment, Food and Drink and Tobacco Equipment.
42	Chemical, Rubber and Plastics Plant and Equipment. Mechanical Preparation of Materials. Collecting and Processing Equipment for Industrial and Domestic refuse. Water Treatment Equipment for Industrial and Domestic Refuse. Water Treatment Equipment. Packaging Machinery.
43	Textile, Clothing, Leather Industry and Shoemaking Equipment.
44	Pulp and Paper Industry. Printing Office Machinery and Equipment.
45	Mining and Quarrying, Oil and Gas Extraction Equipment. Stone and Earth, Ceramic and Glass Industry Equipment. Mechanical Handling Equipment. Road Making, Building, Offshore and Underwater Equipment.
46	Heavy Industry and Metal Working Plant and Machinery.
47	Metal and Woodworking machines, Machine Tools and Accessories, Special Purpose Machines, Industrial Robots.
48	General Mechanical Engineering Sub-Contractors.
49	Watches, Jewellry, Souvenirs and Religious Articles, Brushes, Wigs, Advertising and Display Articles, Labels, Games, Toys, Musical Instruments, Vending Machines, Office Equipment, Camping and Life Saving Equipment.
51	Public Works.
52	Building Contractors and Auxiliary Services.
53	Building Services Contractors.
56	Public Utility Services.
61	Importers/Exporters, Brokers, large Purchasing and Selling Organisations, Department Stores.
62/5	Wholesale Distributive Trades; Consumer Goods 66/7 Wholesale Distributive Trades; Investment, Office, Building and Hospital Equipment and Supplies.
68	Wholesale Distribution; Transport Equipment and Installation.
69	Hotels, Motels, Restaurants, Catering, Conference Centres, etc.
71/3	Land Transportation
74	Sea Transportation, Ports.
75	Air Transportation, Ports.
76/7	Transport Services, Goods Storage.
79	Communication Services, Radio and Television.
80	Administrative, Personnel and Real Estate Services.
81	Commercial Services.
82	Financial and Insurance Services.
83	Leasing/Renting Services.
84	Technical Services, Engineering.
85	Various Services, Research.
86	Training.
87	Public Administration, Social Services, Medical Care.
88	Economic and Professional Organisations.
89	Entertainments Industry.

APPENDIX C

SPECIMEN INTERVIEW REQUEST LETTER

[UNIVERSITY MANAGEMENT CENTRE LETTER HEAD]

Dear Mr. CEO,

I am engaged on research at the University of Bradford Management Centre, into the implementation of capital investment decisions in U.K. manufacturing companies. This work is being sponsored by the British Government's Economic and Social Research Council. The research team consists of myself, Mr. Stuart Sanderson and Dr. John Sharp.

My research focuses on what a firm learns from investing in new plant or equipment. A major portion of the research attempts to discover if learning about implementation gives a company deployable strategic advantages over its competitors. I have taken the view that in order to learn not all projects need necessarily have met their financial targets.

To enable me to test these ideas I need to collect data from manufacturing companies such as yours. I therefore seek your co-operation and request a personal interview with you so that I may ask a number of questions about your firm in general and a specific capital investment project of your choice in particular. This project should have been seen as important, that is, having a long term impact on your company's goals, profitability and/or growth. It is further suggested that this project should have been fully operational for at least six months.

The interview will seek to identify where and how organisational learning has taken place within your firm. To do this I need to ask about the planning, management and operation of the project. However, because these questions focus on the broader managerial effects of the project, as opposed to its purely technical or financial content, it is felt the questions should be answered by a senior manager within your firm who has knowledge of your firm's business environment and the specific project. Such a person may be yourself. If not yourself, would you identify a project and a suitable respondent for interview. I will be contacting yourself or your secretary in the near future to arrange, if you are agreeable, a time and date for the interview, or to find the name of a person within your firm that I may interview with your permission. I anticipate the duration of the interview to be 90 minutes.

I can assure you that the responses to this questionnaire will be kept in the strictest confidence and only reported in aggregate form for bona fide research purposes. Finally, let me thank you in anticipation for your time and co-operation. Believe me, your responses are vital to the success of this research.

Yours sincerely,

APPENDIX D

RAW AND TRANSFORMED DATA SCALE COMPARISONS

PEARSON CORRELATION MATRICES.
NUMBER OF OBSERVATIONS FOR BOTH MATRICES: 45.
LOWER DIAGONAL SEMI-MATRIX - SCALES BASED ON TRANSFORMED DATA.
UPPER DIAGONAL SEMI-MATRIX - SCALES BASED ON RAW DATA.

KEY TO ABBREVIATIONS:

Uncertainty scales:
UXX - Uncertainty
USX - Scope
UNX - Novelty
UUX - Urgency
UCX - Complexity

Information scales:
IMX - Mechanicity
IRX - Range
ILX - Lubrication
IAX - Activity

Success scales:
SEX - Expectation
SEE - Ease
SES - Satisfaction
SCX - Change

RSk - Skewness for scales based on raw data.
TSk - Skewness for scales following data transformations.

	UXX	USX	UNX	UUX	UCX	IMX	IRX	ILX	IAX	SEX	SEE	SES	SCX
UXX	-	**0.840**	0.345	**0.778**	**0.666**				**0.650**	-0.336	**-0.617**		**0.647**
USX	**0.874**	-	**0.412**	**0.551**	*0.257*				**0.470**		**-0.457**		**0.518**
UNX	**0.456**	**0.484**	-			*-0.294*							0.300
UUX	**0.806**	**0.589**		-	**0.463**				**0.521**	*-0.288*	**-0.489**		**0.508**
UCX	**0.576**			**0.463**	-				**0.556**	-0.306	**-0.510**		**0.414**
IMX			*-0.262*			-	0.327		0.341				
IRX						*0.282*	-		*0.254*				
ILX								-	0.316				
IAX	**0.640**	**0.480**		**0.514**	**0.554**	0.348		0.321	-		**-0.416**		**0.443**
SEX	**-0.433**	-0.322		-0.348	**-0.382**				*-0.254*	-	**0.818**	**0.862**	
SEE	**-0.624**	**-0.484**	-0.312	**-0.489**	**-0.509**				**-0.404**	**0.884**	-	**0.417**	*-0.271*
SES										**0.805**	**0.437**	-	*0.281*
SCX	**0.648**	**0.523**	0.377	**0.508**	**0.414**				**0.442**		*-0.271*	*0.266*	-
RSk	0.973	1.727	1.288	0.068	0.336	0.772	1.099	-0.738	0.239	-1.473	-0.295	-2.513	0.369
TSk	0.321	0.301	1.124	0.068	0.336	0.772	0.881	-0.738	0.184	-0.802	-0.295	-1.526	0.369

Two-tailed significance levels for correlations:
$p > 0.10$ not shown.
$0.05 < p \leq 0.10$ shown in italic type.
$0.01 < p \leq 0.05$ shown in normal type.
$p \leq 0.01$ shown in bold type.

Note: Where RSk and TSk are identical, data transformations have not been applied.

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