UNIVERSITY OF SOUTHAMPTON

Dealing with uncertainty within information systems development: Applying prospect theory

Carl Adams

Thesis submitted for the degree of Doctor of Philosophy

FACULTY OF SOCIAL SCIENCE

SCHOOL OF MANAGEMENT

March 2002

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL SCIENCE

SCHOOL OF MANAGEMENT

Doctor of Philosophy

DEALING WITH UNCERTAINTY WITHIN INFORMATION SYSTEMS DEVELOPMENT: APPLYING PROSPECT THEORY

by Carl Adams

Information systems development is complex, involving relationships between distinct groups of people (e.g. users, analysts, designers and system owners), development rituals (e.g. methods and techniques) and dynamic environmental influences. This thesis develops a fuller picture of how uncertainty is addressed in this complex development environment. This is of relevance to the information systems field as many information systems projects involve much uncertainty and the uncertainty is likely to affect the success of these projects.

The main theoretical tool used in this thesis is *prospect theory* (Kahneman and Tversky 1979, Tversky and Kahneman 1992), which is described as a descriptive model of decision-making under risk. The main characteristics of prospect theory are the *'framing effect'*, a hypothetical 'S' shaped *value function* with corresponding weighting function and a two-phase decision process. These have been collaborated with a wealth of empirical studies and are likely to represent some fundamental decision-making behaviour: generally, people are influenced by how a decision situation is represented (framing effect) and, people are risk averse in situations of gains and risk seeking in situations of losses (as described by the value function). However, existing research is inconclusive on the applicability of prospect theory to complex real-life situations. Complex real-life decision environments are likely to involve uncertainty rather than risk and are likely to be conducted in a group context rather than an individual one. This thesis maps the applicability of prospect theory to the complex real-life arena of information systems development.

This thesis adopts an interpretive paradigm and uses mixed research techniques including postal surveys, developers' written and audio diaries, interviews and observations.

While mapping the applicability of prospect theory, this thesis develops a model of dealing with uncertainty, consisting of an iterative process, application of meta rules, group involvement and the identification of coping strategies. In addition, the model identifies the main influences on decision-making including the influences that are likely to be dominant. Where individual and framing influences dominate, then prospect theory seems appropriate. Where group and cultural influences dominate, then prospect theory is less appropriate.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acknowledgements

I would like to thank my supervisor, Prof. David Avison, for his encouragement, constructive criticisms, patience and proof-readings. A PhD study, particularly part-time, is an endurance test for supervisors as well as for students.

Thanks go to the developers who gave up their time to participate in the questionnaires, interviews, diary studies and observation sessions used in this research. Their willing participation has enriched this study. Particular thanks go the Neil Postlethwaite, Lisa, Susanne Reiblen and their team members.

The biggest thanks go to my wife, Melanie, and children, Heather, George and Wesley. Without their encouragement and support, this thesis would not have been completed. Thanks to Melanie for the many proof-readings, suggestions and her acting as a sounding board for ideas.

Chapter 1:Dealing with uncertainty within information systems development: Applying prospect theory

1. Introduction

This thesis examines how uncertainty is addressed within information systems development, the aim being to generate a fuller picture of how uncertainty is addressed in this dynamic, complex environment. To accomplish this, use is made of *prospect theory* (Kahneman and Tversky 1979, Tversky and Kahneman 1992), described as a descriptive model of decision-making under risk. As such, this thesis also suggests the bounds of applicability of prospect theory to information systems development. This is relevant and important to the information systems field, as many development projects involve considerable areas of uncertainty. A better understanding of how this uncertainty is addressed is likely to increase the chance of successful information systems projects.

This chapter discusses the main characteristics of the information systems development environment, the amount of uncertainty in development and the previous works on uncertainty from a variety of fields. This will put the research area in the context of other works, provide rationale for the choice of research approach and the use of prospect theory and lay the foundations for the rest of this thesis.

This chapter is structured as follows. Firstly, literature on information systems development is examined to develop a picture of a complex social environment, encompassing different stakeholders, a multitude of sometimes conflicting goals, where use is made of many methodologies and techniques. There then follows an examination of works covering uncertainty within information systems, which leads into an examination of some key related works on computer failure. Next some key works on risk and uncertainty, from several disciplines, are examined followed by a brief discussion on the choice of prospect theory to investigate dealing with uncertainty within information systems development. Finally the chapter describes the structure of the rest of this thesis.

1.1 The information systems environment

As the discussions that follow shows, there are many development environments each with their own unique characteristics. Throughout this thesis the term '*the information systems development environment*' is used to represent the variety of complex social activities, unique applications characteristics, methodologies, techniques and tools that make up diverse development environments.

1.1.1 Social aspects of development

Hutchison and Rosenberg (1994) consider the organisational context and influences of information systems use and development. They recognize that there are many views of what constitutes 'organisation' but adopt Huczynski and Buchanan's definition: *'Organisations are social arrangements for the controlled performance of collective goals'* (Hutchison and Rosenberg 1994,p7). Hutchison and Rosenberg distinguish between the overt structure (O-structure), e.g. the formal organisation, and covert structure (C-structure), e.g. informal organisation. They discuss the complex relationship and influences between the O-structure and the C-structure in terms of what constitutes the organisation, existing structures and particular positions and roles within the organisation. They argued that: *'the successful design of NGIS [group information systems] must be founded upon: an understanding of the social and organisational setting of work, and of the distinction between the abstract ORGANISATION and the concrete STRUCTURE, as well as between OFFICE and ROLE [*and*] the formal modelling not of a single user (problem solver) but of the whole work group'*. In their work they focus particularly on information systems to address group activities and processes. Key to their work is the concept that group activities have a strong social dimension. The development itself involves group activity by the development team, which by implication would have a strong social dimension. Taking this a step further we argue that, information systems support (social) group activities and the development of the information systems requires (social) group activity.

This is a theme taken up by Bloomfield (1992) who also discusses the social aspects of development. By drawing on MacKenzie and Wajcman (1985), work on the sociology of technology, Bloomfield describes the 'social' within the 'technical' of development practice

and argues for an understanding of '*the social practices underpinning computer science techniques*' as well as a '*socially adequate view of organisations*' (p204). An information systems development project will have (at least) two distinct social arenas, that of the development team focused round the technological practices and that of the organisation itself. '[There is] *an evident tendency towards a proliferation of methodologies within the area of information systems. The perspective adumbrated here would suggest that the root of the problem facing systems developers does not lie so much in the lack of the right method but, rather sociologically impoverished views of organisations and management, and above all their own practices.*' (Bloomfield 1992, p205)

Fortune and Peters (1995, p134), taking an overall systems view of failures, discuss some of the complex factors and human interactions affecting decision-making within organisations. They examine these complex factors at three levels: the organisational, group and the individual level. They use the concept of *cognitive adequacy* (Westrum 1988) to show how organisational level factors are likely to dictate many of the operations and processes within an organisation. For instance, the organisational structure and culture are likely to dictate who has responsibility for what kinds of actions, what is appropriate conduct for various positions, what and how information is communicated, what is considered as fixed or changeable and, how problems are addressed. Fortune and Peters discuss the strong group level influences, which can result in *group think* (Janis and Mann 1977) and group consensus dictating actions within the group. The influences at group level are further complicated when one considers the work on group behaviour and dynamics. Stewart (1991) describes three distinct stages of a group development: first as a new team start-up, then the team developing as a distinct entity, and finally when the team is well established. Decision-making is likely to be affected by the stage of the group's development. Well-established teams may develop a strong team culture where the team cohesiveness becomes more important than individual members. Embryonic teams, made up of a newly formed collection of individuals may find there is uncertainty over what the team is meant to be doing and the scope of their authority. This is likely to result in '*continuous checking of work and decisions*' (Stewart 1991, p140). Fortune and Peters' work is particularly relevant to understanding the strong influences (often pulling in different directions) affecting decision-making individually, at project team level and at organisational level. Decision-making

within information systems development has the potential for many complex social influences and interactions.

1.1.2 Political aspects of development

Block (1983) describes at great length the political nature of development environments. He attributes many problems and failures during development to political influences, most of which are outside of the developer's control. Block describes some of the "political techniques" (i.e. activities people undertake to support or not support an information system development) to be found during an information system development, including entrapment, direct frontal assault, invoking higher authority, false statements, smear tactics, expert witness, bluff, inaction, deadline pressure, appeasement and ignoring orders, hanging tough and, issue confrontation (p105). Block argues that developers should acquire political 'training' and skills to cope with, or at least be aware of, these external influences.

Yourdon (1983), in the forward to Block's book '*The Politics of Projects*', reflects on the pervasive nature of the political arena during information systems development and the lack of political awareness among developers: '*the vast numbers of fledgling programmers and analysts (from whose ranks most project managers eventually emerge) usually have no idea that politics is an inevitable phenomenon whenever two or more humans interact*' (forward).

Sauer (1993, p53), following Kling's (1980) studies of power and organisational change, recognizes the strong political influences an information system development unleashes when it affects aspects of an organisation, especially when the information systems represent innovation and change. Power structures will vary between projects and organisations. Some *project organisations* (i.e. information systems development teams) may wield considerable power while others may not. However, Sauer concludes that though the information system has the potential to unleash political forces, the actual information system development team '*will not typically be powerful*' (p116). The information systems development team will be dependent on the various project supporters who typically control critical resources. The relationship is likely to be an unequal one in which the information systems development team are more dependent on the project supporters than the other way round. The picture painted here is where information systems development processes initiate many political

interactions between powerful organisational factions with the information systems development team placed somewhere in the middle.

1.1.3 Development methodologies and techniques

There is much debate covering development methods, or methodologies, and techniques, which dominates much of the information systems literature (Bell and Oates 1998). Avison and Fitzgerald (1995) suggest there may be hundreds of development methods. There are a variety of frameworks from which to examine these methodologies (e.g. Olle et al. 1982; Olle et al. 1991; Westrup 1993; Jayaratna 1994; Bell and Oates 1998). Given the plethora of methodologies and techniques available, one might assume that the selection of a particular methodology or technique would have an impact on the success or otherwise of a project.

Wynekoop and Russo (1995) critically assess the use of development methods concluding that though there are many systems development methodologies, there is no universal agreement that existing methodologies are useful today (confirming previous work by Lyytinen and Hirschheim 1987), further, '*there is little empirical insight into why some methodologies might be better than others in certain situations*' (Wynekoop and Russo 1995, p69). Wynekoop and Russo site several studies which seem to indicate that development methods are not discrete in that they undergo considerable adaptation by the organisations and within individual projects. This is supported by Fitzgerald's (2000) study of over 300 organisations involved in information systems development, which found that '*the large majority are using something developed or adopted to fit the needs of the developers and the organization, which is perhaps a more thoughtful and sophisticated use pattern than the straightforward adoption of commercial methodologies*' (p16).

Keyes (1992) maintains that there are no methods, just techniques. Wastell (1996 and 1999), examining the use of development techniques in information systems, identifies two concepts which describe how techniques influence development behaviour, these being 'social defence' (Menzies-Lyth 1988; Schein 1991) against the unknown and 'transitional objects and space'. The social defences concept is used to describe how developers follow methods, techniques and other rituals of development as a means to cope with the stresses and uncertainties of the development environment (Wastell and Newman 1993) while the transitional object is seen

as an emotional support mechanism. It enables developers to address development complexities and describe and reduce diverse requirements into manageable tasks.

1.1.4 Uncertainty within information systems

Several writers have indicated there are often areas of uncertainty in information systems development including identifying requirements, selecting appropriate systems and final use (e.g. Glass, 1991; Powell, 1992; Fazlollahi and Tanniru, 1991). Sauer (1993) indicates the depth of uncertainty within an information systems development: *'First, though there may be carefully specified designs, there is always uncertainty about what the final product will be. Second, there is uncertainty about how the process of constructing the product will turn out. Third, there is uncertainty about who precisely the final product will serve and how well it will serve them.'* (p12)

According to Flynn (1992) the level of uncertainty will vary between projects and organisations. Flynn distinguishes between requirements uncertainty and process uncertainty, producing a *contingency framework* (p308) indicating the 'best' approach suited to an application development (figure 1).

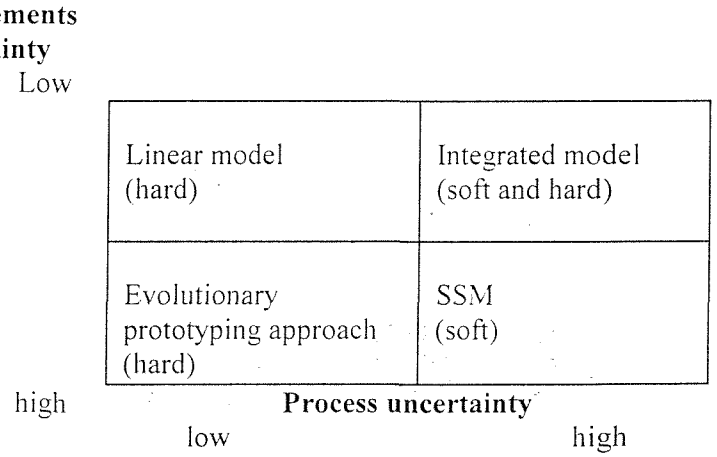


Figure 1: Contingency framework for organisational situation and information systems method

(From Flynn 1992, p308)

Flynn further examines a range of areas of uncertainty including uncertainty and the organisational structure (between mechanistic and organic), task uncertainty and environmental uncertainty.

Wastell and Newman (1993), focusing on stress within the development environment, describe the high levels of risk and uncertainty during development (as well as the exacting cognitive demands and political strife dealing with the complex and different stakeholder interests – all of which contribute towards stress). It is argued that uncertainty is present throughout the development processes.

Sauer (1993,p4) developing a model of information systems failure, focuses on three dimensions within the organisational context, these being the project organisation, the information system, and its supporters. These are then arranged into a *triangle of dependencies*, which are used to illustrate the dynamic processes that can lead to failure. Sauer (1993) refers to the fluid nature of information systems development processes, in which a final system may vary considerably from its initial conception: *'an information system is an organisational resource the responsibility and control for which can shift over time. Different groups can be involved in the innovative process at different times, each trying to make it an effective resource for them. As interests and stakeholder groups change, so the characteristics of the system may be adjusted accordingly.' (p12).* The picture painted here is one of a dynamic process with changing and uncertain requirements which contribute to systems failure.

A further examination of other works on information systems and computer failure may add insight. The earlier works (i.e. those of the 1970s and early 1980s) dealing specifically with computer failure, addressed mostly technical issues (e.g. Martin 1976; Meek and Heath 1981). Later works (i.e. the mid 1980s onwards) start to address management, organizational and social issues and attempt to consider the effect of different interested parties, or 'stakeholders'. One of the most comprehensive of these works was by Lyytinen and Hirschheim (1987) who identified four major categories as follows:-

1) Correspondence failure (i.e. the information systems does not meet the stated design objectives).

2) Process failure (i.e. the information systems is not produced within given time or budget, and includes situations where no workable information system is produced). This is largely related to process management problems and controlling of resources.

3) Interaction failure (i.e. the interaction of the information system by the end-user, where a low level of use can be classed as a failure).

4) Expectation failure (i.e. where the information system does not meet the expectations of one or more of the stakeholder groups).

Lyytinen and Hirschheim stated that the first three categories '*constitute special instances of an expectation failure, reflecting specific interests of a powerful stakeholder*'. They defined computer failure as the inability of an information system to meet a specific stakeholder group's expectations. Lyytinen and Hirschheim argued that '*there is a lack of any detailed treatment of the notion of what precisely is meant by "failure" and what is meant by "success"*'. The notion of success or failure can be viewed as dynamic over time, as Connell and Powell (1992) point out '*It is not clear what constitutes success, how success should be measured, nor if success criteria are stable over time and between projects*'. A system in the 1980s will have been measured against a different set of criteria to a similar system in the 1990s. It is useful to note an analogy with the early studies on employee needs and motivation, and with Maslow's hierarchy of needs, which show that individuals and groups have their own hierarchy of importance and that as soon as one set of needs is satisfied another set becomes important. Other studies show that criteria for positive influences at work are different to negative influences (Herzburg 1966). Following this theme, it is likely that criteria for an information system success will be different to the criteria for an information system failure.

These works indicate there is no one clear definition of information systems failure and deciding if an information system has failed, or alternatively, failing is not always clear-cut. Success or failure of an information system is open to considerable interpretation and is likely to be viewed differently by various interested parties or stakeholders at distinct times. It is difficult to gain a complete picture of the level of computer failure given the unclear definition of 'failure' itself (a factor which may explain the widely varying figures on failure), however, most of the writers on computer failure seem to agree that the level of failure is far too high and that it is a continual problem (e.g. Gladden 1982; Lyytinen and Hirschheim 1987; NAO 1990; Glass 1991; Forester and Morrison 1990; Lederer and Nath 1991; Sauer 1993; KPMG 1992; Ewusi-Mensah and Przasnyski 1994,1995)

These works indicate that there are still considerable problems to be addressed within information systems development. The levels of failure are far too high and the causes are mainly concerned with social and organisational issues, which are themselves the cause of much uncertainty. There are many areas of uncertainty within development environments and this uncertainty is likely to affect the success of information systems projects.

1.1.5 Summary of development environment characteristics

Information systems development has characteristics which makes it different and distinct to other situations and investigations of uncertainty:-

i) The development process often involves complex relationships between distinct groups of people, including users, developers (e.g. analysts, designers, programmers), system owners (i.e. the people paying the cheque) and other stakeholders. The interrelationship between these groups of people affect the uncertainty (possibly increasing it, possibly changing its scope, possibly making it more complex).

ii) The development process may involve development methods, techniques and tools. Even if no 'formal' method is used in a development, some techniques and tools are likely to be used. These 'development rituals' are likely to exert influence by constraining or prescribing approaches to address any uncertainty.

This thesis aims to generate a fuller picture of how uncertainly is addressed within this complex environment. This is of relevance and important to the information systems field as many information systems projects involve much uncertainty and the uncertainty is likely to affect the success of these projects. The following section examines some key works on uncertainty, which together provide a theoretical basis for understanding uncertainty in the complex information systems development environment. It also discusses the choice of prospect theory (Kahneman and Tversky 1979, Tversky and Kahneman 1992) as the theoretical tool used in this thesis.

1.2 Existing works on uncertainty: definitions and concepts

There is much research on 'uncertainty' spanning several disciplines (e.g. psychology, decision sciences, even physics) and there are a variety of theories related to uncertainty. The aim of this section is to give an overview of these disciplines by identifying key works and bringing together the salient aspects of each which are relevant to this thesis. It will also provide a grounding for the selection of prospect theory for this thesis. However, there is a problem to address before examining uncertainty in depth, that is definitions of uncertainty vary and overlap with other related areas. Starting with a dictionary definition:

> **Uncertain:** Not certain; doubtful; not having full knowledge; not certainly known; not having certain knowledge; not sure; not to be depended on; not having the mind made up; not steady; fitful; fickle; inconsistent; capricious
>
> **Uncertainty:** State of being uncertain; want of certainty; doubtfulness; dubiousness; dubiety; hesitation; something not certainly and exactly known; a contingency.
>
> (The Students English Dictionary)

We see that there are potential problems with the use of language to describe uncertainty, which can also be used to describe related and overlapping areas, such as risk, probability, inconsistency, ambiguity and equivocallity.

Indeed risk and uncertainty are sometimes used synonymously in everyday usage and even in more technical works such as de Neufville and Stafford (1971) who describe decision making under risk: '*Decision-making under risk in the traditional sense presumes that the probability of occurrence of each possible outcome is known. The knowledge of the probability permits the calculation of the expected values for the alternatives and thus a rational selection between them.*' (p121). However, they also make a further note about risk: '*it is in fact often difficult to estimate the probability of outcomes with any objective precision*' (p125). Typically then, such traditional approaches were really aimed at addressing 'uncertainty' where some elements of the uncertainty are assumed (e.g. probabilities) or ignored (e.g. limit number of options) to enable a 'rational' selection process.

This is consistent with a major work on *risk assessment* by the Royal Society (1992). Though the focus was on risk assessment and perceptions of risk, the report covered many aspects of

uncertainty, particularly the uncertainty of information surrounding areas of risk and the risk outcomes. The work covers a variety of techniques to assess risk situations, many of which aim to reduce the amount of uncertainty about a situation. Another example, Hendrickx and Vlek (1991) generate a simple taxonomy of uncertainty, categorising uncertainty along two dimensions: 1) the nature of probability information and 2) the degree of personal control, with internal factors at one end (e.g. knowledge, skill) and external factors at the other end (e.g. chance). This taxonomy is examined in terms of risk taking and people's approach to risk taking. Risk and uncertainty are interwoven, it is difficult to consider one without the other.

The concepts of risk, probability and uncertainty are interwoven. This has an important impact on understanding existing works (e.g. considering works on risk and probability) and on analysing research data (e.g. people are likely to use a variety of terminology to describe uncertain situations). Examples of other works which use uncertainty synonymously with the other concepts include uncertainty and inconsistency (Gabbay and Hunter1991; Ferguson et al. 1985; Ganzach 1994; Hunter 1996), risk and risk management (Lyytinen et al 1996), conflict (Janis and Mann 1977) and, ambiguity and equivocallity (Pondy et all 1988; Kashima and Maher 1995).

1.2.1 Existing works on uncertainty

Seminal works on uncertainty can be found in several disciplines, each bringing some key insight or vista. This section examines some of the main works and identifies what they offer relevant to this thesis.

1.2.1.1 Traditional decision sciences

The seminal work of Von Neumann and Morgenstern with their expected utility theory (EUT) (1944) and numerous variations, has dominated much of the decision sciences for several decades. EUT has sporn a plethora of approaches and techniques to decision-making under 'risk', typically reducing decisions to some rational, object selection between options based on some expected value or utility (e.g. Andrew and Moss 1993; Bennet et al. 1992; Bicheno 1994; Carley 1980; Crossland et al. 1992; Eden 1992; Jantsch 1967; Mizuno 1988; Waddington 1977). From the 1980s and 1990s there was more interest in subjective elements

(e.g. Rosenhead 1992; Reinhold 1996) but still the desired aim was to reduce the uncertainty so that a relatively objective 'best choice' is made. Much of the work from the decision sciences are based around techniques, either developing new techniques or applying techniques in particular applications. The work from the decision sciences on decision taking under risk and uncertainty has informed business practice (e.g. the insurance and financial industries), governments and the application of science, many of whom follow a rational paradigm. The underlying view is that if there is a problem that involves 'risk' or 'uncertainty' then one just chooses the most appropriate technique to address it.

1.2.1.2 Social sciences

From the social sciences, the sociologists Ulrich Beck and Anthony Giddens have been very influential, both producing seminal works on risk in society: Beck's *Risk Society* (1992) and Giddens' *Modernity and Self-Identity* (1991). Risk and trust are key and interrelated elements for both Beck and Giddens. For Beck and Giddens, risk is seen as at the heart of 'reflective' or 'late' modernity, resulting in a new society, the risk society. Giddens is more concerned with how individuals relate to this new society or order. A key element that Beck and Giddens bring is that modern society is getting more risky. As Beck states "*forces in the modernization process, hazards and potential threats have been unleashed to an extent previously unknown*" (Beck 1992, p19). Giddens' late modernity is typified by an expanding scope of risks into a global sphere alongside rapidly developing technologies. Here lies a paradox with on the one hand less individual life-threatening risks (e.g. treatments for life threatening diseases) yet on the other hand more technology enabled high-consequence risks where no one escapes: risk is thus universal. For both Beck and Giddens technology and science play an important role in the new risk society/culture and argue that society is becoming more critical, no longer willing to accept the truth claims of scientific knowledge, "*science and its claim to truth are at issue in the risk society*" (p203). Technology is seen as providing increased diagnostics capabilities, being able to identify and categorise a range of new problems and risk. However, technology is also seen as unable to provide solutions to the rapidly expanding set of new risks and problems. Technology enables society to see more risks yet cannot meet society's demands to address them. However, problems of risk are primarily seen by Beck and Giddens as people or social problems, where technology is an integral part of, or object in, the changing culture(s).

Another influential social scientist that has written extensively on risk is the anthropologist Mary Douglas who published a seminal work on risk with Aaron Wildavsky (1982): *Risk and Culture: an Essay on the Selection of Environmental and Technological Dangers*. Like Beck and Giddens, Douglas and Wildavsk were interested in modern societies, particularly America, and make comparisons with other remote, less technological societies. Their work brings a cultural and 'social organisation' perspective to risk. It is argued that, people within similar forms of social organisation have similar risk attributes, such as taking or avoiding similar types of risks. Only by changing the social organisation can the risk attributes be changed.

Douglas went on to develop further her work on risk and culture and has written and co-authored extensively in the area. Much of her work focuses on explaining why different societies and groups within societies view risk differently (Caplan 2000, p12). A further dimension that Douglas brings to our understanding of risk is culture and power (political), particularly the distribution of power and the distribution of incurred risks. Caplan (2000) gives a further critique of Beck, Giddens and Douglas' work and shows the wide influence each has exerted in their fields.

Predating Douglas by half a century is the work by the social anthropologist Margaret Mead, *Coming of age in Samoa* (1928,1971). Mead looked at, among other things, attitudes towards relationships and the view of risk among adolescent girls on the remote island of Samoa and made comparisons with 'similar' adolescent groups in America. Key findings from Mead's work are that decisions are made within complex social settings, involving forces from one's peer group and from the conditions of the social environment. The main focus of the study is on adolescents and how they relate to a changing environment and the stress within it: '*that adolescence is not necessarily a time of stress and strain, but that cultural conditions make it so*' (Mead, 1971,p187). To understand an individual decision requires some understanding of the complex social environment and influences at play in which the decision is made, as Franz Boas states in the forward to Mead's book '*The results of her painstaking investigation confirm the suspicion long held by anthropologists, that much of what we ascribe to human nature is no more than a reaction to the restraints put upon us by our civilization*'.

Lianos Michalis, heavily influenced by Douglas' work, examined the role of automation technology in moulding behaviour in the 'institutional environment' (Michalis and Douglas 2000). Though the focus was on deviant behaviour (*deviance from the community's norm*), Michalis shows how technology, referred to as Automated Socio-Technical Environments (ASTEs), changes patterns of behaviour in communities, such as automatic ticket collection at railway stations. Michalis argues that people readily accept ASTEs, but that such environments radically transform culture: '*the fundamental point ... is that the user cannot negotiate with the system* ...[however,] *negotiation is the prime constituent of culture*' (p264). This has potentially far reaching implications for how developers would deal with uncertainties within highly automated development environments where developer activity would be 'controlled' within the confines of the automated processes and the automation will be readily accepted.

1.2.1.3 Psychology and cognitive psychology

From the (cognitive) psychology field, seminal works on risk are dominated by the partnership between Kahneman and Amos Tversky, particularly with the development of prospect theory (1979) and further enhancements with cumulative prospect theory (Tversky and Kahneman 1992). Prospect theory is described as a descriptive model of decision-making under risk. It was also a critique of the major violations of EUT for choices between risky 'prospects'. The main characteristics of prospect theory are '*framing effect*', a hypothetical 'S' shaped value function with corresponding weighting function and, a two-phase process consisting of an editing phase and an evaluation phase. The framing effect relates that different representations of essentially the same situation will result in a different preferred 'prospect' or choice: people's understanding of a problem is profoundly influenced by how the problem is presented. There is also a time influence to contend with, such as how far into the future situations are likely to occur: "*the results indicate a highly significant interaction between type of outcome (positive or negative) and time. Negative events were seen initially as more likely than positive events, but as decreasingly likely further in the future; conversely, positive events were predicted as increasingly likely over time, being seen as more likely than negative events at the final time period.*" (Milburn 1978, p17) The framing effect has been observed and collaborated by many other studies (Schneider 1992) so represent some core underlying attribute affecting the decision-making process.

Other aspects of prospect theory's value function are that people consider gains or losses from some *reference point* as opposed to the final value of the outcome (which is assumed in EUT), that there is a tendency towards *loss aversion* and *diminishing sensitivity*, where people are less sensitive to changes in value further away from the reference point (e.g. people are likely to be more sensitive for a value increase from £10 to £20 than they are to an increase from £1010 to £1020). The value function characteristics have been collaborated with a wealth of empirical studies and are again likely to represent some fundamental decision-making behaviour: generally, people are risk averse in situations of gains and risk seeking in situations of losses. Prospect theory seems to have been very influential and applied in a variety of applications (Shafir 1999).

Further insight, from the cognitive psychology field on risk understanding is gained from support theory (Tversky and Koehler 1994) which: *'predicts that the judged probability of an event increases by unpacking the focal hypothesis and decreases by unpacking the alternative hypothesis'* (Rottenstreich and Tversky 1997, p406). Effectively, support theory indicates that support for an option will increase the more that the option is broken down into component parts with each part being considered separately. In addition different, more specific, descriptions of the same event will give rise to different probability judgements. For instance, people may attach a higher likelihood of a specific natural disaster occurring, such as an earthquake where 100 people die, than a more general all inclusive natural disaster with the same number of people dying. The implications are that the more a situation is broken down into constituent risks then the more likely those risks will seem, often with individual risks seeming more likely than the overall risk.

Also from cognitive psychology, Teigen (1988), looking at the language of uncertainty, shows that specific language has different interpretations and performs different functions: *'Some terms (like 'risky' and 'promising' prospects) have ambiguous referents, being in some cases interpreted to refer to possible gains and losses, in other cases to levels of uncertainty and certainty. Other terms (like 'highly probable', 'doubtful', 'good chances' etc.) are shown to have other communicative functions besides their purely probabilistic one, some of the most important being to indicate the source of uncertainty'* (p27). The use of language is very complex. There is often more than the literal meaning implied in the use of a term, such as context and relational information or some underlying 'other' message. The

implications are that discussions and discourse on 'risk' cannot be taken at their literal interpretations. There are further works addressing specific aspects of uncertainty from the cognitive psychology fields (e.g. Suedfeld et al. 1996; Tversky and Fox 1995; Wyer 1970) which offer insight into representation and presentation of uncertain information.

1.2.1.4 Collective and topical works

In the late 1970s and early 1980s there was a flourish of general interest into risk management and risk assessment, particularly in the use of objective risk measurement instruments and discerning 'acceptable' levels of risk. This interest spanned governments, businesses and even elements of the general public. In response to this interest the Royal Society, in the UK, commissioned a major work on risk assessment (Royal Society 1983) which collated the main reference works and practice at the time. During the later part of the 1980s and early 1990s it was becoming clear that social conditions were changing and perception of risk became more important: society was becoming more risk aware (as Beck and Giddens discussed). The UK Royal Society commissioned an update study in which public perceptions of risk received greater attention as well as updating current risk management and assessment practice (Royal Society 1992). The report was effectively six independent studies providing different perspectives on risk identification, assessment and management. As such, the report tried to capture the 'current' debate about risks and acceptable risks in society. Of particular interest, the report shows the wide spectrum of risk related interests, concerns and views: it was clear the 'public' can not be classed as one homogeneous group but is many faceted consisting of many interested groups with diverse concerns. It was also clear that the various and diverse subgroups in society were perceptive to a range of 'risks'.

A topical 'Equinox' programme, on Channel 4 Television in the UK (Equinox 1999), covered a range of populist works on risk (including Giddens' work), and examined why people are risk-takers. The programme argued that dealing with risk is, and always has been, a common human activity. As professor of psychology, Gerald Wilde was quoted *'the art of life is not to reduce risk to zero but to take the right amount of risk, not too much, not too little. There should be a risk in your life, like salt in your soup'*. The important element here is that addressing risk can have a pleasurable element, particularly for some people.

A recent set of works on risk in society was collated by Pat Caplan in *Risk Revisited* (2000), which provide diverse cases examining risk taking and attitudes within complex distinct social groupings. Caplan's own contribution looks at risk, knowledge and trust within a largely farming community in West Wales during the very uncertain time of the British BSE beef crisis. A key question Caplan addresses is how do people develop knowledge about a 'risk'. Caplan shows that '*knowledge and trust are intimately linked in the context of the BSE crisis*' (p185). Caplan noted that within this Welsh community *'On the whole ... apart from some members of the alternative community, there were few people in this area who gave up eating beef as a result of the BSE scare*' (p190). The rationale people gave for still eating beef (when other communities were not) was that they 'knew' how the meat was produced: '*This theme of "knowing where it comes from" was a very important one which recurred in many interviews*' (p192). There was a clear 'localising' of risk information where higher trust requires more local information, as Caplan observations of a butcher's shop sign show:

> '***Dinas beef***
>
> ***Peseli lamb***
>
> ***Pembrokeshire pork***

What struck me was that each of these meats was 'localised' at a different level: pork was from Pembrokeshire, the county; lamb was from Preseli Hills (the main sheep-rearing area in the county), while beef, potentially the most dangerous, was from the next village, three miles up the road.' (p198)

Caplan argues that there is a politics of location in relation to risk perception, '*people do perceive risks according to their social location and this is likely to affect their behaviour*' (p199). There are clear links here with the psychology works on diminishing sensitivity discussed above.

Also from Caplan's study it was clear that people distrusted information from either the media, governments or scientists when it came to issues of food safety. Clearly the *sources* of information play an important role in how people understand and interpret risks. Interestingly, Fitzgerald's study of information systems development, suggests that much development is performed in relatively small groups (Fitzgerald 2000, p15), which extrapolating Mead and Caplan's work is likely to result in strong peer, 'localised' influences on decisions.

1.2.1.5 Naturalistic decision-making

The Naturalistic Decision-making (NDM) movement is a collection of researchers who, from the 1980s onwards, started to study how experienced people make decisions in their natural environments. The NDM argue for an interdisciplinary approach. One of the seminal volumes for the NDM is by Klein, Orasanu, Calderwood and Zsambok, *Decision-making in action: Models and methods* (1993), which was really a collection of papers from a 1989 conference for research outside the traditional decision-making paradigm. A further collection of NDM research was produced in 1997, which served as an update on NDM practice (Zsambok and Klein 1997). The main thrust of the NDM movement was that traditional decision-making theories and research (mainly from the decision sciences) were inappropriate for real-life decisions, namely that they missed key elements such as *task and setting factors* (i.e. the environment), that decision makers are usually *experienced* (not naïve subjects in an experiment) and lack of awareness of *locus of interest within the decision episode* (i.e. decisions are not just limited to a selection of options but also involves situation awareness) (Zsambok and Klein 1997, p5). However, given the seemingly wide scope of the NDM movement, most research has been based on military applications (the DoD in the US being by far the biggest funding source) and safety critical environments. These have particular characteristics such as close collaboration and reliance between individuals, with potentially fatal consequences for wrong decisions and, prescribed but changing settings. These are characteristics which may not be fully applicable to wider decision-making activity under risk and uncertainty. However, they do show the interrelated nature of the decision-making process in such environments and, the differences between experts and novice decision makers.

1.2.1.6 Information systems

From the information systems field there are several related works. Anthony Hunter's '*Uncertainty in information systems*' (1996) approaches the topic from a technical engineering perspective, providing formalized representation of uncertainty and probabilistic based tools to address them. Hunter covers topics such as how to handle uncertain knowledge in databases and knowledge-based systems, how to deal with inconsistencies in data and, formalisms and strategies for uncertainty. In an earlier theoretical and descriptive work,

Gabbay and Hunter (1991) focus on coping strategies to address inconsistencies, mainly in databases.

Thomas Lauer (1996) looks at decision-making under risk for project managers and, interestingly, examines the managers' responses to see if they are more consistent with prospect theory or a more rational EUT approach. This is the only study found within the information systems field which specifically uses some aspect of prospect theory. Lauer's study is based on a questionnaire administered to 68 software project managers. The questions were adaptations of the ones used by Tversky and Kahneman (1979), but with an information systems theme, in fact the questions were based on Brooks' (1982) mythical man-month essay (i.e. throwing manpower at a problem). The results showed that decisions were more consistent with prospect theory, however, there was considerable variation in the results: *'judgments were less homogeneous than assumed by either theory'* (Lauer 1996, p287). Disappointingly, little (or no) follow on work seems to have been done with this study, in particular, there seems to have been a lost opportunity in not following up the reasoning for decisions with the project managers.

Wastell (1996,1999) focuses on the learning activities that developers need to undertake to ensure a successful development (i.e. finding out about the requirements/problems an information system needs to address) and the role of development methodologies and techniques in this learning activity. Wastell notes that the rules of the methods and techniques can become paramount against addressing the 'real' problems and uncertainty of development.

Planning is a key approach to reduce the amount of uncertainty within information systems development and was considered as the single most important issue facing information systems managers (Galliers 1987, p251). There have been several works on planning activity and information systems, most focusing on planning techniques. Galliers (1987) compares planning activity between the UK and Australia, and provides a fairly comprehensive study of planning works at the time.

From a computer security perspective there are several works focusing on risk analysis and control (e.g. Chambers and Court 1991; Ciechanowicz 1997). Taking a more general view of

risk assessment, Willcocks and Margetts (1993) discuss the types of risks and problems involved in developing and implementing information systems. They argue for '*interpreting risk operationally as not just inherent in certain structural features of the environment or of a project, but also arising as a result of distinctive human and organizational practices and patterns of belief and action*' (p127).

Robert Glass (1991), focusing on software failure, identifies 'unstable requirements' as the major problem arguing *'No one can solve any problem where the nature of the problem is changing. Not software people, not anyone'* (p218). The changing nature of requirements calls for flexible approaches to development (and according to Glass), getting the customers to pay for the changes.

To address the dynamic nature of requirements, Frank Land developed *future analysis* (Land, 1982, page 203), which takes a future view of requirements. The future analysis consists of two stages. The first attempts to discover potential changes which may have an impact on the information system, by classifying changes into major categories of technology, legal requirements, economic/environmental factors, attitudes and expectations and within the organisation. For each of the categories a multi-disciplinary team would be involved in identifying the possible changes. The second stage used stage 1 outputs to try and assess the kind of future the information system would have to face and included items such as 'what and when are conceivable changes likely to occur', 'what impact they will have on the system' and, 'an estimation of the probabilities of the changes'. The result of using future analysis would be a prediction of likely and possible scenarios and greater insight into the dynamic environment of developing information systems. Avison, Powell and Adams (1994) continue Land's future theme by arguing that future requirements need to be considered, identified and where possible incorporated in information systems development.

Fitzgerald (2000) also continues Land's future theme by looking at adaptability and flexibility in information systems development, suggesting that: '*although the overall percentage effort devoted to maintenance and enhancement has declined, that devoted to enhancement is a large proportion of that total. It may be that systems are getting better at meeting the original requirements but that these systems are requiring more change*' (p17). Galliers (1993) proposes a business process reengineering (BPR) approach to provide

flexibility by developing flexible information systems architectures. Information systems have to meet the demands of a dynamic development and operational environment.

1.2.2 Summary of works on risk and uncertainty

When one makes a 'risky' decision, it is more likely to be an 'uncertainty' decision, where actual probabilities of events and a full list of available options are not known. Also there are many factors influencing the decision-making processes:

Prospect theory shows us that people are generally risk adverse, the fear of loss will be greater than the pleasure of a gain of the same value. However, when in a loss situation people will more likely take risks.

From the sociologists, Giddens and Beck we see that in the risk society and culture, people are faced with more risk. Also that technology plays a key role in diagnosing and perpetuating risk, yet falls short of providing solutions. From support theory we see that the natural outcome of the diagnostic capabilities of technology (enabling identification, categorising and describing of risks in minute detail, then communicating such information in a rich tapestry of multimedia), will make the risks seem more likely. The *perception* of risk is growing faster than the actual risk, and faster still than the capability of technology to address the risk.

From social anthropologists, such as Mary Douglas, we see that risk taking is a social activity where the changing 'culture' of one's peer or social group plays an important part in deciding which risks can be taken and which cannot. Also, the social group influences which information is deemed acceptable and which is not. From anthropologist Margaret Mead we see that decision choices are made with conditioning from a complex social environment, and further that this may constitute a source of stress. From the sociologist Caplen, we see that 'more risky decision scenarios' require more localised information, reverting to '*knowing* where it comes from' before the risk is accepted.

From the developing naturalistic decision-making field we see that people in interrelated environments, particularly safety critical ones, rely heavily on each other and need a more proactive involvement from each player: they 'trust' each other to take appropriate actions.

From the decision sciences and information systems fields we see that there are a large number of techniques and tools to address uncertainty. From the decision sciences the focus is generally on enabling a rational choice between 'risk options'. From the information systems field we see that techniques and tools play an important role in problem understanding as well as providing emotional and cognitive support against uncertainty.

1.3 Relevant disciplines and theories for this thesis

This thesis examines uncertainty within which information systems develop. As indicated above, works on uncertainty are found in many fields, each with something to contribute. There may even be something to be learnt from Physics with Heisenberg's *Uncertainty Principle: ' One can never be exactly sure of both the position and velocity of a particle; the more accurately one knows the one, the less accurately one can know the other.'* (Hawking 1995, p207). Effectively this says that examining in detail one aspect of a particle will change another aspect: one might extrapolate that examining in detail an area of uncertainty within an information systems development will change the nature of that uncertainty.

For informing this thesis, prospect theory is chosen because it seems to describe some fundamental characteristic of decision-making under risk and uncertainty, notably the framing effect and the characteristics of the value function describing risk taking and risk aversion behaviour. The framing possibilities of the development environment, such as development methods, tools and techniques, seem particularly relevant. Prospect theory has weaknesses however, which need to be addressed, namely that it is aimed at individual decision-making rather than the social group activity indicated by the sociology and anthropology works. In addition, prospect theory has been developed in the 'laboratory' using artificial controlled decision-making environments, which may be less appropriate for representing real-life decision-making activity, such as in information systems development.

These aspects will be discussed further in chapters 3 and 4.

The NDM approaches were not used, even though they aimed to look at decision-making in real-life situations. This was mainly because the majority of the work focused on intense safety critical applications with characteristics (arguably) less in common with development environments. In addition, the theory developed in the NDM movement was less well developed and seemed less relevant to a general information systems development environment. The work from the traditional decision sciences also seemed less relevant as the focus of much of the research is on developing 'new' decision-making techniques, or applying techniques to new applications. In addition, the focus on 'rational' decision-making under risk and uncertainty and, indeed on 'rational technique', seemed to miss key elements of the social environment. The sociology and anthropology works offered insight into some social and cultural dimensions of dealing with risk and uncertainty but offered (me) little in theoretical tools to investigate decision-making phenomena within the information systems environment.

None of the existing works on risk and uncertainty seem to address the complex and particular characteristics of an information systems development environment. This thesis aims to address that by applying prospect theory to the distinct characteristics of a development environment. This thesis also aims to inform the application of prospect theory to a complex real-life decision-making arena, information systems development.

1.4 Structure of thesis

The rest of this thesis is structured as follows. Chapter 2 describes the research approach taken throughout this thesis and the research techniques used to inform different aspects of prospect theory in the context of information systems development. Chapter 3 describes prospect theory in greater detail along with main developments and criticisms. Chapter 4 applies the characteristics of prospect theory with those of the information systems development environment. In so doing, it provides further rationale for the choice and application of prospect theory. Chapter 5 attempts to map the framing effects predicted by prospect theory, this is done by collating a range of techniques used to address uncertainty. These techniques are then re-examined with regard to the psychology literature, particularly

the works on visual and linguistic cognitive processes. The thrust of this chapter will be that the visual and linguistic characteristics of a technique are likely to affect the cognition of a problem. An early draft of this chapter was presented at BIT '96 (Adams 1996) as a 'macro analysis of techniques'. Chapter 6 develops planning attributes, which further develop prospect theory's framing influences as well as developing distinct value function characteristics for *planners* and *non-planners*. An early draft of chapter 6 was presented at the BIT'98 conference (Adams 1998) and included as a book chapter (Adams 2000). Chapter 7 examines the decision-making process implied by prospect theory. Developers' written diaries are analysed bringing out an iterative and interactive process, some group responses and some limitations of prospect theory. Chapter 8 examines these limitations further with an examination of a manager's audio diary to analyse social interaction in the development process. Throughout these chapters different aspects of dealing with uncertainty are identified and developed. Chapter 9 attempts to collate these aspects into a coherent whole representing a model of dealing with uncertainty within the information systems development environment. Chapter 10 acts as a consolidating chapter by applying the developed model to a case study involving observations and interviews with a whole project team from a blue chip company.

Chapter 11 summaries the main elements of this thesis, identifying key aspects of prospect theory that proved appropriate to the information systems development environment and those that did not. It also discusses the contribution of this thesis along with suggestions for further research.

Chapter 2:Research approach and philosophy

2.1 Introduction

This chapter discusses the background to the research, the general research approach and philosophy adopted for this thesis and, the research techniques used. The intention is to make the research approach and philosophy explicit as this will influence the choice of research techniques used. It will also aid interpreting the results from this research. The research approach adopted is broadly interpretive and use is made of a variety of research techniques.

First this chapter will briefly discuss the main purpose of this research and putting the research in context of an inductive/deductive frame. There then follows a discussion of the interpretive approach and philosophy. Following this the use and potential limitations of prospect theory are discussed. Finally there is a discussion of the research techniques used in this thesis and how they relate to understanding how uncertainty is addressed within information systems development.

2.1.1 Purpose of this research is descriptive

The research approach taken in this thesis has been heavily influenced by Neuman's (1994, 1997) books on social research methods. Neuman organises the purpose of research into three groups, that of exploring a new topic (Exploration), describing a social phenomenon (Description) and explaining why something occurs (Explanation). This is summarised in table 2.1.

Goals of Exploratory Research	Goals of Descriptive Research	Goals of Explanatory Research
Become more familiar with the basic facts, people, and concerns involved. Develop a well-grounded mental picture of what is occurring. Generate many ideas and develop tentative theories and conjectures. Determine the feasibility of doing additional research. Formulate questions and refine issues for more systematic inquiry. Develop techniques and a sense of direction for future research.	Provide an accurate profile of a group. Describe a process, mechanism, or relationship. Give a verbal or numerical picture . Find information to stimulate new explanations. Present basic background information or a context. Create a set of categories or classify types. Clarify a sequence, set of stages or steps. Document information that contradicts prior beliefs about a subject.	Determine the accuracy of a principle or theory. Find out which competing explanation is better. Advance knowledge about an underlying process. Link different issues or topic under a common general statement. Build and elaborate a theory so it becomes more complete. Extend a theory or principle into new areas or issues. Provide evidence to support or refute an explanation or prediction.

Table 2.1: Neuman's classification of purpose of research
(from Neuman 1997, p20/21)

From Neuman's grouping the purpose of this research could be classed as descriptive. The overall aim of this thesis is to try to describe more fully the complex phenomenon of dealing with uncertainty within the real-life social context of developing information systems.

2.1.2 Inductive or Deductive?

Elements of this thesis are inductive while other elements are deductive. Neuman (1997, p46) distinguishes between inductive and deductive.

'In an Inductive approach you start with a detailed observation of the world and move towards more abstract generalisations and ideas. ... When you begin, you may have only a topic and a few vague concepts. ... As you observe, you refine the concepts, develop empirical generalisations and identify preliminary relationships. You build the theory from the ground up. ...In a Deductive approach you start with an abstract, logical relationship among concepts, then move towards concrete empirical evidence. ... You may have ideas about how the world operates and want to test these against ***hard data****.'*
Neuman also notes: *'In practice, most researchers are flexible and use both approaches at various stages in a study.'*

In this thesis both approaches have been used. With chapter 5, an examination of development techniques involved a deductive approach (at least initially), starting with some general abstract ideas about how techniques impact dealing with uncertainty. There then followed an evidence collecting exercise. In chapter 7, utilising written diaries, and to some extent chapter 6, utilising the MOA survey, the approach was mostly inductive in that once the data was examined then the concepts were refined and some preliminary relationships identified.

2.1.3 An interpretive approach and philosophical standpoint

This research can be classed as a broadly 'interpretive' approach (Neuman's 1997). One of the most influential works on interpretive research in information systems is Walsham (1993), who defines interpretive research as:

> *'IS research can be classified as interpretive if it is assumed that our knowledge of reality is gained only through social constructions such as a language, consciousness, shared meaning documents, tools and other artefacts.' (p3)*

Klein and Myers (1999), who draw upon Walsham's work, say of interpretive research:

> *'Interpretive research can help researchers to understand human thought and action in social and organizational contexts.'*

This is in line with thinking from Sauer (1993, p5) who argues the information systems [development] process should be considered in terms of the full context of the organisation and its history: '*The exogenous factors constitute the* ***context****. They include cognitive limits, technical process, environment, organisational politics, structure and history.*'

As discussed in sections 1.1, the information systems development environment is complex with social, organisational, political, contextual and technical dimensions. Researching 'processes', such as dealing with uncertainty, within this complex environment calls for some consideration of these dimensions. An interpretive perspective is thus required.

2.2 Use of prospect theory

As discussed in section 1.3, prospect theory is used as the main theoretical tool with which to investigate and understand dealing with uncertainty within information systems development. As discussed in section 1.3 and further discussed in chapters 3 and 4, prospect theory does not **explicitly** address all the elements of the development environment described in section 1.1. Further, existing research is not definitive on the applicability of prospect theory to complex real-life environments. At the start of this research project it was unclear if prospect theory is appropriate for group decision-making environments or uncertainty (as opposed to individual decision-making in areas of risk). However, as discussed in chapter 3, there is substantial support for the main attributes of prospect theory. As such, one can conclude that prospect theory represents some fundamental aspect of decision-making. This does not necessarily mean that prospect theory covers **all** aspects of decision making activity (e.g.

some key elements may not be covered) or that **all** elements of prospect theory represent fundamental activity (e.g. some elements may be incorrect or limited in scope). One key aim of this research is to inform applicability of prospect theory to a complex real-life environment. This will be done by mapping out elements of prospect theory and identifying which are consistent with decision-making activity within information systems development and which are not.

2.3 Research techniques used

The methods chosen are, to a large extent, dictated by the research aims and philosophy, applicability to using prospect theory and practicality.

It follows from the interpretive approach taken, that understanding how uncertainty is addressed will need an examination and understanding of the context of the development environment. This will include:

- The rituals of development (such as methodologies, techniques and tools used).
- The social interactions of the development process.
- The goals, aims and context of the information system.
- Other influences, such as individuals orientation towards uncertainty.

The research methods also need to draw out particular characteristics of prospect theory as it is applied to the information systems development environment. This concept will be further discussed in chapter 4. The research methods also have to be practical and achievable within the limited resources of a PhD programme.

Chapter 5 addresses the 'rituals of development' and prospect theory's framing effect by mapping out framing influences due to development methods and techniques. Chapter 6 addresses individual orientations and prospect theory's value function by using a postal survey through the Mass Observation Archive (MOA) at the University of Sussex. Chapter 7 addresses further the rituals of development, contextual aspects and group involvement, while also examining prospect theory's two-phase process. It utilises an initial postal survey supported by developer's written diaries. The chapter also identifies some limitations of prospect theory. Chapter 8 examines the social and cultural aspects of development by using audio diaries. The chapter also identifies further limitations to the applicability of prospect

theory. Chapter 9 collates the different elements of the research together and develops a model, which describes how uncertainty is addressed. It also maps the applicability of prospect theory to information systems development. Chapter 10 applies this developed model to a case study, utilising observations and interviews. The chapter further refines the mapping of applicability of prospect theory to dealing with uncertainty within information systems development. Table 2.2 summarises the research techniques used and corresponding aspect of prospect theory addressed.

Research technique	Main related characteristic of prospect theory and areas investigated	Chapter
Macro analysis of techniques	Framing effect due to methodologies/techniques characteristics.	Chapter 5
Postal survey (through the MOA) on individual orientation to planning and risk	Further framing influences. Individual orientation to planning/risk, individual value functions.	Chapter 6
Preliminary postal survey Written diaries of developers	Cognitive processes and coping strategies. Group activity and some limitations of prospect theory.	Chapter 7
Audio diary, interviews	Social/cultural responses to uncertainty. Further limitations of prospect theory.	Chapter 8
Develop model	Mapping applicability of prospect theory.	Chapter 9
Case study, observations and interviews	Applying developed model and applicability of prospect theory to a case study. Further refining applicability.	Chapter 10

Table 2.2: Association between research techniques, elements of prospect theory and thesis chapters

2.4 Summary of research approach

As consistent with an interpretive philosophy, a full 'picture' of the influences affecting how uncertainty is addressed within information systems development is (probably) not possible: there are too many unknowns and variables. In addition, it is slightly arbitrary to just consider uncertainty within the scope of a project development, as there are likely to be 'pre' and 'post' project stages which will have an impact. However, it is possible to examine elements of dealing with uncertainty in such complex environments. The research methods described here aim to bring out key aspects of dealing with uncertainty within information systems development. The application of prospect theory has been instrumental in providing a

mechanism for understanding these key aspects. The research approach and methods described in this thesis will inform understanding of how uncertainty is addressed within information systems development as well as informing the applicability of prospect theory to this complex real-life environment.

In chapter 3, prospect theory is examined in greater detail while chapter 4 applies prospect theory specifically to the information systems development environment.

Chapter 3:Prospect theory

3.1 Introduction

The previous chapters laid the foundations of this thesis providing an overview of the topic area and how it is being investigated, namely, by applying prospect theory to dealing with uncertainty within information systems development environments. This chapter focuses on prospect theory, looking at its origins, development, applications, limitations and criticisms. The aim is to put prospect theory in perspective and so provide a basis for use in this thesis. The next chapter will apply the salient characteristics of prospect theory to those of the information systems development environment.

3.1.1 Prospect theory origins and development

Kahneman and Tversky (1979) developed prospect theory as a descriptive model of decision-making under risk. Their original paper was also presented as a critique of expected utility theory (EUT) (Von Neumann and Morgenstern 1944) by collating the major violations of EUT for choices between risky 'prospects' with a small number of outcomes. At the time EUT was, and had been for the previous few decades, the dominant normative and descriptive model of decision-making under risk and uncertainty.

Kahneman and Tversky were not the first or only researchers to notice limitations with EUT. For instance, the French economist Maurice Allais (1953) challenged the EUT principle that utility of a risk prospect is linear in outcome probabilities (i.e. arguing that the difference between probabilities of .99 and 1.00 has more impact on preferences than the difference between 0.10 and 0.11, the *certainty effect*). However, Kahneman and Tversky collated previous works identifying limitations of EUT with their own experimental findings to develop (probably) the first succinct coherent descriptive model which, they argue, better explains decision-making under risk. Kahneman and Tversky were from the psychology field and could be classed in the relatively new branch of cognitive psychology. Their original paper seems to have been very influential, indeed it is reportedly '*the most cited paper ever published in the prestigious journal Econometrica*' and prospect theory has been applied in many applications (Shafir 1999).

The main characteristics of Kahneman and Tversky's (1979) original prospect theory are *'framing effect'*, a hypothetical 'S' shaped value function with corresponding weighting function and, a two phase process consisting of an editing phase and an evaluation phase.

3.2 The framing effect

The original prospect theory uses the concept that *'preferences may be altered by different representation of the probabilities'* (p273), i.e. different representations of essentially the same situation will result in a different preferred 'prospect' or choice. This was made more explicit as a framing effect in their later work (Tversky and Kahneman 1981). People's understanding of a problem is profoundly influenced by how the problem is presented.

Tversky and Kahneman (1981) and others (e.g. Schneider 1992) have demonstrated several different types of framing influences. One particularly powerful way is to represent decisions in either a positive or negative light. An example used by Tversky and Kahneman (1981) is the 'Asian disease problem' where potential courses of action are described in positive light (i.e. number of lives saved from an expected high number of fatalities) or negative light (i.e. total number of lives lost overall), whereas in reality, the number of lives lost are the same. Consistently, people choose the option represented in a positive light (i.e. as number of lives saved). The framing effect has been observed and collaborated by many other studies (Schneider 1992) so presumably represents some core underlying attribute affecting the decision-making process.

3.3 The value function

Figure 3.1 represents the distinctive 'S' shape of prospects theory's value function, the main characteristics of which are:

i) A reference point. In figure 3.1 this is represented as a line dividing the outcomes as potential gains or potential losses. Value outcomes above the line are gains and below are losses. The rational is that people consider and evaluate outcomes in terms of either gains or losses from some reference point as opposed to the final value of the outcome (which is assumed in EUT).

'An essential feature of the present theory is that the carriers of value are changes in welfare, rather than final states." [And gives an analogy with our senses] '*When we respond to attributes such as brightness, loudness, or temperature, the past and present context of experience defines an adoption level or reference point, and stimuli are perceived in relation to this reference point*' (Kahneman and Tversky 1979, p277)

ii) Loss aversion. Kahneman and Tversky describe it as losses loom higher than gains. Effectively people are more sensitive to losses than to gains so that displeasure of the loss of £x is more than the pleasure of a gain of £x. This is represented in figure 3.1 with the value of loss 'a' being greater than value of gain 'b' (i.e. a steeper line). Some studies show 'a' can be two to four times greater than 'b' (Schneider 1992).

iii) Diminishing sensitivity. People are less sensitive to changes in value further away from the reference point. So people are likely to be more sensitive for a value increase from £10 to £20 than they are to an increase from £1010 to £1020. The same would apply to negative changes in value, so people are likely to be more sensitive going from a £10 loss to a £20 loss than going from a £1010 loss to a £1020 loss.

The diminishing sensitivity and the loss aversion characteristics give the value function the lopsided 'S' shape (see figure 3.1). Above the reference point the value function is concave, below convex.

With potential gain scenarios, people prefer a 'sure thing' over a gamble with greater numerical utility. For instance, people faced with two options

a) a definite win of £100 or,

b) a 50% chance of winning £250 (which has a numerical utility of £125),

are more likely to go for the sure thing and opt for option a).

With potential loss scenarios, people are more open to risky decisions. For instance people faced with two options

a) a definite loss of £100 or

b) a 50% chance of losing £250 (which has a numerical utility of -£125),

are more likely to choose the gamble and opt for option b).

The value function has been tested out with several empirical experiments based on 'participants' deciding between hypothetical risk options. Generally, people are risk averse in situations of gains and risk seeking in situations of losses.

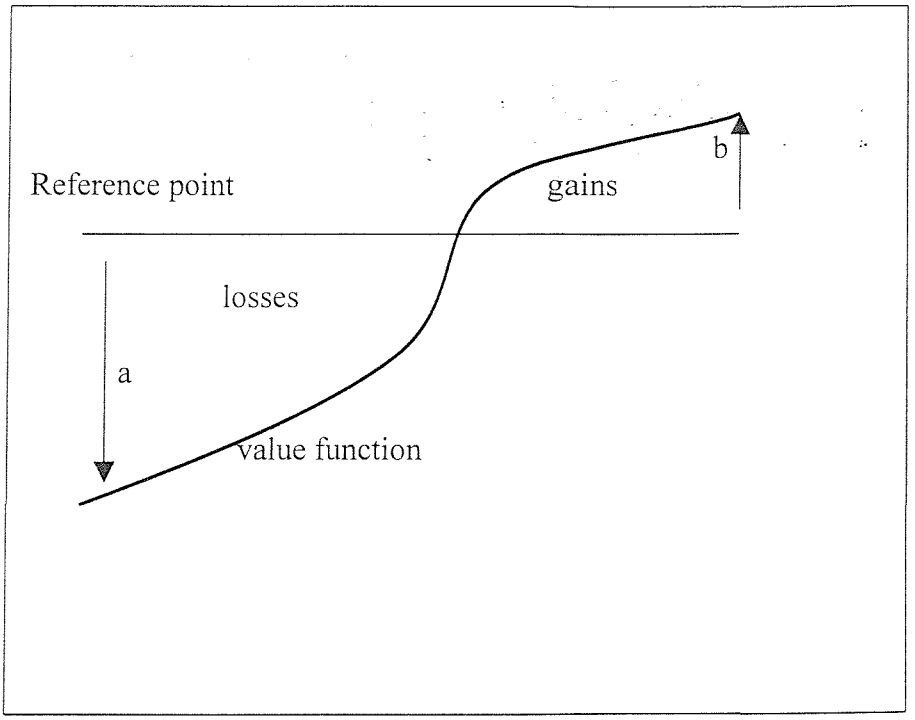


Figure 3.1: Prospect Theory's *value function*, from Kahneman and Tversky (1979)

3.4 Weighting function

In the original prospect theory the value of each outcome is multiplied by a *decision weight* where '*decision weights measure the impact of events on the desirability of prospects, and not merely the perceived likelihood of these events*' (Kahneman and Tversky 1979, p280). So decision weights are not probabilities (i.e. do not obey the probability axioms) and are not meant to be measures of degrees of belief.

The weight function π has some similarities with probabilities, such as

$\pi(0) = 0, and \pi(1) = 1$ (e.g. impossible events are ignored, certain events are classed as certain)

However, the weighting function differs from probability functions in that it takes account of the desirability of the outcome, a phenomenon which is used to explain lottery behaviour and insurance behaviour: '*people prefer what is in effect a lottery ticket over the expected value of that ticket*' (p281).

A related, but different, aspect is the overweighing and overestimation of the possibility of rare events. Kahneman and Tversky argued it is important to distinguish between overestimation and lottery behaviour, in the latter case the actual small probability of the event is known (i.e. even though the remote probability of winning a lottery is known, a greater weight is attached to the outcome than the expected value would indicate). [However, 'lottery' behaviour seems to be more complex than described by Kahneman and Tversky and, involves many interrelated issues (Griffiths 1997).]

3.5 Cumulative prospect theory

Later Kahneman and Tversky revised their original theory with *cumulative prospect theory* (Tversky and Kahneman 1992) to take account of uncertainty and risky prospects with any number of outcomes. In addition, cumulative prospect theory developed the weighting function further by addressing some of the limitations in the original version, namely that it operated as a 'monotonic transformation', i.e. used just once, which made it less suitable for prospects with a large number of outcomes and did not satisfy stochastic dominance (i.e. did not obey statistical rules). These limitations were assumed to be addressed in the editing phase in the original version. Cumulative prospect theory provided an alternative model which takes account of cumulative representation of prospects by enabling, among other things, similar prospects to be grouped and interpreted together and applied cumulative functions separately for gains and losses. The result was "*a distinctive fourfold pattern of risk attitudes: risk aversion for gains and risk seeking for losses of high probability; risk seeking for gains and risk aversion for losses of low probability*" (p297). The essential features of the original prospect theory were preserved in the newer version (i.e. value function, framing etc.). The newer version, cumulative prospect theory, effectively increased the applicability

of prospect theory to cover uncertainty and risky prospects with several outcomes and further defined the shape of the theoretical value function.

3.6 Two-phase process

The original prospect theory distinguishes between two phases in the choice process (Kahneman and Tversky 1979, p274). The first phase is described as a preliminary analysis of the prospects. This is effectively a framing or editing exercise where, it is argued, the prospects are often put into a simpler representation. The second phase is described as an evaluation phase where the edited prospects are evaluated and the prospect of the highest value chosen.

It is argued that the edited phase consists of several operations including *Coding* (considering the outcomes as gains or losses against a reference point), *Combination* (simplifying prospects by grouping like prospects together), *Segregation* (separating risk-less components from the risk components) and *Cancellation* (disregarding components that are shared by different prospects), *Simplification* (rounding of probabilities) and *Dominance* (rejecting alternatives without evaluation). The evaluation phase is described as the decision-maker evaluating each of the edited prospects and choosing the prospect of highest value. The overall value is expressed in terms of two scales: a subjective value of an outcome and the weighting function.

The operations are presented as possible activity in the editing phase, however, they are not brought together to represent a coherent process.

3.7 Limitations and criticisms of prospect theory

Overall, prospect theory provided a credible alternative to EUT and addressed many of the inconsistencies and deviations from observed behaviour to that predicted by EUT. Prospect theory has been supported by a wealth of research extending or confirming aspects. It has been applied to decision-making in a variety of fields (see Shafir 1999 for examples). However, there are some limitations to prospect theory that need to be addressed.

First the cognitive processes implied in the theory are not well developed. The theory seems to be good on describing what decisions people will make and what items may influence those decisions. However, it does not describe *how* people reach the decisions. This is not too surprising since the research tools adopted to develop and collaborate prospect theory (laboratory experiments based on subjects selecting from two risk options) are fairly blunt instruments with which to examine complex decision-making processes.

Further, the two-phase process of prospect theory seems to be limited in scope in that little or no history to the decision is considered (e.g. have similar experiences and decisions been made or, how does the decision maker arrive at the current decision state?). [See Crozier and Ranyard (1999) for a description of some of the weaknesses and alternative cognitive process models.]

Another major limitation focuses around the research methods used to develop the theory and collaborate its findings, namely laboratory settings with artificial decision scenarios. Typically the artificial scenarios were limited to a very few given, risk options. Further, many of the subjects in these research activities were psychology (or similar) students. It is difficult to say how realistic and relevant such studies are to real-life decision-making activity, which is likely to include more options, more uncertainty and, a far wider set of variables and influences.

Also, the decision situations were artificial in that the decisions did not affect (other than on a trivial level) the participants and resources. One study aimed to address this by applying the same laboratory experimentation with students in China, where the exchange rate made potential 'wins' relatively more substantial. The results generally supported prospect theory, however, other than the relatively substantial 'win' offered, the decision choices did not affect the students in any lasting sense (e.g. they did not have to 'live with' an erroneous decision).

Another concern is that there seems to be little information on the level of support for decisions made by the participants. For instance, it is unclear if an *individual participant* has strong support for one particular option over another or if options are viewed as similar. [The

way most of the research works attribute support for options is to use overall statistical measures.] As discussed in section 1.2, Lauer's (1996) study examined software project managers' responses to risk decisions, to see if they are more consistent with EUT or prospect theory, using adaptation of questions used by Kahneman and Tversky (1979), with an information systems theme. The results showed some support for prospect theory, however, there was considerable variation in the results. Information on level of support for individual decision may explain the variations in Lauer's study.

A further limitation, evident from the sociology and anthropology literature (described in section 1.2.1.2) is that risk and uncertainty are social phenomena. Real-life decisions about uncertainty are likely to be conducted in group/social contexts. Prospect theory has no dimension with which to examine social interaction, except possibly as one element of framing.

Most of these and other criticisms of prospect theory are recognised in the cognitive psychology field itself. Cognitive psychology contains at least four distinct approaches to research and there is debate between supporters of each over the suitability or otherwise of different approaches (Barsalou 1992, p340). The four approaches are:

i) **Laboratory approach**

This dominates cognitive psychology and accounts for the bulk of publications and research activity. Kahneman and Tversky's work, including prospect theory, fit comfortably in this category.

ii) **Formal approach**

This focuses on the theoretical or formal models of cognitive phenomena.

iii) **Computational approach**

These try to simulate cognitive phenomena on computers.

iv) **Ecological approach**

These argue that cognitive psychologists must understand the physical environment if they are to understand cognition. Supporters of the ecological approach focus on human behaviour in natural setting (as opposed to a laboratory setting) surrounded with all the complexity of natural environment. They criticise laboratory approaches arguing that '*many laboratory paradigms are too artificial and simplified to be informative about important cognitive mechanisms*' (Barsalou 1992, p342). This

thesis fits more comfortably with this approach than the other three.

However, as Barsalou notes, many cognitive psychologists do not just work within one research paradigm and a more typical representation would be that different research approaches would be used to complement each other. For instance, an ecological researcher may develop a cognitive theory from observing activity in a natural setting, then test aspects of that theory in a controlled environment. Likewise a phenomenon observed in the laboratory will be examined in natural settings, and this would be the case of prospect theory (Shafir 1999).

Criticisms aside, the weight of supportive evidence for the key aspects of prospect theory (framing, value function characteristics etc.) is substantial and represents some fundamental aspect of decision-making activity.

Chapter 4:Applying prospect theory to ISD

4.1 Introduction

The previous chapter described the main characteristics of prospect theory along with examples of where it has been used and a discussion of some criticisms of the theory. This chapter applies the main aspects of prospect theory to the salient characteristics of information systems development. As such this chapter provides further rationale for the research approach and techniques used in this thesis.

As discussed in section 1.1, the main characteristics of the information systems development environment include:

- group activity, with different stakeholders
- social dimension
- use of particular development methods, techniques and tools
- goal orientated activity with particular resource constraints (e.g. produce an information system for £x in 6 months)
- the development environment has much potential for situations of uncertainty (i.e. where some elements of probabilities, options and/or payoffs are not known)

The main characteristics of prospect theory, discussed in the previous chapter, include

- framing effect
- lopsided 'S' shape value function with the following attributes
    - a reference point
    - loss aversion
    - diminishing sensitivity
- aimed at individual decision making
- aimed at dealing with risk (i.e. where the probabilities, options and payoffs are known)

The following sections will examine the applicability of prospect theory, with its particular traits, to the information systems development environment with its particular traits. The key areas that will be examined are

i) Framing influences
ii) Goal orientation
iii) Value function characteristics
iv) Risk versus uncertainty and group versus individual decision-making

4.2 Applying framing influences

One of the cornerstones of prospect theory is that the framing, or representation, of a problem situation will profoundly influence how people deal with that situation. This is known as the '*framing effect*'. The information systems development environment, probably more than other environments, has many characteristics which may contribute to framing influences. Most notably would be the use of a particular development methodology, method, tool or technique.

The development methodology, or method, is likely to dictate the underlying philosophy and paradigm used. These will be the taken-for-granted rules and vista used when examining a problem situation. One development method may view a system from a reductionist engineering perspective while another may view the system from a socio-technological perspective. The development method is also likely to dictate which tools and techniques to be used and the processes surrounding their use. Wynekoop and Russo (1995) describe development methods as a collection of different techniques within some formal framework. The methods provide the framework, which development techniques and tools will be used and how the results are interpreted.

The development techniques and tools themselves are likely to exert influences in representing problem situations. Particularly, the techniques and tools are likely to use specific terminology and language to collect information about the situation and describing the situation. Wastell (1996, 1999) shows that development techniques play an important role in helping developers to learn and understand about the requirements for an information system. Further, the techniques and tools are likely to use specific visual aids, such as

diagrams and tables to represent the requirements and design of a system. The techniques are likely to provide structure, focus and direction in learning about and describing a problem situation.

Any framing effects are likely to be cumulative in that many of the development techniques act as a communication medium between interested and participant parties (e.g. analysts using particular techniques to collect and represent requirements, the output of which will be used by designers to design the system).

The development environment is likely to provide much potential for framing effects. Chapter 5 examines these framing influences in greater detail.

4.3 Applying goal orientation

Information systems development, as with most project orientated activity, is driven by *goals* in various forms, such as project milestones, meeting a set of criteria (e.g. achieving a particular function or requirement) or completing the project within time or funds. There are two possible ways that these goals could be considered with regard to prospect theory. One is as a framing influence and the other as a reference point.

Any such framing influence is likely to be closely associated with the framing influences of development techniques and methodologies described above. For instance, the development technique and/or methodology is likely to dictate the characteristics of goals on the project development, such as what milestones are expected and what needs to be achieved for each milestone. Within information systems development a range of language is used to describe such goals including stages, phases, milestones and more generic plans. Even if no development methodology is used there are likely to be a host of plans indicating when specific activities are expected to take place, when resources are required and when the final project is likely to be completed.

Heath et al. (1999) show that goals can function as reference points and can alter people's behaviour consistent with the value functions: *'goals inherit the properties of the value function'*. Goals and deviations from them are consistent with prospect theory.

Information systems development goals are relevant to a prospect theory context and have the potential for providing framing influences and influence reference point characteristics of the value function. However, when examining such goal influences there is likely to be a problem with language since different development methodologies and techniques use their own specific terminology. In addition, some developments may not use formal development methodologies or techniques. To address this the generic term 'planning' is used in chapter 6 to examine goal influences in greater detail. Chapter 6 develops planning orientations, with corresponding value functions, for *planners* and *non-planners*.

4.4 Applying value function characteristics

4.4.1 Loss aversion

One result of loss aversion is that people prefer a 'sure thing' over a gamble with greater numerical utility. Closely related to this is a bias to the status quo. The implications of loss aversion are that there would be a tendency to be conservative in making decisions by always going for the 'safe' option. This may result in stifling innovation and less than optimal decision-making.

4.4.2 Diminishing sensitivity characteristics

According to prospect theory people are less sensitive to changes in value further away from the reference point. The concept of diminishing sensitivity may be particularly relevant to information systems development practice. The nature of most system developments are that tasks are broken down into a set of smaller tasks, e.g. into smaller sets of functional modules or objects, which will be given to individual developers. Each individual developer will focus his/her attention on their own small set of tasks. In larger systems there are typically several teams of developers, with each team focusing on a group of tasks and individuals focusing on

their own (relatively) small set of tasks. The tasks of the other members of the team are likely to be 'less visible' and hence of less importance for the individual developer, as would be tasks in other teams. There are clear analogies with Caplan (2000) *'politics of location'* in relation to risk perception and decision taking discussed in section 1.2.1.4. There is potential for a certain amount of in-built diminishing sensitivity in the development process, where 'distant' activity is given less (cognitive) attention. One can see possible examples where a development decision may have a small impact on one's own software modules but a much larger impact on modules in other development teams.

4.4.3 Risk seeking in loss scenarios

Risk seeking in loss scenarios may be of particular relevance to information systems development in that it may explain apparently risk-taking behaviour when project developments are running over time or budget. Brooks (1982, p24) gives examples of such behaviour, including 'throwing manpower' at a project when it falls behind resulting in further problems (such as training of new recruits and fixing their introduced 'bugs').

4.5 Risk versus uncertainty and group versus individual decision making

Information systems development is associated with areas of uncertainty whereas prospect theory has been developed around areas of risk. The later cumulative prospect theory expanded applicability to include a wider set of risks, though still limited to situations where at least some probabilities and payoffs are known beforehand. Existing research is inconclusive on the applicability of prospect theory to complex real-life situations.

For instance, Steen-Sprang's (1999) study applied prospect theory to international relations, which typically involves aspects of uncertainty (as opposed to risk) and group decision-making activity rather than individual. Steen-Sprang study concluded

'that prospect theory does not explain or predict how decision making will occur in groups under uncertainty, but prospect theory does somewhat predict how individuals under uncertainty make decisions' (p1)

However, Steen-Sprang's (1999) study was based on a selection of political science students operating in controlled individual and group settings and given international relations decision-making options with risk and uncertain scenarios. The findings of the study were not conclusive in that prospect theory explained behaviour under uncertainty for some individuals and not for others. Also, prospect theory seemed better suited to different types of scenarios. For instance, international relations associated with war fitted behaviour predicted by prospect theory better than those associated with aid, where it was noted '*the underlying claim is that the change from uncertainty to risk is almost too much for prospect theory to handle*' (Steen-Sprang's 1999, p35). Another limitation to Steen-Sprang's study is that the group settings were contrived and artificial: groups of students were artificially 'organised' into groups just for the duration of the decision task. No account seems to be taken of how groups develop over time and the specific roles within groups (other than nominally allocating a group leader). Also the decision situations were artificial in that decisions did not affect (other than on a trivial level) the participants, resources and other people.

A further possible limitation of prospect theory as applicable to information systems development, as discussed in the previous chapter, is that prospect theory has been developed around laboratory experimentation where participants are typically given a choice between two options. However, it is questionable if in real-life situations will exist where just a few clear-cut decision options are relevant. Also there seems to be little information on the level of support for such decisions, e.g. was a particular decision favoured very strongly over the other option or was it a close decision? Information on the level of support, and what influences this support, for one decision over another within the prospect theory framework, would add to the robustness of the theory.

4.6 Summary and applicability

As the above discussion highlights, real-life decisions are likely to involve uncertainty rather than risk and are likely to be conducted in a group context rather than purely at an individual level. It is clear that for prospect theory to be useful in real-life settings it **must** be relevant to situations of uncertainty (rather than just risk) and **must** be applicable in a group context (rather than just an individual context). If it is not, on either account, then prospect theory

will be relegated to an interesting phenomenon that occurs in the laboratory with little relevance to real-life decision-making. There is a clear need to apply prospect theory to a real-life decision making settings, as Steen-Sprang (1999,p35) relates '*the psychological process [*described in prospect theory*] needs to be studied in the field*'. This thesis addresses this need by applying prospect theory to the real-life setting of information systems development.

The next chapter examines possible framing influences due to development methods and techniques.

Chapter 5: Macro analysis of techniques to deal with uncertainty within information systems development: Mapping the framing effect

5.1 Introduction

This chapter aims to map framing influences (Tversky and Kahneman 1973,1974), suggested by prospect theory (Kahneman and Tversky 1979), within the information systems development environment. The focus is on the effects on problem cognition due to distinct characteristics of the development methods, or more typically the component techniques. An initial classification of techniques, based on visual and linguistics characteristics, is developed providing likely problem/solution spaces for different types of technique. Drawing upon psychology literature, particularly works on visual and linguistic cognitive processes, enables an analysis of how specific characteristics of techniques may influence problem understanding. In addition, examining the taken for granted paradigm of a particular technique provides a further dimension on influencing problem understanding. These dimensions (i.e. visual/language and paradigm attributes) are used to further develop classification, which is applied to over 100 development techniques (see appendix A). This classification is then applied to prospect theory's *framing effect,* indicating how different types of technique are likely to influence problem cognition.

The structure of the rest of this chapter is as follows. First there is a discussion on methodologies and techniques, which provides rationale for focusing on 'techniques'. Then follows an examination of what techniques offer developers and an examination of the main characteristics of techniques. This is used to develop an initial classification of techniques based on representational attributes and language constructs used. The initial classification provides information on problem/solution spaces covered by different techniques and likely 'social defence' attributes. Then there follows an in-depth examination of how particular aspects of techniques may influence problem cognition. To do this, specific works from the cognitive psychology literature are used which cover potential biases on cognition. These works are then used to inform the initial classification of techniques to develop finally a two-dimensional classification of techniques based on final presentation attributes and the

underlying technique paradigm which is used to identify likely framing influences for different types of technique.

5.2 Examining methods and techniques

There is much research and debate covering development methods, or methodologies, and techniques (Hardy et al 1995; Fitzgerald 1996,1997). Wynekoop and Russo (1995) critically assesses the use of development methods and asks some searching questions of the IS development community. They conclude that though there are many systems development methodologies, there is no universal agreement that existing methodologies are useful today (confirming previous work by Lyytinen, 1989), further, "*there is little empirical insight into why some methodologies might be better than others in certain situations*" (p69).

Wynekoop and Russo (1995, p66) discuss the variety of terminology and definitions surrounding what constitutes a systems development methodology and groups three concepts under:-

1) *Methodology: a systematic approach to conduct at least one complete phase (e.g. design or requirements analysis) of software production, consisting of a set of guidelines, activities, techniques and tools, based on a particular philosophy of systems development and the target system.*
2) *Technique: specific steps for conducting a portion of a phase of software production (e.g. design techniques).*
3) *Software process model: a representation of the sequence of stages (e.g. requirements analysis, specification, planning, design, implementation, integration, maintenance and retirement) through which a software product evolves.*

Wynekoop and Russo cite several studies which seem to indicate that development methods are adapted considerably by organizations and even individual projects. Keyes (1992) maintains that there are no methods, just techniques, not a common view within the IS literature, but it highlights the prominent role of 'techniques' in development practice. In Wynekoop and Russo's work, development techniques are seen as component parts of methodologies, collected together within a particular philosophical framework. From this

description, development techniques may be classed as a 'lowest common denominator' between methodologies.

In Fitzgerald's (1996) postal survey investigating use of methodologies, 60% of respondents were not using a formalised commercial development methodology and very few (6%) actually rigorously followed a development methodology. Many of the respondents from Fitzgerald's survey using a formal development methodology tended to adapt the methodology to specific development needs. In a later study Fitzgerald (1997) found that considerable tailoring of methodologies was common practice, with the tailoring involving using additional techniques or method steps and/or missing out specific techniques and/or method steps. Techniques play an influential role in how an information system is developed, and the selection and use of techniques distinguish one development method or approach from another.

When examining the use of techniques in information systems development one is struck by two things, the variety of 'different' techniques available and the similarity between some of the techniques. For general problem and business analysis (an integral part of many information systems developments) there are a wealth of available techniques: for instance Jantsch (1967) examined over 100 techniques for general business and technological forecasting: in the Royal Society's work on *Risk Assessment* (Royal Society 1992) numerous techniques from several business areas are examined; Bicheno (1994) examined 50 techniques and business tools focusing on improving quality; Couger (1995), Adams (1987) and de Bono (1969, 1970, 1977) between them examined many techniques to improve creativity, innovation and lateral thinking in problem solving and; Obolensky (1995) examined a range of techniques suitable for business re-engineering. There are common or similar techniques to be found in each of those works, emphasizing that techniques can have a generic use and be suitable for a wide variety of situations such as those found in information systems development. There are also techniques specifically aimed at information systems development. Information systems development often involves several specific stages (e.g. analysis, design, testing) with each stage having an associated set of techniques. Thus there are a range of techniques to help conduct a feasibility study, to analyse requirements, to design a system and to develop, test and monitor systems (e.g. Flynn 1992; Avison and Fitzgerald 1988, 1995; Downs et al. 1988; Jackson 1983; Gane and Sarson

1979; de Marco 1979; Yourdon and Constantine 1979; Anderson 1974). Practitioner and academic journals contain abundant descriptions of new development techniques. New technologies and applications give rise to new techniques and new tools to support development (e.g. Reubenstein and Waters 1991; Proctor 1995).

Seemingly, there is an abundance of different techniques available to developers. However, there is much similarity between many of the different techniques. Several techniques have different varieties, for instance, there are several variants of Data Flow Diagrams (DFDs) (Downs et al. 1988, p16). A closer examination of the items listed by Bicheno (1994) reveals that they are heavily based on previous works, with many newly claimed techniques being adaptations of older techniques or compilations of other techniques.

5.3 What techniques offer

Given that development techniques play such an influential role in how an information system is developed it would be useful to consider what is gained from using a development technique. An initial list of what a technique can offer may include the following:

- Reduces the 'problem' to a manageable set of tasks.
- Provides guidance on addressing the problem.
- Adds structure and order to tasks.
- Provides focus and direction to tasks.
- Provides cognitive tools to address, describe and represent the 'problem'.
- Provides the basis for further analysis or work.
- Provides a communication medium between interested parties.
- Others (e.g. provides an output of the problem solving activity, provides support).

The initial items in this can be considered as aiding developers in understanding the problems and requirements of an information system. This is supported by Wastell (1996, 1999) who, examining the use of development techniques, identified two concepts which describe this learning support behaviour: 'social defence' (Menzies-Lyth 1988; Schein 1991) against the unknown and 'transitional objects and space'. Wastell's later work focuses on the learning activities developers need to undertake to ensure a successful development (i.e. finding out about the requirements/problems the system is to address).

> '*We argue that the operation of these defences can come to paralyze the learning processes that are critical to effective IS development. ... These* ***social defences*** *refer to modes of group behaviour that operate primarily to reduce anxiety, rather than reflecting genuine engagement with the task at hand.*' and '[Transitional] *spaces have two important aspects: a supportive psychological climate and a supply of appropriate* ***transitional objects*** *(i.e. entities that provide a temporary emotional support).* (Wastell 1999,p3)

The social defences concept is used to describe how developers follow methods, techniques and other rituals of development as a means to cope with the stresses and uncertainties of the development environment (Wastell and Newman 1993). The negative aspects of these social defences mean development teams are likely to withdraw into the bureaucracy of the methods and techniques: the rules of the methods and techniques become paramount against addressing the 'real' problems of development. Further, the social defence concept becomes more pronounced when one examines different types of techniques. Couger et al. (1993) use the term 'completeness' to describe the depth of study undertaken by a technique, with more bureaucratic techniques attracting higher levels of completeness. The more bureaucratic the technique (and method) then the higher the potential for use as a social defence mechanism in a negative sense (i.e. engagement in method rather than task).

Wastell's transitional object is seen as an emotional support mechanism to help developers deal with the complexities and uncertainties of development. It enables developers to describe and reduce development requirements into manageable tasks. Wastell argues that '*IS development should be re-framed as a transitional space, with particular attention given to*

the selection of appropriate transitional objects to assist in breaking down defensive processes'.

This concept of supporting the learning process is consistent with the findings of Fitzgerald's (1997, p342) study, which found that there was considerable tailoring of development methodologies and that tailoring was more likely to be conducted by experienced developers. Inexperienced developers tend to rely more heavily on rigorously following a development method or technique. Inexperienced developers require more guidance and support in the development process and look to the method, or collection of techniques for that support.

Key elements here are that techniques play an important role within information systems development influencing developers' learning and understanding process (about the IS requirements) and the potential negative influences when developers engage in the rituals of technique at the expense of problem understanding.

The next section examines more closely the characteristics of techniques to identify further possible influences on problem cognition.

5.4 Characteristics of techniques

By examining a variety of techniques certain attributes become apparent:

- Visual attributes, e.g. visual representation and structure of technique output.
- Linguistic attributes, e.g. terminology and language used – not just English language, but also others such as mathematical and diagrammatical (Adams 1987,p103).
- Genealogy attributes, e.g. history of technique, related techniques.
- Process/procedure attributes, e.g. description and order of tasks.
- People attributes, e.g. roles of people involved in tasks.

- Goal attributes, e.g. aims and focus of technique.

- Paradigm attributes, e.g. discourse, taken for granted elements, cultural elements.

- Biases, e.g. particular emphasis, items to consider, items not considered.

- Other attributes, e.g. technique or application specific attributes.

Some characteristics of a technique are explicit, for instance if a particular visual representation is prescribed, while other characteristics are less obvious such as an underlying paradigm. Many of the characteristics are interwoven. Thus the visual, linguistic and goal attributes might be dictated by the genealogy and paradigm of the technique.

Take as an example, decision tree techniques, which may not necessarily be widely used but are widely known about (typically being on undergraduate courses) and have specific characteristics. Decision trees can and have been used for a variety of tasks but traditionally have been used for decision-making under risk. In this case the probability of possible outcomes of a decision are known and one has just to work through some calculation to identify the most attractive decision option (e.g. de Neufville and Stafford 1971, p121). Use of this 'traditional' type of decision tree technique could be used in some feasibility stages of an information systems development to decide among particular major options. More common use of decision trees within information systems development would be to represent processes containing alternative actions (de Marco 1979; Avison and Fitzgerald 1988, 1995; Flynn 1992).

The underlying paradigms of a traditional decision tree technique can be classed as deterministic in nature where all the alternatives are known, along with associated probabilities and payoffs. It is taken for granted that probabilities are known or can be accurately calculated, that payoffs can be calculated up-front and represented in some common form (usually monetary) and that all the elements and options of the decision are known or knowable beforehand.

The goal or aim of using a decision tree technique is to identify the most beneficial or optimal option, usually represented in *expected value* or *expected utility*.

The visual representation of the technique is a tree structure consisting of *decision points* (or nodes), with each possible decision branching out, and *chance points* (or nodes) with the probability of outcomes branching out, see figure 5.1.

As for the genealogy of decision tree techniques, they are related to basic hierarchical diagrams, basic tree diagrams or dendrograms, mixed with probability theory (Waddington 1977, p55). Hierarchical representation is one of the simplest and most basic mechanism of structuring complex situations or systems (ibid p48). Many biological systems and manmade systems have hierarchical characteristics (e.g. an organizational structure), so hierarchical structuring is a familiar concept. Decision tree techniques provide cognitive tools which enable complex situations to be considered in some common and familiar representation.

The linguistic attributes revolve around deterministic and numerical characteristics such as probability and expected values. The process and procedures are mostly prescribed by the technique, as are the people attributes (e.g. usually an individual activity, possibly checked or considered by other individuals).

There are several possible biases inherent in decision tree techniques such as constraining options to only those listed (e.g. not considering unpredictable events), forcing an artificial structure which may not represent the actual situation and giving emphasis on some items while not giving sufficient emphasis on others. (We will look again at the biases of decision tree techniques in the later section on lessons from cognitive psychology.)

There may be other application or company specific attributes such as prescribed in-house accounting rules for allocating costs and considering investments.

In contrast, decision tables or decision matrices can be used to represent the same problem situation in both the traditional decision tree (Jansch 1967) and the more common (for information systems development) variants (de Marco 1979; Flynn 1992, p201). There would be considerable differences between a decision tree and decision table representation of a

problem situation. For instance the visual presentation characteristics would be considerably different with decision tables using a matrix structure instead of a hierarchical structure. Though the visual representations for both may be *logically* the same, the implied structure and emphasis to the problem situation would be different.

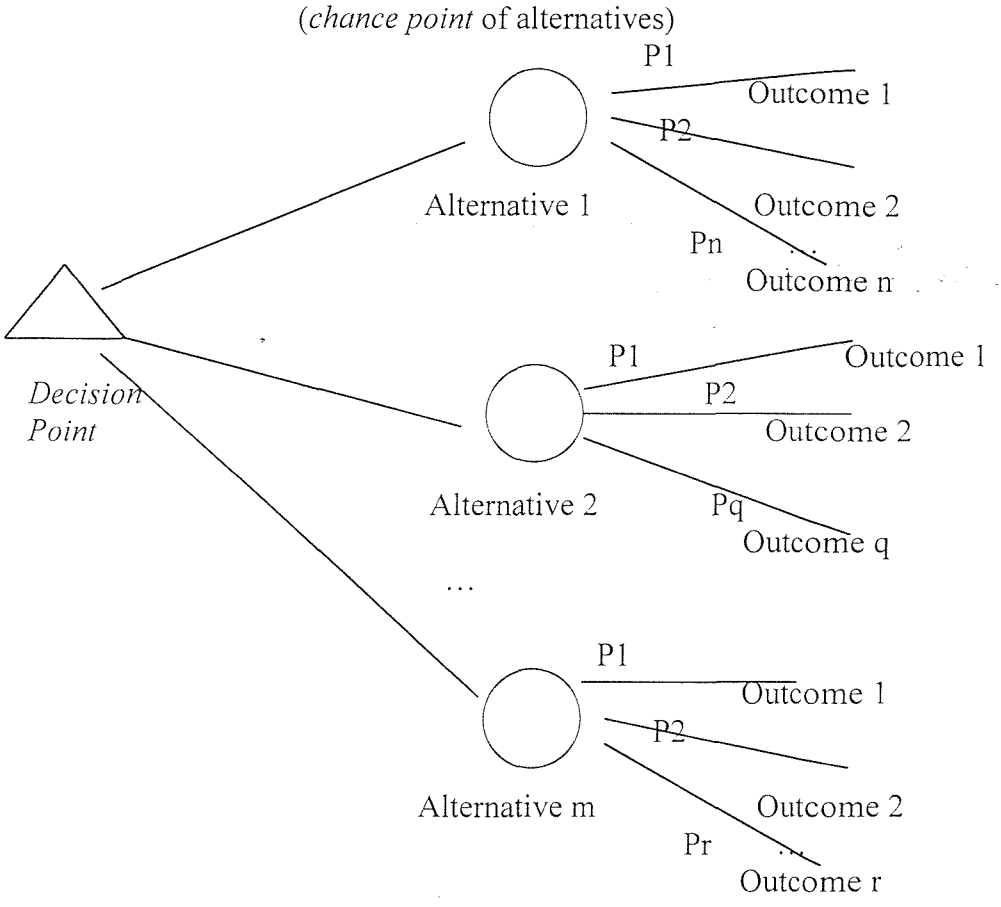


Figure 5.1: Example decision tree representation

5.5 Initial classification of techniques

This section develops an initial classification of techniques, based on Waddington's (1977) 'natural' attributes for grouping items. An early version of this classification is described in Adams (1996). Waddington discusses our 'basic', or natural, methods of ordering complex systems, the most basic of which relies on identifying simple relationships, hierarchies, patterns and similarities of characteristics. Feldman (1997) discusses a similar means of grouping items referred to as a 'logical grouping'. The 'natural' grouping was based on the generic name(s) given to a technique and by the final presentation of a technique, i.e.

grouping techniques with similar looking presentations together. The result is six groups: (i) Brainstorming Approaches, (ii) Relationship Approaches, (iii) Scenario Approaches, (iv) Reductionist Approaches, (v) Matrix Approaches and (vi) Conflict Approaches.

Brainstorming Approaches

This group is defined by a generic name 'brainstorming'. Brainstorming is probably the most well known, well used and most modified of the techniques. Brainstorming is often associated with De Bono (e.g. 1970, 1977) who covered it as one of a set of lateral thinking techniques, though others seem to have earlier claims (e.g. Clark 1958, p262). It is a group activity to generate a cross stimulation of ideas.

Relationship Approaches

This group is defined mainly by the final presentation of the techniques. The important characteristic here is representing the problem area as relationships between component parts. Included in this grouping are Network Diagrams (e.g. Bicheno 1994, p40; Mizuno 1988) and Cognitive Mapping (Eden 1992), which some might argue are quite different techniques, however, the final output presentations are topologically very similar. A further characteristic is the use of a diagram to present and model the situation.

Scenario Approaches

This group is defined by a generic name 'scenario'. These techniques involve getting participants to consider different possible futures for a particular area of interest.

Reductionist Approaches

This group is defined by a group of generic names which all have similar meaning: that of reducing the problem area into smaller component parts. Once a problem has been 'reduced' then the component parts are addressed in turn before scaling back up to the whole problem again.

Matrix Approaches

This group is defined more from the final presentation, that of a matrix or list structure, though often the generic name 'matrix' is also used. Using some form of

matrix or list approach for structuring and making decisions is widely known and frequently used (e.g. Jantsch 1967, p211). A list of factors are compared or analysed against another list of factors.

Conflict Approaches

This grouping is defined by the generic name 'conflict'. It underlines an approach to view the problem from different and conflicting perspectives.

Each group can be considered in terms of 'social defence' against the unknown (Menzies-Lyth 1988; Schein 1991; Wastell 1996). As discussed in section 1.1.3, 'social defence' in this context represents organisational or individual activities and rituals that are used to deal with anxieties and uncertainties. It is argued that the more quantitatively rigorous and detailed (depth of study) the technique then the higher the potential for being a social defence mechanism. Rosenhead (1992) uses problem/solution space diagrams to represent the scope of possible solutions for techniques. This concept is developed and applied to each of the groups. A summary of the characteristics of the initial grouping of techniques is represented in the table 5.1 and problem/solution space diagrams for each technique are presented in figure 5.2.

Group	Quantitatively rigorous/Depth of study	Potential for social defence	Area of Problem/ Sol. Space covered
Brainstorming	LOW	LOW	SCATTERED
Relationship	HIGH	MEDIUM-HIGH	LOCALISED CLUSTERS
Scenario	MEDIUM	MEDIUM	SCATTERED CLUSTERS
Reductionist	VERY HIGH	HIGH	LOCALISED
Matrix	HIGH	MEDIUM-HIGH or HIGH	LOCALISED CLUSTERS
Conflict	MEDIUM-HIGH	MEDIUM-HIGH	VERY LOCALISED

Table 5.1: Characteristics of natural grouping for techniques to deal with uncertainty.

This initial classification is applied to approximately 100 techniques, the results of which are represented in appendix A, columns (j) to (o).

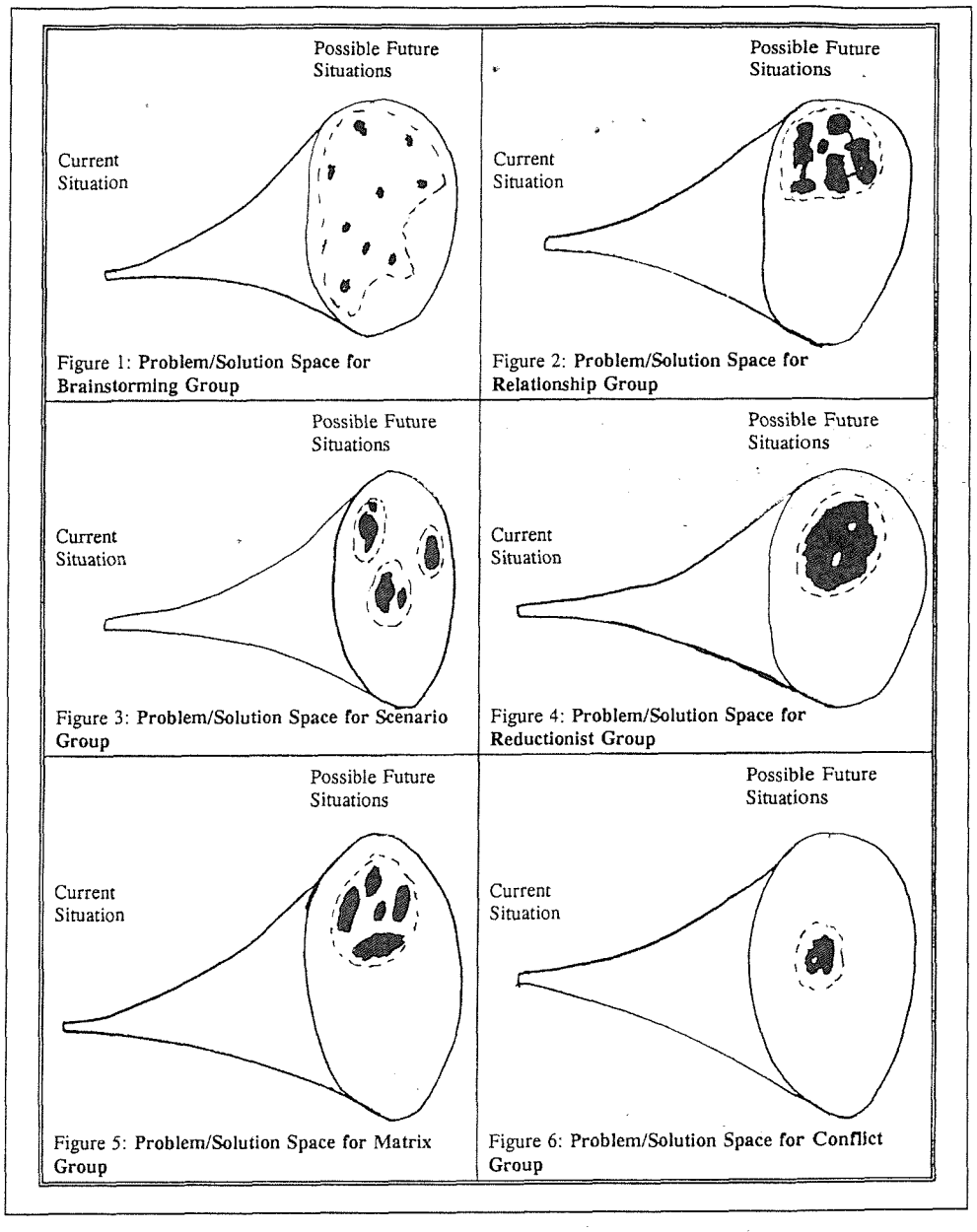


Figure 1: **Problem/Solution Space for Brainstorming Group**

Figure 2: **Problem/Solution Space for Relationship Group**

Figure 3: **Problem/Solution Space for Scenario Group**

Figure 4: **Problem/Solution Space for Reductionist Group**

Figure 5: **Problem/Solution Space for Matrix Group**

Figure 6: **Problem/Solution Space for Conflict Group**

Figure 5.2: Problem solution space for each of the initial natural groups

Though providing a different vista on the classification of techniques, with possible social defence attributes and problem/solution spaces mapped out, this initial grouping proves too simplistic in that it does not address 'how' techniques in a particular group would affect problem cognition. The next section draws upon psychology literature to inform the initial grouping with cognitive influences.

5.6 Techniques impact on problem understanding: Lessons from cognitive psychology

5.6.1 Potential blocks to problem cognition

From creative, innovative and lateral thinking perspectives, Groth and Peters (1999) examined barriers to creative problem solving among managers. They identified a long list of perceived barriers to creativity including *'Fear of failure, Lack of confidence, Environmental factors, Fear of success and its consequences, Fear of challenge, Routines, Habits, Paradigms, Pre-conceived notions, Rules, Standards, Tunnel sight, Internal barriers, Structure, Socialization, External barriers, Money, Rebellion, Health and energy, Mood, Attitudes, Desire, Time'* (Groth and Peters 1999,p183). They grouped the perceived barriers into 'Self imposed', 'Professional environment' and 'Environmentally imposed'. Fear of some sort seems to be the predominant barrier, at least for these managers.

For more general barriers, James Adams (1987) in his book *Conceptual Blockbusting*, draws heavily from the psychology literature to identify four main areas of conceptual blocks:

- **Perceptual Blocks**:
  Seeing what you expect to see – stereotyping
  Difficulty in isolating the problem
  Tendency to delimit the problem area too closely (i.e. imposing too many constraints on the problem)
  Inability to see the problem from various viewpoints
  Saturation (e.g. disregarding seemingly unimportant or less 'visible' aspects)
  Failure to utilize all sensory inputs

- **Emotional Blocks**:
  Fear of taking risks
  No appetite for chaos
  Judging rather than generating ideas
  Inability to incubate (ideas)
  Lack of challenge and excessive zeal
  Lack of imagination

- **Cultural and Environmental Blocks:**

  Cultural blocks could include:

  Taboos

  Fantasy and reflection are a waste of time

  Reasons, logic, numbers, utility, practicality are *good*; feeling, intuition, qualitative judgements are *bad*

  Tradition is preferable to change

  Environmental blocks could include:

  Lack of cooperation and trust among colleagues

  Autocratic boss

  Distractions

- **Intellectual and Expressive Blocks:**

  Use of appropriate cognitive tools and problem solving language

These 'blocks' indicate that techniques could have a variety of adverse influences on problem cognition. The influences could derive from each of the four areas identified (e.g. 'blinker' perception from a particular perspective, lack of emotional support as a transitional object, providing flawed approach and logic and not providing appropriate cognitive tools).

5.6.2 Visual and linguistic influences on problem cognition

5.6.2.1 Gestalt psychologists

One of the earliest and most influential movements of cognitive psychology was the *Gestalt psychologists* initiated by Max Wetheimer, Wolfgang Kohler and Kurt Koffka (Wertheimer 1923;Honderich 1995, p312;Gillam 1992). *'In Gestalt theory, problem representation rests at the heart of problem solving – the way you look at the problem can affect the way you solve the problem. ... The Gestalt approach to problem solving has fostered numerous attempts to improve creative problem solving by helping people represent problems in useful ways.'* (Mayer 1996, p68)

The key element here is that how a problem is represented will affect the understanding of the problem, which is consistent with prospect theory. Relating this to techniques one can deduce that the visual, linguistic and other representation imposed by a technique will impact problem cognition.

The Gestalt movement in cognitive psychology has a (comparatively) long history and had a big impact on the understanding of problem solving. The movement has spored various strands of techniques such as lateral thinking and creative techniques. Gillam (1992) gives a more current examination of Gestalt theorists and works particularly in the area of perceptual grouping (i.e. how people understand and group items). Gillam shows that perceptual coherence (i.e. grouping) is not the outcome of a single process (as originally proposed by Gestalt theory) but may be best regarded as a domain of perception (i.e. the grouping process is likely to be more complex, influenced by context and other aspects) (ibid p161).

The Gestalt psychologies indicate a potential strong influence on problem understanding, that of functional fixedness '*prior experience can have negative effects in certain new problem-solving situations ...the idea that the reproductive application of past habits inhibits problem solving*' (Mayer 1996). The implication is that habits 'learnt' using previous techniques and problems will bias the application of new techniques and problems. This could be particularly relevant given the glut of 'new' techniques and may explain why many techniques are rehashes of older techniques.

5.6.2.2 Normative and paradigm influences

The cognitive psychology literature indicates that there will be a different weight attached to the results of *normative* as opposed to *descriptive* types of techniques. The basis for this is the 'understanding/acceptance principle' (Slovic and Tversky 1974), which states that "*the deeper the understanding of a normative principle, the greater the tendency to respond in accordance with it*" (Stanovich and West 1999, p349). Further, some studies indicate there is a tendency to move towards normative reasoning as opposed to non-normative reasoning to describe problems, particularly so when the initial problem is represented using predominantly normative attributes. However, in other studies when a problem is presented

using both normative and non-normative argument there was no significant tendency to move towards normative descriptions (ibid p374). Relating this to development techniques, there are two items of interest. First, the deeper the understanding of a technique (e.g. by previous experience or training) then the more likely the findings will be accepted. Second, that there will be a tendency to move towards the use and acceptance of the findings from techniques based more on *normative* than *descriptive* models. This is particularly so if starting from a (more) normative perspective. The underlying paradigm of a technique is likely to dictate the normative/descriptive characteristics of the technique. There is an in-built bias in techniques based on normative principles and the bias is self-perpetuating.

As discussed in section 1.2.1.3, framing situations in either a negative or positive perspective is likely to influence problem cognition, particularly on estimating the likelihood of events (Tversky and Kahneman 1973). Milburn (1978, p17) identified a *time influence* on viewing problem situations, particularly with positive and negative events: negative events are seen more likely in the short term while positive events are seen as increasingly likely over time. This, Milburn argues, '*might help explain why often so little long-range planning is done: If one feels that things are bound to get better later on, no urgent pressure is felt to plan for problems which might occur later.*' (ibid p26). The implications are that how a technique frames a problem situation, in both a positive/negative and a time perspective will influence problem cognition, particularly the perception of the likelihood of events.

Another major area that a technique can influence cognition can be deduced from support theory (Tversky and Koehler 1994) which indicates that support for an option will increase the more that the option is broken down into smaller component parts with each part being considered separately. The more specific the description of an event then, the more likely the event will seem. The implications are that the more a technique breaks down and considers a situation into component parts or alternatives, then the more likely the situation will seem. In addition, a technique's underlying paradigm is likely to dictate whether or not a problem situation is broken down into increasingly smaller component parts or if a situation is represented in a negative or positive light.

5.6.2.3 Structure influences

Prescriptive structure is also likely to exert influence on problem cognition. For instance, hierarchy and tree structures are likely to exert some influence on problem cognition in binding attributes together (e.g. on the same part of a tree structure) and limiting items to the confines of the imposed structure. In cognitive psychology this is known as *category inclusion* (Anderson and Bower 1973). '*One enduring principle of rational inference is category inclusion: Categories inherit the properties of their superordinates*' (Sloman 1998, p1). The implication is that techniques dictating hierarchical structures will force a (self - perpetuating) category inclusion bias. An element in one branch of a hierarchical structure will automatically have different properties to an element in another branch of the hierarchical structure. For instance, take a functional breakdown of an organization (as in Yourdon and Constantine 1979). One might conclude from category inclusion that a task in an accounting department will always be different to a task in a personnel department, which clearly may not be the case as both departments will have some similar tasks, such as ordering stationary.

However, this category inclusion is not universally the case. Sloman (1998) found that the process is likely to be more complex. In his study participants frequently did not apply the category inclusion principle '*instead, judgments tended to be proportional to the similarity between premise and conclusion*' and concluded '*arbitrary hierarchies can always be constructed to suit a particular purpose. But those hierarchies are apparently less central to human inference than logic suggests*' (p31). The initial premise surrounding a situation is likely to be related to the underlying paradigm. Dictating a hierarchical structure in itself may not result in category inclusion biases. However, coupled with an underlying paradigm of closed hierarchical properties will more likely result in category inclusion biases. Along the same theme are proximity influences and biases. The understanding of items can be influenced by the characteristics of other items in close proximity.

5.6.2.4 Discourse influences

The discourse and language used to describe a problem is likely to play a role in problem understanding. Adams (1987) discusses various different types of 'languages of thought'

used in problem representing and solving. People can view problems using mathematical symbols and notation, drawings, charts, pictures and a variety of natural verbal language constructs such as analogies and scenarios. Further, people switch consciously and unconsciously between different modes of thought using the different languages of thought (p72). The information systems development environment is awash with technical jargon and language constructs. In addition, different application areas have their own set of jargon and specific language. Individual techniques have their own peculiar discourse consisting of particular language, jargon and taken for granted constructs, all of which may exert influence. For instance, the initial discourse used affects understanding of a problem situation, particularly in resolving ambiguities (Martin et al. 1999). Resolving ambiguous requirements is a common task in information systems development (Gabbay and Hunter 1991). The initial discourse sets the context with which to consider the situation. A technique will usually dictate some elements of initial discourse and subsequent processes with their own discourse, effectively leading questions and processes: "*the strength of context variable is critical and should receive more focus in language comprehension research, especially in the areas of ambiguity research*" (ibid p835).

Perceptual processing is profoundly influenced by order of information and the relational constructs of information (Mulligan 1999). The order and number of items in a list will influence how people will understand (and recall) the items and how people will categorize items. The implications are that the language and order of describing a problem situation, the questions asked and how they are asked and the implied relationships (all of which are usually prescribed by a technique) will bias problem understanding, e.g. by forcing 'leading questions' or 'leading processes'.

Language aspects highlight another set of possible influences, that of communication between different groups of people (e.g. such as between analysts and users). Differences of perspective between different groups of people in the development process has been discussed within the IS field under the heading of the 'softer' aspects or as the organizational or people issues (e.g. Checkland 1981; Sauer 1993; Lederer and Nath 1991). Identifying differences and inconsistencies can be classed as a useful task identifying and dealing with requirements (Gabbay and Hunter 1991). From cognitive psychology there are also other considerations. As discussed in section 1.2.1.3, Teigen's (1988) work on the language of

uncertainty, shows that there is often more than the literal meaning implied in the use of a term, such as contextual and relational information or some underlying 'other' message. The use of language is very complex. The implications are that even if a technique prescribes a set of 'unambiguous' language and constructs, there may well be considerable ambiguity when it is used.

5.6.2.5 Preference influences

There are also likely to be individual preferences, and corresponding biases, for some techniques or specific tasks within techniques, as Puccio (1999, p171) relates: '*The creative problem solving process involves a series of distinct mental operations (i.e. collecting information, defining problems, generating ideas, developing solutions, and taking action) and people will express different degrees of preference for these various operations*'. Couger (1995, p5) has noted similar preferences: '*It is not surprising that technical people are predisposed towards the use of analytical techniques and behaviorally orientated people towards the intuitive techniques*'. In addition there may be some biases between group and individual tasks, a point taken up by Poole (1990) who notes that group interaction on such tasks is likely to be complex with many influences. This theme is taken up with Kerr et al. (1996), who investigated whether individual activities are better than group activities (i.e. have less errors or less bias), but their finding were inconclusive '*the relative magnitude of individual and group bias depends upon several factors, including group size, initial individual judgement, the magnitude of bias among individuals, the type of bias, and most of all, the group-judgment process ....It is concluded that there can be no simple answer to the question "which are more biased, individuals or groups?"*' (Kerr et al. 1996, p687). To address the potential individual/group biases, many authors on using techniques recommend some consideration of the make-up of different groups (e.g. Bicheno 1994; Couger et al. 1993), though give limited practical guidance on doing so.

5.6.2.6 Goal influences

Goal or aim aspects also profoundly influence problem understanding by providing direction and focus for knowledge compilation (Anderson 1987). Goals influence the strategies people undertake to acquire information and solve problems. Further, when there is a lack of clear

goals people are likely to take support from a particular learning strategy, which will typically be prescribed by the technique:

'The role of general methods in learning varies with both the specificity of the problem solver's goal and the systematicity of the strategies used for testing hypotheses about rules. In the absence of a specific goal people are more likely to use a rule-induced learning strategy, whereas provision of a specific goal fosters use of difference reduction, which tends to be a non-rule-induction strategy.' (Vollmeyer et al. 1996).

The implications are that techniques with clear task goals will impact the focus and form of information collection (e.g. what information is required and where from, along with what information is not deemed relevant) and how the information is to be processed. Also, if there are no clear goals then people are likely to rely more heavily on the learning method prescribed by the technique.

5.6.3 Summary of possible framing influences

The framing influences discussed above indicate that any *framing effect* due to the characteristics of a technique is likely to be complex and interwoven. However, there are some main themes that emerge. The visual, structure and linguistic aspects can be combined in a general 'representational' heading. Equally, there are several aspects which can be classed collectively as 'paradigm/process' influences. Arguably, the more prescribed and structured a technique is, then the more likely that 'predictable' framing influences can be ascribed. Overall, the works from the cognitive psychology field give several indications how the characteristics of a technique are able to exert some influence on problem cognition.

5.7 Applying framing influences: a macro analysis of techniques

5.7.1 Applying lessons from cognitive psychology

As the previous discussion shows, the literature from cognition psychology indicates two main types of influences: representational influences (e.g. prescribing certain visual and other

'language' representations) and paradigm/process influences (e.g. underlying approach, prescribed processes and tasks utilising specific language).

The 'visual and language' characteristics imposed by techniques are likely to be explicit in that specific representations will be prescribed such as distinct diagrams, tables and other visual outputs in the final representation. The process characteristics may also be explicit (e.g. list and order of tasks to be completed). The underlying paradigms for techniques are likely to be far less explicit. However, there is likely to be some relationship between paradigm and process since an underlying paradigm is likely to dictate the processes and activities to be undertaken. As such, a classification by representational influences and paradigm/process influences provides a fairly objective metric with which to view influences on cognition.

5.7.2.1 Representational influences

Focusing on the representational influences the initial grouping can be informed by the cognitive psychology literature discussed above. The final representation of techniques, consisting mainly of visual characteristics and some language constructs, fall into three distinct categories: a matrix/table structure, a hierarchical structure and a non-hierarchical structure. In addition, there is a fourth category to account for techniques which do not prescribe a particular presentation, this could be called structure free. The characteristics of each are detailed below.

Matrix/Table Structure:
- lists, tables or matrix format

Hierarchical Structure
- functional breakdowns
- similar visual representations to a hierarchical organisation chart

Hierarchy Free Structure
- clear relationships
- network structures

- non hierarchical structures

Structure Free (Other, non prescribed)

- non prescribed structures
- non diagrammatical structures (e.g. verbal, written structures)
- other, freer structures

5.7.2.2 Paradigm/process influences

Focusing on the paradigm and process influences, the initial grouping can also be informed by the cognitive psychology literature discussed above. Examining different categories for the underlying paradigm and processes of techniques, one could group by the qualitative/quantitative (or by Subjective/Objective, Judgemental/Rational) characteristics (e.g. Wright and Ayton, 1987). Objective techniques being those relying on 'hard facts and figures', use fairly rigid scientific or mathematical 'rules' and are aimed at situations which 'follow' these rules. Subjective techniques are those which rely more on judgement and interpretation of complex situations. However, few decision situations (if any) are totally quantitative or totally qualitative based (e.g. Wright and Ayton, 1987; Powell 1992), but techniques could be classified on some form of qualitative/quantitative scale. However, deciding which is the predominant characteristic is itself subjective: Powell (1992) describes some techniques for evaluation as quantitative, whereas Farbey, Targett and Land (1994) argue that these same techniques are qualitative. As Jantsch (1967, p113) relates '*there is no clear boundary line (*between qualitative and quantitative techniques*) in many cases, and the same technique can take either approach*'.

Another approach to categorise the paradigm/process elements of techniques is to consider how innovative or creative they are. Couger et al. (1993, p380) give such a perspective and use a continuum from 'analytically dominant' to 'intuitively dominant'. Analytically orientated techniques use a structure to generate a logical, linear, pattern of thought and steps. Intuitive orientated techniques tend to skip steps and be far less linear, arriving at solutions by leaps. Similarities can be found here with de Bono's 'vertical' and 'lateral' thinking classification of techniques (de Bono, 1977). As with the qualitative/quantitative categories discussed above, this grouping is open to considerable interpretation on where a technique

would fit on the continuum. A variation to this approach has been suggested by McFadzean (1998,1999), who used a creativity continuum based on three categories: Paradigm Preserving techniques, Paradigm Stretching techniques and, Paradigm Breaking techniques. Again, placing techniques on this creativity continuum is likely to be subjective, for example, McFadzean classifies the Brainstorming technique as 'Paradigm preserving' where a better interpretation might be to class it as 'Paradigm stretching'.

A further approach to categorisation, by *explorative/normative* characteristics, has been proposed by Gabor (1968) and Jantsch (1967). In this context, exploratory techniques start by assessing the present situation and moves towards the future. Normative techniques start by assessing future goals, aims and desires, then working back towards the present situation. However, as with the qualitative/quantitative categories discussed above, several techniques can be grouped in both categories (e.g. Jantsch 1967).

There are similarities with each of these classifications, they seem to have fairly 'closed' techniques at one end of a continuum and fairly 'open' techniques at the other. Of course, placing techniques on this closed/open continuum is likely to be subjective (as with the previous classifications), but may provide a useful perspective:

Closed paradigm/process

- stays within defined scope
- closed set of rules and language
- prescriptive processes and tasks
- prescriptive representations
- mostly objective

Open paradigm/process

- open, less defined scope
- more open set of rules and language
- less prescriptive processes and tasks
- less prescriptive representations
- mostly subjective

5.7.2.3 A two-dimensional classification: visual/language and paradigm/process influences

There are likely to be some correlations between the 'visual/language representation' and the 'paradigm/process representation'. For instance, techniques which impose strong hierarchical structures are likely to have 'closed' dispositions (e.g. more formal and structured, restrictive scope, more objective paradigm). Grouping according to visual/language and paradigm/process attributes can be represented two dimensionally, as in figure 5.2.

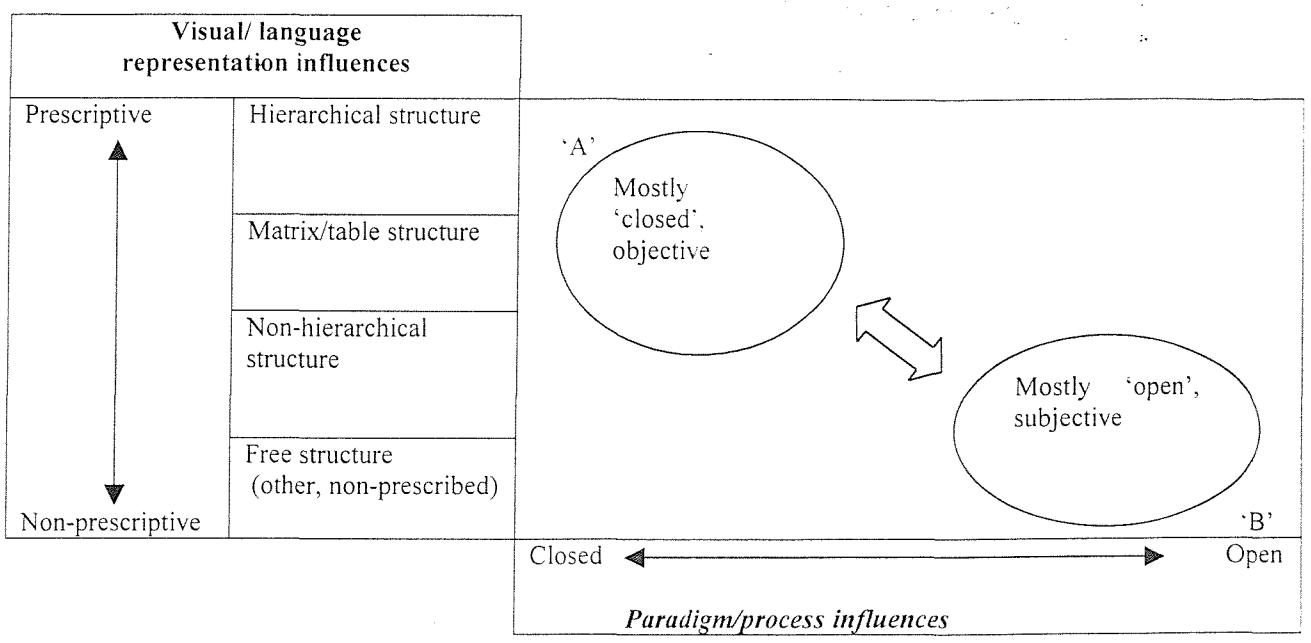


Figure 5.3: Grouping of techniques by visual / linguistic and paradigm characteristics

The closer to 'A', the more closed and 'objective' a technique will be and is likely to have the following cognitive influences:

- reduced, but defined, problem/solution spaces
- more 'social defence' attributes providing cognitive and emotional support, but also more 'rituals' of technique detracting attention on actual 'problem'
- more *functional fixedness* and *category inclusion* biases (or similarly, item ordering and relational/proximity biases)
- more normative representation and correspondingly, more acceptance of results
- more detailed description of items, resulting in increased perception of likelihood of items

- more defined goals, resulting in more rule-induced learning activity

In addition there are likely to be further influences as detailed in section 5.6.2, such as individual biases towards different types of techniques (or tasks within them), negative versus positive framing,

Possibly techniques closer to 'A' would provide more support for novice developers, whereas techniques closer to 'B' would be more suited to experienced developers (i.e. novices are likely to need more guidance and cognitive support in a development).

Appendix 'A', columns (d)-(i), contains the results of applying existing techniques to the developed categorisation by the visual/language representation and paradigm/process influences.

5.8 Summary of framing influences

This chapter has contended that techniques influence problem understanding during information systems development. The influences can be considered under certain visual and other 'language' representation characteristics and under paradigm/process characteristics. Further, works from cognition psychology indicate how these characteristics are likely to affect problem understanding. In prospect theory this is known as the *framing effect*. By classifying the characteristics of techniques this chapter has tried to indicate how different types of technique are likely to influence problem cognition, and in doing so has tried to map the framing effect of techniques.

Some potential biases and blocks to cognition were identified. These biases become more prominent when one considers that the results of a technique (i.e. diagrams, tables etc.) may be used by different groups of people to those that produced them (e.g. analysts may produce some charts and tables which will be used by designers) and are likely to perpetuate such biases throughout the development.

Also there seems to be something different here with the visual to cognitive links than that covered in the cognitive psychology literature. The cognitive psychology literature is full of works on how the characteristics of an object or situation affect our understanding of that object or situation. However, when one starts using visual tools (e.g. techniques) there seems to be a reverse link, in that our initial cognition of an object or situation will affect our visual representation of that object or situation, which in turn will further affect our understanding of the object or situation. There seems to be an iterative loop of influences on problem cognition, implying that any framing effect will be complex and dynamic.

The next chapter will examine aspects of the value function for prospect theory.

Chapter 6: Value functions of planners and non-planners

6.1 Introduction

Planning tasks are pervasive throughout all stages of information system development, implementation, management and use. Planning is also a key response to uncertainty, the main focus of this thesis. This chapter examines planning activity by using prospect theory which describes how people deal with uncertain situations based on the framing of a situation, the *framing effect*, and more particularly for this chapter, an 'S' shaped value function. Chapter 5 mapped the *framing effect* of different types of development techniques. This chapter takes the application of prospect theory further by examining the value function in greater detail and applying it to everyday planning activities. There are three key features of prospect theory's value function, a reference point, loss aversion and diminishing sensitivity. To investigate individual value functions a survey on planning activity was conducted through the Mass Observation Archive (MOA). The responses were analysed and two distinct planning profiles, that of *planner* and *non-planner*, were developed. The profiles indicate likely differences between reference points, approaches to loss aversion and varying levels of diminishing sensitivity.

The rationale for focusing on planning activity is based on three things. Planning activity is prevalent throughout information systems development, it is possible to examine planning activity of individuals and planning is a basic response to address uncertain situations. Prospect theory, with the focus on describing how individuals deal with uncertainty, provides an ideal cognitive tool with which to consider planning activities of individuals.

This chapter is structured as follows. The role and variety of planning activities are considered in information systems development. The MOA study is described along with the rationale for the survey and sample. Initial expected responses are discussed and compared against actual responses. The responses are analysed further to develop distinct planning profiles. These profiles are then examined in the light of planning tasks required for information systems development and use, with potential synergies and barriers being identified. These are then related to prospect theory developing distinct value functions for planners and non-planners.

6.2 Planning within information systems development

Developing information systems involves many planning activities (Avison and Fitzgerald 1988, p30). As Sprague and McNurlin (1993, p105) relate, *'planning has always been an important task in information systems'*. Information systems development involves a variety of planning tasks, probably more than many other professions. As much as a third of development activity can be related to planning tasks (Brooks 1982, p20) which permeates through all the stages of a development project. Some development methodologies can be considered as being based around a set of prescribed planning activities, such as SSADM (Downs et al. 1988, p151), and a range of tools exists to help planning project developments. From the perspective of the managers and users of technology, planning is an important skill, as effective and efficient running of any information systems requires considerable planning of resources and activities (Case and Smith 1995, p268). At the strategic level, effective information systems planning has become key for businesses to operate in today's technology-based world (Ward et al. 1990; Flynn 1992, p337; Laudon and Laudon 1996, p292).

As can be seen, planning is a key issue for the development, management, introduction and use of information systems and concerns users, managers and strategic managers as well as the information systems development community. Potential planning problems and synergies are not just relevant to the information systems arena, but are also applicable to any major adventure in business and society where planning forms an integral part (Hall 1980).

6.3 The MOA survey

6.3.1 Focus on a sample from the general public

The focus here on the planning profiles of a selection of the *general public* as opposed to concentrating on planning profiles of, say, just information systems *developers*, deserves some discussion.

If one was to consider developers only there is a problem in actually identifying who are the developers. There are a whole set of job titles which constitute a 'developer' role, including

analyst, systems analyst, designer, software engineer and programmer, to name a few. One could concentrate on a specific job category, say 'designer'. However, there can be much overlap between job descriptions. Indeed, a 'designer' at one organization may well be performing a similar set of tasks to an 'analyst' at another; and 'designers' at two different organizations may well be performing substantially different sets of tasks. So the definition of a 'developer' can embrace a diversity of activities and job descriptions.

In addition one would expect the user(s) to have some influence on the planning activities. It is their system and their set of requirements that have to be addressed. Further, the people involved in and influencing an information systems development are likely to constitute more than the 'developers' and associated user(s) (Finlay 1994, p190). Typically people separated from the development process, both geographically and functionally, are likely to have some influence.

The distinction between developer and user is becoming blurred. For instance in participative approaches (Mumford 1983; Avison and Fitzgerald 1988, p35, 1995), development activity involves considerable input from both users and developers. A further example of 'blurring' development activity can be with decision support systems where the manager/user involvement in the development process is typically multifaceted: 'Management involvement in DSS is extensive in both breadth and depth. Management's role cuts across each of the areas of approval and administration, developer, operator and user' (Hogue 1993, p54).

Researching planning activity within information systems development by solely concentrating on some arbitrary definition of 'developers' would be open to potential criticisms of unrepresentative sampling. The approach taken in this work is to make explicit the assumption that the wide variety of people involved in information systems development can be considered as a close approximation of the wide variety of people from the general public. Effectively, this assumption says that information systems developers are not too dissimilar to ordinary people. There seems some support for this. As indicated above, development activity has expanded to include a wider group of people. Development tools have become more sophisticated to allow development activity by non-technical people. The wider population has become more IT literate and a substantial proportion of the working population has working contact with information systems. This assumption will be examined

further in chapter 10, when the planning profiles for all developers in a project are investigated.

[It is recognised that in the early years of information systems development, say back in the 1950s, 1960s etc., when development was a more specialist engineering activity, there may have been more pronounced trait differences between developers and non-developers. However, these differences, if they actually existed, are likely to be far less pronounced in today's business environment for the reasons stated above.]

Further rationale for considering planning profiles from a sample of the general public is that developers will be selected from the public pool. As such they will be bringing with them a whole set of skills and experiences related to planning activities. Johnson and Scholes (1993) use the analogy of a 'recipe' to describe how one deals with a situation similar to one previously encountered by reverting to the 'recipe' of how they dealt with that similar situation previously. This concept was developed further by Boland and Greenberg (1988) who show that even when a situation is relatively new, people still need to draw upon analogies of previous familiar situations and experiences: '*The symbolic function has an important impact on our everyday life in organizations. In particular, the metaphors we draw upon to frame our analysis of organizational situations can radically affect the kind of analysis we will make. The more ambiguous a situation is the more important metaphors become for ordering the situation and making sense of our organisational experience*' Boland and Greenberg (1988, p20). Using past experiences to inform solving new problems is the cornerstone of the case based reasoning (CBR) (e.g. Kolodner 1993) approach used in expert systems and intelligent systems. In CBR a case base (database) of past problems and solutions is developed. When a new problem is encountered analogy is made with previous cases in the case base. The most similar case is retrieved and used to address the novel problem.

6.3.2 Administration of survey

The survey of a sample from the general public was conducted through the Mass-Observation Archive (MOA) at the University of Sussex. The survey, called a directive within the MOA,

was sent out to a self-selecting panel of 460 people nationwide. The panel is not fully representative of the general population and contains age and gender biases (weighted towards older people and females). However, the panel does represent people from a wide selection of socio-economic backgrounds and is likely to provide a good window into 'every day contemporary life' (Sheridan 1996).

The directive contained a set of three open questions on planning activities, under the heading of 'The Future', these being:

* *How far into the future do you usually plan?*
* *What things do you usually plan for?*
* *What does the 'Millennium' mean to you?*

The responses were 'free format' in that respondents could write as much (or as little) as they wish and answer the questions however they wished. The responses were written on a variety of paper in a variety of writing styles; some were hand written, some were typed, one or two even contained pictures. As such, a framework was used to categorize responses. This entailed using a table to record each response to identify what events and activities people usually plan for, how people plan and, how far in the future people plan for.

The question on the Millennium was included purely as a focus for considering possible long-term planning activity. Note that with the survey being distributed in November 1997 the 'Millennium' was attracting much coverage in the media at the time, particularly with the Millennium dome and other events. Thus the Millennium provided a common long-term event that people could discuss.

The survey was sent out as the third part of the 'Autumn' directive of 1997, the first two parts of the directive covering aspects of music and dance. A copy of the directive is contained in appendix B. The third part of a directive often results in relatively poor response rates, however, the actual response rate for this part of the directive was fairly good at 51% overall (48% for men and 54% for women). The content was also relatively good, consisting of a variety of responses ranging from just a few hand-written lines to over nine typed pages. The average length of response was a little over one and a half pages for both males and females

(though it is difficult to make direct comparisons, given the variability in handwriting etc.). The quality of responses (relative to researching planning profiles) was also varied and was not always related to the length of the response. Some responses spanning multiple pages contained interesting insights on 'life's activities' but little on planning, while other responses spanning half a page would contain succinct poignant information. The average age of respondents was in the high 50's for females and near mid 60's for males (the panel contains a comparatively large number of retired people). The youngest male respondent was 17, the oldest 84. The youngest female respondent was 18, the oldest 86. There were over twice as many responses from females than from males, which roughly matches the panel gender distribution. The MOA periodically recruits panel members using national advertising campaigns and some effort is given to try and get a representative sample of the population. However, there tend to be more females and older people interested in continuing to be panel members and being new members. As such the responses contain biases towards the older members of the population and females. The age bias will be discussed later in the chapter.

The MOA administer the distribution, collection and coding of the directives and associated responses. The confidentiality of each respondent is ensured by a coding system which enables researchers to identify the gender, occupation, town (or approximate location) and age of respondents, without actually giving information which could identify a respondent. To ensure further confidentiality of respondents, access to the returned responses was limited to visits at the MOA. The confidentiality of respondents is a key issue for the MOA and goes some way to ensure free and frank responses.

6.3.3 Expected responses

Before the survey was distributed, certain responses were expected, one such area being associated with gender. From a cognitive perspective the gender debate has a long history predating the introduction of intelligence tests in the early 1900s, and still provokes much controversy (Brannon 1996, p87). For instance, the Wechsler intelligence test, though showing no difference in overall performance, shows differences between specific types of skills: women scored higher on the verbal sections, men performed better in action-orientated tasks. Later studies showed more complex relationships (ibid, p91). Many of the gender-related differences are attributed to spatial awareness (Geary 1996, p241), though again there

are differing views on the effect and magnitude of any disparity in these abilities (Epstein 1996; Chipman, 1996; Dowker, 1996). In addition, there are role differences (e.g. generally women are more likely to stay at home and look after children than men). It is clear that any gender-related differences are likely to be very complex involving many factors. [For a fuller discussion of possible gender differences, readers are referred to Brannon (1996) and Geary (1996).] With such a weight of evidence, it was expected to see some gender differences. However, given the debate over gender issues, the inconsistencies between different works and the interpretations of their results, it was not clear how any gender differences would manifest themselves.

Cognitive differences at the individual level were expected with some people being more oriented towards planning tasks than others and, that people will have different 'future views' (Waddington 1977, p185). However, it was unclear what these different planning orientations would constitute and particularly how far into the future people plan for.

Age differences were also expected, given the 'common perception' that younger people are more 'rash' and spontaneous, with older people being more conservative and more inclined to plan. However, it was unclear how much this 'common perception' would actually hold true for planning activities. In addition, given the age bias of the panel, it was expected that issues more pertinent to older people (e.g. retirement related issues) would be more in evidence. Common planning items, such as holidays and retirement/pensions, were expected, though it was unclear what would constitute a full list of items planned for and the relative distribution of these items.

6.4 Analysis of survey responses

An initial list and analysis of cited planned items along with the overall relative occurrences of these items are displayed in the first two columns of Table 6.1. In addition, the 3rd and 4th columns show the relative proportions of cited planning items for males and females respectively. Overall, females cited a slightly higher number of planning items per respondent (2.8 per response for females and 2.3 for males), which may indicate that females are involved in more planning activities than males. However, this sort of frequency data should be treated with caution as there may well be other influences which could account for

any differences. For instance, other studies have shown that females may have a better affinity for writing than males (Brannon 1996), so the female respondents may have recorded more items but may not actually plan for more items.

Cited Items	% of Total Cited Items	% of Male Cited Items	% of Female Cited Items
Holidays	24	21	25
Social Events	15	11	16
Financial	11	15	10
Daily Activities	8	7	8
Work Related	6	6	6
Retirement	5	8	5
Home Improvements	5	5	5
Death/Wills	5	6	5
Christmas	5	4	5
Birthdays	3	3	3
Moving House	3	3	3
Gardening	3	4	2
Large Items of Expenditure	2	1	2
Anniversaries	2	1	2
Dentists/Doctors	2	1	2
Others	1	3	1
Planning for a Family	1	0	1
Total	101 (not 100, due to rounding errors)	99 (not 100, due to rounding errors)	100

Table 6.1: Distribution of cited planning items

In addition, not all respondents cited items that they planned for, indeed some were adamant that they do not plan. The most frequent planning item cited for both males and females was 'holidays'. The second and third places were reversed for males and females: 'Social Activities' was the second most listed item for females and 'Financial' was third; whereas for males 'Financial' second and 'Social Activities' third. In addition, females cited a higher proportion of 'holidays' and 'social activities'. It seems the females from this sample were more involved in organizing and planning holidays and social activities than the males.

An examination of 'how far into the future people plan' proves interesting. For 'holidays', the most cited item, replies on how long into the future varied from just a few days or weeks to several years. However, a more typical representation is that people generally start to think about holidays 6 to 12 months in advance and book the holidays 3 to 9 months in advance. The Christmas and New Year period is a watershed time for some people, i.e. they can't start to think about holidays until Christmas is over. Relatively few people had longer than a 12 months' future-view for holidays, and where this occurred it was usually a special holiday (e.g. a 3 week visit to Australia). 'Holiday' was also an interesting item as several people wrote that the time-frame for planning holidays was effectively prescribed for them, e.g. they needed to book specific times off work within a holiday rota.

People seem less able to deal with long-term plans. Even with 'planners', long-term planning is a problem: '*I'm a fairly obsessive planner for the immediate future. I'm full of lists of things to do today, tomorrow, next week. But I rarely plan further ahead.*' (H2784, a 48 year old aid worker in Oxford). This did not seem to be age dependent, but the topic of planning was. For example, older people were more focused on planning for retirement or burial arrangements. People generally planned in different ways for different activities. The closer to an event then the more detailed the planning became, as the following demonstrates:

> *'I plan into the future really on a few scales.*
> *1) Very close planning of professional, social, leisure and domestic activities approx. a week ahead.*
> *2) Slightly less close, but still fairly detailed planning of professional, social and leisure activities upto[sic] around a month ahead.*

3) Broad outline planning of important professional and leisure activities - aprox.[sic] a year ahead.

4) Very vague long term plans - like eventual retirement .....

The closer short and medium term plans are vital in my occupation .... not choice but necessity' (C2256, male, 49, Teacher from Birmingham)

The responses discussing long-term plans were consistent with responses to the third question 'what does the Millennium mean to you?'. Very few responses (2) addressed the Millennium as a *personal* long-term planning event (i.e. booking a holiday or activity to celebrate/coincide with the event). Most that did respond to the question focused on the suitability or otherwise of the Millennium dome. Others discussed the Millennium as being the start of another new year (e.g. a new beginning, hoping it would be better than the last). A few discussed when the start of the Millennium would take place (e.g. 1/1/2000 or 1/1/2001). However, for the majority of these respondents, 'two years' was outside their 'future view' for personal planning activity associated with the Millennium.

The descriptions of respondents seemed to fall into that of 'planners' or 'non-planners', with a little over half of respondents explicitly classifying themselves as one or the other. This seemed to be irrespective of age and gender. It was interesting to note that some people classed themselves as 'planners' but described fairly spontaneous activity. The reverse was also true, with people classifying themselves as non-planners yet describing some fairly detailed planning activities (albeit, in the short term). There may be proportionally slightly more females classing themselves as non-planners yet describing some fairly involved planning tasks. The concept of planner or non-planner is open to a certain amount of subjectivity.

Some examples of responses from the 'planners':-

'I am an inveterate planner and worrier so I am always planning ahead, be it one hour, twenty four hours or the next week or month. ... The older I get the more I try and plan for financial provision for the twilight years ahead and this is my main area of long term planning. ... I find it very difficult to relax and go with the flow, just letting things happen.' (M1593, 51year old male, Technical person in the oil industry, based in London and Aberdeen)

'I usually plan things for the future ... I cannot live day to day. I need goals and things to look forward or strive towards. This has always been the case.' (S2813, female, 29, Television Producer from Devon)

'I try to plan as far into the future as I can, as I don't like uncertainty, and always prefer to know what is happening' (S221, 41 year old male, Writer from Watford)

'I like to know, at least provisionally, what I am going to be doing a couple of months ahead. I don't like surprises and I hate being insecure about what is going to happen in the future' (B2638, female, Learning Resource officer from Manchester)

'Planning, if only working out what to get for the next meal, is a normal activity and I have always liked things in order ... Thus planning is a personal thing: my late wife never planned, never filed anything away, yet she was in her own way organised and as a result, left far more than I will' (S2246, male retired Teacher from Northants)

'I enjoy planning and looking forward ... its part of the enjoyment of the event, even if it never happens for some reason' (C2091, female retired librarian from Eastbourne)

Some examples of responses from 'non-planners':-

'...live for today ... About the only planning I have consciously done is to put my delivery notes in the right order and find out where an unknown delivery point is. So I suppose the precise answer to the question is 24 hours.' (R470, male, a retired driver from Basildon)

'I dislike planning very far ahead for most things, more than a couple of months seems far too far ahead' (B1426, male, a School Science Technician from Bracknell)

'I fear the Future. I find it impossible to plan for the future ... It's impossible to plan - I don't know what will happen' (D2664, female, recent graduate based in Bristol)

'Look, I can just about get to the end of today remembering every thing I've got to do. Even tomorrow is 10 years away. ... I know I should think and plan ahead, and I have to for my jobs, but apart from that, just get me thro' today please' (A1706, female, artist from Shoreham by Sea)

'I have never - but never - planned for the future as it is a fact that has sometimes caused me concern, but of cause[sic] I have also reached the age when nothing on earth can make me do what ever is sensible ... I only live for today' (T2459, male, a retired Railway clerk from Birkenhead)

'I tend to not plan very far into the future, probably because I am a bit of a fatalist and expect any long-term plans to be upset ... I feel sorry for people who have to plan their lives a long time ahead, it doesn't allow for much spontaneity in life does it?" (C2053, female, 44 year old chartered librarian from Norwich)

'I don't plan very far into the future and tend to let events take their own course, unlike my wife who likes to plan ahead and know what we're going to do from one week to the other' (G2134, retired civil servant from London)

A summary of the overall responses for planners and non-planners is contained in table 6.2.

Planners	Non-planners
Need to plan. Use lists and diaries. Don't like changes to plans and can be stressed when changes take place.	Like spontaneity. Happy to 'go with the flow'. Difficult to consider things long-term. Can be stressed when confined to a prescribed plan.

Table 6.2: Summary of planner / non-planner characteristics

In addition, female non-planner responses seemed more fatalistic, expecting longer term plans to be unsuccessful.

The responses indicated that there was a full range of combinations of 'planners' and 'non-planners' within marriages and partnerships. Sometimes it seemed to be role-filling activities within partnerships, where one of the partners (male or female) assumed the role of 'planner'. The mixed combinations, as shown in S2246, G2134 responses, that opposite planning orientations can work together very well, but that it takes work and communication:

> *'I think the crux of successful planning and seeing our schemes for the future come to fruition is communicating our dreams and hopes and fears to each other'* (B1215, female, 44, shop supervisor from Plymouth).

There were a few cases of major events 'blinding-out' other events:

> *'At present we are not planning far into the future as we are moving house in a month, and so most of our planning is on a short term scale'* (D2123, female, bookshop manager from Isle of Man).

Planning activities and approaches to planning are affected by external events:

> *'being long-term unemployed .... I give little thought to the future and make no future plans'* (K2721, male, former NHS administrator from Bognor Regis)

> *'If you had set these questions two years ago, my answers would have been very different ...the word farm at the top of the page is a clue. From being a confident producer of top quality food we are now still producers of top quality food but with no confidence in ...'* (H1820, female, 42, farmer from Cornwall).

'Stress' is directly mentioned in some of the responses, particularly when external events are introduced outside of the respondent's control. Stress was also raised when a mismatch between a planning activity and individual's planning orientation arose, for instance, when a 'planner' unexpectedly had to change plans or when a 'non-planner' had to conform to and contribute to some prescriptive plan. Control issues came up in several places, notably when describing how people planned.

The most popular aids to support planning activities were diaries (including calendars and wall charts) and lists (including mental lists and lists of lists). The most ardent of planners

invariably used lists. Indeed, it seemed that for some they derived more than cognitive support from lists:

> *'I find lists make me feel more secure. In an uncertain world I feel I've got a grip if my lists are up to date. It's far more important to me than getting the task done'* (S2207, female, 45, writer from Brighton).

There are clear comparisons here with the 'social defence' activity and 'transitional objects' discussed in section 5.3. It is also interesting to note the large number (approximately 30) of techniques based on list (and matrix) representation in appendix A. This is consistent with Boland and Greenberg's (1988) work indicating people draw upon previous and familiar experiences to address new situations. People 'generally' use lists to address planning activity and many techniques are based on lists.

The bias towards the older population gave some concerns before the survey was distributed. However, after analysing the responses, the older perspective proved useful as a guide to how people change their views on planning over time. Several older respondents did reflect on how their planning activities changed over time. However, this was typically a change in the focus of planning attention, such as planning for retirement, rather than changing their planning orientation. Some respondents explicitly stated that they were 'always' planners or non-planners. There were a few examples where respondents seemed to have changed planning orientation. In the few examples given, this was when some event occurred, such as when a couple gets married and one of the partners assumes the planning responsibility.

6.5 *Planners* and *non-planners*

Overall, *planners* seem to be focused on planning goals and sub-goals. Indeed, *planners* seem to actually 'need' to have clear goals and plans, both as a cognitive support and an emotional support. *Planners* use planning aids such as diaries and lists. Planners seem to have a longer future horizon, typically 12 months or more. *Planners* seem to take pleasure in planning tasks, such as generating lists and lists of lists, even if the plans do not turn out as expected. *Planners* find it stressful if plans change and, generally do not like spontaneity. The reverse is true for *non-planners* who like spontaneity, find it stressful sticking to rigid plans and have a shorter planning horizon.

6.5.1 Synergies and mismatches between planning profiles

By applying the characteristics of planners and non-planners to information systems development, some possible synergies and mismatches between planning profiles can be deduced:

Possible synergies

* Match planning task to individuals. This would require identifying 'planners' and 'non-planners'. It may also involve getting the right mix of planners and non-planners involved in the task.

* Use list and/or diary based techniques. These are what people are most likely to have used in previous planning experiences. Failing that, people will need to be *trained* in using other techniques.

* Be up-front in that some plans, particularly long-term plans, may not turn out as expected. There is an expectation, certainly from the non-planners, that long-term plans will not work out.

* Employ older people for planning tasks, particularly those who have experience of planning activities such as holidays, social activities, financial and everyday life activities. There is a wealth of planning experience to be made use of.

Possible mismatches/barriers

* Allocating a planning task to a 'non-planner' could be stressful to the individual. Excessive stress can be harmful and affect the individual's performance (Atkinson 1994; Fletcher 1991). The same applies when 'planners' are put in spontaneous situations.

* Encountering major changes to a planned task is also likely to be stressful, particularly for planners.

* People need some control over the items they are planning. The study showed that lack of control over planning items lead to considerable stress for some people.

* The Planning Horizon (PH) for most people is one year, with many people having a PH considerably less than that. This could cause problems when information system developments require planning activity spanning more than a year. Developers, managers and users may need training to address longer PHs.

Other results include the existence of some gender differences in planning activities which are relevant to information systems development, management and use: Females may be more involved, and so more experienced in planning tasks. This may influence selection practice particularly favouring mature females returning to work.

6.6 Developing *value functions* for *planners* and *non-planners*

From the planning profiles described above it is possible to deduce some key value function attributes for *planners* and *non-planners*. Figure 6.1 represents the value functions of *planner*s and *non-planners*.

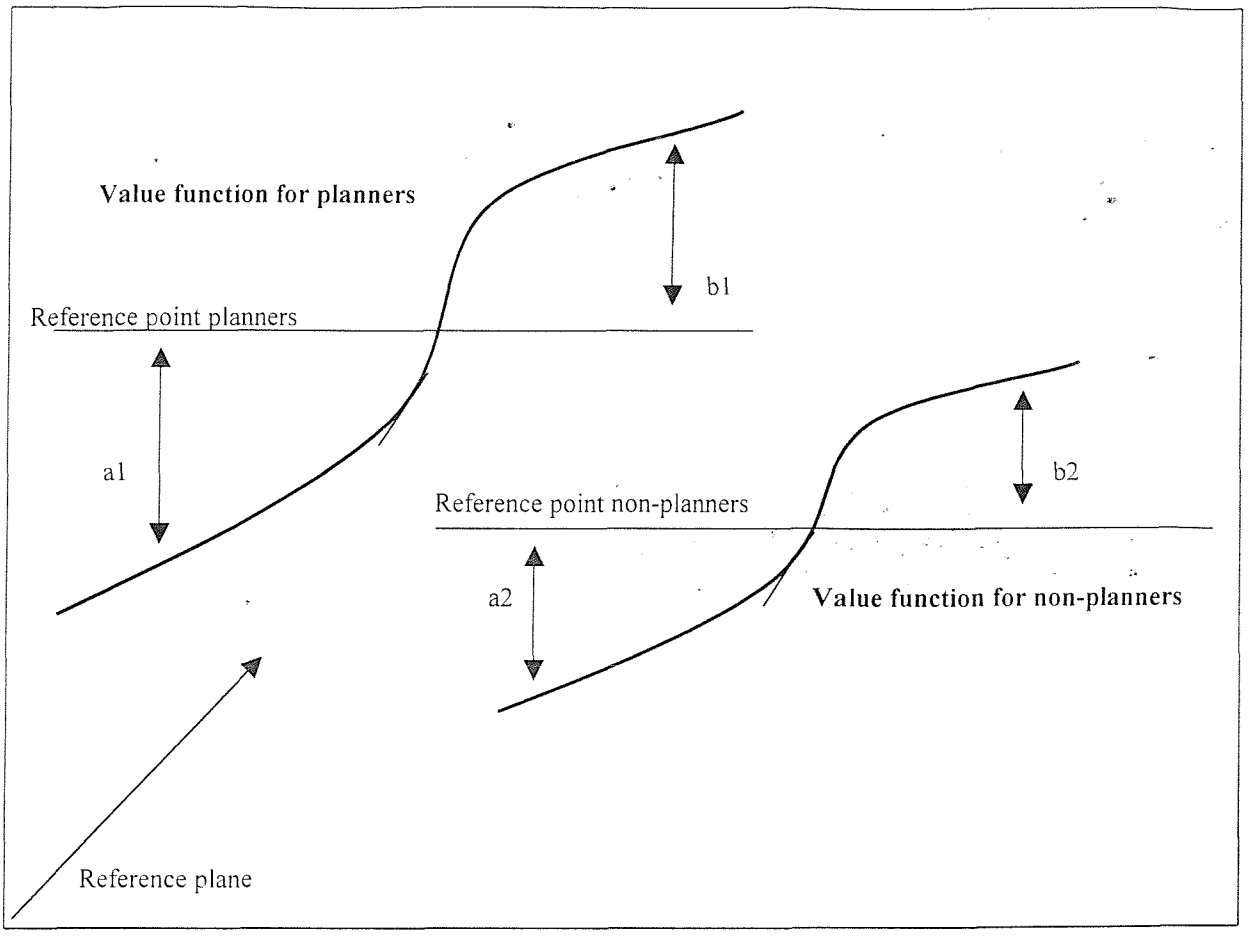


Figure 6.1: ***Value function*** **of** ***planners*** **and** ***non-planners***

In figure 6.1, 'a1' and 'b1' represents the loss values and gain values for *planners* and, 'a2' and 'b2' represent the loss values and gain values for *non-planners* respectively.

Reference point attributes:

Planners are likely to be more goal-driven, needing explicit goals and sub goals. In Heath et al's (1999) study it was shown that goals function as reference points and that goals can alter people's behaviour consistent with the value function. *Planners* are therefore likely to have goal-orientated reference points, where decisions will be considered in terms of deviation from previously defined goals and plans. *Non-planners* are likely to have less goal-orientated reference points. Indeed, *non-planners* may view deviations from predefined plans in a completely different light to that of *planners*. *Planners* and *non-planners* will consider decisions from different reference points. Further, it is likely that these reference points will be on different reference planes.

Loss aversion attributes:

Non-planners are more open to surprises and non-planned events. Planned events for some *non-planners* were stressful. This may imply that *non-planners* are more risk seeking and prepared to consider gambles. This would result in a less lopsided 'S' shaped value function than for *planners*: losses will loom higher for *planners* than for *non-planners*.

Diminishing sensitivity attributes:

Planners seem to have a longer future view, or planning horizon than *non-planners*. In addition, planners are more able to consider long-term plans by breaking the plans down into goals and sub goals. The implications being that, *planners* would be more sensitive to changes in values further away from the reference point than *non-planners*. This would result in flatter value functions for *non-planners*.

6.7 Summary

This chapter has examined key features of prospect theory's value function, including reference point, loss aversion and diminishing sensitivity attributes. Analysing the results of a survey on planning activity, conducted through the Mass Observation Archive, enabled distinct planning profiles to be developed for *planners* and *non-planners*. These planning profiles were further applied to value function's features resulting in distinct value functions for *planners* and *non-planners*. This informs understanding on how uncertainty within information systems development is addressed at the individual level.

The next chapter focuses on the two-phase process described in prospect theory.

Chapter 7: Coping strategies and process: A framework for information systems development

7.1 Introduction

Previous chapters have applied different aspects of prospect theory to dealing with uncertainty within information systems development. Chapter 5 examined a range of development techniques considering them as having visual, 'language', and paradigm/process characteristics. This classification of techniques was then applied to prospect theory's *framing effect,* indicating how different types of technique are likely to influence problem cognition (understanding). Chapter 6 examined prospect theory's 'S' shaped *value function* in greater detail and applied it to information systems development by focusing on planning activities, a core response to addressing uncertain situations. Chapter 6 also described a survey, conducted through the Mass Observation Archive (MOA), used to develop two planning profiles, *planner* and *non-planner*. These two profiles were then considered in terms of prospect theory's value function, resulting in two discrete value functions representing the characteristics of planners and non-planners.

This chapter examines the two-phase decision process implied by prospect theory (Kahneman and Tversky 1979, p274). In prospect theory it is argued that the first phase consists of preliminary analysis and editing, while in the second phase the evaluation takes place and the best 'prospect' chosen. This chapter examines aspects of 'process' in decision-making by focusing on *strategies* to cope with inconsistencies and uncertainties within information systems development. Drawing upon other works, a model of strategies to deal with inconsistencies and uncertainties is developed. This is then informed with empirical work based on developers' written diaries. The enhanced model is then contrasted with the two-phase process implied by prospect theory.

Firstly, this chapter examines the relationship between inconsistencies and uncertainties within information systems development. Drawing from a variety of fields, existing works on coping strategies are then examined and combined into an initial descriptive framework. This framework is applied to information systems development resulting in some limitations being identified, particularly with respect to *process* and *group/social interactions* within the development environment. Requirements for testing and enhancing the framework are

discussed and an investigative study is described based on an initial postal survey and a more substantial study using developers' written diaries.

The postal survey had two functions, firstly to get an initial 'feel' for the type of strategies used within information systems development and secondly to identify participants for the diary study. The diary study involved developers maintaining a written diary over a period of between two to four weeks. In all, over 190 days of development activity are recorded where developers typically indicate main tasks undertaken, problems encountered and how the problems were addressed.

The diaries proved a rich source of information on development activity and the content of these are used to inform the initial descriptive framework with elements of process and group/social interaction. The enhanced framework represents a model of the strategies to deal with uncertainty and inconsistency within a development environment. It details available strategies to address uncertainty/inconsistency and describes iterative and interactive processes. Though the enhanced framework details a range of likely strategies to deal with uncertain situations, there are limitations, particularly in identifying influences on choice of strategy. Existing literature, and the diary data, indicate that a set of meta rules, or rules about rules, are at play influencing strategy choice. To get a fuller understanding of the influences on choice of strategy we are drawn back to prospect theory, which provides further refinement to the framework.

The final framework represents strategies to deal with uncertainty and inconsistency within a development environment including the complex processes based on group/social interactions and meta rules which influences choice of strategy. The final framework is re-applied to the diary data and checked for consistency. The chapter concludes with a discussion of and comparison with prospect theory's two-phase decision process.

7.2 Focus on inconsistency resolving strategies

As discussed in chapter 1, there are many definitions and perspectives on uncertainty, and this thesis addresses a variety of aspects of uncertainty. When considering development

activity itself (e.g. analysis of requirements, design, etc.) one particular aspect of uncertainty plays a prominent role, that of *inconsistency*. For instance, an information system is likely to have a variety of different stakeholders with differing perspectives and requirements (e.g. Avison and Fitzgerald 1995). The analyst is thus faced with much uncertainty over interpreting and identifying important requirements for the final system. In practice, the analyst will be involved with sorting out 'inconsistent' requirements or descriptions of requirements. Dealing with inconsistency is a major part of development activity and underlying the inconsistencies are elements of uncertainty. This is supported by Flynn and Warhurst's (1994) empirical study into the requirement validation process, which found that 90% of respondents cited detection and resolution of inconsistency as a major problem and task. As Flynn (1992) states in an earlier work, '*It is common for different users to disagree about requirements, especially where information is to be shared between departments*' (p153), uncertainty about requirements (and other aspects of development) will often transpire as some form of inconsistency.

In addition, the term 'inconsistency' is (probably) a better understood and used concept in information systems development than 'uncertainty'. For instance, Brooks (1982) in the influential *mythical man-month* states '*I will contend that conceptual integrity is the most important consideration in systems design*' (p42), by which Brooks means having one, consistent, design. Many development processes are associated with generating one consistent set of requirements, design or programs. Indeed, whole development methods may have explicit tasks revolving around identifying and resolving inconsistencies. For instance, SSADM (Downs et al. 1988) has explicit activity checking for consistency between requirements, design etc. Within development processes, inconsistencies are made more explicit than uncertainties.

There are similarities between risk and uncertainty and between inconsistency and uncertainty. Killworth (2000), when examining soldiers' responses to risk and uncertainty in Northern Ireland used Knight's (1921) distinction between risk and uncertainty: risk is measurable whereas uncertainty is immeasurable. Inconsistency, like risk, has explicit or measurable characteristics.

Inconsistency is encountered in most human activity and seems to be part of our everyday lives, enabling learning processes and giving 'spurs to action' (Gabbay and Hunter, 1991). From a developer's perspective, addressing inconsistency in requirements enables better understanding about the requirements and gives impetus to actions (i.e. tasks, such as finding more information).

As discussed in chapter 1, inconsistency and uncertainty, though having a close relationship and sometimes used synonymously, are not the same. A focus on inconsistency will not identify all the elements of uncertainty with information systems development. However, given the 'spur to action' and other elements, focusing on inconsistency is likely to provide a mechanism to examine much development activity associated with underlying uncertainties.

From this discussion four things arise:

- Inconsistencies within information systems development can be considered as a manifestation of some underlying uncertainty.

- Inconsistencies are more likely to be explicitly described than uncertainties.

- Addressing uncertainty, particularly inconsistencies, is an important learning exercise (such as better understanding of requirements).

- Inconsistencies are usually a 'spur to action', and examining these actions will provide a mechanism with which to monitor how people address the underlying uncertainty.

Focusing on development activity and tasks associated with dealing with inconsistencies will give a window on how uncertainty within information systems development is addressed. To do this requires an examination of the range of responses, or resolving *strategies*, to inconsistencies. The next section will examine existing works on resolving strategies to inconsistency, collating them into an initial framework. This will provide a tool with which to examine development activity directly related to inconsistency resolution and the underlying uncertainty.

7.3 Initial descriptive framework: Coping strategies for inconsistency/ uncertainty

This section examines existing works on coping strategies to inconsistencies/uncertainty and combines these strategies into an initial descriptive framework.

Humans are generally fairly good at dealing with inconsistency: From a very early age we are able to identify and deal with inconsistency (Ferguson et al. 1985) and we encounter inconsistencies in everyday life, work and science. Given this, it is unsurprising that there are a variety of fields that look at aspects of inconsistency resolution, including psychology, decision sciences, artificial intelligence (AI) and software engineering. The works themselves mainly fall into two categories: experimental studies in controlled conditions and theoretical and experiential propositions. However, there are relatively few works which examine the inconsistency resolution within complex real-life applications, such as the development of information systems.

There have been several controlled environment studies of how people identify and deal with inconsistency. Some studies examined time aspects of inconsistency, or 'temporally inconsistency', where people make changes to previously made plans without receiving any new information (Strotz 1956). Effectively people are not consistent over time and will change their minds on what they want. Kockerlakota (1996) examined 'temporally inconsistency' for macro economic games.

Some of the literature, particularly from the psychology and cognitive psychology fields, examine how we learn from inconsistencies. As Ferguson et al. (1985), observe:

> *'attention [in the literature] has been given to how a conflict between two or more cognitions gives rise to cognitive transformations...ranging from changes in attitude to more widespread changes to a cognitive system'*

They also observe that most of the attention is on adults dealing with inconsistency and argue that *'less attention has been given to how experienced conflicts are resolved by children'*. Their study, examining conflict and inconsistency resolution in children, found that some

aspects of resolution are age dependent, while others, such as the *manner* of resolving inconsistencies/conflict, are less age dependent. We are able to deal with inconsistencies from an early age and the manner, or approach, to address inconsistencies seems stable from an early age.

A few studies have identified a 'pragmatic' approach (i.e. disregard or ignore less relevant aspects of information) to deal with inconsistency. For instance, Ganzach (1994) examined undergraduate students making group judgements using uncertain and inconsistent information. Ganzach used the term disjunctive strategies to describe the notion that some information is disregarded:

> '*consistent with the notion that the relationship between inconsistency and judgement is due to reliance on disjunctive strategies. ... judgement is based primarily on some aspects of information, while other aspects are, to some extent ignored.*'(Ganzach 1994).

Explicit in Ganzach's study is some process involved in identifying which information to take note of and which to ignore: Applying a higher set of rules to the inconsistent situation. This notion of a 'higher set of' rules supports previous work by Wyer (1970).

Fazlollahi and Tanniru (1991), in a mainly theoretical study based around requirement identification of information systems, identify using consensus seeking procedures to resolve equivocal (i.e. inconsistent) situations. [They take this further by suggesting a framework for requirement determination methodology based on the amount of uncertainty and equivocality inherent in the problem being addressed.] The consensus seeking procedures discussed by Fazlollahi and Tanniru revolve around group activity. This has similarities with the *reviews*, or *walkthroughs*, suggested by Fagan (1976) in a mainly experiential work. Fagan's work, based within the information systems field, involves a group of developers critically examining each code or design item, the emphasis being on identifying any possible errors, inconsistencies or problems and resolving them. The reviews were mainly aimed at the design and code activities though they have been used at other stages of development.

In Janis and Mann's Conflict Theory of decision-making (1977), which focuses on the stress generated by difficult and potentially threatening decisions, five coping patterns are identified (Mann et al. 1997):

* *Unconflicted adherence* - decision maker ignores information about risk and continues present course of action.
* *Unconflicted change* - the decision maker uncritically adopts whichever new course of action is most salient or most strongly recommended.
* *Defensive avoidance* - the decision maker escapes conflict by procrastinating, shifting responsibility to someone else or constructing rationalizations.
* *Hyper-vigilance* - the decision maker searches frantically for a way out of dilemmas and seizes upon hastily contrived or 'panic' solutions.
* *Vigilance* - the decision maker clarifies objectives, canvases alternatives and relevant information before a decision is made.

According to the conflict model, vigilance is the only coping pattern that allows 'sound and rational' decision making.

The first two of these coping patterns have similarities with Ganzach's pragmatic approaches. Conflict Theory concentrates on the psychological stress at an *individual* level when a person is in a *conflict* situation. In such situations it is assumed that the individual is concerned about losses of reputation, self-esteem or of personal, social or material losses.

A more comprehensive set of responses, and also related to the information systems field, have been suggested by Gabbay and Hunter (1991), in another mainly theoretical and descriptive work. The focus of their work is on AI rules for coping with inconsistent data in databases. They argue that inconsistency is usually considered undesirable, but in fact it should be considered as mostly a 'good' thing: inconsistency can be read as signals to take internal or external actions, or to invoke procedures to enable different views to exist concurrently, or to activate or deactivate other rules (p19). They show how contradictory information seems to be part of our lives (p25) and give examples of inconsistency situations along with discussion on some corresponding coping strategies. They classify inconsistency according to the appropriate *action* that is required and develop a descriptive framework. The

'intention of the framework is to identify general principles of reasoning with inconsistent information' when developing intelligent databases. The actions, or strategies, identified in their framework roughly correspond to their examples.

> 1) Learning action - resulting in some form of revision of information.
>
> 2) Information acquisition action - seeking further information to reconcile an inconsistency
>
> 3) Inconsistency removal action - adopting strategies for resolving an inconsistency such as localizing (isolating) the inconsistency, adopting some belief revision or some other means of resolving the inconsistency.
>
> 4) Inference preference action - or preferring one set of information over others. In the example, this corresponded to deferring or refusing to use new input until a later date and keeping options open. In another example, one set of data was used for one situation while another (inconsistent) set of data was used for another situation.
>
> 5) Argumentation action - using the inconsistency as the focus for further dialogue. In the example this resulted in building up a case for argument.
>
> (From Gabbay and Hunter 1991,p30)
>
> [Note: Gabbay and Hunter actually list up to 6 strategies but only explicitly include 5 – either one of the intended strategies is missed from the paper or their numbering is at error.]

The first two can be considered as 'resolving' strategies, the next two as 'living with' strategies. The final strategy could be classed as a separate type with elements of deferring judgement and building up an argument.

Other interesting aspects of their work include:

> *'Resolving inconsistency is **not necessarily** done by 'restoring' consistency but by supplying rules telling one how to act when inconsistency arises'.*

This has similarities with Ganzach's (1994) and Wyer's (1970) higher set of rules discussed earlier. Gabbay and Hunter (1991) discuss a similar process and call it applying 'meta-rules' to inconsistent situations:

'There seems to be a hierarchy of rules involved in rationalizing inconsistency. Rules of the form when contradictory information is received about A, then do B seemed to be used constantly. These are Meta-rules, i.e. rules about rules.'

Generally, studies based on controlled experiments focus on a limited set of strategies to address inconsistency/uncertainty, whereas the more descriptive and theoretical works embrace a wider set of strategies. The next section combines the identified strategies.

7.4 The descriptive framework

This initial framework builds on Gabbay and Hunter's (1991) descriptive framework, adding the expected responses identified in other works. As in Gabbay and Hunter's framework, inconsistency is classified according to the appropriate action that is taken. Table 7.1 contains a combined list of coping strategies.

	Coping responses	**Literature/Field**
Resolving strategies	Learning – cognitive transformation, using the inconsistency to learn more about the situation	Gabbay and Hunter's 'Learning action', conflict theory, Cognitive Psychology
	Collect further information	Gabbay and Hunter's 'Information acquisition', conflict theory's 'Vigilance
	Group discussion / review	Fagan (similar to the previous two, however resolved as a group activity)
Living-with strategies	Accommodate multiple options	Aspects of Gabbay and Hunter's 'Inconsistency removal'
	Pragmatic - ignore some (least relevant) aspects	Gabbay and Hunter's 'Inference preference', also Ganzach's and Wyer's pragmatic approaches and conflict theory's 'Unconflicted adherence' and 'Unconflicted change'
	Deferring judgement - either in time or to someone else	Conflict theory's 'defensive avoidance', and Gabbay and Hunter's keeping-options-open aspect of 'Inference preference'
Hyper-vigilance	Panic – hastily selected option	Conflict theory's 'Hyper vigilance'
Argumentation	Argumentation	Gabbay and Hunter's 'Argumentation action'

Table 7.1 Initial framework of inconsistency coping strategies

As discussed, these works imply a process that involves applying some Meta rules to decide on an appropriate strategy. Figure 7.1 represents the deduced process.

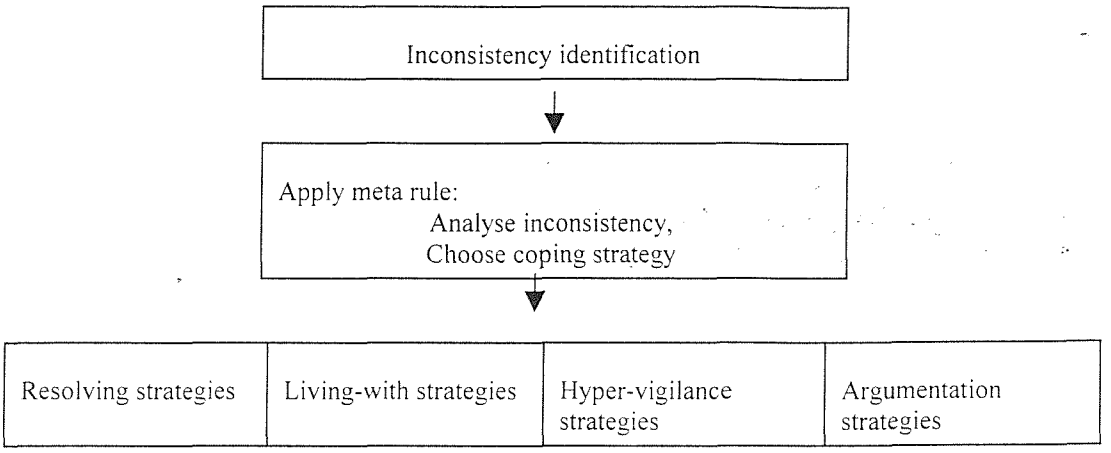


Figure 7.1: Initial process of coping with inconsistency

The existing works do not indicate likely frequency data on particular responses (i.e. how often a particular strategy is likely to be selected), though some works discuss likely conditions for particular responses (e.g. stressful situations for Hyper-vigilance strategies).

7.4.1 Applying the initial framework to ISD

The initial framework, based on existing literature, indicates there are a range of possible strategies to address inconsistent situations, and a process involving selection of appropriate strategy. However, it is not clear whether these strategies and process are relevant to information systems development. To validate this framework for information systems development, two things are required:

1) Show that all the strategies suggested in the framework are used within information systems development.

2) Show that all the strategies used within information systems development correspond to those in the framework.

If example(s) of each strategy suggested by the framework can be found within information systems development then the first criterion can be met. Frequency data would not be needed to validate the framework on the first criterion, though it would offer enhancement to the framework. The second criterion is more problematic in that it would require examining a representative sample of information system development projects and checking that only those strategies in the framework are used. This would be difficult (if not impossible) to achieve given that there would be problems in identifying a truly representative sample of developments (e.g. it would require identifying all the different types of developments and the frequency of each type) and it would involve resources outside the scope of this research project (e.g. monitoring all development activity on a large number of development projects). However, one can take a developmental approach and enhance the initial framework when new strategies or aspects of process are identified. Such an enhanced framework would not necessarily be able to claim wide-scale applicability, but would provide a base from which to develop a robust framework.

The method for validating the initial framework is described in the next section.

7.5 Research method

A mixed method was chosen for this study consisting of an initial postal survey and a diary study. The postal survey had two functions, firstly to get an initial 'feel' for the type of strategies used within information systems development and secondly to identify participants for the diary study. The diary study involved developers maintaining a written diary over a period of time. The aims of the study were to identify the range of strategies to address uncertainty used within information systems development (with which to validate and enhance the initial framework) and to inform the framework with aspects of process.

The postal study involved sending a questionnaire to a group of experienced developers. The rationale for targeting experienced developers was that they would be likely to have encountered a wide range of inconsistent situations during development activity.

The sample of developers targeted for the questionnaire was unlikely to be representative of the whole population of developers. As discussed in chapter 3, it would be difficult to identify a representative sample of developers given the changing and varied definitions of what constitutes a 'developer'. The lack of 'representativeness' will inevitably limit the use of any data, particularly any frequency data generated.

Targeting an experienced group of information system professionals has merits: More experienced people are likely to have encountered several development projects and possibly several aspects of the development cycle. They are likely to have both 'breadth and depth' to draw upon. This approach has clear analogies with Bertaux's history on political behaviour (1981), as he writes (quote taken from Sheridan 1996):

> '*We may say that our sample is representative, not in the morphological level, (at the level of superficial description) but at the sociological level, at the level of socio-structural relations. These two levels should not be confused. If, for instance, one wants to know how a given population is going to vote in the next general election, the first field is the right one, but if one wants to understand the practice of voting and choosing to vote...then it is the second level which is relevant*'.

Applying the analogy to this study, the intention is to find out about the processes of dealing with uncertainty/inconsistency and the range of strategies adopted, rather than to develop representative frequency data (such as the proportion of all developers using a particular strategy).

This theme is further supported by work on the Mass-Observation Archives at the University of Sussex, UK, where a *very rich* set of information is collected from a 'select' group of people (Sheridan 1996; Bloome and Sheridan 1993; Calder and Sheridan 1984). The information from such a select sample has been described as providing 'useful information'

and that it is likely to generate a 'thickness' of data (Sheridan 1996). [This is discussed further in section 6.3.2.]

There are some limitations of the research method adopted, for instance a limitation in using a questionnaire survey for this study is in identifying the severity of any inconsistency recorded. Some respondents may be referring only to large inconsistencies in requirements while others may be referring to very minor ones. A diary study can go some way to address this by recording the amount of effort expended to deal with an inconsistency. One of the questions on the questionnaire asked 'how were the inconsistencies generally dealt with', in which case it would be difficult to identify a particular response to a particular instance of inconsistency. A diary study enables the identification of individual responses to particular inconsistent situations. A further problem to both the diary study and the questionnaire survey is that they are both forms of self-reporting, which has several limitations (e.g. Sellen 1994) and biases (Barker-Bausell 1991). Also, maintaining the diary may actually change the working practices of the developers. However, the reflective process of maintaining diaries can be beneficial to individual developers and for the management of the development project (Jepsen et al 1989). [See Attewell and Rule (1991) for a discussion and comparison of survey instrument use in information systems research.]

The questionnaire survey and diary study complemented each other: the questionnaire identified the *general* range of both the levels of inconsistency and the responses to inconsistencies, while the diary study enables more *specific* information on responses and on processes when dealing with inconsistency. The main utility of the chosen mixed questionnaire and diary study is thus as a descriptive device (Sellen 1994).

7.5.1 Management of studies

7.5.1.1 Questionnaire survey

Questionnaire surveys have been widely used for research (e.g. Easterby-Smith et al. 1996). Many studies have been carried out, using a variety of rigorous sampling techniques, to enable a representative set of data to be generated with which to perform some frequency

analysis (e.g. Barker-Bausell 1991). The aim of this analysis was not to quantify the frequency of different instances of uncertainty and inconsistency situations, but rather to provide a descriptive framework, such as has been used in other studies (e.g. Sellen 1994). This questionnaire survey has been used to generate a general list of inconsistent situations and the general responses to those.

The questionnaire survey was piloted by telephone interviews with developers. The main questionnaire was self-completion and distributed within a single mailing to professional members of a local branch of the British Computer Society (BCS) of the UK. The questionnaire distribution was restricted to full professional members of the BCS and excluded other members such as students. Access was limited to a single mailing without the opportunity for follow-up of non-respondents. A covering letter was included in the mailing.

A low response rate was expected, as consistent with other studies (Ewusi-Mensah and Przasnyski 1994, 1995). Even with a small number of responses, valid work can still be conducted, as consistent with other studies (e.g. Lubbe et al 1995). To help increase the response rate, incentives were used (e.g. Yu and Cooper 1983) including a draw for books and free attendance at a workshop. The questionnaire was mainly free format.

7.5.1.2 Diary Study

Diary studies have been used to investigate a range of complex real-life situations (Easterby-Smith et al. 1996). One study used diaries to examine the process of detecting and dealing with errors (Sellen 1994). Some studies used daily diaries and logs to research daily tasks and activities of managers and other professionals (Stephens 1993; Luthans et al. 1988; Jones et al. 1988; Mangan 1994). Other studies used diaries to examine the information processing needs of managers and business professionals (Jones and McLeod 1986; Luthans et al. 1988). Sellen (1994) argues that the primary advantage of diary studies is in '*capturing a wide range of phenomena, often in rich detail*' and that '*diary studies are particularly well-suited for forays into unexplored territory*'. This would support the general aims of the research, to develop and test a descriptive framework of the process of managing inconsistency.

Diary participants were selected from two sources. The first was from respondents to the questionnaire survey, the second was by contacting two development organisations. The diaries were free format and consisted of a page per day, with diaries spanning either 14 or 28 days of work activity (selected by participants). Each page was roughly in two equal parts. The top part asked respondents to list and describe activities undertaken. The bottom part asked respondents to describe in greater detail events that entailed uncertain situations and how the uncertain situations were dealt with. A covering letter and instructions were included which gave examples of uncertain situations, one of the examples being inconsistency. The diaries also had a page for personal details which, if requested, were removed (after appropriate coding) from the main diary. This enabled anonymity to participants if preferred.

The diary responses are grouped into two cases. Cases A contain responses from the organisations contacted and case C from the questionnaire respondents. Diary participants were monitored by telephone contact and/or e-mail to check on progress. In case A there was no direct contact with participants with all contact going through the participant's managers. Participants returned the completed diaries in postage-paid envelopes.

7.6 Analysis of results

7.6.1 Questionnaire survey results

As already discussed, a low response rate was expected, however, the actual response rate of approximately 5% was (disappointingly) lower than expected. The fact that it was a single distribution with no means of a follow-up of non-respondents probably had an impact on the response rate. Also, the sample population of experienced developers may have had an impact given that it would include several groups of people who may not consider themselves software developers, such as hardware professionals, managers and academics. This was confirmed by the average age of the respondents (41 years) and the job descriptions of the respondents (over half had management or senior positions). In all, a total of 41 responses were received, of which 3 were discounted as inappropriate for the study, leaving 38 usable responses. The respondents are likely to be experienced professionals actively involved and interested in the development process. As such, they are likely to have much to offer on the practice of dealing with uncertain and inconsistent situations.

Analysing the first question on how often situations of conflicting requirements arise, one respondent ticked the 'Never' category (incidentally, this respondent was one of the youngest), 13 respondents ticked 'Sometimes', 11 ticked 'Frequently' and 11 ticked 'Very Frequently'. None of the respondents ticked 'Don't Know'. Nearly all the respondents, then, have encountered some conflicting requirements, with most of the respondents encountering these situations either 'Frequently' or 'Very Frequently'.

The follow-on question to this asked 'how was the conflicting situation(s) usually dealt with?'. A wide variety of approaches were listed, including:-

* *Discussions* were raised 12 times, an example being QR25 '*getting all interested parties round the table and discussing the conflict ...*'
* *Reviews* were raised 7 times (4 of them in conjunction with discussions).
* *More analysis* (including finding more information) was raised 7 times.
* *Cost/benefit analysis* was raised 4 times.
* *Compromise* was raised 6 times.
* *Prioritise* was raised 5 times.
* *Negotiate* was raised 3 times, with another respondent taking this further suggesting the resolution can be subject to who is the "best politician".
* *Arbitration* was raised 3 times.
* *Selecting most popular* was raised 3 times, with one of the respondents suggesting the option which "most closely matched the overall vision of the project" (QR20).
* *Accommodate several alternatives* was raised twice.
* *Users resolve conflict themselves* was raised twice.
* *Deferring* option was raised once.
* *Commercial aspects* were identified twice, an example being:

QR14 '*1. If customer can afford to pay, customer is asked to choose solution.*
2. If customer cannot/will not pay, project team chooses lowest cost.'

Applying these responses to the initial framework we see that most of the suggested strategies are present, a summary of these are represented in Table 7.2.

Interestingly, in several responses reference was made to the use of an independent agent, for instance QR8 '*Discussion between the parties, refereed by an impartial person, often from the systems department*'. In addition, for some, this arbitrator was expected to have some authority.

Several of the responses could fall into the 'pragmatic' strategies identified from the literature, including *Compromise, Prioritise, Arbitration* and *Selecting most popular*. There seems to be a rich variety of pragmatic strategies and it may be more enlightening to group the responses to different types of pragmatic strategies.

	Coping Responses	Present from Survey
Resolving strategies	Learning	Yes, e.g. 'More analysis' responses.
	Collect further Information	Yes, e.g. 'More analysis' and 'Cost/benefit' responses
	Group discussion / review	Yes. This was the most popular response.
Living-with strategies	Accommodate multiple options	Yes.
	Pragmatic	Yes. Several examples of pragmatism.
	Deferring judgement	Yes.
Hyper-vigilance	Panic – hastily selected option	No.
Argumentation	Argumentation	Yes, e.g. the 'Negotiation' and 'Arbitration' responses.

Table 7.2 Coping responses present in survey

When the 'commercial' or 'project management' type responses are examined, these pose some difficulty in allocating them within the existing list of strategies suggested by the framework. On first inspection one might classify commercial type responses as another example of a pragmatic strategy. However, this causes problems as there are conceivable commercial responses to inconsistent situations which are less 'practical' from a project or user perspective. For instance, conceivably, a 'commercial' developer may well be more interested in the profit implications of a development project than whether the final system is wholly appropriate or practical for the users (as indicated in the example).

A further question on the questionnaire examined the use of 'Walkthroughs' during the development process. Walkthroughs seemed to be used widely with the majority of respondents (29) using them and over half of those using Walkthroughs on a frequent basis. The number of people involved in these Walkthroughs range from 1 to 45, with the most common being in the range 2 to 4 people. About half the respondents involved users in the Walkthroughs. Group reviews seem to be common practice from this group of professionals. This further supports 'Group discussion/review' as the most common responses to inconsistency. Also from the responses, experience plays an important role in dealing with inconsistency (not surprising, from this particular group of *experienced* professionals).

In summary, from examining the survey replies, most of the suggested responses to inconsistency are present. The exception being the 'Hyper-vigilance' or panic response which was not directly quoted. However, there does seem to be inferences to situations that could involve psychological stress for individual developers (e.g. QR39 '*This area is the major cause of stress in my work. Moving goal posts of legislation and technology do not make specifying requirements easy*'), which according to conflict theory (Janis and Mann 1977; Mann et al. 1997) can result in Hyper-vigilance responses. The initial framework seems to be deficient with allocating commercial and project management responses and on the processes involved in dealing with uncertainty.

7.6.2 Analysis of written diary responses

The quality of responses on the diaries varied. Some respondents wrote items every day, while others missed out days but wrote in greater depth about activities and situations of inconsistency/uncertainty. The progress of participants was monitored every few weeks with telephone and/or e-mail contact. There was no direct contact with some of the respondents, with all information (instructions and report on progress) going through a respondent's manager. Generally, better quality responses were obtained where there was direct contact with diary participants. The quality of some of the diary responses degraded over time.

Participants in case 'A' were recruited by personal contact to the organisation and generally entailed all contact going through the participants' managers. For the organisation in case A,

a further two projects started participating in the diary study, however, no final responses were received from the participants, other studies refer to this problem as 'mortality' rate of the respondents. Participants in case 'C' were recruited from the questionnaire survey. In total eight developers maintained diaries, recording a total of 191 days of development activity. The total elapsed development time covered was greater than 191 days due to weekends, holidays and periods when no entries were recorded. Table 7.3 contains a breakdown of the respondents' participation in the study by number of days recorded and duration of recording.

Case number	Job description, project/organisation type	Diary Type (days actually recorded)	Date started diary	Date of last entry
A1	Analyst programmer/ Government organisation	28 days (16)	2/6/97	20/6/97
A2	Analyst programmer/ Government organisation	28 days (21)	19/5/97	20/6/97
A3	Not specified/ Government organisation	28 days (19)	30/6/97	24/7/97
A4	Application programmer/ Government organisation	28 days (28)	9/6/97	25/7/97
C1 (1st diary)	Test and Integration Manager/ Air traffic Management project	14 days (14)	24/6/97	5/8/97
C1 (2nd diary)		28 days (19)	22/9/97	5/11/97
C2	Not specified/ ATM Network Management	28 days (28)	17/6/97	28/8/97
C3	Research analyst/ Business systems	28 days (18)	19/5/97	13/6/97
C4	Senior analyst/ Education	28 days (28)	2/4/98	12/5/98
Totals		(191 days)		

Table 7.3 Summary of days participation of diary respondents

In some incidents the recorded diary event provided only a very brief (and limited) description of an interesting situation that would have been potentially useful to follow-up with a more detailed study, such as an interview. However, it was not always possible to conduct follow-up interviews due to participants requesting the responses to be anonymous.

7.6.2.1 Case 'A' responses

This consists of four developers all working for the same large UK government organisation. Two were working as Analyst/Programmers in the same 'Systems Integration' section. The participants in this case are likely to share similar aspects, such as environment, organisation,

procedures and culture. The responses as a whole indicate a very formal set of procedures. Accounting aspects were also formal, for instance, each activity seemed to have been charged to a specific job number.

One of the participants, 'A1', was working on a procurement package and classed the project as being in the 'systems test' stage. The next participant, 'A2', was working on an electronic messaging system and described the project as being in the 'development' stage. Participant 'A3', did not include job or application details but from the diary transcript was involved in the testing of a database. Participant 'A4' job description was 'application programmer' and was involved in developing an in-house application. Both A1 and A2 were using ORACLE Forms and SQL. A3 used ORACLE and Dynix. A1 maintained the diary over a 14 day working period, A2 over a 21 day period and A3 over a 19 day working period. The quality of responses from A1, A2 and A3 tailed off towards the end, which seems to be consistent with other diary studies. A4 maintained the diary for the whole 28 days, though the responses tended to be briefer than the others.

Typically the recorded situation involved interaction with other people to resolve the inconsistency, as demonstrated in the following examples.

A1. Incident:1. '*When re-working package, some code was different to that in the interface specification so it appeared wrong data was being selected*'

Response:1. '*Spoke to Analyst team to discover which was the right method.*' [1 hour and 1/2 hour sessions of interaction with the analysis team were recorded before the main task could be resumed, which took 3 hours in that day and a further 3 hours documentation the following day.]

A2. Incident:2. '*Conflict of message to be processed.*'

Response:2. '*Asked analyst to check with sender of message.*'

Also note in the first example that the main activity, in time, spent in resolving the inconsistency (6 hours over two days) seems to have been spent in individual activity, however, A1 could not proceed until two discussions with the analyst took place, taking one hour and a half hour respectively.

Not all instances of inconsistency were recorded in the diaries as inconsistency events. As an example, consider an item under the list of tasks undertaken by A2 '*Re-code package that was incorrectly specified*' [1 hour and 4 hours, there was a break to support colleagues]. Underlying this is some form of inconsistency between the code and the specification: The task was trying to resolve the differences. These events are referred to as *implied inconsistency.*

A3 recorded 4 incidents of inconsistency but did not fully record the responses to those incidents. In all, 8 incidents of inconsistency were recorded and a further 8 *implied* incidents of inconsistency were recorded. The resolution of all but one of these incidents involved interaction with other people, typically the analysts who were outside of the working section. The time taken to resolve these inconsistencies ranged from between a few hours to several days.

It is difficult to say if all the inconsistencies encountered by this group were recorded. There were a few blank day entries and several of the times to perform tasks did not add up to a full working day, however, it was clear that working activity was taking place during the whole day. Possibly maintaining the diary intruded on the participants working practice and they may only have included items that were deemed specifically relevant to the study.

Several entries go under the heading of 'providing assistance to a colleague' indicating that this is very much a team environment. Support was given to both 'colleague' developers and analysts, who are outside of the participant's sections. It seems for this case free access to colleagues, what some refer to as the 'sneakernet' (e.g. Nadeau 1995), plays an important role in the management of inconsistencies.

7.6.2.2 Case 'C' responses

This consists of four developers, all experienced and fairly senior, from different organisations. One of the participants, 'C1', is a 'test and integration manager' for an Air Traffic Management system that is undergoing both hardware and software upgrades. The next participant, 'C2', is involved in developing Network Management Software and describes the current development stage as 'somewhere between design and coding'. Though

no job title was given, it is clear from the diary that C2 has some management responsibilities. C1 and C2 maintained the diary for 14 and 28 days of actual work activity respectively. C1 also elected to continue to maintain a second diary, which she did for a further 19 days of work activity. C3 worked as a 'research analyst' developing business and accounting software. C3 worked on more than one project, each at different development stages. C4 worked as a 'senior systems analyst' on a student record system for a higher education establishment using a RAD development approach. C4 maintained the diary for 28 days.

In all, about 40 events of inconsistency were recorded for Case C, the resolution of which ranged from a few hours to over 7 days. These participants seem to have more senior positions than in the other Case. Case C participants were generally more prolific writers than those of case A. C2, C1 and C3 were most prolific (in that order) and all female. In other diary studies, female writers were usually more prolific than their male counterparts (e.g. Sheridan 1996; Calder and Sheridan 1984), though in this study the numbers involved are too small to make significant claims.

This case offers a particularly rich source of information on the process of managing inconsistency. Out of the events identified, all but a few of them involved a group activity (as in case A), and several events involved some iteration in the process. An example from C2: '*when using a new development tool along with a new OOD methodology, in which the interpretations of what should happen were different to what was being experienced*'. The response to this situation involved quite a saga including: investigation of attending a course (presumably with her manager); self study from a book; consultation with suppliers; trying out examples; finding more differences between book and practice; contacting technical support (suppliers); consultation with manager (resulting in changing method to one that has already been used); trying required functional examples with tool; contact technical support. The saga lasted several days until the inconsistency between what was expected from the development tool and what was produced was resolved. Along the way the resolving strategies included aspects of learning, group activity (including some negotiation), collecting more information as well as fixing a few errors. The full saga shows how the nature and focus of the inconsistency changes over time, and along with focus of the inconsistency the

selected responses also change. This example is consistent with other examples from the diaries.

As regards the strategies suggested in the initial framework, most of the strategies were present. There was also further evidence for the existence of situations that may cause Hyper-vigilance responses, an example would be from C2 at a presentation review given to customers: Ex.5

> *'Some questions were completely outside the scope of the review, in these cases we answered as fully as possible, but pointed out that the questions were outside the original brief, so we were talking about things we had not investigated in depth, and therefore we would be making false assumptions. ... I was very conscious that we were answering from past-knowledge and would be giving a misleading picture... In other cases we did not have full up-to-date information as the presentation took place a month after the review, so we told them what we knew and gave contact details for people who could provide the latest information if required. This applied particularly to the state of planning and progress on the project* ***we were repeatedly asked*** *(*my emphasis*) for up to date information which we didn't have. All we could do was give projections based on what we did know and invite the audience to contact people who knew more than us'.*

Obviously, a very gruelling and stressful time for these developers. It is easy to see the potential for Hyper-vigilance responses from less experienced and competent developers.

7.6.3 Summary diary responses

The identification and resolution of inconsistency seems to be an integral part of the work activity for these cases, which supports the findings of the questionnaire survey. For these diary cases, free access to colleagues, or the existence of a 'sneakernet', plays an important part in addressing inconsistencies. As diary participant C1 comments "*The most important means of resolution is discussion*", which also supports some of the findings from the questionnaire survey. Examining the diary data we are also able to understand more of the processes involved in managing inconsistent situations.

For these diary cases, dealing with inconsistency seems to follow a pattern:

- some identification process
- response to inconsistency, either
    - individual activity to decide on strategy or response
    - consultation activity with one or more people (often outside of the participants section) to decide on strategy or response
- then some individual endeavour carrying out the strategy.

Sometimes this process seems to have an iterative element involving further consultation followed by individual endeavour, with the focus of the inconsistency changing over iterations.

7.7 A revised framework

From the survey and diary responses, the initial descriptive framework needs to be expanded to include a 'commercial' strategy. Table 7.4 contains the updated list of coping strategies.

	Coping Strategies
Resolving strategies	Learning
	Collect further Information
	Group discussion / review, 'consensus seeking'
Living-with strategies	Accommodate multiple options
	Pragmatic, ignore some information
	Deferring judgement
Hyper-vigilance	Panic - hastily selected option
Commercial	Commercial and project management
Argumentation	Argumentation

Table 7.4 Revised list of strategies for framework

In addition, the 'Pragmatic' strategy may warrant further subdivision. Also, the process of managing inconsistency within information systems development can be better informed, as detailed in figure 7.2.

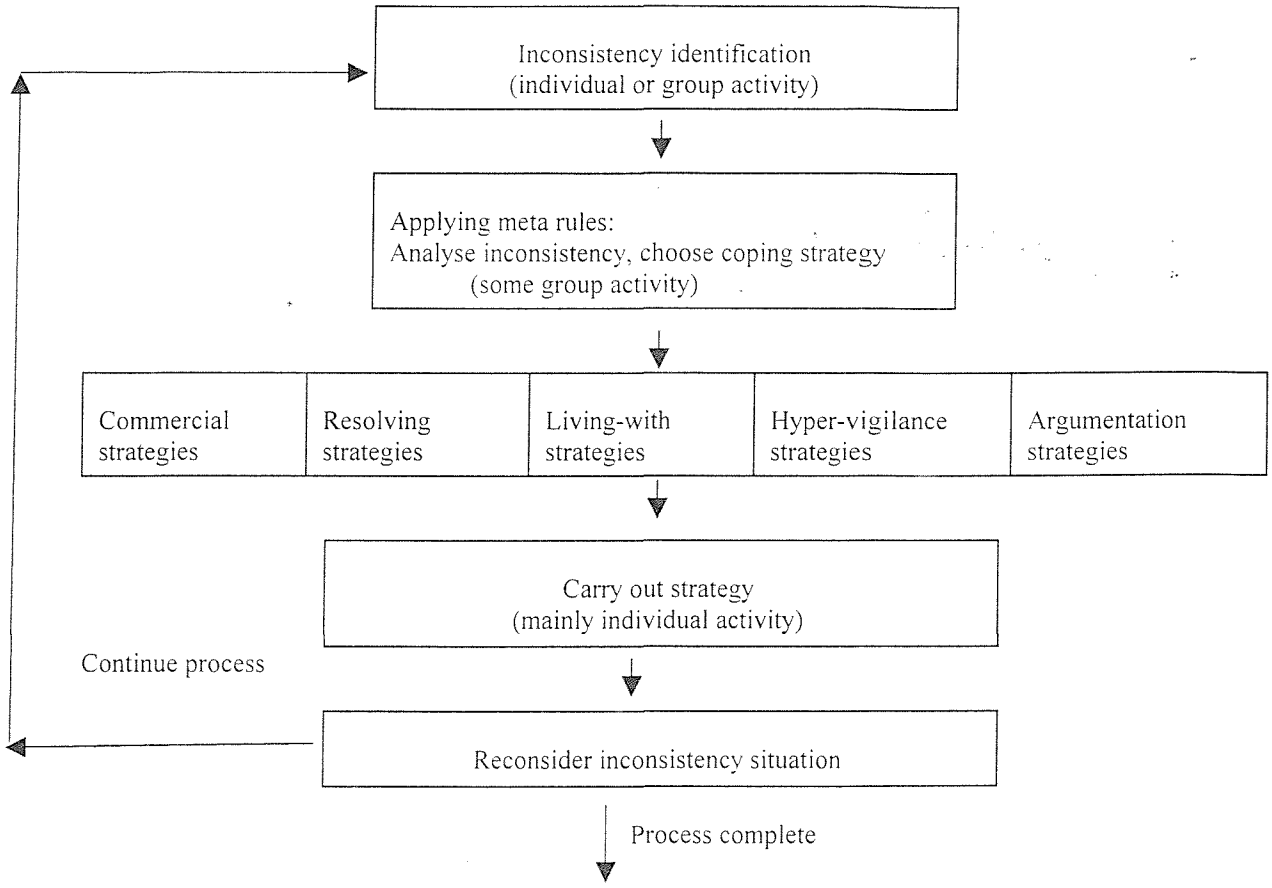


Figure 7.2: Enhanced framework with elements of process and group interaction

With each iteration the focus of the inconsistency/uncertainty changes, which may result in different strategies being selected.

As discussed in earlier sections, existing literature and the diary responses indicate some form of higher level of rules, the meta rules, being involved when selecting a strategy. This is represented in the enhanced framework which also contains further elements of process and some group interaction. However, the framework does not indicate what these meta rules are and how they will influence choice of strategy. The next section will examine possible influences on strategy and detail some likely meta rules.

7.8 Further enhanced framework: Coping strategies and influences on choice

The theory of cognitive dissonance (Szajna and Scamell 1993), which assumes people seek consistency among the ideas they hold dear, show how 'initial perceptions and expectations' affect decision making and choices. Cognitive dissonance holds true for both negative and positive perceptions and expectations. The implication being that there are likely to be early iterations in the process suggested by the framework, where selection of coping strategy will be influenced by initial perceptions and expectation. Another implication of cognitive dissonance, is its potential to resist change and stay with the status quo. This is likely to result in procrastinating (collecting information, deferring judgements) and pragmatic (ignoring some information) strategies.

In some studies considerable differences have been noted between the weight given to negative and positive attributes of information (Ganzach 1995). This is further complicated over longer periods of time:

> *'Negative events were seen initially as more likely than positive events, but as decreasingly likely further in the future; conversely, positive events were predicted as increasingly likely over time, being seen as more likely than negative events at the final time period'* (Milburn 1978).

Choices between possible options may also be affected by this melioration, or optimistic, effect. The implication being that people may have a tendency to adopt a procrastinating strategy, assuming the inconsistency will be 'alright in the end'.

Other studies show that people are biased in favour of more complex solutions (Suedfeld, et al. 1996). This bias was observed for both novices and informed experts. The preference for more complex solutions has similarities with the concepts of 'social defence' (Wastell 1996, 1999; Menzies-Lyth 1988; Schein 1991) and 'transitional objects and space' (Wastell (1996,1999) discussed in section 5.3. The social defence concept is used to describe how developers follow methods, techniques and other rituals of development as a means to cope with the stresses and uncertainties of the development environment. Wastell's transitional object is seen as an emotional support mechanism to help developers deal with the

complexities and uncertainties of development. Developers may withdraw into the more intricate and complex strategy, effectively engaging in the rituals of a complex strategy at the expense of problem understanding. The implication on selecting strategies being that developers would favour strategies involving a complex set of tasks.

Decision making processes within information systems development involves group interactions (Knottnerus 1994; Kerr et al. 1996; Poole 1990; Adams 1996). Team make-up, cohesion and effort have been shown to affect the overall quality and development process of information systems (Jones and Harrison 1996; Stephens 1993). Social aspects within the development environment will influence development activity. There are clear similarities with works on cultural effects. As discussed in section 1.2.1.2, Douglas and Wildavsky (1982) proposed a social and cultural theory of risk, in which it is argued that perceptions of risk are a social process where some risks are highlighted and others suppressed. The theory also indicates that people will be influenced on selecting certain risks, and not others, by cultural characteristics: '*people who adhere to different forms of social organisations are disposed to take (and avoid) different kinds of risk. To alter risk selection and risk perception, then, would depend on changing the social organisations*' (p9). It is expected that the development team, organisation and culture, will have some influence on selection of coping strategies, possibly favouring strategies which conform with social and cultural aspects of the project team.

7.9 Further application of prospect theory

Prospect theory offers further guidance on influences on strategy selection. Chapter 5 discussed prospect theory's *framing effect* on choice. The framing effect relates to how our judgement and choice are dependent on how the decision choices are framed. The implication being that, choices will be strongly influenced by how an inconsistency is presented and described. Section 5.6 discussed how visual, 'language' and paradigm characteristics of a technique are likely to exert a framing influence on problem understanding. For instance, a technique with a strong hierarchical structure and a closed paradigm is likely to limit the scope of the problem description and prescribe rigid rules and procedures, the implication being that such a technique is likely to favour 'resolving strategies' and may even prescribe which strategy to adopt.

There are also likely to be individual influences on coping strategy selection, as indicated in prospect theory's *value function.* Section 6.6 described two distinct value functions, *planner* and *non-planner. Planners* 'enjoy' the planning activity itself, to the extent that for some the planning activity is more important than the planning result. They need to have clear aims and clear schedules on when things are likely to happen. They find unplanned situations stressful. From this caricature of *planners* one can deduce that they are likely to be strongly influenced by 'initial perceptions and expectations' suggested by the theory of cognitive dissonance (Szajna and Scamell 1993), i.e. more likely to want to stick to existing plans and ideas. The enjoyment element for 'planning activities' may also indicate *planners* would favour strategies involving planning tasks. Conversely, *non-planners* prefer spontaneity to rigid plans, have shorter time horizons than *planners* and find sticking to rigid plans stressful. From this caricature of *non-planners* one can deduce that they are likely to be less influenced by 'initial perceptions and expectations' and be more able to challenge and change existing plans and ideas.

Prospect theory also uses the concept of a *reference point.* Decisions are considered with regard to some *reference point* where outcomes can be considered as gains or losses. Figure 3.1, shows prospect theory's value function representing gains and losses from a reference point. Analysis of the diary data implies an iterative process based on meta rules. The meta rules are concerned with identifying which strategy to adopt and, by implication, which reference point or base to consider decisions. This has similarities with the findings described in section 6.6, which shows that there are likely to be different reference planes for planners and non-planners. It follows that different strategies may be considered on different reference plains. The process of applying the Meta rules could be described as identifying/finding a reference to consider decisions, or 'searching for a base' to consider decisions.

Section 3.6, discussed the two-phase process, consisting of editing and selection phases, implied by prospect theory. A 'general' two-phase process consisting of some 'editing function' followed by some 'selection function' seems consistent with the developed model, particularly with the concept of applying meta rules and then selecting and applying a strategy.

However, in prospect theory, the editing phase is said to consist of several operations including:

Coding (considering the outcomes as gains or losses against a reference point)
Combination (simplifying prospects by grouping like-prospects together)
Segregation (separating risk-less components from the risk components)
Cancellation (disregarding components that are shared by different prospects)
Simplification (rounding of probabilities) and
Dominance (rejecting alternatives without evaluation).

A closer examination of these editing operations, indicate that they do not correspond well to the concept of applying meta rules. In addition, they are an individual activity where as applying meta rules in the developed model shows some group involvement. However, the editing operations may well correspond to carrying out a particular strategy once it has been selected. In addition, the evaluation phase may also correspond to carrying out a particular strategy once it has been selected.

The process of selecting a coping strategy described in the developed model seems to be consistent with much of prospect theory on a 'general level'. However, there are differences. The developed model involves group interaction whereas the two-phase process in prospect theory is based on individual activity. This is particularly relevant to the concept of applying meta rules, or searching for 'base' which in the developed model involves group activity. Once a 'base has been found', i.e. a coping strategy chosen, then prospect theory's two-phase process seems more consistent with carrying out the strategy. The 'scope' of the process implied by prospect theory seems limited.

7.10 Summary and limitations: Robustness of revised framework

Overall, addressing inconsistency within information systems development is a complex process involving a wide set of influences. The revised framework describes a set of coping strategies to deal with uncertainties/inconsistencies within information systems development. It also describes an iterative process, which involves some meta rules on which strategy to adopt. The framework describes likely influences on the meta rules. The initial framework

has developed through the chapter, starting with an analysis of existing works, then enhanced with the results of the postal survey and the diary study.

The resulting revised framework details a range of coping strategies to deal with inconsistency/uncertainty within information systems development. The range may not be exhaustive. Of the identified coping strategies, all but one, 'Hyper-vigilance strategies', were evident in the survey and diary study. However, there was evidence of stressful situations, which are likely to give rise to Hyper-vigilance strategies being adopted. The framework provides limited information on frequency data, such as how often particular coping strategies are used. Indeed, it would be problematic to provide 'representative' frequency data (i.e. difficult to identify a truly representative sample of developments/developers and would involve considerable resources). However, frequency data for a whole project development or a defined subset of developers may be possible.

There may be implications for training developers. The studies described in this chapter show how important group activities are for the management of inconsistency within information systems development. Of particular interest are strategies that involve aspects of 'Compromising', 'Prioritising', 'Negotiation' and 'Arbitration'. These skills may need to be given greater emphasis when training developers. The studies also confirm that inconsistency and inconsistency management are integral parts of the development process, again this may have implications for developer training.

The two-phase process described in prospect theory seems consistent, on a 'general' level, with the developed model. However, the scope of prospect theory's process is too narrow missing out key group involvement and the application of meta rules for selecting coping strategies. In addition, the process in the developed model itself seems incomplete. The actual process seems to be more complex with many influences, such as social and cultural ones. The research methods described in this chapter (postal survey and written diaries) are fairly 'blunt tools' with which to investigate such a complex and involved process. Examination of such processes requires more qualitative in-depth investigation. The next chapter describes an audio diary study which provides a window into the complex social, political and cultural aspects of development which are missing when using 'blunt tools'.

Chapter 8:Group and social activities: Some limitations of prospect theory

8.1 Introduction

Over the previous chapters a framework has been developed detailing an iterative process and a range of coping strategies to deal with inconsistency/uncertainty within information systems development. The framework has been developed by applying different aspects of prospect theory to the mixed set of research data described in chapters 5, 6 and 7. This chapter applies the developed framework to the social and group dynamics of development practice by analysing audio diary and interview data covering a problematic three-month project.

The audio diary highlights some limitations of the framework and the applicability of prospect theory to dealing with uncertainty within information systems development, namely the inability to address some social and political aspects of development. Some previous works indicate that prospect theory may be less relevant to represent group decision-making (Steen-Sprang 1999; Kerr et al. 1996). However, these are based on artificial group decision-making situations limited in scope. [These studies are based primarily on group experiments in 'controlled' conditions, and as the authors of these works report 'studying group decision-making in real-life situations is difficult'.] The audio diary data, supported by the interview data, provide a window into the complexities of real-life decision-making. An analysis of this data reveals that prospect theory is limited in representing the whole group decision-making environment. However, it does seem appropriate to represent certain group decision-making activity, namely when the group acts as a *single body* in certain situations. It also seems to be an appropriate mechanism to *represent* other group decision-making activity by providing decision-making vistas from an individual group member's perspective. Further, this has the possibility of identifying areas of conflict and stress in group decision-making activity.

The framework is enhanced with the audio diary and interview data resulting in a dynamic model showing that decision-making to address uncertainty in real-life situations, such as information systems development, is a complex activity involving group and social dynamics.

Chapter 5 developed a classification of techniques which was then applied to prospect theory's *framing effect,* indicating how different types of technique are likely to influence problem cognition (understanding). Chapter 6 examined prospect theory's 'S' shaped *value function* in greater detail by focusing on planning activities and use of a survey, conducted through the Mass Observation Archive (MOA), to develop two distinct planning profiles: those of *planner* and *non-planner.* Chapter 7 examined a range of coping strategies to deal with uncertain situations and examined in greater detail the 'process' implied by prospect theory. The framework developed through chapter 7 represents a model of the strategies to deal with uncertainty and inconsistency within a development environment. It also described iterative and interactive processes based on a set of meta rules (rules about rules) and some likely influences on the meta rules. The process seems to be complex with many influences, including social and cultural ones. However, the research techniques used in the previous chapters are fairly 'blunt tools' with which to investigate such a complex, involved process. Examination of such processes requires more qualitative in-depth investigative techniques. This chapter addresses this shortcoming by using a project manager's audio diary and interviews with two project managers. These provide a window into the complex social, political and cultural aspects of development missing from the 'blunt tools' discussed in the previous chapters.

The structure of the rest of this chapter is as follows. First, the use of audio diaries as a research tool is discussed. Then the project manager's audio diary is described including a background to the project, main activities and events, perspectives from some of the main players and the development environment. The interview sessions are described and some relevant transcripts presented. The qualitative data from the audio diary and interviews are then collated and applied to the developed framework, resulting in enhancements in the range of coping strategies and the processes involved. Appendix C contains a brief transcript of the main activities from the audio diary.

8.2 Diaries and audio diaries as development and research tools

As discussed in chapter 4, written project 'diaries' have been used by developers to monitor their own activities and develop reflective practice (Jepsen et al. 1989; Naur 1983). In addition, individual professional diaries have long been used in a variety of professions for recording and monitoring activities and logging time expended on different assignments (Markham 1987, p46). They can generally be regarded as good practice. Maintaining individual project diaries helps develop individual reflective practices and develop a reflective culture, as well as providing a record of what happened.

Within information systems development, documenting aspects of the development has long been recognised as a critical aspect of a successful development process (e.g. Brooks 1982). Many development approaches rely heavily on rigid documentation, an example being SSADM (Downs et al. 1988) in which the complete set of logically arranged documents used, collected and created during the development are referred to as the project file. The use of such project files performs many roles (Willcocks and Lester 1993) including a planning aid, monitoring and controlling aids, showing conformance to standards, enabling evaluation of projects and enabling reflection of the whole development process. The reflective element is seen as key to improving the success rate of future project developments (Fortune and Peters 1993), however, experience from many projects shows that this rarely happens (NAO 1990; Willcocks and Lester 1993).

Brooks (1982) refers to the collection of the written project documentation as the 'project workbook' and argues that the '*Technical prose is almost immortal*' (p75) emphasising the formal nature of these project artefacts. Typically, they represent the 'formal view' of what happens during a project development detailing the technical attributes (such as which tasks are performed, by whom, when tasks are performed, the content of the final technical output from a task etc.). Reflection, thus, is typically based on these 'formal', technical, details of a project development. This sort of reflection is useful, if not essential, however, a project development involves many social interactions (Bloomfield 1992) between different functional groups of people and within groups of people. Development can be considered as

a social process (Gasson 1998). These social aspects of a development are often termed the 'informal' aspects of a project development.

However, the more personal the developers' diaries are, then the more they will be able to capture the informal aspects of the development process, including items such as: what were the problems and how they were overcome; what were the things that went really well and what and why things were held up; what items motivated or de-motivated people; the politics and interactions between people and, all the other frustrations and problems inherent in the development of complex computer systems. However, some people have difficulty expressing themselves in written format. In addition, people are not always comfortable writing *personal* diaries, instead preferring to resort to the more "technical prose" of project diaries discussed by Brooks (1982). The written individual project diary, though very useful, has some limitations as a recording medium particularly in representing thoughts and feelings. From an *information richness* (Daft and Lengel 1984) perspective, written format is limiting.

The audio diary offers a richer medium with which to record the informal activities involved in project development. It makes use of natural language enabling recording of voice inflections representing emotional aspects, such as frustrations, anger and happiness. From the information richness perspective it scores far higher than the written counterpart. It may also overcome some of the inhibitions found with written diaries: people may be more comfortable with 'verbalising' an event than writing about it. One is also likely to get a more free-flow description of events.

In addition, the process of actually articulating one's thoughts helps with the cognition and understanding of problems (Biggs et al. 1993). Ericsson and Simon's (1980, 1984) *Cognitive Theory of Verbalisation* (i.e. thinking aloud thought processes) shows that decisions and understanding are affected by thinking aloud. Talking aloud has been shown to improve aspects of performance in decision-making (Boritz 1986).

However, there are some limitations to relying exclusively on audio diary, particularly with the truthfulness and subjectivity of responses and interpreting any frequency data. Typically,

diary data will need to be supported with other research data such as surveys and follow-on interviews (O'Callaghan and Callan 1992).

So it seems audio diaries offer some potential to capture the 'informal' aspect of development processes and in doing so may actually improve problem understanding and associated decision-making. However, audio diaries are a subjective research medium, typically requiring further supportive research activity.

8.3 Audio diary: Use and reflection from the project manager

The project manager who maintains the audio diary had previously used audio diaries on other projects. In fact the manager was an advocate of the audio medium to record project activities, so once contact with the manager was made (via 'conference networking' - following up a contact at a conference) the manager was fairly amenable to participation in the research.

The project manager initially started using an audio diary when working at one of the top 6 [at the time] consultancy firms while managing a project at a client site. The project manager was required to maintain a detailed written log of activities, however, as a result of tight time constraints the manager started recording the activities in audio form ready to be written up at a later stage. The contents of the audio diary expanded to include some of the informal aspects, particularly problems of managing the project [such as lack of cooperation and support from individuals and events that led to delays].

> *'The project ran into difficulties and at one stage the [*consultancy*] firm was being challenged by the client about the running of the project. ... Because I kept the diaries, the partners sat and listened to the entire tape at a review meeting. The contents were such that there was sufficient information that could be used to satisfy any legal challenge. The audio diary was transcribed into a readable format and presented to the client, effectively saying "this is the project as we saw it ... where in this do you disagree". The client didn't challenge it.'*
>
> [Extract from taped interview with project manager]

It apparently resulted in a better working relationship with the client and a better understanding of development responsibilities by both the client and the consultancy firm. The consultancy firm also seems to have learnt from the exercise since they changed their quality procedures to provide more support for isolated project managers.

The following are some reflections gleaned from the project manager, during an interview, on using audio diaries:

- Tendency to record more when things go well, as the following interview extract demonstrates

  'You record more when you have a really good day ... when things go really well'.

  Equally, more is recorded when problems are encountered. This is particularly relevant as these are the events and items that are likely to impact the project success or failure.

- *Talking* about problems acts as a mechanism to deal with some of the frustrations in the development process, as the following interview extract demonstrates:

  'When things go really wrong, then [you are] *able to let it out of your system. Also when working on my own, at client sites, I am the only company representative there so it is difficult to let off steam to anybody. The audio diary fulfils that function, so at the end of the day in the car you can let vent'.*

- Audio diaries are maintained in conjunction with written logs (as most project managers have to keep fairly comprehensive logs). They do not replace the written artefacts, but complement them.

- An audio diary may warrant some editing, or toning down, before inputting into 'formal' written documentation. [The manager gave a few examples, such as personal comments about colleagues which would not be appropriate in a more formal domain.]

Interestingly, the project manager suggested that the use of audio diaries may help with dealing with 'stress' in the workplace. The computing industry has all the hallmarks of a stressful working environment, such as tight schedules, resource constraints, politics, conflicts and a range of other problems outside of the control of the developer. These types of situations can result in many health problems for the individuals under stress (Fletcher 1991; Atkinson 1994). Also, the influences of stress on decision-making have been well documented (Anderson 1987; Anderson and Bower 1973). For instance, in Anderson's studies on managers under perceived stress situations, it was found that high levels of stress have a dramatic negative impact on performance (though a moderate amount of 'stress' can be beneficial). As the levels of stress increase then it becomes important, both from a decision-making and a health perspective of the developer, to find coping strategies to deal with this stress. Audio diaries seem to offer one mechanism for this by providing '*an outlet to vent frustration*'.

The main benefits of using audio diaries can be summarised as providing:

1) Therapeutic support, enabling one to vent frustrations and deal with stressful situations.

2) The ability to record more freely the processes involved in development.

3) The ability to focus on the problems and successes during the development processes.

4) The potential to improve decision-making. The literature on cognitive theory of verbalisation (Ericsson and Simon 1980,1984) indicates that talking aloud about a problem, such as into a Dictaphone, is likely to have a positive impact on problem cognition and decision-making.

There are of course potential problems associated with the audio medium, such as acceptability and accuracy, as well as practical problems of recording. Audio diaries are not a panacea for all information systems problems. However, they have much potential as a qualitative research tool with which to investigate the complex processes and influences of dealing with uncertainty within information systems development. From an individual

perspective they are able to provide a window into the complex social, political and cultural aspects of development, as discussed in section 7.10. The next section describes the background and progression of a high tech software development project in which the manager maintained an audio diary.

8.4 Project details and background

The project manager works for a well-known consultancy company and was brought in to manage a troubled project developing software for state of the art interactive television services. In the previous year there was a succession of three project managers on this project. The project manager started on the project in mid 1997. The project manager was expected to fulfil more than a project management role in that the remit covered 'business analysis' activities.

The project manager was effectively an external person brought in to turn around a failing project. The failing aspects were less to do with the technical development of the project than the changing market place. The project manager was very experienced in project management and business analysis and had turned round projects in the past. The project team consisted of over a dozen highly qualified developers (about half with PhDs). The parent company, and hence the project, was funded by a consortium of big-name external backers. The parent company produced one of the first interactive television services but had difficulty selling the product to the public. The backers were starting to get concerned about the lack of sales and "*there was always the threat that the backers would withdraw funding*" [from interview transcript]. The project was state-of-the-art at the time but operating in a very competitive market in which more than one competing service was being developed and introduced. The project had limited resources, particularly time and staff. The project was effectively scrapped before the new product came to market due to the company changing direction and adopting a competing set of technologies. Overall, there were lots of uncertainties surrounding the project and the environment of the interactive television market place during the development period.

The project manager agreed to maintain the audio diary for the duration of the project, which was expected to be three months. Recoding in the audio diary usually occurred at the end of the day, though not every day. More recording was done at the start of the project both in length of discourse and frequency. Not all events and activities are covered in the audio diary transcript in appendix C. Access to the audio diary was conditional on a certain amount of editing, such as changing names of participants and removing commercially-sensitive information. In addition, the project manager edited some of the more personal aspects of the audio diary. However, the audio diary transcript contains a record of this project development (albeit a personal perspective) representing main events and activities and the social interactions.

The project described is not typical, being involved in a very dynamic and uncertain environment. In addition, the project has some overtly political manoeuvrings which are probably untypical. However, these characteristics make the project particularly relevant for this study.

The following edited extracts from the project manager's audio diary gives further background to the project:-

> *Project background.*
>
> *The NEWTV launched on the 15th March 1997 with an analogue service in the central region.*
>
> *The service was aimed at C2/C3/D1s. The service take up required the purchase of a set top box for £99.99 or £129.99 for Nicam and a monthly subscription of £6.99 thereafter.*
>
> *Sales in the first couple of weeks were minimal.*
>
> *The strategy changed very quickly to one which they would give the box away and increase the monthly subscriptions to £9.99. This was also supported by free giveaways and various other combined activities such as three months free subscription, sale or return and various other things like this.*

Even so, after three months they still only had 2800 subscribers and the subscribers were not frequent users. Most of them were returning after their free period, and the service was dwindling.

The analogue service is doomed, it will be truncated very quickly. The backers will not support the cost of broadcasting for very much longer they have indicated that future financing would be extremely limited if NEWTV continued in the same vane.

NEWTV have been give three months to come up with an alternative strategy. The strategy at the moment is 'we will go digital'.

8.5 Expected influences

For methodology influences it is difficult to identify any significant influences as there was little information on the use of methodologies, tools and techniques. No 'formal method' was used, but the team was moving towards some formal aspects.

From the revised framework developed in chapter 7, there were a variety of coping strategies to deal with uncertainty (see table 7.4). Particularly relevant for this project are the 'commercial' and 'pragmatic' strategies given the strong commercial orientation of the project and environment. Also, the dynamic environment may result in some hyper-vigilance (panic - hastily selected) strategies being used.

8.6 Main project events and activities

Below is an abbreviated edited list of events and activities during the project reported through the audio diary. The list concentrates on initial events at the start of the project and a few of the key events through to the final stages of the project. A more detailed account of the initial events are included because they set the scene for the rest of the project and inform activity later on. Not all activity is included.

Though it is still a personal account of events, from the project manager's perspective, most

of the 'personal' reflection and viewpoints have been edited out. Names have been changed to ensure anonymity of participants.

Abbreviated edited extracts from the audio diary:

Project for NEWTV starting at 30th June.

The project will be kicked off on 1st week in July with a week-long workshop by taking a selection of 8 developers, key personnel, away for a week at Henley Rowing Club. I will be running the workshop for the full week. Unfortunately NEWTV can't afford additional support.

Workshop planning.

When I am going to have time to do this I haven't the faintest idea, but it has to be done - probably at the weekend.

Friday before the workshop.

There's been lots of meetings about what going digital means (and) what they actually want out of this workshop.

I have yet not planned the workshop - which is great fun.

The only thing that has actually been planned is that we have got a hotel that's prepared to take up 4 of the staff because the Liander Club can't hold them all! [resulting in splitting the group up]

Set up meetings with Fred [the MD] *and the team so that Fred can discuss the financial packages for them. Fred cancelled meetings at the last minute* [four times].

I've asked Fred to come on Monday to open the workshop and have a word with the staff before it starts.

Start of the workshop is 9:30.

Expecting Harry [the previous project manger] *who is being exited out of the company by Fred, to be told over this weekend by Fred that his services will not be required after the workshop.*

[However] *Harry has got a wealth of support.*

Saturday.

I've got to plan this workshop. I'm not quite sure how I'm going to do it.

Monday morning 6 o'clock.

I feel absolutely dreadful.

Well the workshop has been planned. It was done last night which probably demonstrates the level of planning I've done.

I think the structure's OK, I'm expecting an awful lot of the lads, I'm sure they will deliver.

A bit worried about three of them 'cause I don't really know them, I mean I've met them but that's about it.

I'm going to open up, and say exactly what the situation of the company is, why we're doing things. And I think honesty is going to be the best policy.

Harry didn't phone over the weekend so presumably Fred hasn't contacted him at all. Not quite sure if that indicates that Fred has changed his mind or whether the opportunity didn't arise.

Monday night.

I think the workshop went reasonably OK. To be honest the introduction went well.

Fred didn't turn up. I've got a message 5mins before he is due to be there to say that he couldn't make it. He's got something more important.

He didn't say anything to Harry because he wants to see how the workshop goes, which means that he's not going to tell Harry till Friday morning.

The lads were absolutely wonderful apart from the person that's a real pain in the neck, as could be predicted its Wilbert. Wilbert is now exceedingly greedy, he wants wants wants wants and he wants it on the table there and then. He really did want some assurance from Fred that he would get the financial package that he wants before he was going to contribute towards the workshop. If he carries on much more I am just going to dress him down.

I've had to leave the lads to their own devices tonight because I've got a council meeting, which means they are probably going to go on the razzle.

Tuesday.

I arrived to a lot of wingeing and abuse from the staff. They failed to realise they have got to pay their own expenses and they will be re-embersed and they believe that all drinks for the entire week should be paid for by the company

Wilbert [one of the developers] *went over the edge today, this the first thing in the morning and I ripped him off, and as a consequence he hasn't contributed all day. If he keeps this up much longer I will ask him to leave.*

Richard [another of the developers] *has been a brick. He has done all the documentation directly into his lap top. This is going to be the log of the workshop and form part of the final document.*

The objective of tomorrow is to get them thinking about how we could produce an architectural document for how we would put the service onto digital.

I must admit I found this workshop very very tiring. I left them tonight at about 10pm.

Wednesday.

The lads are working more on their own and breaking off and forming discussion groups in their own discreet areas, which is good. The three of Jeffrey's [another project manager at NEWTV] *lot are integrating into the team and in actual fact the team is coming together*

nicely thank you very much.

Today I have enjoyed, even Wilbert has come out of his shell, and Charles [one of the developers] *has been an absolute brick.*

Harry is getting lonely. He keeps ringing up and asking if there is anything he can do.

Thursday.

We've just about got the architectural document sorted and we've got a presentation for Fred in the morning.

Fred rang up today to ask whether its appropriate that he should be here! He said he's got a lot of important things to do!

The lads have done a sterling job and they are actually going to do the presentation tomorrow, not me.

Harry is coming tomorrow at the request of Fred. That is also interesting, I wonder when Fred is going to tell Harry.

Presentation to Fred and Bobby [a senior finance executive] *and Harry*

[end of side one of tape one]

Presentation to Fred and Bobby went very well. They are very pleased with the document, it needs a lot of work to tidy it up but it was an excellent document.

Fred didn't turn up till um after 12oclock, he hasn't spoken to the staff, nor has Bobby.

Charles was an absolute gem. He told them exactly what he thought of the marketing. And why NEWTV are in the situation that they are in.

I'm absolutely shattered. I really feel quite drained. Running a workshop on your own is not a good idea.

End of second week of July.

On Monday Fred did not talk to the staff. He asked me to do it. The package that he agreed to is not what they wanted, not what he told me he was going to give them. It falls a long way short, the reason being is a lack of finance.

But the staff have given a lot for this and they don't deserve the package that they have been offered even though it is a generous package by normal standards. This is not what was given by any indication to expect.

He left me to deliver the message, the result, both Wilbert and Paul [one of the developers] *have handed in their resignation, this is going to be a big hole in the project and puts the project at risk.*

The document that they produced in the workshop needs to be reviewed and amended to take out all the politically incorrect statements and to be put into a form that is publishable.

I am annoyed with Harry this week. I've tried to instil on the staff the importance of documentation as a sales mechanism and he has undermined this and said just get on with the work.

Fred still hasn't addressed the issue of Harry.

Third week of July.

Held a project planning meeting this week to try and get some idea of a project plan and when things can be done. Delivery One should be ready within 8 weeks. When we've actually started to plan it out it looks more like to be three months but that's to be expected. The amount of effort that went into the workshop's time estimation was negligible. But Fred didn't like it.

The project plans having to being revised as a result of loosing Wilbert and um Paul. They're bringing documentation up to date. I've asked them to work off site because they are a disruptive influence.

Last week in July.

Fred is asking people to do work outside the project, without asking me first.

He wants an investigation on open TV, which apparently does the same thing as we was suggesting in the architectural design.

I am not in control of this project. I have no authority, no support and Fred is not focused on an end objective.

If the architectural document and the strategy that we were pursuing were incorrect we will need to start again. But that needs to be done at a managerial level and not for him to go round my back.

Bobby has asked for the report to be sent to the backers to demonstrate the fact that they have got a strategy.

First week in August.

Fred is again asking staff to do more work on open TV. This is taking away effort from the digital project, which from what I can gather but reading between the lines because nothing has been said overtly, is not going to happen in the way that we thought it was.

Fred is still expecting the digital project first delivery to be within 8 weeks, even though he's asking staff to do things that are not in the project and he's taking away approximately 50% of a reduced resource. He is pushing me for a project plan, I don't even know what project I'm planning for!

Had a word with Jeffrey this week he's as confused as I am about the situation over Harry.

Third week in August.

Glad of my break. I was hoping that I would come back feeling better, but I don't.

I still feel resentful over Fred and he is actively managing the staff now, I have very little control, I feel like a puppet. I'm not quite sure what I'm contributing

First week in September.

Resources are very scarce in NEWTV there's actually no money. Even so they've sent three staff on a trip to France looking into open TV.

NEWTV can't even afford the development kit of open TV so I'm not quite sure how they are going to proceed. They have got a backers meeting [soon].

The order that I placed right at the beginning of the project for prerequisites is still not being satisfied. The project has not really started.

Further round of redundancies.

I don't think at this stage that I'm going to be able to keep all the staff (slight pause) *that are not working on digital issues.*

I will actively plan the security over the redundancies over the next week.

Second week of September.

The second week of September saw more redundancies, NEWTV have now dwindled to about 50 staff. The place looks like a morgue, they can't really afford me, they are going to put me down to one day a week, I don't think that is really viable. The project is ended, essentially. I can't do any more.

The project documentation needs to be brought up-to-date as far as it went. This is just for archiving purposes.

NEWTV have completely changed their strategy, they are still desperately short of money. The strategy now seems to be dwindling into software projects for digital TV producers.

The analogue service to the Midlands was closed. This is causing an additional workload that will see me through till the first week in October. I will not be working on the digital project, as I say it didn't really exist.

Last update on what was the digital project.

Some of the concepts and designs in the original technical architectural document are going to be subject to patents.

It does look as though open TV have omitted certain niceties of operating in a live environment that were in that architectural document.
It could be that we could sell or licence the use of the design to be implemented within open TV.

This is going to be the last update of the digital project.

8.7 Views from key players

Below are interpreted views of some of the main players in the project development. The interpretations have been gleaned from the diary extracts and from supportive events such as interviews with the project manager and, telephone and e-mail correspondence with the project manager. In addition there have been two phone calls with the director and further phone calls with two of the developers. It is recognised that any such interpretations are likely to be subjective. However, they may provide further insight to the development practice described.

8.7.1 View from managing director (*Fred*)

Reviewing the background to the project a few things stand out:

The initial product introduced, in March 1997, with an analogue service in the Central region, was not very successful.

'Sales in the first couple of weeks were minimal.'

The strategy changed

'to give the box away and increase the monthly plus free giveaways etc'

However, there were

'still only 2800 subscribers and the subscribers were not frequent users'

and

' most of them were returning after their free period'

The backers were no longer happy to finance the development as it stood

'NEWTV have been given three months to come up with an alternative strategy [which was]' *"we will go digital"'*

The managing director (MD) had responsibility for most of the business activity at NEWTV, of which the software project development was only one (key) area. At the start of the diary, the MD was in a precarious position with the project being in a make-or-break position and only three months to come up with a winning strategy. There is uncertainty over the future of the project, and presumably over the future employment prospects of the MD and the employees. One can imagine this being a stressful time for the MD (and other staff). Finance is likely to have been a particularly limited resource on the project.

There must have been a sense that the project could go under at any moment and a temptation to 'protect your back' against any possible incriminations.

Further, the development project had seen three project managers over the past year. [There is little data on the reasons for this.] A new, external, project manager has been brought in. One can infer from the diary extracts that the new project manager has a strong character and does things 'differently' to the MD.

8.7.2 View from previous project manager (*Harry)*

It is difficult to fathom what was going on with the situation of Harry, the previous project manager. Presumably there were events leading up to Harry not being the project manager and being replaced with the new project manager. No details have been given on this in the audio diary, except that there was a general move by the MD to replace Harry. However, it is not clear if Harry was aware of this.

The transcript did not show Harry had any animosity towards the new project manager, indeed several of the recordings indicate that the relationship was quite friendly. There were

a few incidents in which Harry clashed with the work of the project team and the new project manager, however, this seems to have been related to conflicting demands from the MD.

8.7.3 View from developer *(Wilbert)*

Wilbert was a highly qualified developer with very marketable skills, working in a cutting-edge development environment. As the transcript indicates, Wilbert handed in his resignation during the early stages of the project when 'expense payment' conditions for the workshop attendance were changed. Wilbert would have had little difficulty in getting further employment given his skills and experience, indeed he may have been tempted to leave for more money anyway. He was at an early stage in his career and there was strong demand for his skills.

Wilbert was clearly disgruntled from much of the activity described and was not adverse to stating his views. This may have made him difficult to work with and manage. The diary extracts implied previous events involving Wilbert, which seems to have set the expectation of him being a 'problem' by the project manager. The interview data also showed there was probably a personality clash between Wilbert and the project manager. However, he seems to have been liked by the other developers.

8.7.4 Summary of views from key players

Viewing decisions from individual perspectives provides potential for applying prospect theory. As shown in section 6.6, individuals may have different *value functions* with corresponding *reference points* with which to consider decisions. For instance, Fred seems to have a reference based on the whole company's financial position as well as a desire to 'protect his own back', whereas Wilbert's reference seems to be based on individual financial gains and a desire for 'fairness' in expense payments. Applying prospect theory to individual players in a decision environment has the potential to identify where there are substantial differences in decision references and other value function characteristics. This will highlight potential conflicts and problem areas in a decision environment.

8.8 Applying audio diary data: Limitations of prospect theory

The diary extracts show a dynamic environment with many contextual, social and wider environmental influences. It is interesting to note that the majority of events recorded on the audiotape are social activities. Decisions are described in terms of the input or influence from other people or the effect on them. Very few events relate solely to technical activity for managing a software project.

This audio diary shows a distinct political dimension within this project, particularly with the situation between the project manager, the previous project manager (Fred) and the managing director. It is difficult to say how typical this level of political activity is, however it is clear that some projects do suffer from internal political influences. Block (1983) described the political nature of project developments and he argued that developers should have training in understanding some of the political interactions inherent in development projects. Yourdon, in the forward to Block's book, cites several examples of political complications during the development process. A decade later, Sauer (1993, p47) discusses how the organisational politics influences the development environment, a theme further taken up with Fortune and Peters (1995, p44). Bloomfield (1992) examined information systems development from a social perspective and argued that even in very formal technical development environments there are considerable social interactions and influences. Introducing a new information system introduces change into an organisation, the very item which initiates organisational politics (Huff 1989). This does not necessarily indicate a problem, as political activity can be positive in '*enabling action consistent with an organisation's strategy*' (ibid, p89).

The main characteristics of prospect theory, described in chapter 3, are focused on individual activity. The audio diary and interview data show a very strong set of social dimensions to decision-making. However, no specific examples of *groupthink* (Janis and Mann 1977; Janis 1982) were identified. Even with the strong influence of the managing director, there seemed to be an equally strong desire for the developers to make 'correct' decisions (i.e. not just conform to the wishes of the dominant MD which would be expected with *groupthink* behaviour). There seemed to be several people with a 'strong character', which may have added political influences on decisions and reduced *groupthink* activity.

However, there may be some scope for considering 'the group' as a consistent entity, for instance when individuals share similar decision references. One such example was demonstrated when the development team developed a set of documentation standards for the project. The 'need' for documentation standards was raised by an external event (implied requirement from one of the backers). The team decided on what level to provide and how to 'police' the standards. Here the whole development team seems to have adopted a consistent reference for documenting development activity. There are similarities here with the concept of *collective mind* (Weick 1993; Weick and Roberts 1993): 'Collective mind *is manifest when individuals construct mutually shared fields* (Weick and Roberts 1993, p365). There may be scope for this *collective mind* behaviour to be consistent with prospect theory. However, the collective mind is dependent on heedful or mindful interaction. In a collective mind, people make decisions while being mindful of the needs of other people in the group. Prospect theory has no dimension to address this mindful interaction in decision-making (other than as one element of individual framing or reference).

In addition, discussions about decisions (on the audio diary) typically referred to previous historical events. These previous events seem to have been used to inform the decision or put the decision in context. Clearly, decisions do not take place in a 'clean slate' scenario, there are likely to be previous events which inform and frame decision events.

Section 7.10, identified limitations with the scope of prospect theory's process, which does not address group involvement and application of meta rules for selecting coping strategies. The scope of prospect theory also seems too narrow to address the complex social and environmental aspects of development. There is no dimension in prospect theory to take account of the political manoeuvrings and social interaction influencing many of the decisions described in the audio diary. In addition, the scope of the decision process described in prospect theory seems too narrow to account for previous events leading up to a decision.

The next chapter collates the results of this thesis so far into a coherent model, including decision processes and likely influences on decisions. In addition it will collate the identified

limitations of prospect theory and identify where it is relevant to decision making within information systems development.

Chapter 9:Developed model

9.1 Introduction

This chapter collates the different elements of the model developed through the previous chapters into a coherent whole. Chapter 3 described the main characteristics of prospect theory in greater detail, including the value function, represented in figure 3.1, and a descriptive theoretical two-phase process. Chapter 4 applied these characteristics to the information systems development environment. Chapter 5 mapped the framing effects of techniques and methodologies by examining their visual and linguistic characteristics. The classification of techniques and corresponding framing influences developed are represented in figure 5.3 and section 5.6.2.3. Chapter 6 further developed possible framing influences and suggested distinct value function characteristics for *planners* and *non-planners*. The value functions are represented in figure 6.2, which details the individual influences on decision-making. In addition, people are likely to use previous decision experiences to inform current decisions. Chapter 7 focussed on the decision *process* and developed an iterative and interactive model of decision-making when dealing with uncertainty and inconsistency. This is represented as figure 7.2. This chapter also discussed further influences on decision-making, particularly in the choice of coping strategy. These were then applied to the theoretical two-phase process described in prospect theory, which was found to be limiting in scope. Chapter 8 looked further at the decision-making *process*, focusing on the social aspects of development. The chapter identified further strong influences on decision-making, as well as identifying some limitations of prospect theory.

The final model builds on the interactive and iterative model in figure 7.2, but is enhanced with further influences identified throughout this thesis. The information systems environment influences can be classed under three groups:

a) Individual orientation with corresponding individual value function
b) Framing influences, which can be further divided into influences from specific 'context' (e.g. application, environment) and 'technique /method' used
c) Social/cultural influences, particularly of individuals being 'mindful' of the rest of the group.

It is clear a decision is not started with a completely 'clean slate'. Each person in the decision-making environment has previous experience to draw upon and there are many events involving framing activity leading up to a decision. It is difficult to say when an actual 'decision' starts or finishes. This complex interactive process is represented in figure 9.1.

9.2 Enhanced framework

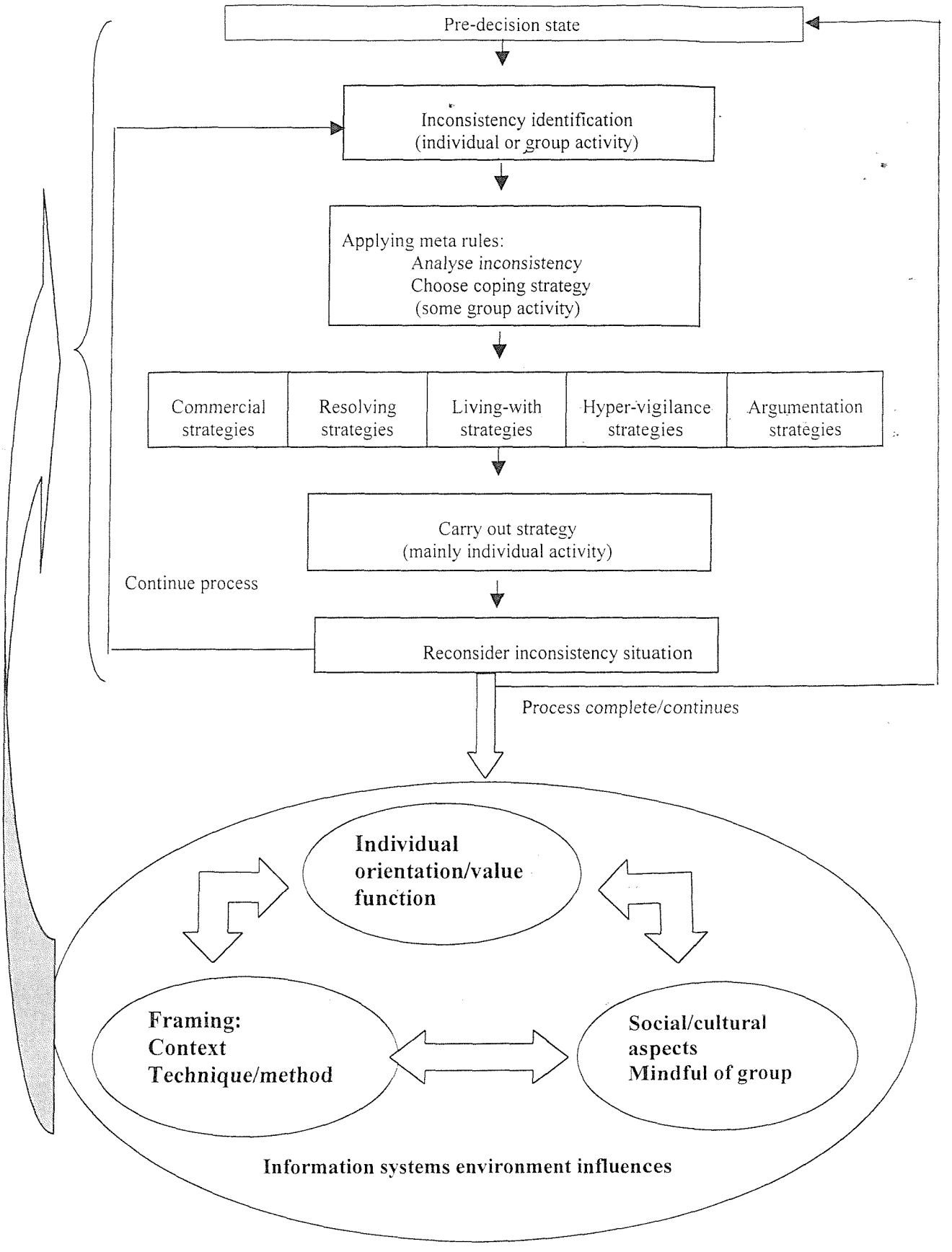


Figure 9.1: Enhanced framework, with main influencing elements

The developed model shows a complex set of influences impacting on a continual iterative decision process within the information systems development environment. There is clearly some potential for interaction between the three areas of influence. The development environment's impact will range from a fully supportive, consistent set of influences to a set of inconsistent, conflicting set of influences resulting in a stressful decision environment. For instance, a consistent impact would exist where individuals concur with the group cultural perspective, which is also consistent with the characteristics of the methods/techniques used. Possible inconsistent, stressful impacts will occur when individuals disagree with the group cultural view of a problem and the methods used to address the problem. These impacts are represented in Figure 9.2.

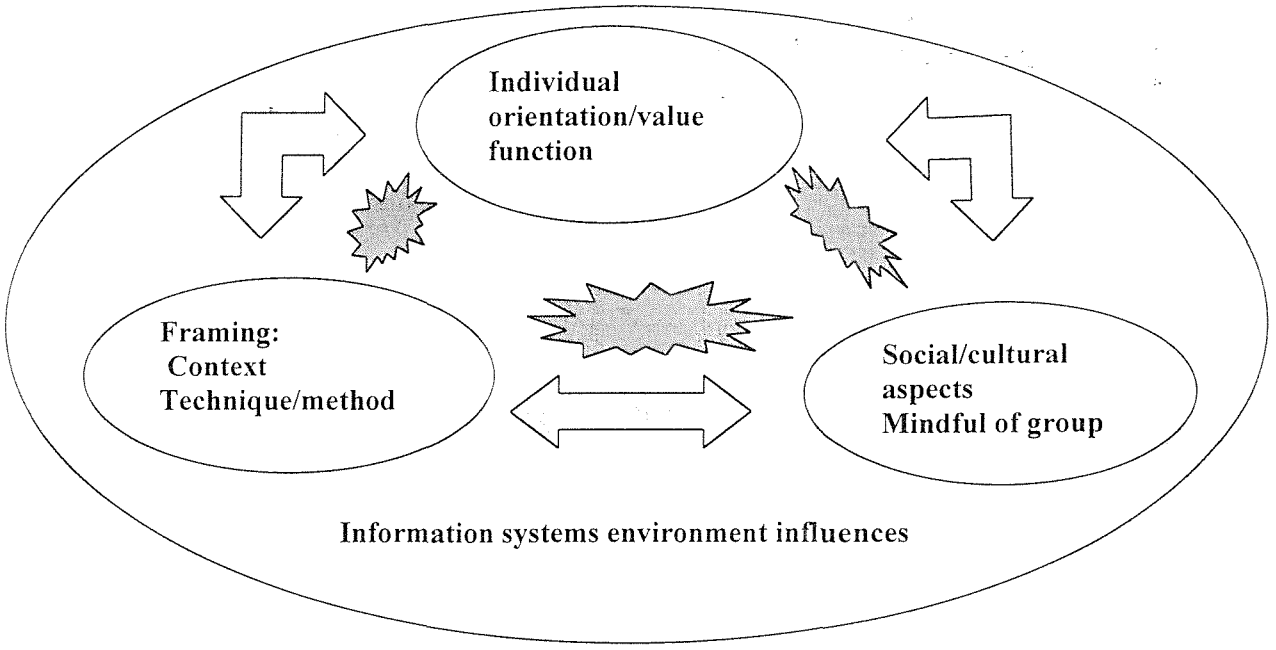
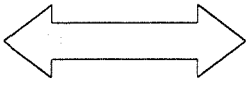
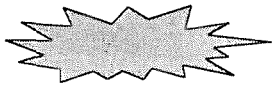


Figure 9.2: Potential conflict and stress between influences

Key:

 = Supportive, consistent set of influences

 = Inconsistent, stressful set of influences

Where there are conflicts it is difficult to say which will be the dominant set of influences. Chapter 6 indicates potentially strong individual influences based on an individual's risk/planning orientation. This concurs with the main vista of prospect theory: that decisions are based at the individual level. Chapter 5 indicates potentially strong framing influences, particularly from technique characteristics, which again is consistent with prospect theory.

The 'context' framing influences are likely to be more complex and involved. They are also likely to be associated with the social and cultural aspects of the development environment. Chapters 7 and 8 indicate potentially strong social/group influences where conformance to, or at least mindful of, the group perspective, would dominate. However, the dynamic nature of the developed model indicates that dominating influences will change over time. The results of decisions will further inform the information systems development environment. Individual perspectives will change due to feedback on specific decisions and continual learning about the environment. The group culture itself is a changing entity and will be influenced by past decision processes and results. The development techniques and methods used are typically adapted to specific development requirements and presumably are likely to be affected by past processes, decisions and experiences.

9.3 Summary

The developed model shows that dealing with uncertainty in the information systems development environment is a complex dynamic process. Comparing the developed model with prospect theory, indicates there are consistencies when considering decision-making from a purely individual level but there are limitations when a wider group view of decision-making is taken. If the individual and framing influences dominate, then prospect theory seems consistent with decision-making activity. If group culture dominates or has a significant impact, then prospect theory seems inadequate to represent decision-making activity in information systems development.

Chapter 10 will apply the developed model to a case study, the results of which may inform us about the likely dominating influences from the information systems development environment.

Chapter 10:Confirmation case study: Applying the model

10.1 Introduction

Over the previous chapters a dynamic model has been developed to represent how uncertainty is addressed in information systems development. The full model is described in section 9.2. This chapter applies the model to a small development team from a blue chip company.

The main aim of the case study is to 'test out' the model as a whole and check for consistency with actual development practice. More specific aims are to examine particular attributes of the developed model for consistency including:

1) the social/group responses to uncertainty indicated in the model
2) individual orientation towards risk and planning
3) iterative process indicated in the model
4) any biases in approaches to uncertainty.

The model has been developed throughout this thesis with different chapters focusing on particular aspects of prospect theory. This chapter applies the case study to the model as a coherent whole and therefore acts as a consolidating and unifying activity.

The next section will describe how the case study was set up and organised. Then the development of the structured questions used in the case study is described. This is followed by an analysis of the interview responses and observation sessions. Finally, the chapter revisits the model, noting where there are consistencies and inconsistencies with the observed development practice.

10.2 Case study background and organisation

The case study was initiated through contact with a senior manager at the blue chip company who sought permission to conduct the interviews and observations from appropriate authorities within the company (e.g. from the public relations function, senior management and a willing development team). Permission was granted and the interview and observation sessions were due to take place in late October/early November 2000. Permission was

sought, and granted, on the basis of keeping specific commercial development details confidential and to ensure the confidentiality of participants. In any event, the commercial details were less important to the aims of the case study, namely looking for social interaction and iterative processes. Consequently, actual names of individuals cannot be used and questions were restricted to ensure that no commercially sensitive material was disclosed. A draft of the written-up case study was passed round the project manager and development team for their approval. The process of setting up the case study ready to undertake interviews and observations took about two months.

The interviews took between ½ and 1½ hours to conduct and were based around a set of structured questions. Appendix D contains a copy of the structured questionnaire. All but one of the interviewees were happy to have the interview recorded on audio tape. The recording was done on the basis that interviewees could keep the audio tape if they were not happy with the recording. All respondents were happy and none asked for their recording. In addition, written notes and mnemonics were taken on blank questionnaires. For the interviewee that did not wish the interview to be recorded, more substantial notes were taken. The time and place of interviews were negotiated with individual developers on the team and the team leader. One of the developers worked off-site during the interview sessions, so for this developer the interview was conducted over the telephone. Again, the interview was recorded.

The development team consisted of a project leader and seven software developers, with a variety of job titles. One of the software developers did not wish to participate in the interview sessions, though he was happy to be observed with the rest of the development team. In addition, interviews were conducted with the senior manger who had overall responsibility for the project and a support analyst who was located nearby the team and interacted frequently with team members. The team were located in a general open plan environment with two rows of four desks cordoned off with partitions.

A mixture of open and closed questions were used in the structured questionnaire. The audio recordings enabled a free flow of answers to be recorded, backed up with hand note taking. This enabled interesting answers to be followed through with further clarifying questions.

Observations took place throughout the visits. The aims of the observations were to note the social interactions and dynamics within the group and provide a comparison against the structured questionnaire responses. The intention was to get a 'flavour' of normal group interaction within the development team rather than a detailed observation of every development activity. It is recognised that observations only provide a snapshot of activities and that there are likely to be a range of other development activities not covered during the observation sessions.

Several observation sessions covered 'coffee breaks', which were usually planned team activities in the staff canteen. One observation session spanned a lunchtime pub visit, to celebrate a 'new arrival' (birth of baby) from one of the development team, followed by an interview at the work place. Observation sessions were usually a whole morning or afternoon and were mostly based around interviews with developers. In addition, one extended observation session took place.

The blue chip company chosen for the case study is a market leader in software products and services and the development team were involved in porting a new version of an existing product onto a new and technically different platform. The team had been working together for about 18 months on the project. Some team members had worked together on previous projects. At the time of the interviews and observation sessions, the project completion was scheduled for a further four or five months. The development team could be classed as a fairly mature group with clear roles and responsibilities.

The development team was particularly relevant for applying the model of dealing with uncertainty within information systems development. The 'team' was mature in that most of the team members had been working together for the previous 18 months, some for longer periods. So the team dynamics had settled down (Stewart 1991, p140), which reduced the amount of variables at play (e.g. did not involve frequent sorting out responsibilities etc.). The team was functioning within time (and presumably cost) schedules and the team operated in a relatively stable environment in that there were no major conflicts or disruptions. The team may be classed as an example of a typical development project where no 'major' problems exist. The team was described as a 'good development team' when negotiating the case study with the senior manager, particularly in that the team members

worked well together and were progressing on schedule. The developed model, described in chapter 9, consists of an iterative process, involving interaction between group members, to deal with uncertain situations. To be effective in dealing with uncertainty requires structures that support such interaction between group members. For the development team in the case study, which apparently has good group interaction, one would expect to see appropriate supporting communication structures.

10.3 Structured questionnaire development

The questionnaire consisted of three parts. The first contained questions on previous work experience and main work activities including team interactions. Questions covering risk aversion and planning attributes were included to assess the individual influences described in the developed model. Similarly, questions on previous experience and preference for development tools and techniques were included to identify possible prior influences on problem cognition.

The second part contained questions on risk and planning orientation, and the questions distinguished between individual and group aspects. Questions on individual aspects to risk and planning are aimed at identifying individual influences on problem cognition, as developed in chapter 6. The questions with a team focus aimed to identify group influences. The results of these questions will help inform the question raised in section 9.2, on which are the dominant influences on decision-making.

The third section contained questions on how uncertainty and general problems are addressed. These were aimed at eliciting information on the 'process' of dealing with uncertainty, which, according to the developed model, should have iterative characteristics.

The developed model identified some possible limitations with prospect theory, particularly the social/group interactions. In addition, while developing the model some concerns were raised on the validity of the methods used in developing prospect theory, namely the use of 'controlled and artificial environments', usually involving an experiment where a simple risk choice of (only) two options is offered to participants. As discussed in section 3.7, there is some question on the validity of this approach to real-life situations, particularly whether a

simple choice between two options is sufficient. To address these concerns, the structured questionnaire included a third option of 'depends', the aim being to gauge the individual support for each decision choice. In addition, question scenarios were developed based on information systems activity.

A fuller description of the questionnaire development follows.

10.3.1 Section A: experience/expertise questions

These included questions on previous experience at the blue chip company and other companies. They also included questions on development methods/methodologies and tools used and, whether there were preferred development methods or tools. Chapter 5 described the likely framing effect of development tools, methods and associated techniques, and these questions would give some measure of framing due to prior experience preference.

Questions were asked on the main work activities of the developers, which also provide a preliminary measure of the level of group interactions. More focused questions then followed to gauge the level and form of interaction between members of the development team and people external to the team. Additionally, questions on the importance of teamwork and interaction were asked.

10.3.2 Section B: risk and planning questions

The first set of questions examined the risk aversion of the developers. These were supported by questions on how much respondents were willing to risk for a 50/50 chance of winning increasingly larger sums (from £5 to £5M). The aim of these exercises was to identify the level of risk aversion, provide a measure of 'diminishing sensitivity' (i.e. people are more sensitive to changes in smaller values) and to provide a lead into the following questions on risk decision in particular project development scenarios. The model developed was based on prospect theory's value function, which predicts people will be risk averse in areas of gain and risk seeking in areas of loss. These questions aimed to examine decision making in loss scenarios where projects were running behind time schedule.

The first scenario involved a project running one **month** late, a moderate loss situation, whereas, the second involved a project running one **year** late, a more pronounced loss situation. Conformity to the value function of prospect theory responses should show a tendency towards diminishing sensitivity and risk seeking in the loss scenario.

For the first scenario a set of four questions was asked on what would be the response to taking a 'gamble' to rectify the one-month overrun where there was:

a) a 50% chance that the project would be put back on schedule/budget, but there was also a 50% chance that the project will slip a further **week**.
b) a 50% chance of that the project would be put back on schedule/budget, but there was also a 50% chance that the project will slip a further **month**.
c) a 60% chance that the project would be put one month ahead of schedule/budget, but there was also a 40% chance that the project will slip a further **month**.
d) a 10% chance that the project would be put back on schedule/budget, but there was also a 90% chance that the project will slip a further **week**.

There were three options given, '*Yes take gamble*', '*No don't take gamble*' and '*depends*'. The 'depends' option was included to gauge the level of support for taking the decision and as a focus to discuss the relevant issues in making such a decision.

The second scenario included a set of four questions on responses to taking a 'gamble' to rectify the one-year overrun where there was:

a) a 50% chance that the project would be put back on schedule/budget, but there was also a 50% chance that the project will slip a further **year.**
b) a 60% chance that the project would be put **one month ahead** of schedule/budget, but there was also a 40% chance that the project will slip a further **month**.
c) 10% chance that the project would be put back on schedule/budget, but there was also a 90% chance that the project will slip a further **two months**.
d) 90% chance that the project would be put back on schedule/budget, but there was also a 10% chance that the project will slip a further **two months**.

Slightly different figures, in both probability and payoff, were used in the second scenario to ensure that respondents did not simply repeat answers from the previous scenario. A

comparison can be achieved by considering the percentage payoffs versus probabilities. The measure of weeks, months and years were used as a common time concept in information systems project management and development (as opposed to a % change in the overrun: a one month change over a year equates to a 8.33% change over the year, which is probably less meaningful to developers).

Questions were also asked about the expected level of individual and group input to making these decisions. Again these were to provide another metric for the group involvement in decision-making and a checking mechanism to other questions on group interaction.

The follow on questions examined the planning attributes of the developers starting with their own perceptions of themselves as planners (on a scale of 1 to 10) and questions on planning activities at work and at home. Chapter 6 identified possible conflicts of planner orientation and task, hence there are further questions on stressfulness of plans not work and of having to work to other peoples plans. A similar set of questions was asked on spontaneity attributes, again with the aim to identify possible conflicts in spontaneity orientation and task.

10.3.4 Section C: Questions on dealing with problems, inconsistencies and uncertainty

This section contained a set of three questions revolving around dealing with problems in general, inconsistencies and, uncertainties. As discussed in previous chapters, there is a potential problem in the use of language to describe uncertainty situations: there is an overlap between the terms 'inconsistency', 'uncertainty' and 'problems' with many of the terms used synonymously in different situations. Consequently, a set of questions was developed revolving around each of the different terms to solicit a full set of responses to uncertain situations.

Each set of questions included 'do you encounter many *problems/ inconsistencies/ uncertainty* in your work?', 'What form do they usually take?' and 'how would you try and resolve them?'. Specific examples were also sought, the aim being to provide a focus for discussion.

The questionnaire was concluded with a set of questions looking at the relative proportions of individual and group involvement to resolve *problems*, *inconsistencies* and *uncertainties*. Again, these questions aimed to identify the level of group and individual involvement in decision making activity.

10.4 Analysis of questionnaire responses

10.4.1 Section A: experience/expertise questions

Respondent	Experience at other companies (years)	Experience at current company	Job title/ function
I1	10+	18months+	Team leader
I2	13+	6 months	Analyst S/W Engineer
I3		17 years	Systems analyst
I4	20+	3 ½ years	S/W engineer
I5	10+		S/W engineer
I6	20+	Several	S/W developer
I7	16	18months+	Systems engineer/ Support analyst
I8	2 ½	2+ years	S/W developer
I9	18months+	6+ years	Project manager

Table 10.1: Experience/expertise overview

Overall, the team represents a range of expertise and experience. The combined experience covers several project developments within the 'blue chip' company as well as other companies.

10.4.1.1 Experience and areas of expertise

Overall, the use of development methods and tools was not as prevalent as the literature would suggest. Most respondents had used a development method or tool before, including the in-house method, however, no formal method was used for the current project. Nevertheless, the approach to development described does roughly conform to a 'SCRUM' approach (Beedle et al. 1999), though it is more structured.

Some relevant responses to '*Do you use any development method/methodology(s)*'

> *'All companies do different things ... little application of [formal] methodologies ' (I7)*

'Don't really use a development methodology [currently] ... have been on a Jackson course, but never used... mostly code generation tools ...previously used case tools' (I5)

'None preferred [doesn't really like using tools/methods ...too restricting] ... it forces you down a [particular] route' (I6)

*'Used [*in-house*] methods. Mostly don't use a method' (I3)*

' Case tools ... prototyping ...quite like state flow diagrams '(I2)

10.4.1.2 Main activities of developer

The following table summarises the main activities of the development team.

Respondent	Main activities of developer
I1	Team leading activities, planning / estimating, technical support in operating system, interaction with other people
I2	Porting activities, code development activities
I3	Integration and building activities, role in more than one development team
I4	1) Specific technical work - fixing bugs 2) Technical consultation
I5	Basically given a s/w eng task, coding
I6	Design and coding
I7	Support activities – related to team products/ services
I8	Porting exercises; early stages – design; general coding, fixing bugs, checking against functional descriptions
I9	20% customer interaction, 30% team A and 30% team B, 20% mixed activities

Table 10.2: Main activities of developer

10.4.2 Team/group interaction

The next table contains a summary of responses to questions on teamwork and interaction.

Respondent	Interaction within team	Interaction outside team	Teamwork important?
I1	Yes, lots ...	Yes	Yes
I2	Yes, a lot of interaction ...	Not very much...	Yes
I3	Yes, quite a bit	Not a lot for this team role, yes for other team role	Has to be in this case... lots of dependencies
I4	Yes	Yes	Within team, yes Outside, less so
I5	Yes, certainly	Not a great deal – sometimes	Yes
I6	[Currently] not really – except for specific tasks. [Mainly involved in distinct tasks] - earlier tasks far more interactive	Very rarely, normally for expert discussion or project direction	Yes it is
I7	[actually part of other team]	Yes. Service team more interaction with development team than service team	Yes and no. Yes for dealing with a problem [able to] pick up what is going on and ideas
I8	Yes, do work at home 2/3 days a week, but have regular telephone meetings .. [plus] face to face meetings	Some ... with support team + social	Yes, without team difficult to ...
I9	Yes. Open door policy so as much as [team A] wants, other team in Boston but visit "regularly"	Yes, customers and peer group of other project managers	absolutely, vital

Table 10.3: Team/group interaction overview

Some further relevant responses to questions on the team interactions and the importance of team interaction follow.

> *' at start ... has a lot less interaction ...* [resulting in] *found it frustrating* [getting information] *building up a backlog of questions then have to 'collar' people for an hour to answer questions ..* [then moved closer to team – desks adjacent to theirs] *now a very good working relationship ... able to get response/information quicker – and in small* [chunks] *' (I7)*

> *'Giving technical guidance ...Half of people are recent employees so [tended to] do most of mentoring... [also] act as a referee on technical debates'* I4

> *'Yes, there is a lot of interaction within the team ... team meetings once a week, regular coffee meetings ... '(I2)*
>
> *'Yes it is important. Team has a common goal ...*[it is] *important to have regular meetings ... '*(I2)

'its a close knit team of 8 .... We sit next to each other ... service people and developers sit close together so there are close links... [there is] a jovial relationship between people ... ' (I1)

'Team work is important ...a problem requires team effort... Coming to work is a social thing ... I need to work with people ... '(I1)

What form of interaction usually takes place?

'generally need to talk to people, sometime find a room, ... mostly informal' (I5)
'If work on own [then] feel very isolated ... good to get team interaction' (I5)

'open door', 'need to be available and flexible', 'within the team it is very important, ...outside it is less so ...need to clarify requirements' (I4)

10.4.3 Section B: risk and planning questions

The next table summaries the responses to questions on risk aversion.

Respondent	Risk averse?	1- 10 Scale
I1	Yes, sort of, need to know as much as possible first	3
I2	Yes, don't like taking risks	3
I3	Don't mind	8
I4	Yes	3 or 4
I5	Fairly neutral	5 or 6
I6	No, 'do like risk'	6-7 'depends'
I7	Yes	3 or 4
I8	Don't know	4 to 5
I9	Possibly, yes	1-5

Table 10.4: Responses to risk aversion

The next table summaries the responses to questions on participating in a lottery situation where there is a 50/50 chance of winning different amounts of money.

Respondent	a) £5	b) £50	c) £500	d) £5000	e) £5M
I1	Not a lot	Wouldn't	Wouldn't	£50 in a lottery situation	£500 would like to be part of a syndicate
I2	£1	£10	£50	£100 max	£1000
I3	50p	£5	£10	£100	£100
I4	£1	£5	£50	£500	£10,000
I5	£3	£10	£50 tops	£200	£1000
I6	£5	£15	£30	£50	£1000
I7	£5	£10-£15	Difficult, presumably more	£50	£50-£100
I8	£2	£20	More difficult,£150	£1000	£20 - £30K
I9	£5	£10-£20	£50	Couple of hundred	£5K

Table 10.5: Responses to questions on lottery type investment for different values

Generally participants were reluctant to participate in gambles at the higher levels. The results indicate a range of responses 'as an academic exercise', however, it is unlikely that the responses would translate into actual gambling activity as some of the following relevant quotes indicate:

'more of how much you can afford to lose' (I9)

'depends on financial status ...' (I6)

'don't know .. very difficult, almost worth taking risk because payout so big',

'depends on how much money got or willing to lose' (I5)

'uncomfortable with this [gambling activity] *... probably would not get involved in this* [gambling activity]*' (I3)*

'always think of what I could lose' (I1)

The aims of the gambling questions were two fold, as a warm-up exercise for the following questions on project-related risk and as an indication of the amount of variation in approach to risk in the team. There seems to be a variety of risk orientations within the team, which supports the assumption made in section 6.3.1, i.e. 'developers' are not homogeneous in their approach to risk.

10.4.4 Decision scenarios: risk taking one month and one year behind schedule

The following questions were related to making decisions for scenarios of a project being one month and then one year behind schedule. There were three options open for each decision

'*Yes take gamble*', ' *No don't take gamble'* and '*depends*'. Three categories are used to represent the answers to these sets of questions:-

Mild yes, mild no, mild depends - show weak agreement to selected response.

Strong yes, strong no, strong depends - show strong agreement to selected response.

Yes, no, depends – show 'medium' agreement to selected response.

When respondents indicated 'depends', they were further asked to indicate if they had an inclination to yes or no, this usually resulted in a 'Mild' response. Allocating the different depth of answer (i.e. mild to strong) was based on an interpretation of the strength of support given to the responses. As such, the classification is a little subjective, though it does represent one view (and metric) on the strength of support for each response.

10.4.4.1 First scenario questions: running 1 month over time

If you are working on a project which was running 1 **month** over time (and costs), what would be your response to taking a 'gamble' to rectify the situation as follows:
(*say the gamble is using a relatively untried development resource, or a radical redesign or missing a section out*)

a) Take a gamble where there was a 50:50 chance that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further **week**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1		Mild no	Depends
I2	Mild yes		Depends
I3	Strong yes		
I4		Mild no	Depends
I5	Mild yes		Depends
I6	Yes		
I7	Yes		
I8	Yes		Depends
I9	Strong yes		Mild depends

Table 10.6: First scenario responses, 50:50 chance of success, slip of one week

b) Take a gamble where there was a 50:50 chance that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further **month**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1		Mild no	Depends
I2		Mild no	Depends
I3	Yes		
I4			Strong depends
I5			Strong depends
I6		Strong no	Mild depends
I7	Mild yes		Strong depends
I8		No	Mild depends
I9	Yes		Depends

Table 10.7: First scenario responses, 50:50 chance of success, slip of one month

c) Take a 60:40 gamble (i.e. 60% chance of success) that the project would be put one month ahead of schedule/budget, but there will also be a 40% chance that the project will slip a further **month**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1	Mild yes		Depends
I2		Mild no	Depends
I3	Strong yes		
I4	Yes		Depends
I5	Mild yes		Depends
I6		No	
I7	Mild yes		Depends
I8	Yes		Depends, "difficult one"
I9	Mild yes		Strong depends

Table 10.8: First scenario responses, 60:40 chance or success, slip of one month

d) Take a 10:90 gamble (i.e. 10% chance of success) that the project would be put back on schedule/budget, but there will also be a 90% chance that the project will slip a further **week**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1		Strong no	
I2		No	
I3		Strong no	
I4		Strong no	
I5		Mild no	Depends
I6		Strong no	
I7	Mild yes		Strong depends
I8		(strong?) No	
I9		Strong no	Depends

Table 10.9: First scenario responses, 10:90 chance of success, slip of one week

e) Take a 90:10 gamble (i.e. 90% chance of success) that the project would be put back on schedule/budget, but there will also be a 10% chance that the project will slip a further **week**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1	Yes		
I2	Strong yes		
I3	Strong yes		
I4	Strong yes		
I5	Yes		
I6	Strong yes		
I7	Strong yes		
I8	Yes		
I9	Yes		Mild depends

Table 10.10: First scenario responses, 90:10 chance of success, slip of one week

The next question looked at differences between making similar decisions but the time scale was a **year** instead of a **month**.

Respondent	Would answers be different if the time scale was a year instead of a month?
I1	
I2	'Yes, less inclined or open to risk ... more at stake'
I3	'Yes, probably not take the gamble quite so much'
I4	'Yes, more causes of losses ...'
I5	'Yes, more dependent, need to consult more'
I6	'Same'
I7	'Yes, depends on % of slip [scale of project]'
I8	'Possibly'
I9	

Table 10.11: Responses to different time scale

10.4.4.2 Second scenario questions: running 1 year over time

The next set of questions focused around a reference point of one year behind schedule, e.g. a project running 1 **year** over time (and costs).

f) Take a gamble where there was a 50:50 chance that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further year.

Note the big penalty here of a further year's slip.

Respondent	Yes take gamble	No don't take gamble	Depends
I1		No	Depends
I2		Strong no	
I3		Mild no	Strong depends
I4		Strong no	
I5		Mild no	Strong depends
I6			Strong depends
I7			Depends
I8			Strong depends
I9		No	Mild depends

Table 10.12: Second scenario responses, 50:50 chance of success, slip of one year

g) Take a 60:40 gamble (i.e. 60% chance of success) that the project would be put one month ahead of schedule/budget, but there will also be a 40% chance that the project will slip a further **month**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1	Yes		Mild depends
I2	Mild yes		Depends
I3	Yes		Mild depends
I4	Strong yes		
I5	Yes		
I6	Yes		
I7	Strong yes		
I8	Strong yes		
I9	Strong yes		

Table 10.13: Second scenario responses, 60:40 chance of success, slip of one month

h) Take a 10:90 gamble (i.e. 10% chance of success) that the project would be put back on schedule/budget, but there will also be a 90% chance that the project will slip a further **two months**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1		No	
I2		No	
I3		Strong no	
I4		Strong no	
I5		Mild no	Depends
I6		Strong no	
I7	Mild yes		Depends
I8			Strong depends
I9	Mild yes "inclined to"		Depends

Table 10.14: Second scenario responses, 10:90 chance of success, slip of two months

i) Take a 90:10 gamble (i.e. 90% chance of success) that the project would be put back on schedule/budget, but there will also be a 10% chance that the project will slip a further **two months**.

Respondent	Yes take gamble	No don't take gamble	Depends
I1	Yes		Depends
I2	Yes		Depends
I3	Strong yes		
I4	Strong yes		
I5	Strong yes		
I6	Strong yes		
I7	Yes		
I8	Strong yes		
I9	Strong yes		

Table 10.15: Second scenario responses, 90:10 chance of success, slip of two months

Some relevant quotes related to the above scenarios:

'need to know project size / time scales for project' (I9)

'need to know context round [the situation]' *(I9)*

'depends on consequences' (I8)

'need other information as well ...' (I6)

'depends on overall plan [scale of project] and overall percentage slip' (I6)

'depends on how serious the over run would be ... ' (I5)

'depends on criticality of project ... '(I2)

'need more information' (I4)

want to know the full facts first' (I1)

10.4.4.3 Summary of scenario responses

First scenario, 1 month behind schedule		Second scenario, 1 year behind schedule	
Situation	**Responses**	**Situation**	**Response**
a) 50:50 chance of being on schedule, possible slip of one week	2MY, 3Y, 2SY 2MN MD, 5D		
b) 50:50 chance of being on schedule, possible slip of one month	MY, 2Y 2MN,N,SN 2MD,3D,3SD	f) 50:50 chance of being on schedule, possible slip of one year	2MN,N,2SN MD,2D.4SD
c) 60:40 chance of one month ahead of schedule, possible slip of one month	4MY,2Y,SY MN,N 6D,SD	g) 60:40 chance of one month ahead of schedule, possible slip of one month	MY, 4Y, 4SY 2MD,D
d) 10:90 chance of being on schedule, possible slip of one week	MY MN,N,6SN 2D,SD	h) 10:90 chance of being on schedule, possible slip of two months	2MY MN,2N,3SN 3D,SD
e) 90:10 chance of being on schedule, possible slip of one week	4Y, 5SY MD	i) 90:10 chance of being on schedule, possible slip of two months	3Y,6SY 2D

Table 10.16 Comparison of responses for the two scenarios

Key:

MY = mild yes, Y = yes, SY = strong yes

MN = mild no, N = no, SN = strong no

MD = mild depends, D = depends, SD = strong depends

Responses to b) and f) are interesting as they have the same expected values (which is neutral since the probabilities and the value of proportional losses and gains are the same). There is a bigger tendency **not** to take the gamble in the second scenarios. This is consistent with risk aversion (i.e. giving the value function a lopsided 'S' shape), big losses loom greater than big gains.

It is also interesting to note there is a willingness to take risks to get a project back on schedule. For instance, responses for d) and i) which both have only a 10% chance of success, though the majority of respondents are unwilling to take the gamble, there are a few that are at least open to taking the gamble. In this case there is slightly more inclination to take the gamble in the second scenario than the first (MY to 2MY and 6SN to 3SN), which may by consistent with diminishing sensitivity (however, direct comparison is not possible given different expected values).

It is particularly interesting to note the number of 'depends' with the responses. The responses indicate that contextual influences are very strong for this team, particularly in regard to the wider consequences of decisions, scope of decision and how decisions would affect other groups. This would seem to indicate that 'social/cultural' and 'contextual framing' influences, as discussed in section 9.2, would be dominant.

Following on from this, questions then asked whether respondents were happy to make these decisions totally on their own. A summary of the responses is given in the following table.

Respondent	Happy to make decisions on own?
I1	No, in a project it is more a team effort ...
I2	No, would like to discuss with other interested parties ..
I3	No
I4	Would not be too happy ...
I5	Would consult with ...
I6	Yes
I7	Some, not all ..Would expect involvement of others
I8	Not really (at the moment .. need more experience)
I9	Yes. But would receive input from team.

Table 10.17: Summary of responses to "Happy to make decisions on own?"

Clearly from the responses there is an expectation that such decisions would be made with, at the very least, consultation with other parties, i.e. project risk decisions are likely to be 'group' decisions in that there is group consultation beforehand. However, once this consultation had taken place, then people were generally willing to make the decision themselves.

Some relevant quotes:

> *'need input* [and discussion] *from team .... Job of manager' (I8)*

'would consult with [line manager] *at time ... probably consult with appropriate* [people] *' (I5)*

'depends on level of risk ... ' (I7)

'would expect input from others' (I6)

'would not be too happy ... might be willing to ...[in] reality, would not be able to [make decisions on own] ...prefer to do with other's involvement ... depends, need to talk to other people ...[but, given these] would be happy to, yes. ... Where definite [quick] decision needed then OK to make decision, otherwise need more balanced view - need more people involved' (I4)

'[would expect involvement] from customer, they should be involved most' ,

'not really a decision [totally] for a single person [lots of people involved]' (I3)

'depends on feeling of team ... in a project it is more of a team effort... ' (I1)

Generally, the team members would expect to receive input from and consultation with other team members and affected parties before making these types of decision. However, several seemed happy to make the decision themselves, once the consultation had taken place.
The next section looked at planning and spontaneity orientation of respondents.

10.4.5 Questions on planning

These included questions like 'Do you class yourself as a planner?', 'On a scale of 1 to 10, where 10 = an 'obsessive planner' and 1= 'don't like/do planning', where would place yourself?' and questions on the amount of planning done at work and home. Finally a set of questions looked at planning and stress. The following table summarises the planning responses.

Respondent	Class yourself as a planner?	Scale 1 - 10	Do planning at home?	Do a lot of planning at work?	Stressful if your plans do not work out?	Like having to work to other people's plans?
I1	No	4	No	No	Yes ...	Depends
I2	No	3	"No ... but yes for holidays "	"Not a lot, have a plan for ..."	"Yes, to a certain extent"	"Not really, no"
I3	No	5	Reasonable amount	No	"No, don't get stressed ..."	"Don't mind, provided they are achievable"
I4	[mild] Yes "can do it [planning]"	4	"Wife says yes, but I don't think so"	"No [not currently], but early part of project yes"	Sometimes	Depends
I5	Yes	6 - 7	"Not a great deal"	"Where appropriate"	"No not really"	I5
I6	No	5	Never	No	Yes	Yes ...
I7	"Not really"	3	Yes	No [dealing with customer enquiries]	No	"Depends on plan ... probably don't ... being constrained"
I8	"Not especially ... do some planning"	4	"Not a great deal"	"In current role, not much"	"Yes a bit stressful"	Neutral, OK
I9	"don't like to do it, but have to"	5 at work, 1 at home	No ...	"Yes, a fair bit .."	"not stressful, more ..responsible"	

Table 10.18: Planning responses

Some relevant quotes:

'Not at home. In different roles it is nice to work to other people's plans ... but have to have faith in other person's plan.' (I9)

'Do like to know when I am doing things ...Yes, prefer that [working to other people's plans] ... as long as I have some input ... [the plan] needs to be achievable.' (I6)

'As long as they are realistic objectives to work to' (I5)

'Stressful [if plans don't work out]? Difficult to answer. Plans not working out usually due to some other factors - which are stressful' (I4)

'depends on merit of plan , i.e. if looks realistic [then don't mind] ... [With] impossible plans "why bother"?' (I4)

'[I] like to have an input into the plan ... '(I2)

'[I] like to have a plan for things and go along with it ... like to be co-ordinated' (I1)

Overall, there seemed to be a variety of planning orientations within the group. Also, they generally were happy to work towards other people's plans as long as they were achievable, realistic and/or they had some input to developing the plans.

10.4.6 Questions on spontaneity

These included questions like 'Do you like spontaneity?' , 'On a scale of 1 to 10, where 10 = 'live for/love spontaneity' and 1= 'don't like spontaneity', where would you place yourself?' and 'Do you find it stressful?' and 'Do you generally like surprises? ' The following table summarises the responses to questions on spontaneity.

Respondent	Do you like spontaneity?	Scale 1 - 10	Do you find it stressful?	Do you generally like surprises?
I1	Yes	6 or 7	Sometimes, yes	Yes
I2	Yes	6	Not that stressful	Not that much no ... like to know what is going on
I3	Yes	8	No	Yes, good surprises. Generally don't mind
I4	No	3	No	No
I5	Yes	5	Not really	Nice surprises
I6	Very much	8	No	Yes
I7	Yes	7	Imposed spontaneity, yes	Pleasant ones, yes
I8	Yes. Some spontaneity is definitely necessary	6	No	Depends on surprise
I9	Yes, particularly at home, not much at work	7	Yes, from high up management ...	If they are good ones!

Table 10.19: Summary of responses to spontaneity questions

Some relevant quotes/responses:

'Customer wise, yes. Other project work, not much' (I9)

'mainly for small tasks [and activities] .. big tasks [and activities] are generally planned for' (I5)

The responses are consistent with the findings and assumptions made in chapter 6, namely that developers are not 'one type of person', i.e. they are likely to be drawn from a variety of people consisting of planner and non-planners, and people who do and do not like spontaneity.

10.4.7 Responses to section C

The next main section contained questions on dealing with problems, inconsistencies and uncertainty. For each, questions were asked on how often the situations were encountered and how they were addressed. The following three tables summarises the responses.

Respondent	Do you encounter many *problems* in your work?	What form do they usually take?
I1	Some, not a lot	Usually technical
I2	Some	Generally S/W not working
I3	Not many within this group	Tend to be quite minor …
I4	Yes	1) code badly written, 2) bugs, 3) unnecessary obstacles to get the job done
I5	Yes, a fair few ...	Mainly technical related
I6	Yes	Logic problems, design problems
I7	Yes	Not able to generate the problem the customer has reported
I8	Yes, in development work and support work	1) service type ones (failure for some specific reason) 2) problems in development- due to lack of understanding of system
I9	Yes	[From] customers, unforeseen areas of work or technical problems. People problems sometimes

Table 10.20: Responses to dealing with problems

Some relevant quotes/responses to how they would be resolved:

'lateral thinking .. take new direction ... being quite radical ' (I6)

'this group is a good bonding group ... '(I3)

'need to understand problem' (I1)

Respondent	Do you encounter many *inconsistencies* in your work?	What form do they usually take?
I1	No, not really - more uncertainties	
I2	Rarely … not really at the moment	
I3	Not now, … most [elements] becoming standard	
I4	Yes	Would use the term 'bug'
I5	Some	[In other people's work]
I6	Not really	
I7	Not many	[type of work activity, limited inconsistencies]
I8	Yes	On a major systems document .. two places trying to document same thing
I9	Yes	Between product sets, between working hours, staff

Table 10.21: Responses to dealing with inconsistencies

Some relevant responses to how they would be resolved:

'depends how much it is going to cost ... '(I9)

'depends on scale ... e.g. localised then spend effort and fix it, large inconsistencies required larger [scale] effort' (I8)

'go back and forwards between chain of people – need good inter team communication' (I7)

'go back to source, e.g. customer' (I6)

'speak to people ... talk to customers [and ask] what they want [or mean]' (I5)

'need to go to the relevant people and ask what they mean ...finding people' (I4)

'informal discussions in group with people involved... generally covered in monthly meetings' (I3)

'talk to people, find further information' (I2)

Respondent	Do you encounter many *uncertainties* in your work?	What form do they usually take?
I1	Some	Lack of information
I2	Sometimes, yes	Not sure S/W will work ....
I3	Occasionally	Software upgrades resulting in strange results
I4	Yes	Examples given
I5	Yes, quite a lot ...	[specific examples given]
I6	No [but gave example(s)]	Didn't know [likelihood of event]... Lack of knowledge
I7	Not many, except spontaneity of task/job	
I8	Yes, in planning stage ... big uncertainties then	Lack of knowledge in what needs to be done
I9	Lots, absolutely More so than the team	Customer driven

Table 10.22: Responses to dealing with uncertainty

Some relevant responses to uncertainties and how they would be resolved:

"have to shield the [staff / team] from many of the uncertainties" (I9)

"being asked to do something that I know nothing about ..." (I5)

"Features of [product] interfacing between databases . The uncertainty is do customers want the feature? Which databases do they want? And customers don't understand the question!"(I4)

[e.g. budget/staffing] *"try and resolve it with peer group i.e. other managers, to shield teams" (I9)*

"systematically work it out ...work at problem behind it " (I8)

"cost benefit analysis, ... go back to customers to get solution" (I7)

" try to speak to someone ... to check problem ...make an educated guess...[being] creative "(I5)

"By being incredibly clever [a bit tongue in cheek]. *Try to balance alternatives. Select most popular database and do it just for that ...[have] fix boundary then can have fixed or limited costs ... take a middle road ... bounded on losses... "(I4)*

"Consult original people ...lots of talking to people if you get problems"(I3)

"Gathering information, evaluating information ...coming to own conclusion ....going to relevant people..."(I2)

"Ask other members of team .... Find technical resource [expert] for that area ... let as many people that need to know get involved / know about the problem" (I1)

Overall, several examples for all three types of situations were given and discussed by the respondents. The 'addressing' responses are consistent with the range of coping strategies discussed and developed in chapter 7. Also there are clear elements of iterative processes to

address the uncertain, inconsistent or problem situations, which is again consistent with the developed model.

The next set of questions focused on the amount of individual and group involvement expected to address the uncertain, inconsistent or problem situations. The following three tables summarise the responses for proportion of individual and group involvement to address uncertain, inconsistent or problem situations

Respondent	Proportion of problems solved with individual effort	Proportion of problems solved with group effort
I1	Mainly 75%	 25%
I2	75%	25%
I3	80%	20%
I4	50%	50% more for harder problems
I5	80%	20%
I6	90%, most	10%
I7	In terms of time 80% In terms of numbers 90%	20% 10%
I8	60 %(70?)	40 %(30?) 20% brief ideas with team 20% more team effort
I9	Depends on problem A) if mine 90% B) if teams 20%	 A) 10% B) 80%

Table 10.23: Summary of proportion of individual/group involvement for problems

Some relevant responses to the proportion of individual or group involvement in addressing problem situations:

> *"most solved individually. Only those problems that can't be solved require group effort - based on experience" (I6)*

> *"Individual effort may not come to other people's attention. Harder problems are more likely to involve team effort." (I4)*

Respondent	Proportion of inconsistencies solved with individual effort	Proportion of inconsistencies solved with group effort
I1	[Not many examples]	
I2	25%	75%
I3	50%	50%
I4		Most
I5	50%	50%
I6	10%	90%
I7	10%	90% "virtually all (but doesn't really apply in current position)"
I8	Depends on magnitude Small: high Medium: Large: Very low	 Small: low Medium: Large: Very high
I9	Depends on type 20%	 80%

Table 10.24: Summary of proportion of individual/group involvement for inconsistencies

Some relevant responses to the proportion of individual or group involvement in addressing inconsistent situations:

"would require many days discussion"(I8)

"have to discuss the inconsistency" (I6)

"Mostly going to involve other people, e.g. to find out they want/mean" (I4)

"less that can be controlled [addressed] by self..."(I2)

Respondent	Proportion of uncertainties solved with individual effort	Proportion of uncertainties solved with group effort
I1		Mostly
I2	25%	75%
I3	50%	50%
I4		100%
I5	40	60
I6	Depends on scope, Within own scope/control then, most 90% Outside scope 10%	 10% 90%
I7		100% "have to talk to someone else"
I8	Almost entirely individual	
I9	Product: 20% Staffing etc 25% ish	80% 75%ish (75/80)

Table 10.25: Proportion of uncertainties solved with group effort

Some relevant responses to the proportion of individual or group involvement in addressing uncertain situations:

"almost entirely individual but feedback to team ..... more of a process"(I8)

"depends on the uncertainty –[e.g. scope]" (I6)

"Difficult to think of a case less than 100%" (I4)

"most cases would require input from other people"(I2)

"own responsibility but involves group effort" (I1)

10.4.8 Summary of questionnaire responses

The responses show a range of individual attitudes towards risk and planning, which is consistent with chapter 6. The responses also show some consistency with prospect theory, particularly with risk aversion, some diminishing sensitivity and some acceptance of project plans as reference points. However, responses also indicate strong contextual and social/group influences on risk decisions. Responses indicate an iterative process involving other group members to address uncertainty. The responses indicate support for the model described in section 9.2.

10.5 Analysis of Observations

10.5.1 Observation aims and introduction

The main aim of the observation sessions was to examine the social interactions and dynamics within the group, generating a 'flavour' of normal group interaction. This would then provide a comparison against the structured questionnaire responses. Of particular relevance for testing out the models was to check for communication structures which support (or otherwise) group interaction required to deal with uncertainty. The team was presented as a 'good development team' where team members worked well together and where the project was progressing successfully. To be consistent with the model, one would expect good communication structures supporting interaction and flow of information between team members.

Observations took place throughout the visits. Though only providing a snapshot of the activities for the development team, it did provide a window into the general group working environment and interaction.

Of particular relevance were the observation sessions during 'coffee breaks', which seemed to be planned 'team' activities. It seems there are usually two such coffee breaks a day, one mid morning and one mid afternoon. They would involve most of the team members moving together to the canteen, which was situated along a network of corridors. Typically the coffee breaks covered social interaction and discussion, however, approximately half of the discussion observed in these sessions were work related.

The most striking characteristic of the team interaction during the observation sessions was the general *open door* approach, which was present at all levels in the team, from overall manager, team leader and individual developers. It was also manifest in the open seating arrangements and the 'swivel chair' reactions described later. Figure 10.1 shows the office layout. The development team operated in an open plan environment. The team leader and seven developers occupied a rectangular area, delimited by partitions. Four people were seated either side of the area facing the partitions and a passageway between. Additionally, the support analyst, who had much interaction with the team, was located in an adjacent section on the other side of one of the partitions. The project manager with overall responsibility was located in an office nearby.

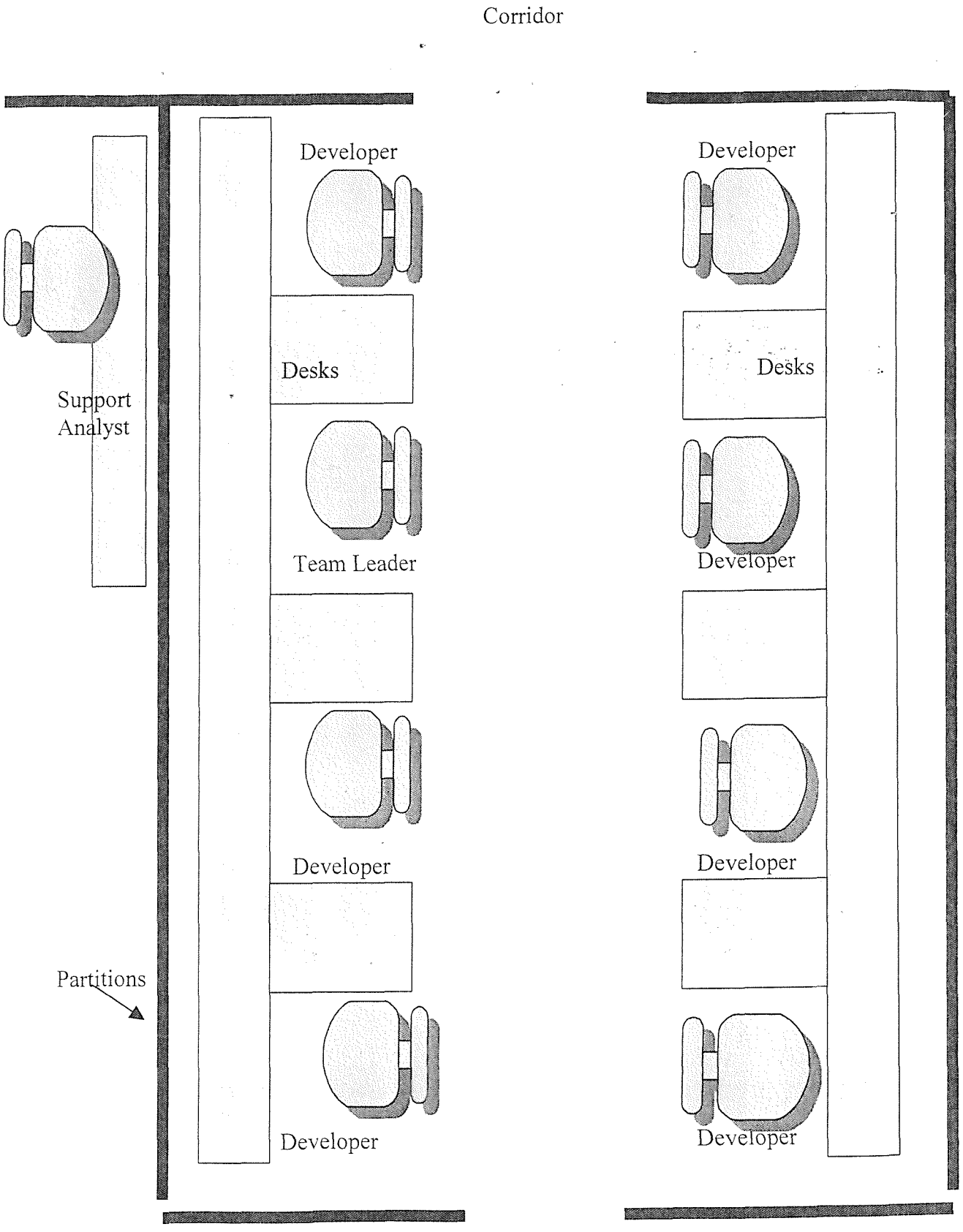


Figure 10.1: Layout of office space for team

10.5.2 Example incident

Figure 10.2 shows an interaction diagram for an incident where someone from another team came to get information and general help with a problem. The interaction described was fairly typical of the incidents observed in the amount of interaction between different team members.

Key to figure 10.2:

D1 to D5 = developers

TL = team leader

V = visitor

SA = support analyst

OB = observer

#1 to #11 = list of main interactions/events

#1 The initial incident consisted of V coming into the developer's area and starting some social banter with D5. In addition, greetings were exchanged between the visitor and the TL and D3 – with 'swivel chair' movement. The social banter/interaction lasted 6 minutes. From this V asked D5 a specific technical question.

#2 This resulted in TL participating in the discussion with D1 and V.

#3, #4, #5, #6 After a round of discussion, TL asked D3 for some specific information. D3 then asked V for clarification on aspects of the problem. D3 did some individual work on his screen for about 4 minutes, to locate some key information, then had a discussion with D5 and V for a further 5 minutes. During this time V sat down in a spare seat and continued some social banter with D5 and TL.

#7, #8 SA answering a telephone query leant over the partition and asked a general question to the team 'does anyone know about problem x?'. D2 responded and asked TL specific questions. TL did some information searching.

#9 D1 provided some further information to V. This was then discussed with V, D3 and D5.

#10 TL gave some information to SA who passed on the information to the telephone caller.

#11 The discussion between D3, D5 and V came to a close and TL asked for a summary of the response and made some notes in the problem record. V then leaves the team's area with some further social banter.

During this observed incident D4 contributed little to the discussion, other than general greetings, and worked on his own. D3 used headphones until #3 and replaced them after V left. D2 and D1 mainly worked on their own but provided key information when requested or when it was needed. The resolution of V's problem required input from most of the team members. Some of the input was very brief, others took more involved activity such as information searching. There were several themes to the discussion with V. This seemed to revolve around narrowing down the characteristics of the problem to particular areas. Once one avenue for the problem was eliminated then attention turned to another.

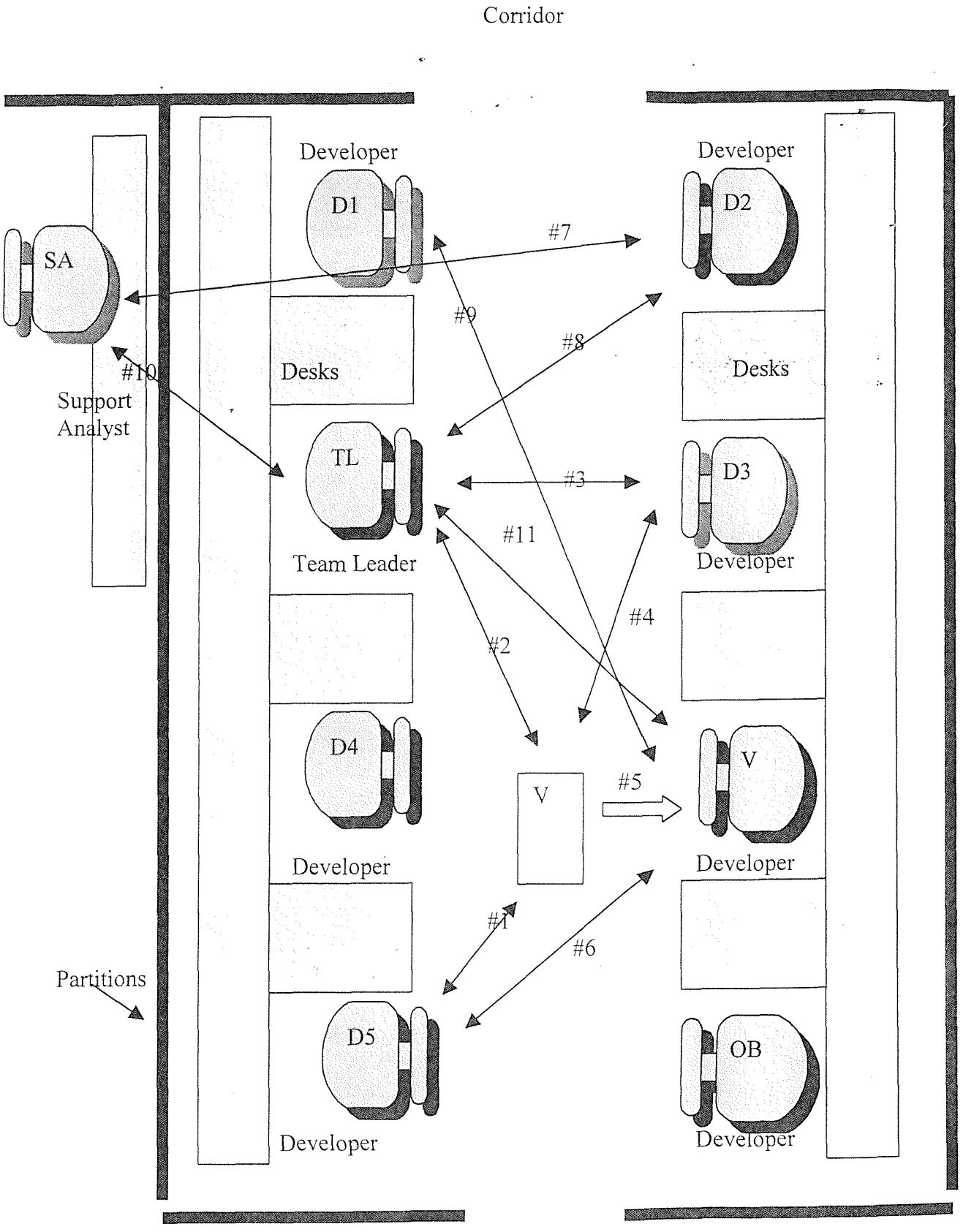


Figure 10.2: Interaction diagram for example incident

10.5.3 Summary of observation sessions

As the example incident shows, addressing a 'problem' typically involved much group interaction and an iterative process. The communication structures supported and encouraged small and frequent interactions between members of the development team. This seemed particularly relevant for sharing information about problems between the team members. The team also had focused review sessions at the start of the week where they shared information on progress in the previous week and problems in the coming week. There was a strong social element to the team. This was particularly evident in the coffee breaks which typically had some general socialising followed by discussion about technical issues.

Main characteristics of the development team

1) 'Swivel chair' and 'open door' culture
   - easy for people to contribute to discussion
   - easy for people to ask for help and information

2) Supportive environment and communication structures
   - regular weekly meetings, mainly informal
   - daily telephone contact with remote workers
   - regular coffee breaks, which involve socialising and work activity
   - 'can help' attitude supported with friendly social interaction

Overall, the communication structures seem appropriate to facilitate frequent interaction between group members. The observations are very consistent with the iterative and interactive model developed in section 9.2.

10.6 Analysis of results: Consistency with model

As described previously, the main aim of the case study was to 'test out' the model as a whole, checking for consistency between actual development practice and the model. The more specific aims were to examine particular attributes of the developed model for consistency:

1) the social/group responses to uncertainty indicated in the model
2) individual orientation towards risk and planning
3) iterative process indicated in the model
4) any biases in approaches to uncertainty

Overall, there seems to be consistency with the observed development practice from this case with the expected practice indicated in the model. On a more general level, case responses are consistent with elements of prospect theory, namely, risk aversion, diminishing sensitivity and the use of reference points for decisions (particularly project milestone and goals). There is a less-pronounced support for the framing effect, particularly framing of requirements from customers. No framing effects were observed due to particular development techniques of methods. This is partly explained by the limited use of 'formal' techniques and methods in the development project.

For this case study there is a strong social dimension to dealing with uncertainty: It is very much a group activity. The communication structures and practice facilitates frequent interaction both on a social and a work level. Indeed, the social interaction strongly supports the frequent work interactions: within this team it is easy and quick to solicit needed information from a colleague to address an uncertain/inconsistent/problem situation. This is consistent with the concept of *collective mind* (Weick and Roberts 1993; Weick 1993) discussed in section 8.8. The case study shows much 'heedful' interaction with good communication structures: '*The collective mind that emerges during the interrelating of an activity system is more developed and more capable of intelligent action the more heedfully that interrelating is done.*' (Weick and Roberts 1993, p365) and '*as heedful interaction and mindful comprehension increases, organisational errors decrease*' (ibid p357). In addition, the type of interaction with newcomers into the group is also an indicator of the level of collective mind: '*The quality of collective mind is heavily dependent on the way insiders interact with newcomers*' (ibid p368). The 'good' example of a development project (as described by the senior manager) fits the concept of collective mind. A developed *collective mind* may provide elements of common problem framing, which would result in group decision-making consistent with prospect theory. However, a developed *collective mind*

requires heedful and mindful interaction in decision-making, which is outside the scope of prospect theory.

The team consists of a mixture of planners and non-planners. This supports the assumptions made in chapter 6. Responses to decision-making at the individual level seem consistent with aspects of prospect theory. However, there are strong social/cultural and contextual influences present in the case study which are not addressed by prospect theory. In the case study these social/cultural influences seem to be dominant. Overall, the case study seems to support the developed model.

Chapter 11: Summary, contribution and areas for further research

11.1 Introduction

This chapter summarises the main elements of this thesis, identifying key aspects of prospect theory that proved appropriate to the information systems development environment and those that did not. It also discusses the contribution of this thesis along with areas for further research.

11.2 Overview of thesis chapters

Chapter1 puts this thesis in context by examining the main characteristics of the development environment, uncertainty within the development environment and some of the key works on risk and uncertainty. It also discusses the choice of prospect theory as the main theoretical tool to examine uncertainty within information systems development. Chapter 2 examines the research approach and philosophy taken, and identifies how each of the chapters contributes to this thesis. Chapter 3 examines prospect theory in greater detail, identifying the main attributes, background, applications and limitations. Chapter 4 applies the main elements of prospect theory to the information systems development environment. In doing so it also provides further rationale for the use of prospect theory in this thesis. Chapter 5 examines the *framing effect* within the development environment due to the 'rituals of development' by focusing on the characteristics of development techniques. Chapter 6 develops individual *value functions* for *planners* and *non-planners*. Chapter 7 examines prospect theory's two-phase decision-making process and develops a model of dealing with uncertainty within information systems development. The chapter identifies some key limitations to the scope of prospect theory. Chapter 8 focuses on the social and cultural aspects of development and identifies further limitations to the use of prospect theory. Chapter 9 brings together the different elements of the preceding chapters to develop a coherent model describing how uncertainty is addressed in information systems development. It also details the likely scope of prospect theory for describing decision-making within information systems development. Chapter 10 applies the developed model to a case study based on a small development team.

This enables further refinement of the developed model and mapping the applicability of prospect theory to dealing with uncertainty within information systems development.

11.3 Contribution, observations and reflections

This section brings together the main thesis contributions and observations of development practice and reflections on the research process. First the applicability of prospect theory to information systems is examined followed by an examination of the contribution of the developed model. Finally, there is an examination of and some reflections on the research approach and mix of techniques used in this study.

11.3.1 Mapping applicability of prospect theory

One of the main thesis contributions is mapping the applicability of prospect theory to the complex real-life arena of information systems development. As discussed in chapter 9, some of the main elements of prospect theory seem applicable to information systems development. Framing influences seem relevant to the development environment, particularly potential influences on problem understanding due to characteristics of prescribed development techniques and methods. As discussed in section 4.4, the *Value function* characteristics of a *reference point*, *loss aversion* and *diminishing sensitivity*, seem particularly appropriate to the information systems development environment. The weight of supporting literature (see end of section 3.7) indicates that prospect theory is likely to be appropriate for representing 'risk' type decision-making activity at the individual level where outcomes and probabilities are known. Where such 'risk' type decisions exist in information systems development prospect theory would be an appropriate theoretical tool to inform decision-making activity. It is also likely to be applicable when there are strong framing influences due to a prescribed process (such as in a formal technique).

However, prospect theory is less able to represent the social/cultural influences on decision-making, dealing with uncertainty (which requires a strong group/cultural input) and, dynamic contextual influences. This is particularly limiting since most 'risk' decisions are really 'uncertainty' decisions and most real-life decision-making is conducted within a group context. Prospect theory can be applied in these situations, however, the scope is limited to a subset of the overall decision-making process and to carrying out a particular strategy once it

has been selected. The two-phase process described in prospect theory seems appropriate on a 'general' level. However, closer inspection shows the two-phase process to be limited in scope: not all the decision-making processes are addressed, particularly the consideration of possible meta rules and the pre and post decision states. Chapters 8 and 10 show that group decision-making activity are consistent with the concept of a *collective mind* (Weick and Roberts 1993; Weick 1993), which requires mindful interaction. This mindful interaction is also outside the scope of prospect theory.

Section 9.2, discussed likely dominant influences on decision processes. The real-life decisions evident from the developers' written diaries described in chapter 7, the audio diary and interview data described in chapter 8 and the observed case study described in chapter 10, all had strong group and social/cultural influences. In these cases the social/cultural influences seem to dominate. In addition, the richer audio diary data and observation data from the case study indicate some strong contextual influences, which would further indicate limited applicability of prospect theory.

The information systems development *projects* described in chapters 7, 8 and 10 are by no means a representative sample of all project developments. However, the projects covered in chapter 7 with the written diaries represent a range of applications, project sizes and different industries. The project manager's audio diary described in chapter 8 represents an unsuccessful project while the case study described in chapter 10 describes a successful project. Indeed, the case study in chapter 10 was described as a 'good example' of project development. The projects covered in this thesis do not seem to have any common characteristics separating them out from *all* project developments: The projects are not too untypical of other project developments. Assuming that the characteristics of the sample projects used in this thesis share similarities with many others information systems projects, it is likely that the social/cultural and contextual influences will dominate decision-making for many other developments. Consequently, prospect theory's applicability to other information systems developments will be limited in scope. However, the scope of applicability could be increased with a refinement of prospect theory to take account of contextual and social/group issues. Such a refinement is described in section 10.4.4, where a 'depends' dimension is used to solicit information on level of support and the main influences for specific decisions. This refinement is discussed further in section 11.3.2.4.

11.3.2 Developed framework

As discussed in chapter 1, this thesis aimed to develop a fuller picture of how uncertainly is dealt within the complex environment of information systems development. This aim has been achieved with the development of the model described in section 9.2. The model includes an iterative process, application of meta rules, group involvement and identification of coping strategies. In addition, the model identifies the range of influences on decision-making and which influences are likely to be dominant. The model provides contribution on several fronts. First, it brings together previous works on uncertainty from diverse disciplines into a coherent framework which describes decision-making activity within the information systems development environment. Second, the model extends the scope of examining decision-making to include 'pre' and 'post' decision activity: Decision makers have the experience of previous decisions to inform current decision-making activity and the results of current decisions will inform future decisions. Third, the model extends the examination of decision-making by identifying information systems environment influences. Further, the model identifies some stresses between the individual orientation, framing and social/group influences and describes which is likely to be dominant. Fourth, the model extends the number of likely coping strategies identified by Gabbay and Hunter (1991) and those identified in Janis and Mann's (1977) conflict theory to include commercial and pragmatic strategies. Fifth, the model has many generic attributes making it potentially applicable to other real-life decision-making arenas.

11.3.2.1 Classification of techniques

One prominent area for influences on decision-making when developing information systems is the use of particular development methodologies and their component techniques. These influences are defined in chapter 5 where two classifications of techniques are developed. An initial classification was based on representational attributes and language constructs used. The initial classification provides information on problem/solution spaces covered by different techniques and likely 'social defence' attributes. There are six groups in the initial classification. The second classification is informed with works from cognitive psychology and provides information on likely influences on problem cognition. It has two-dimensions,

one covering representational attributes and the other covering paradigm/process attributes. Both of the classifications are applied to approximately 100 techniques in appendix A.

The classifications give new and distinct vistas on techniques providing much potential for informing technique selection within the information systems field. The initial classification gives guidance on the likely problem/solution space covered by a technique and the potential of operating as a social defence mechanism. The second classification gives further guidance on the likely impact on problem cognition for techniques with particular characteristics. As discussed in section 5.6.2.2, classifying techniques in existing categorisations can be somewhat subjective and techniques can often be placed in more than one group. The second classification developed in chapter 5 separates out the objective and subjective characteristics of techniques, so provides a more objective tool.

The two classifications together provide a detailed mapping of likely framing influences due to a technique's characteristics. Examining likely framing influences provides further guidance on understanding *how* a technique will impact problem understanding. This has the potential for providing guidance in selecting appropriate combinations of techniques to limit any negative framing influences and support an appropriate problem-learning environment.

11.3.2.2 Distinct value functions of planners and non-planners

Chapter 6 described the development of distinct *value functions* for *planners* and *non-planners* based on a postal survey of a sample from the general public. The original prospect theory (Kahneman and Tversky 1979) developed a descriptive model of decision-making which included general characteristics of a value function. The refined cumulative prospect theory (Tversky and Kahneman 1992) further defined the shape of the theoretical value function effectively applying cumulative functions separately for gains and losses. Chapter 6 complements the theoretical concepts by defining key attributes of the value function, the *reference point* and *risk aversion*, for distinct groups of people.

Since the survey draws upon responses from the general public the results are applicable to a wider arena than just the information systems field.

11.3.2.3 Wider development of coping strategies and process

Chapter 7 collated previous works on strategies to deal with inconsistency and uncertainty (Gabbay and Hunter 1991; Janis and Mann 1977) and inconsistency resolution processes (Ganzach 1994; Wyer1970) into an initial framework representing strategies and process to deal with inconsistencies. The initial framework is applied to survey and written diary data from information system developers enabling further enhancement of the framework. The final model extends the number of likely coping strategies to include commercial and pragmatic strategies.

In addition the concept of meta rules is developed to include likely influences on the rules. The developed framework identifies particular influences on strategy selection including: initial perceptions and expectations; a melioration or optimistic effect (i.e. assuming the inconsistency will be 'alright in the end') resulting in a tendency to adopt a procrastinating strategy; resistance to change due to cognitive dissonance, resulting in further tendency towards procrastinating strategies; biases towards more complex solutions favouring strategies involving a complex set of tasks and; group and cultural influences and biases.

Given the environmental attributes which give rise to the identified 'commercial' and 'pragmatic' coping strategies, it is likely the enhancements of the developed model will be applicable to a wider arena than the information systems field.

11.3.2.4 Enhancing prospect theory: a 'depends' dimension

Existing research is inconclusive on the applicability of prospect theory to complex real-life situations, often with mixed results being observed. For instance, Lauer's (1996) study examining software project managers' responses to risk decisions, found considerable variation in the results (see section 1.2.1.6). In Steen-Sprang's (1999) study applying prospect theory to international relations the findings were inconclusive in that prospect theory explained behaviour under uncertainty for some individuals and not for others. In addition it seemed prospect theory was better suited to some scenarios than others (see section 4.5).

Possible variations in decision-making responses were specifically examined in chapter 10 by focusing on what influences support for individual decisions. This was done during structured interview sessions where respondents were asked to make specific risk decisions related to information systems activity. As consistent with other studies, the options open to respondents were either 'yes' or 'no' to take the risk. However, this study included a further option of 'depends' for the respondents. This acted as a focus of discussion and proved a powerful mechanism in soliciting information on what influences specific risk decisions. For the respondents in the case study, the main discrepancies were associated with being mindful of specific context and group/social needs (e.g. how specific decisions would affect other people).

This 'depends' dimension has the potential for significant contribution by providing a mechanism with which to investigate discrepancies in decision-making activity observed in other studies.

11.3.2.5 Appropriate communication structures

This thesis has the potential for informing on appropriate communication structures to support easy sharing of information and mindful interaction (Weick and Roberts 1993) when addressing uncertain situations. The developed model in section 9.2 indicated that addressing uncertainty is a group process where individuals seek key input from other people. This was clearly shown in the diary responses described in chapter 8. Here developer's progress on a problem was halted, sometimes for long periods of time, until they were able to get input from other developers, managers or customers. To ensure minimum delays in addressing such problems, communication structures are required which encourage quick and easy interaction between teams and team members. In addition the structures should encourage mindful interaction, i.e. mindful of the potential impact of decision choices on other people (see section 10.6).

A 'good example' of such supportive communication structures was discussed in section 10.5.3. In the example the communication structures provided a supportive environment making it easy for people to solicit help and information. The environment characteristics covered the physical layout and location of desks, type and frequency of formal and informal

meetings, a general 'can help' attitude and a strong social dimension to the team. The observation sessions described in section 10.5 show that the social dimension plays a particularly key role in supporting information sharing, typically with requests for information being prefixed by some social interaction or banter.

There seems to be clear implications for the education of future developers. The success of a project may be strongly influenced by the social aspects and informal communication structures of the development environment.

11.3.3 Application of research methods

This thesis has used a variety of research tools to investigate the multifaceted phenomenon of dealing with uncertainty within information systems development. There are two aspects of the use of these mixed research tools that have potential for further contribution to the information systems field. First, some of the research techniques have either been little used or not used before in the information systems field so their use in this thesis provides guidance on the suitability or otherwise in other research projects. Second, the combination of different research techniques used in this thesis further informs other researchers wishing to use mixed techniques to investigate complex information systems phenomena. There follows an examination of each of the novel research techniques used and novel application of previously used techniques.

11.3.3.1 Use of the mass observation archive (MOA)

This was the first time that the Mass-Observation Archive (MOA), based at the University of Sussex, was used within information systems research. The MOA consists of a self-selecting panel of between 500 to 700 people from a wide selection of socio-economic backgrounds. The MOA aims to be representative of the general public, however, there are some biases including location (more in the South than in the North), age (more older people) and gender (more females). Periodically there are national and regional advertisements to recruit more panel members and readdress some of the biases (i.e. by targeting younger people, different regions and males). However, there seems more reluctance from younger people and males to participate (Sheridan 1996).

Three or four times a year a survey, called a directive within the MOA, is sent out to the panel members. The directives contain a set of questions on specific topical themes or issues. Questions are usually open and responses are free format. Panellist can answer whichever questions they like and write as much or as little as they like. Typically there are two themes though occasionally there are three, as in the case for this study. The response rates are usually very high with 70% or more for a main theme and 45% or more for a third theme. Quality of responses can be very high, for instance some main issues attract several pages per respondent.

There are some interesting features to the MOA that may make it suitable for other researchers in information systems. It is an existing tried and tested survey mechanism with high response rates and potentially high quality responses. In addition the survey is managed through the MOA, including copying, posting, maintaining and motivating the panel population, ensuring confidentiality and anonymity of responses and, processing sorting and coding the responses (i.e. by profession, age, location, gender). There are some limitations to the MOA. The sample biases may be prohibitive for some studies. (Indeed this was a major concern for this study, however, the age bias proved to be less of a problem than expected and provided an unexpected reflective element to the responses.) Also, since the survey mechanism is based on anonymous replies there is no opportunity to follow-up interesting responses. Another major limitation is that access to data is restricted to reading and processing responses at the MOA itself.

For researchers considering using such a research mechanism, the main challenge is to find a suitable focus that is relevant to the general public and information systems activity. The focus used in this study was 'planning activities' and an explicit assumption was made that, from a planning perspective, information systems developers are not too dissimilar to the rest of the general public (see section 6.3.1).

11.3.3.2 Use of written diaries

Written project 'diaries' have been used by developers and researchers to record and monitor development events (such as logging time expended on different tasks and when events take

place) and support reflective practice (Markham 1987; Jepsen et al. 1989; Naur 1983). The focus of using developers' written diaries in this thesis has been to examine specific development activity. Diary participants were given guidance on recording items, including their main activities, any problems they encountered and how the problems were addressed. The aim was to examine how developers actually address problems. Diaries were chosen as they seemed to provide a mechanism for recording the amount of effort expended on specific activity and provide some information on process, particularly in the order of events and who is involved in the events. In addition, a diary study enables the identification of individual responses to particular situations.

Developers' written diaries has been under-utilised as a research tool within the information systems field, with examples mainly focusing on the amount of effort involved in specific tasks. This thesis has shown how diaries can be used to examine specific activity, such as addressing problems, and also to provide a window into the interaction between developers. There seems much potential for using diaries in other studies examining specific development activity.

11.3.3.3 Audio diaries

Chapter 8 described the use and development of using a project manager's audio diary as a research tool. This seems to have been the first time that audio diaries have been used in the information systems field. The project manager's audio diaries contained a rich set of data covering political and social interaction and influences throughout the project development. Some potential benefits of using audio diaries for the participants have been identified, including providing therapeutic support to address stressful situations by 'venting frustrations' and to improve decision-making by articulating one's thoughts (Biggs et al. 1993; Ericsson and Simon 1980, 1984). The audio diary provides the researcher access to freely recorded development activity, which for this example, focuses on the problems and successes during the development. There are some limitations to using audio diary data. An inherent bias is the individual perspective from the diary participant which may not represent a full, or even true, picture of events. It is unlikely that diary data alone will provide sufficiently robust information on development activity. For this study the audio diary was supplemented with an initial interview session setting up the study, a more substantial

recorded interview session at the end of the project development and informal contact via e-mail and telephone during the project development. In addition there was limited telephone contact with other members of the project development to provide further supportive information. The combined supportive information provided a contextual framework with which to interpret the audio data and some metric on the validity of the data. There seems much potential for using audio diaries on other studies particularly those examining social aspects of development.

This thesis has the potential to make further contribution by given guidance on the application of written and audio diaries as research tools within the information systems field. In addition, the combination of mixed research techniques used in this thesis has potential for informing other research studies investigating complex information systems development activity. This will be discussed further in the next section reflecting on the research process.

11.3.4 Reflections on research process

As discussed in chapter 2, an interpretive approach was adopted using mixed research techniques. At the start of the research study the topic area could be described as investigating how developers deal with problems particularly when addressing possible future changes. The motivation was an initial 'unease' with the apparent high level of computer failure and high proportion of maintenance activity during project developments. A literature search identified several existing bodies of work offering potential to inform this thesis, most notably were works on development activity (see section 1.1) and works on decision-making, particularly works on addressing uncertainty (see section 1.2). As a consequence the focus of the research project changed to that of 'dealing with uncertainty within information systems development'.

On closer investigation this turned out to be a complex unstructured research area with many interwoven attributes: the development environment along with the decision-making processes and influences seemed multifaceted. To help provide structure and further focus the research study needed to apply the topic area to a suitable theoretical framework. As discussed in section 1.3, none of the existing frameworks addressed all aspects of decision-making within information systems development. However, prospect theory seemed the most

promising because it described some fundamental aspect of decision-making and provided key elements consistent with the development environment, notably framing influences, value functions and a two-phase process (see chapter 4).

The choice of prospect theory was also influenced by the innovation/novelty factor since it had not previously been applied to the information systems field. Consequently, there seemed much potential for making a contribution by mapping the applicability of prospect theory to the information systems development environment. In addition, there seemed potential for the information systems field to learn from a tried and tested theory from another discipline (cognitive psychology).

The key elements of prospect theory provided further support in selection and application of appropriate research techniques. For instance, to investigate framing influences one is drawn to an examination of development methods and techniques since these potentially play a key role in soliciting and representing system requirements (i.e. problem framing), hence the macro analysis of techniques described in chapter 5. To investigate further framing influences requires examining actual development activity. This was partially addressed with the use of a postal survey of experienced developers, described in sections 7.5 and 7.6, and the use of developers' written diaries described in section 7.6 and a project manager's audio described in chapters 8. The use of developers' diaries also provided a mechanism with which to examine decision-making processes suggested by prospect theory.

To examine value function attributes one is drawn to investigating individual orientations to decision-making activity. The approach taken in this thesis was to focus on 'planning activity' and use an existing postal survey mechanism administered through the Mass Observation Archive (MOA) at the University of Sussex (see chapter 6). This provided access to a selection of the general public through a tried and tested robust mechanism. The robustness of the mechanism was evident in the high response rates (approximately 50%) and quality of responses (on average 1 ½ pages per respondent). The focus on 'planning activity' for the survey topic was influenced by the need to finding a common bridge between activity in the general public and information systems development activity. The choice of the MOA survey was further influenced by a 'novelty/innovation' element since this was the first time

it was used in the information systems field so offered potential for informing the use of survey mechanisms within the field.

In using the MOA the assumption was made that, from a planning perspective, information systems developers were not too dissimilar to the rest of the population. This highlighted a need to revisit this assumption later on in the study and resulted in specific planning-orientation questions being included in the structured interview sessions used in the confirmation case study (see section 10.4.3). The planning orientations from the confirmation case study were consistent with the sample from the general public in the MOA, which provides support for the assumption made, i.e. from a planning perspective, information systems developers are not too dissimilar to the rest of the population.

The competing theoretical frameworks to prospect theory provided pointers to potential limitations of the applicability to the information systems development environment. Most notably the sociological works pointed to potentially strong social and cultural influences (as summarised in section 1.2.2) which are not addressed by prospect theory (see section 3.7). These competing theoretical frameworks gave further guidance in the choice of research techniques resulting in the use of audio diaries supported by follow-on interviews (see chapter 8). The audio diaries provided a window into the social interaction within a project development. The follow-on interviews provided background details, context and further information on the social aspects of development.

Different research techniques were used to address specific elements of prospect theory as applied to the information systems development environment. Techniques were also chosen to examine likely limitations of prospect theory. Collating the results of these research activities enabled the development of a map of the applicability of prospect theory and a model of how uncertainty is addressed in information systems development (see chapter 9). During the development of the model specific areas were identified as needing further attention, such as the planning orientations of developers and the need for a metric on the amount of support for decisions. In addition the developed model suggested some distinct social activity, communication structures and development processes. There was a need for a further research activity to confirm or refine the developed model and map of applicability. The result was a case study involving structured interviews and observation sessions of an

information systems development project. The specific areas needing further investigation were used as the basis for the structure interview sessions. The observation sessions focused on specific communication structures, development processes and the social activity of development suggested by the model. The developed model also influenced the choice of a suitable case study: A 'good example' of a development project was actively sought which, according to the model, would have communication structures supporting quick and easy access to help and information and mindful interactions.

The developed model and mapping of prospect theory to information systems development are likely to be incomplete. For instance, considering potential framing influences there is likely to be scope for refinement given the vast range of different development projects each with their own specific context. The focus on development techniques and methods seemed appropriate at the start of the project, however, it seems their use and hence influence in actual development practice may be less than originally thought. There may well be other avenues for framing influences, such as the wider political and cultural arena. In addition, the social interaction examined in this thesis is limited and there is likely to be much scope for enhancements. A complete picture of how uncertainty is addressed in information systems development is probably not possible. It is also likely to be dynamic. Development activity is evolving with new technologies, tools and applications as well as the evolving role and sophistication of users and stakeholders. The application of prospect theory is also dynamic with new studies adding refinements and different focus to the theory.

It is interesting to note that the research process described in this thesis has much in common with the process described in the developed model of section 9.2. The research process is iterative with attention and focus moving with each iteration. It is also a development process with results and experiences of previous activity used to inform the next activity.

11.4 Areas for further research

One of the most promising areas for future research is the development of prospect theory. Prospect theory seems to address some fundamental decision-making behaviour, however, the scope of applicability seems limited. Prospect theory has been developed and collaborated using laboratory experimentation based on respondents choosing between two

decision options. Little work seems to have been done examining the support for particular options at the 'individual' level and what influences this support. Such a metric has been suggested in section 10.4.4 with a 'depends' dimension. There are two ways this could be developed. One way could be to bring a 'depends' dimension into a laboratory environment where respondents could indicate decision influences (say from a list) and/or some indication on the strength of support for specific decisions. Alternatively, a more qualitative study could be conducted to identify reasoning, contextual characteristics and social and wider influences on specific decisions. This seems to be a particularly fertile area for further research and has potential for further developing prospect theory.

As discussed in the previous section, the model described in section 9.2, has been developed using data from a limited number of information systems projects. There is considerable scope for applying the model to a wider set of projects, possibly focussing on distinct attributes such as size, application or development methodology. This would inform understanding of dealing with uncertainty within complex environments and further refine the developed model. In addition the model could be applied to other non-information systems environments. In each of these cases there is scope for re-examining the applicability of prospect theory. These would develop understanding of the scope of applicability for prospect theory in real-life decision-making environments.

The expected framing influences from development methods and techniques (as described in chapter 5) were not observed in either of the empirical works described in chapters 7 and 8. Further investigation, focusing around more formal development environments with a prescribed methodology, would inform the understanding of framing influences. In addition, there are likely to be more framing influences due to specific contextual and specific application characteristics. In-depth case study investigations and possibly participatory studies may be appropriate for investigating these framing influences.

There is much scope for research projects to use mixed research techniques to investigate complex information systems development phenomena (Gable 1994). In this thesis a mix of research techniques were used with each focusing on specific phenomenon attributes of the main theoretical tool used (prospect theory). This enabled a model to be developed by analysing and collating the results of each technique. The model was then applied to a final

'confirmation' case study by focusing on key elements of development practice described in the model. There are likely to be other combinations of research techniques which would be appropriate for the information systems field. For instance, it may be appropriate to develop a model based on case studies and developers' diaries, then to test the model with a survey. In addition, as shown in this thesis, there may be suitable existing research mechanisms (such as the MOA) available to researchers within the information systems field.

The use of different forms of developers' diaries seems a particularly promising area for further research. Possible enhancements could include the analysis of developers' diaries for whole development teams. This has the potential for providing rich data on interaction and processes through the stages of a project development. In addition diaries could be used to record specific events, tasks or problems, thus adding particular focus to research projects. In addition there are a range of existing project artefacts which could be useful sources of research data. For instance, there are often formal project diaries or logs maintained when developing systems. Access to such artefacts may provide a further vista on development activity.

11.5 Some final reflections

Developing successful information systems is difficult. This is especially so for large and involved systems where there are likely to be demanding software engineering and technical challenges to produce a system once the requirements have been identified. There are likely to be demanding challenges in identifying, defining and resolving requirements for a diverse set of users and stakeholders. In addition, information systems will typically operate in a dynamic environment so that any 'final' system may have to address a different focus or set of requirements than those initially envisaged.

This thesis has shown that within such a challenging development environment, developers are likely to encounter many situations of uncertainty where they have to learn about the problem/solution space and make appropriate decisions. Addressing situations of uncertainty is likely to be an iterative process where the focus changes as the developers learn more about the problem area. To address an uncertain situation, developers will often require input from other people either within their development team or further afield.

This thesis has also shown that efficient decision-making within information systems development requires communication structures and an environment that supports quick and easy information sharing and mindful interaction. For the 'good example' case study described in chapter 10, such communication structures and mindful interaction were strongly supported by 'social interaction' within the team and between the team and external people.

An environment that supports informal meetings round a coffee machine may add more to the success of a project than the choice of particular development methodologies, techniques or tools.

Appendices

Appendix A: Table of techniques to deal with uncertainty in IS development

This appendix supports chapter 5, which examines the framing effect due to the characteristics of the various techniques. In chapter 5, two classifications of techniques were developed. An initial classification was based on representational attributes and language constructs used. The initial classification provides information on problem/solution spaces covered by different techniques and likely 'social defence' attributes. There are six groups in the initial classification. The second classification is informed with works from cognitive psychology and provides information on likely influences on problem cognition. It has two-dimensions, one covering representational attributes and the other covering paradigm/process attributes.

Initial classification groupings	**Developed, two-dimensional classification**
Brainstorming Approaches (BRA) Relationship Approaches (REL) Scenario Approaches (SCE) Reductionist Approaches (RED) Matrix Approaches (MAT) Conflict Approaches (CON)	Representational influences Hierarchical Structure (HS) Matrix/Table Structure (MS) Non-Hierarchy Structure (NHS) Structure Free (other, non prescribed structure) (SF) Paradigm/process influences Closed (C) Open (O)

Both classifications have been applied to approximately 100 techniques, the results of which are represented in the following table. Technique allocation in the initial classification is represented in columns (j) to (o) and in the two-dimensional classification in columns (d) to (i).

(a)	(b)	(c)	Two-dimensional classification						Initial classification					
Technique	**Description**	**References**	(d) **HS**	(e) **MS**	(f) **NHS**	(g) **SF**	(h) **C**	(i) **O**	(j) **BRA**	(k) **REL**	(l) **SCE**	(m) **RED**	(n) **MAT**	(o) **CON**
Affinity Diagram	This is a brainstorming technique aimed at aiding idea generation and grouping. It seems to be particularly good at identifying commonalities in thinking within the group. Relies heavily on using	Bicheno (1994, p39): Mizuno (1988)			*			*	*					

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
	a facilitator to run the session.													
Analytic Hierarchy Process	Saaty's AHP uses a (3 level) hierarchy to represent the relationships. Used in analysis of spare parts for manufactures.	Gajpal, Ganesh and Rajendran (1994)	*				*			*				
Attribute Association	Works from the premise that all ideas originate from previous ideas (ie. they are just modified ideas), based on lists of characteristics or attributes of a problem or product. Each characteristic is changed and the result discussed. A cross between brainstorming and matrix.	Couger, Higgins and McLyntyre (1993, p394)		*				*					*	
Association /Images technique	Tries to link and find associations between processes (and items).	Couger, Higgins and McLyntyre (1993, p385)			*		*		*					
Boundary Examination	Defining and stating assumptions about problem boundary.	Couger, Higgins and McLyntyre (1993)			*			*		*				
Brainstorming	Aimed at idea generation. See also lateral thinking.	De Bono (1977): Clark (1958): Waddington (1977)				*		*	*					
Brainwriting - Shared Enhancements Variation	Similar to brainstorming, but gets participants to record ideas themselves.	Couger, Higgins and McLyntyre (1993, App) Geschka (1996)				*		*	*					
Bug List	Gets participants to list items that 'bug' them about the system. Aims to get a consensus on what the problem areas are.	Couger, Higgins and McLyntyre (1993, App)		*			*		*				*	
Cognitive Mapping	Develops a model of inter-relationships	Eden (1992)			*		*	*		*				

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
	between different features.													
Common Cause Failures (CCFs)	More an engineering tool to identify common causes for possible failures.	e.g. Andrew and Moss (1993, p201)		*			*					*		
Critical Path Analysis (CPA), Critical Path Method (CPM)	See network techniques.	e.g. Jantsch (1967, p233)			*		*			*				
Critical Success Factors (CSF)	Looks at the critical factors which will influence the success of an IS or, from a strategic view, all the organisation's IS. It is a matrix type technique with the characteristics of the technique down one axis and the factors on the other axis. Note: this looks like it may also be appropriate to examine Critical *Failure* Factors.	e.g. Flynn (1992); Pinto and Slevin (1987)		*			*						*	
Cross-Impact Matrices	See matrix techniques.	Waddington (1977, p202)		*			*						*	
Decision Matrices	See matrix techniques.	e.g. Jantsch (1967, 206)		*			*						*	
Decision Trees	See tree techniques.		*				*			*				
Decomposable Matrices	The components of each sub-system are listed and arranged within a matrix and the interactions between elements are weighted. Relationships between components can then be focused on. [A cross between *matrix* and *relationship*.]	Couger, Higgins and McLyntyre (1993, App)	*	*			*						*	
Delphi	Aims to get a consensus view, or long-	e.g. Carley (1980,				*	*		*					

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
	term forecast, from a group of experts by iteratively polling them. Developed by Helmer and Dalkey at the RAND corporation in the 1960s.	p148): Waddington (1977)												
Dimensional Analysis	Aims to explore and clarify the dimensions and limits of a problem /situation. It examines five elements of a problem: substantive, spacial, temporal, qualitative and quantitative dimensions.	Couger, Higgins and McLyntyre (1993, App)		*	*		*						*	
External Dependencies	A list summary list of an external item that affect the project. Oblensky (1995, p313) these "need not be planned of detailed. However, they do need to be summarised to remind the project team that there are activities outside of the project which they need to be aware of".	Oblensky (1995, p313)		*			*						*	
Fagan Reviews	Effectively just getting a group of peers to critically review an analysis, design or code module.	Fagan (1976)				*	*		*					
Failure Modes and Effect Analysis (FMEA)	Examines the various ways a product, or system, can fail and analyses what the effect of each fail mode would be.	e.g. Bicheno (1994, p65); Andrew and Moss (1993, p66); Fortune and Peters (1995)	*	*			*						*	
Fault Tree Analysis	A tree approach to relating potential fault causes.	Vesely (1970);Andrew and Moss (1993, p144)	*				*			*				
Five 'Cs' and 'Ps'	Checklists of things to consider. (The Cs are Context, Customers, Company, Competition and Costs; The Ps are	e.g. Obolensky (1995, p252)		*			*						*	

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
	Product, Place, Price, Promotion, People).													
Five Whys	Invented by Toyota, it is basically developing a questioning attitude, to probe behind the initial given answers. There is also a 'Five Hows' along the same principles. These are very similar to the earlier lateral thinking 'Challenging Assumptions' and the examine stage of a Method Study.	Bicheno (1994, p58)		*			*						*	
Five Ws and the H	Who-what-where-when-why and how. Brainstorming techniques answering these questions.	Couger, Higgins and McLyntyre (1993, p382)		*			*	*	*					
Force Field Analysis	Idea generation and list technique to identify 'forces' pulling or pushing towards an ideal situation.	Couger, Higgins and McLyntyre (1993, p383)		*			*	*	*				*	
Future Analysis	A technique specifically aimed at IS development, it examines possible future scenarios which an IS would have to operate in.	Land (1982, p203)		*			*	*			*			
Gaming, Game Theory	Several gaming techniques to deal with competitive or conflict situation. See also Metagames and Hyper games.	e.g. Jantsch (1967,p237)			*		*							*
Hazard and Operability Studies	A systematic technique to assess the potential hazards of a project, system or	e.g. Andrew and Moss (1993, p52)	*	*			*					*		

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
(HAZOP)	process. Usually associated with the chemical industry.													
Hazards Analysis and Critical Control Points (HACCP)	Identifies critical points in the work processing which need controls or special attention. Usually associated with production, particularly food production.	Camden (1987)		*			*					*		
Hypergames	A variation on game theory which develops a 'game' from the prospective of the different stakeholders.	Bennet, Cropper and Huxham (1992, p283)			*		*							*
Influence Diagrams, Interrelationship Diagrams	Similar to Cognitive mapping, it generates logical relationships between events or activities.	e.g. Bicheno (1994, p39)			*		*			*				
'Johari' window of knowledge	The technique named after inventors (Joe Luff and Harry Ingham), tries to identify areas of understanding and lack of understanding.	e.g. Obolensky (1995, p290)		*	*		*						*	
Lateral Thinking Techniques:- Generation of Alternatives, Challenging assumptions, Suspended judgement, Dominant ideas and crucial factors, Fractionation, The reversal method, Brainstorming,	Several techniques, including:- The Generation of Alternatives, Challenging assumptions, Suspended judgement, Dominant ideas and crucial factors, Fractionation, The reversal method, Brainstorming, Analogies and, Random stimulation. Arguably these types of techniques would be suited to early analysis and problem identification. Equally, some of the techniques could be used in the later stages of systems development. For instance, Fractionation and Challenging assumptions could be	De Bono (1969,1970,1977)		*	*	*		*	*					*	

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
Analogies and, Random stimulation.	and Challenging assumptions could be used in a design situation. Many of these lateral thinking techniques have been modified and combined to make 'new' techniques.													
Maintainability Analysis	Examines the component parts of a system and analyses them, in probability terms, for easy of maintenance. Usually associated with engineering product design.	e.g. Andrew and Moss (1993, p218)	*				*					*		
Markov Chains, Markov Analysis	Uses probability to model different states within a system.	e.g. Andrew and Moss (1993, p229)			*		*						*	
Matrix Techniques, Matrix Analysis	There are several 'matrix' techniques which aim to represent and compare requirements or features in a matrix format. Some techniques add a weighting or ranking of the requirements or features.	e.g. Jantsch (1967, p206); Bicheno (1994, 43); Geschka (1996)		*			*						*	
McKinsey 7 S Framework	A diagnostic tool to identify the interactions within an organisation.	e.g. Obolensky (1995, p272)		*			*			*				
Metagames	A variation of game theory which attempts to analyse the processes of cooperation and conflict between different 'actors'.	Howard (1992, p239)			*		*							*
Morphological Approaches	This takes a systematic approach to examining solutions to a problem. It does this by identifying the important problem characteristics and looks at the solutions	e.g. Jantsch (1967, p175); Couger, Higgins and McLyntyre (1993, App); Geschka (1996)		*	*		*					*		

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
	for each of those characteristics. First developed by Zwicky, a Swiss astronomer, in 1942.													
Network Techniques	There are several diagramming techniques that can be classed at network techniques. Some, like CPM and PERT are very quantitative, relying heavily on numbers. Others like Interrelationship diagrams rely more on subjective logical relationships or connections.	e.g. Jantsch (1967, p75): Lucy (1992, p313)	*		*		*			*				
Nominal Group Technique (NGT)	Similar to Brainstorming.	Couger, Higgins and McLyntyre (1993, App)			*			*	*					
Opposition-Support Map	A representation of opposition and support for particular actions.	e.g. Obolensky (1995, p273)			*		*						*	
Options Matrix	See matrix techniques.	e.g. Obolensky (1995, p250)		*			*						*	
Planning Assistance Through Technical Evaluation of Relevance Numbers (PATTERN)	Developed by Honeywell, it is the first large scale application of Relevance Trees to numerical analysis, and makes use of computing support.	e.g. Jantsch (1967, p219)	*				*			*				
Precedence Diagramming Method (PDM) network	Similar to PERT, but has 4 relationships (FS finish - start, SS start - start, FF finish - finish, SF start - finish	Obolensky (1995, p308)	*				*			*				
Preliminary Hazard Analysis (PHA)		e.g. Andrew and Moss (1993, p60)	*	*			*					*		

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
Program Evaluation and Review Technique (PERT)	A networking technique similar to Critical Path Analysis, but addresses uncertainty in calculating the task times.	e.g. Jantsch (1967, 233)	*		*		*			*				
Rapid Ranking	Technique aims to list and rank the important issues to a problem.	e.g. Andrew and Moss (1993, p58)		*			*						*	
RBO - Rational Bargaining Overlaps	Technique used in negotiating situations.	e.g. Obolensky (1995, p297)				*	*							*
Relevance Trees, Reliance Trees	Relevance Trees (or Reliance Trees) sometimes referred to as hierarchical models or systems, probably first proposed by Churchman, Ackoff and Arnoff (1957).	e.g. Jantsch (1967, p219)	*				*							
Reliability Networks	These are representations of the reliability dependencies between components of a system. Similar to CPA/PERT type networks, but represent 'dependencies' rather than order of events. Once the networks are drawn then estimates for failure rates of each component can be evaluated. Similar to Relevance/Reliance Trees.	e.g. Andrew and Moss (1993, p214)	*	*			*			*				
Requirements, Needs and Priorities (RNP)	Based on lists and matrices, aims to understand the impact of an application on the organisation prior to development. Top management play a key role.	Batiste and Jung (1984)		*			*						*	
Risk Assessment/ Engineering /	Attempts to identify and, where possible, quantify the risks in a project. Usually	e.g. Grey (1995); Andrew and Moss	*	*			*					*		

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
Management	associated with large scale engineering projects but principles can be appropriate to smaller scale situations.	(1993); Chapman (1984, 1990); Beard (1969);Bohlman (1909)												
Robustness Analysis	The aim is to 'keep the options open'. It does this identifying and analysing a range of scenarios and examining actions are most 'robust' in those scenarios.	Rosenhead (1992, p193); Rosenhead and Mingers (2001)		*	*		*				*			
Scenario Writing / Analysis	Scenario planning gets participants to consider different possible futures for a particular area of interest.	e.g. Carley (1980 p148)				*	*	*?						
Shareholder Value Analysis (SVA)	Tries to identify the key values and needs of the shareholders and how those needs are currently being met.	e.g. Obolensky (1995, p47, p282)		*	*		*						*	
Stakeholder Analysis	Tries to understand the needs of the key stakeholders and how those needs are currently being met. It is effectively a range of techniques where different techniques are used for different stakeholder groups, e.g. use VCA for analysing supplier stakeholder group and SVA for analysing the shareholder stakeholders.	e.g. Obolensky (1995, p40)		*	*		*						*	
Simulation	The features and workings of a complex situation are simulated. The model can then be changed (either the inputs or workings of the model) to observe what will happen. Good for developing a deeper understanding of the problem area.	e.g. Carley (1980, p129): Andrew and Moss (1993, p244)			*		*							*

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
Strategic Choice	Aims to deal with the interconnections of decisions/problems. Focuses attention on alternative ways of managing uncertainty	Friend and Hickling (1997, p121) also in Rosenhead (1992)	*	*			*			*				
Strategic Options Development and Analysis (SODA)	Though it has a 'strategic' title it is aimed at getting consensus actions in messy situation.	Eden (1992)	*				*			*				
Soft Systems Methods (SSM)	A well known method aimed at problem identification and representing views of a problem form different stakeholders perspectives - a theme common in many of the subjective/qualitative techniques.	Checkland (1981)			*	*		*			*			
SIL - suggested integration of problem elements	A brainstorming technique, gets participants to write down ideas, then pairs of ideas are compared to integrate and interrogate the ideas.	Couger, Higgins and McLyntyre (1993, App)				*		*	*					
Synergistic Contingency Evaluation and Review Technique (SCERT)	Risk assessment technique used in oil processing installations, power plants and large engineering projects.	Chapman (1984)	*	*			*					*		
Systems Failure Method (SFM)	Looks at three level of influence: organisation, team and individual. Examines potential failure from these three levels.	Fortune and Peters (1995)			*		*	*?				*		*
SWAT analysis (Strengths, Weaknesses,	Generates perceptions of how customers (or others) view the organisation (or problem situation).	e.g. Obolensky (1995, p252)		*				*					*	

(a) Technique	(b) Description	(c) References	Two-dimensional classification						Initial classification					
			(d) HS	(e) MS	(f) NHS	(g) SF	(h) C	(i) O	(j) BRA	(k) REL	(l) SCE	(m) RED	(n) MAT	(o) CON
Opportunities and Threats)														
Tree Analysis	See decision trees.	e.g. Andrew and Moss (1993, p144)	*				*.			*				
Value Engineering/ Management	Similar to Value Chain Analysis.		*				*						*	
Value Chain Analysis	Analyses the supply chain within an organisation and tries to identify (and usually quantify) when extra 'value' is added to a product or service.	e.g. Obolensky (1995, p259)	*				*			*			*	
Wildest Idea	Tries to get people to come up with a wild idea to address a problem. With this as a starting point the group continue to generate ideas.	Couger, Higgins and McLyntyre (1993, App)				*		*	*					

Appendix B: MOA 1997 Autumn directive

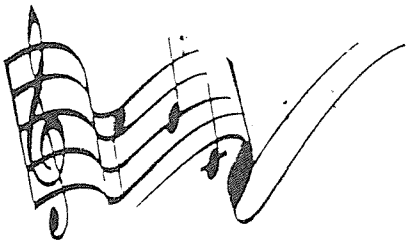
The following is a copy of the 'Autumn' 1997 directive from the Mass Observation Archive, distributed by the University of Sussex, in November 1997.

The first two parts of the directive cover aspects of music and dance. The third section covers questions on planning, the results of which are used in chapter 6 to inform and develop individual value functions.

Appendice

Autumn Directive 1997

Part One: Music



Please remember to start with a brief (2-3 line) autobiography: M-O number (NOT name), sex, age, town or area where you live, occupation or former occupation

Please could you tell us all about you and music. Remember that you don't have to answer all the questions, or all of them in the same order. Many of your answers will overlap, and that's fine. Also, as always, please include anything you feel I should have covered.

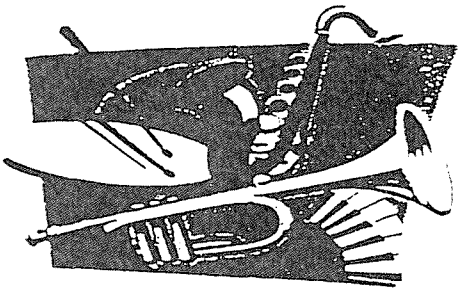
Does music play an important part in your life? What kinds of music do you enjoy? Have your tastes changed over your life?

What kinds of music do you dislike? Can you explain why you get more out of some kinds of music than others?

Do you play a musical instrument or sing yourself? Do you perform in public? Now or in the past? (Please tell us if you are in a band or group or orchestra or choir).

Have you ever had music lessons (other than classroom music)? What do you feel about yourself in relation to performing music? Are you, or could you have been, good at it?

Special Task No 1
If you were allowed only 6 pieces of music, which would you choose - and why?



Do you have special associations with music? Perhaps a piece of music reminds you of an important event, a film or TV show you like, a person you care about.

Do you have only positive associations, or are there negative ones too?

Do you use music in different ways? My mother used to play fast Greek music to get her going with the housework - do you have habits like this? Are they linked to particular times, places, activities or moods? For instance, you might use music in different ways at home, outdoors, or at work; in company or on your own; while you exercise, cook, study, make love, travel, or sleep; to cheer you up or calm you down. *PTO*

Music at home

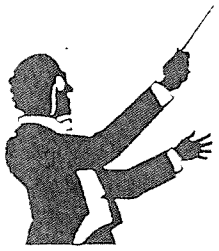
Listening: If you listen at home, which room do you use, when and why? What kinds of music systems do you use? Where are they located? How have they changed over the years? Is the radio important to you for listening to music? Which stations do you prefer?

If you live with other people, how do your music habits fit with those of the others?

Storing your music: If you have records, tapes or CDs, please describe where they are kept and how you arrange them. Please include the collections of other people in your home.

Live music at home: Do you have musical instruments in your home? Where are they kept? When and by whom are they used? Who listens?

Music in public places



Do you go out to concerts or clubs for live music? Please describe the kinds of events you enjoy. Please include comments on the cost, the venue, the audiences at the kinds of places you are familiar with.

Please include any musical experiences you have had in other countries, especially any you would enjoy experiencing again.

Special Task No 2
Describe the last time you listened to some music. What was it? Where were you? Who with? Day? Time? Did you enjoy it?

Do you enjoy music in pubs? Restaurants and cafés? Supermarkets? Shops? Streets? Do you ever *dislike* music in public places?

Do you belong to any music-related clubs, groups or societies? Or any fan clubs? Do you buy magazines or other publications (or other items such as t-shirts, badges, mugs) related to your musical activities and tastes?

Spending money on music

How do you budget for musical events or buying music?

Can you estimate how much you spend on:

(1) tickets for public performances
(2) on your sound system at home (or in your car or personal stereo system)
(3) buying tapes, records or cassettes

Could you give a rough estimate of cost for all these *over the past six months*?

Finally, have you been listening to music as you answer this directive? If you have, what was it?

Part Two: Dancing

Please remember to start on a new page with a brief (2-3 line) autobiography: M-O number (NOT name), sex, age, town or area where you live, occupation or former occupation

What kind of dancing do you like? Think very widely and include everything from ballroom to ballet, from line-dancing to disco, from flamenco to morris dancing, barn dancing to the waltz, tap dancing to jigs, tangos to jive, belly dancing to tea dancing..... In the Archive we have accounts of people doing the "Lambeth Walk" and "Knees up Mother Brown". Does anyone remember these?

Please describe any dancing you do now or have done in the past? It would good if you could include details such as:

- the kind of dancing you do (dance names, steps etc)
- where you do it
- with whom (a partner, a group)
- the accompanying music (is it live?)
- the clothes and shoes you wear

Special Task N°3

Supporting I had to edit a new M-O anthology of Dance Stories - experiences of Mass-Observers over the years.... What would you send in? Stories please of your experiences — good & bad, about dancing! Thanks. D.

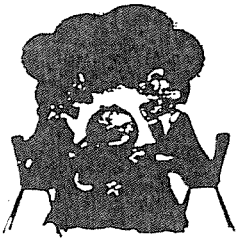
Do you ever dance at home?
Have you had lessons?
Please include how your experience has changed over time.

Do you watch dancing - live on stage or in dance halls, in films or on TV? What kind do you enjoy?

Part Three: The Future

Please remember to start on a new page with a brief (2-3 line) autobiography: M-O number (NOT name), sex, age, town or area where you live, occupation or former occupation

Finally, three questions - please write as much as you feel able.



How far into the future do you usually plan?

What things do you usually plan for?

What does the "Millennium" mean to you?

DS/17 Nov 1997/Dir. No. 53

The Mass-Observation Archive ▲ The Library ▲ Freepost 2112 ▲ University of Sussex ▲ Brighton BN1 1ZX

Appendix C: Brief transcript of project manager's audio diary: Some key events and activities

This Appendix supports chapter 8 and contains extracts from the transcript of a project manager's audio diary. The transcript is an abbreviated version covering some of the main events in the project development, much of which is covered in chapter 8. However, this transcript includes some inflections evident from the audio diary and some of the colloquialisms used by the project manager. It also contains some of the breaks, pauses and grammatical errors, colloquialisms, and in some places shows some cognitive development while maintaining the diary. As such this transcript gives a better indication of the feelings and thoughts of the project manager during the project. The transcript covered in chapter 8 did not include inflections since the focus of the chapter was on representing a list of critical events.

Note: Names of projects and people have been changed to ensure the anonymity of the participants.

Key:

Inflections are included in square brackets, []

[p] indicates a pause

Project transcript:

Project for NEWTV starting at 30th June.

The project will be kicked off um on 1st week in July with a weeklong workshop by taking a selection of developers, key personnel, away for a week at Henley Rowing club. I will be running the project, sorry, I will be running the workshop for the full week. Unfortunately NEWTV can't afford additional support.

I am not looking forward to this. I think its unreasonable to take a group of 8 individuals all who are under 25 down to a rowing club for a week to run a workshop. How much work will get done I haven't the faintest idea, but given the fact that this is so important to NEWTV I'd better do my best shot.

Background on the project.
The NEWTV launched on the 15th March 1997 with an analogue service in the central region. The service was aimed at C2/C3/D1s the service take up required the purchase of a set top box for £99.99. Or £121 if you wanted Nicam. Sorry it was £129.99 if you wanted Nicam and a monthly subscription of erh £6.99 thereafter.

Whereas I don't believe that the product was, is, as particularly appealing, that is from my perspective, er, the marketing was aimed at a different market place, and although, er. well I think basically their marketing was absolutely crap and the whole thing failed.

The take-up in the first couple of weeks of em. Sales were minimal [left hanging - unsaid - possibly over written]

The strategy changed very quickly to one which they would give the box away and increase the monthly subscriptions to £9.99. This was also supported by free giveaways um and various other combined um activities such as three months free subscription um sale or return and various other things like this. Even so after er three months they still only had 2800 subscribers and the subscribers, how can we put it, were not frequent users, most of them were returning after their free period, and the service was dwindling. This was this showing was incredibly poor given that the original business plan showed that millions of people will be buying the set top boxes.
The analogue service is doomed it will be truncated very quickly. The backers will not support the cost of broadcasting for very much longer they have indicated that, um, future financing would be extremely limited if NEWTV continued in the same vain. NEWTV have been give three months to come up with an alternative strategy. The strategy at the moment is 'we will go digital'.

We've tried to isolate what that exactly means, but Fred **[the MD]** *being Fred, means that his* [p] *focus, thinking is as cloudy as ever.*

Workshop Planning.

When I am [sic] going to have time to do this I haven't the faintest idea, but [p] *it has to be done - probably at the weekend. Not quite sure what Richard's going to think about this but there you go.*

Friday before the workshop.

There's been lots of meetings about what going digital means, what they actually want out of this workshop but I have yet not planned the work shop - which is great fun. The only thing that has actually been planned is that we have got a hotel that's er prepared to take up 4 of the staff because the Liander Club can't hold them all. Having a split group doesn't help um on what basis we split the rooms god above knows. At the moment I'm suggesting a first come first served basis.

The other thing that I have suggested is that Fred because he has failed to come and talk to the staff before the workshop about financial packages for them. Given the uncertainty of the um er, environment and the part of the retention package because he's failed to do this um today having set up meetings and having cancelled them at the last minute four times I've asked him to come on Monday to the workshop and open the workshop and have a word with the staff before it starts. Start of the workshop is 9:30 um I suspect that in reality if Fred does a one to one with the staff we won't actually start it for real till about 11.

Harry **[the previous project manger]** *who is a subject of being exited out of the company by Fred and in his true style of Machiavellian manoeuvrings um will be told on over this weekend by Fred that his services will not be required after the workshop. I'm not quite sure if this is a sensible approach and what effect this will have on the staff that are contracted to Harry. Harry has got a wealth of support.*

Saturday.

I've got to plan this workshop. I'm not quite sure how I'm going to do it. Planning that is, not the workshop, I haven't even thought about that.

Monday morning 6 o'clock.

I feel absolutely dreadful.[and sounds it] *Um Well the workshop has been planned the, it was done while Richard was doing his ironing last night which probably demonstrates the level of planning I've done. I think the structure's OK, er, I'm expecting an awful lot of the er lads um I'm sure they will deliver. A bit worried about three of them 'cause I don't really know them I mean I've met them but that's about it. They're part of Mark er Jeffrey's group. Um I'm going to open up, and say exactly what the situation of the company is, why we've doing things. And I think honesty is going to be the best policy.*

Harry didn't phone over the weekend so presumably Fred hasn't contacted him at all. Er, not quite sure what if that indicates that Fred's changed his mind as he frequently does or whether the opportunity didn't arise or he just cowarded out which he frequently does.

Monday night.

I think the workshop went reasonably OK to be honest. Er, the introduction went well. Fred of course didn't turn up! I got a message 5mins before he is due to be there to say that he couldn't make it, he's got something more important. [p] *I'm not quite sure what could be more important but there you go. Er I think he is trying to save his own neck more than anything else but at the same time I think he is actually jeopardising the loyalty of the staff. He didn't say anything to Harry because he wants to see how the workshop goes so which means that he's going to not [sic] tell Harry till Friday morning. Good start ey!*

The lads were absolutely wonderful apart from the fact of um in terms of the workshop the person that's a real pain in the neck as could be predicted is Wilbert. Wilbert is now exceedingly greedy um he wants wants wants wants and he wants it on the table there and then and, he really did want er some assurance from Fred that he would get the financial package that he wants before he was going to contribute towards the workshop. I'm absolutely getting pig sick of er hearing wingeing from this lad. If he carries on much more I am just going to dress him down.

I've had to leave the lads in the em to their own devices tonight because I've got a council meeting which means they are probably going to go on the razzle but [p] *I'm afraid my council meeting's more important than Fred!.*

Tuesday.

Wilbert **[one of the developers]** *went over the edge to day and just* [p] *And this morning I arrived to a lot of wingeing and abuse of the staff. They failed to realise they have got to pay their own expenses and they will be reimbursed and er the they believe that all drinks for the entire week should be paid for by the company I haven't the faintest idea whether this lot have been born or not. Wilbert pushed me over the edge, this the first thing in the morning, and I gave him and I ripped him off, and as a consequence he hasn't contributed all day. If he keeps this up much longer I will ask him to leave.*

Richard has been a brick. He has done all the documentation directly into his lap top um and this is going to be the log of the workshop and part form part of the final document. The objective of the of tomorrow is to get them thinking about how we could produce and architectural document for how we would put the service onto digital. Er I'm going to leave this um I must admit I found this workshop very very tiring. I left them tonight at about 10pm, and to be perfectly honest I just want to go back to the hotel and sleep, I'm knackered!

Wednesday.

The lads are working more on their own and breaking off and forming discussion groups in their own discreet areas, which is good. The three of Jeffrey's ***[another project manager at NEWTV]*** *lot um are integrating into the team and in actual fact the team is coming together nicely thank you very much. Um today I have enjoyed, even Wilbert has come out of his shell, and Charles* ***[one of the developers]*** *has been an absolute brick.*

Harry is getting lonely, erm he keeps ringing up and asking if there is anything he can do. In actual fact he's quite sweet.

Thursday.

We've just about got the document, the architectural document sorted and we're got some we got a presentation for Fred in the morning. Fred rang up today to ask whether its appropriate that he should be here. I could have cru... throttled him! He said he's got a lot of important things to do um [p] *I'm afraid Fred's not exactly endearing himself to me.*

The lads have done a sterling job and they are actually going to do the presentation tomorrow not me. [p] *So its going to be interesting.*

Harry's coming tomorrow at the request of Fred. That is also interesting, I wonder when Fred is going to tell Harry.

Presentation to Fred and Bobby **[a senior finance executive]** *and Harry*
[end of side one of tape one]

Presentation to Fred and Bobby went very well. Erm they are very pleased with the document it needs a lot of work to tidy it up but it was an excellent document. Fred of course didn't turn up till um after 12oclock, he hasn't spoken to the staff, nor has Bobby. er Charles was an absolute gem, he told them exactly what he thought of the marketing. And why that er NEWTV are in the situation that they are in. Honesty hurt, it was written all over Bobby's face.

Richard's [project manager's partner] *going to come down erm he's going off to Bournemouth and I'm going up back home. I'm absolutely shattered.* [Sounds quite shattered - and a little relieved]

I really feel quite drained, running a workshop on your own is not a good idea.

End of second week of July.
On Monday [p] Fred did not [p] talk to the staff [p]. He asked me to do it. [sounds angry] *The package that he agreed to is not what they wanted, not what he told me he was going to give them. er It falls a long way short, the reason being is a lack of finance. But the staff have given a lot for this and they don't deserve the package that they have been offered even though it is a generous package by normal standards. This is not what was given by any indication to expect. He left me to deliver the message, the result [p], both Wilbert and Paul* **[one of the developers]** *have handed in their resignation. This is going to be a big hole in the project and puts the project at risk. Fred has only got himself to blame.*

The document that they produced in the workshop needs to be reviewed and amended to take out all the politically incorrect statements. And needs to be put into a form that erm that is publishable. I am annoyed with Harry this week um I've tried to instil on the staff the importance of documentation as a sales mechanism. [and] He has undermined this and said just get on with the work. As you can gather by that comment, Fred still hasn't addressed the issue of Harry.

Third week July .
Held a project planning meeting this week er to try and get some idea of a project plan and when things can be done. Delivery 'One' should be ready within 8 weeks. When we've actually started to plan it out it looks more like to be three months but that's to be expected. um The amount of effort that went into the workshop's time estimation was negligible. But Fred didn't like it.

The project plans having to being revised as er a result of loosing Wilbert and um Paul. They're bringing documentation up to date. But I've asked them to work off site because they are a disruptive influence.

The Last week in July.
Fred has started to ask people to do work outside the project, without asking me first. How in earth he expects me to keep to a project plan I haven't the faintest idea.
[Sounds angry/frustrated? Break in recording - possibly things taken out?]

He wants investigation on open TV, which apparently does the same thing as we was suggesting in the architectural design. [Further break in recording - possibly things taken out?]

I am not in control of this project, I I I have no authority, no support and Fred is [p] not focused on an end objective [sounds 'upset' and angry]. *If the architectural document and the strategy that we were pursuing were incorrect we all need to start again. But that needs to be done at a managerial level and not for him to go round my back* [definitely sounds 'upset' and angry].

Bobby has asked the report to be sent to the backers to demonstrate the fact that they have got a strategy. I'm not sure what the backers are going to make of an architectural document but there you go.

First week August.
Fred is again asking staff to do more work on open TV. This is taking away ... [break in recording - possibly things taken out? Does not sound too happy]

Effort from the digital project, which from what I can gather but reading between the lines because nothing has been said overtly, is not going to happen in the way that we thought it was.

Fred is ex still expecting the digital project first delivery to be within 8 weeks, even though he he's asking staff to do things that are not in the project and he's taking away approximately 50% of a reduced resource. He is pushing me for a project plan, I don't even know what project I'm planning for! [sounds fairly upset/angry] [break in recording - possibly things taken out?]

I've had a word with Fred and he nods his head and looks at me and grins. Had a word with Jeffrey this week he is as confused as I am about the situation over Harry.

Third week August.
Glad of my break. I was hoping that I would come back feeling better, but I don't.
I feel still feel resentful over Fred and he is actively managing the staff now. I have very little control, I feel like a puppet. I'm not quite sure what I'm contributing.

First Week September.
*Resources are very scarce in NEWTV there's actually no money. Even so they've sent three staff on a trip to France looking into open TV. [*break in recording - possibly things taken out?]

NEWTV can't even afford the development kit of open TV so I'm not quite sure how they are going to proceed. They have got a backers meeting but I'm not sure the backers are going to

come up with very much money. The order that I placed right at the beginning of the project for prerequisites is still not being satisfied. Fred doesn't think that a prerequisite is a prerequisite. The project has not really started. Further round of redundancies. I don't think at this stage that I'm going to be able to keep all the staff (slight pause) that are not working on digital issues. I will actively plan the security over the redundancies over the next week. And the plan should be ready by the end of next

Second Week of September.
The second week of September saw more redundancies, NEWTV have now dwindled to about 50 staff. Em The place looks like a morgue, they can't really afford me, they are going to put me down to one day a week, I don't think that is really viable. Er [p] The project is ended, essentially. Um I can't do any more.

The project documentation needs to be brought up-to-date as far as it went. Um this is just for archiving purposes. No use will come of it.

NEWTV have completely changed their strategy, they are still desperately short of money. The strategy now seems to be dwindling into software projects for digital TV producers. They are going to have massive problems. CWC are interested in NEWTVs offerings, but the financial guy does not want CWC to be at risk by a company that is about to go under. I heartedly agree.

The analogue service to the Midlands was closed. This is causing an additional workload that will see me through till the um the first week in October. I will not be working on the digital project, as I say it didn't really exist.

I'm not really sure where the money is going to come from to work on these additional projects, I think closing down of NEWTV is a real possibility.

Last update on what was the digital project.
Some of the concepts and designs in the original technical architectural document are going to be subject to patents. It does look as though open TV have omitted certain niceties of operating in a live environment that were in that architectural document.

It could be that we could sell or licence the use of the design to be implemented within open TV.

This is going to be the last update of the digital project.

Media project.

First day back on holiday is the third of November.

[Manager at consultancy] *wants me to help create a media marketplace offering. I am actively pursuing that, it is something I really wanted to do. Essentially I'm picking up from where I left off last year.* [Sounds a lot happier]

Appendix D: Structured Interview questions: Dealing with uncertainty within ISD

This appendix supports chapter 10. It contains the structured questionnaire used as the basis for the interview sessions at the case study.

Main areas of questions:

- Risk aversion of developer
- Planning attributes of developer
- Experience/expertise of developer (including techniques/methods used)
- Main activities of developer
- Team/group cohesion
- How to address problems/uncertainty
- Any specific examples

Questions to be a mix of open and closed questions.

Questionnaire/Interview Session Sheet

Interview Date ..... Time ..... Name: .....

.....

...

Section A: Experience/expertise Questions

Job title: .....

Experience and areas of expertise

Previous experience (years):
Experience at present company (years):
Do you use any development method/methodology(s): [eg SSADM]
Have you a preferred development method/methodology(s)?
(if so which)

Do you use any development 'tools' [non-software and/or software]?
(eg Brainstorming, DFDs)

Have you any preferred development tools?
(if so which)

Main activities of developer

Could you describe your main work activities? (eg over a week)

Team/group interaction

Do you have much interaction with the other members of your development team to do your work?
What form of interaction usually takes place?
Do you have much interaction with other people **outside** your development team to do your work?
Is team work important for your work?
What form of interaction usually takes place?

.....

...

Section B: Risk and Planning Questions

Risk aversion of developer

Do you class yourself as risk averse? (ie do you like taking risks)

How much would you bet for a 50/50 chance of winning

a) £5? b) £50?
c) £500? d) £5000?
e) £5M?

If you are working on a project which was running 1 **month** over time (and costs), what would be your response to taking a 'gamble' to rectify the situation as follows:
(*say the gamble is using a relatively untried development resource, or a radical redesign or missing a section out*)

e) Take a gamble where there was a 50:50 chance that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further **week**.

Yes take gamble / No don't take gamble / depends

f) Take a gamble where there was a 50:50 chance of that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further **month**.

Yes take gamble / No don't take gamble / depends

g) Take a 60:40 gamble (ie 60% chance of success) that the project would be put one month a head of schedule/budget, but there will also be a 40% chance that the project will slip a further **month**.

Yes take gamble / No don't take gamble / depends

h) Take a 10:90 gamble (ie 10% chance of success) that the project would be put back on schedule/budget, but there will also be a 90% chance that the project will slip a further **week**.

Yes take gamble / No don't take gamble / depends

Would your answers be different if the time scale was a **year** instead of a **month**?
(If so how?)
eg project which was running 1 **year** over time (and costs), would you:-

i) Take a gamble where there was a 50:50 chance of that the project would be put back on schedule/budget, but there will also be a 50:50 chance that the project will slip a further year.

Yes take gamble / No don't take gamble / depends

j) Take a 60:40 gamble (ie 60%chance of success) that the project would be put one month a head of schedule/budget, but there will also be a 40% chance that the project will slip a further **month**.

Yes take gamble / No don't take gamble / depends

k) Take a 10:90 gamble (ie 10% chance of success) that the project would be put back on schedule/budget, but there will also be a 90% chance that the project will slip a further **two months**.

Yes take gamble / No don't take gamble / depends

Questions on Planning/Spontaneity

Do you class yourself as a planner?
On a scale of 1 to 10, where 10 = an 'obsessive planner' and 1= 'don't like/do planning', where would place yourself?

Do you do a lot of planning at home? (eg for holidays, weekly events)
Do you do a lot of planning at work?
Do you find it stressful if your plans do not work out?
Do you like having to work to other people's plans?

Do you like spontaneity?
On a scale of 1 to 10, where 10 = an 'live for/love spontaneity' and 1= 'don't like spontaneity', where would place yourself?

Do you find it stressful?
Do you generally like surprises?

.....
...

Section C: Questions on dealing with problems, inconsistencies and uncertainty

How address problems, inconsistencies, uncertainty

Do you encounter many **problems** in your work?
What form do they usually take?
Any example?

Do you encounter many **inconsistencies** in your work?
Can you give any examples that you have encountered?

If you encounter some **inconsistencies,** say in the requirements, how would you try and resolve them?
Can you give any examples?

Do you encounter many **uncertainties** in your work?
Can you give any examples that you have encountered?

If you encounter some **uncertainties**, say in whether a requirement is wanted, how would you try and resolve them?
Can you give any examples?

References

Adams C. (1996) Techniques to deal with uncertainty in information systems development, paper presented at 6th annual conference of Business Information Systems, BIT'96, 7th November 1996, Manchester Metropolitan University.

Adams C. (1998) Planning activities: Lessons for information systems development. Paper presented at 8th annual conference of Business Information Systems, BIT'98, November 1998, Manchester Metropolitan University.

Adams C. (2000) Planning Activities: Lessons for IS development. In: Hackney R. and Dunn D. (Eds), *Business Information Technology Management: Alternative and Adaptive Futures.* Macmillan Press, Basingstoke, UK, pp25-39.

Adams J. (1987) *Conceptual Blockbusting, a guide to better ideas.* Penguin, Harmondsworth, Middlesex, England.

Allais M. (1953) Le Comportement de l'Homme Rationnel devant le Risque, Critique des Postulats et Aximoes de l'Ecole Americaine. Econometrica, 21, pp503-546.

Anderson J.R. and Bower G.H. (1973) *Human associative memory.* Winston, Washington.

Anderson J.R. (1987) Skill acquisition: compilation of weak-method problem solutions. *Psychological Review,* 94, pp192-210.

Anderson R.G. (1974) *Data processing and management information systems.* MacDonald and Evans, London.

Andrew J. and Moss T. (1993) *Reliability and risk assessment.* Longman, Harlow, UK.

Atkinson J. (1994) *Coping with stress at work.* Thorsons, London.

Attewell P. and Rule J. (1991) Survey and other methodologies applied to IT impact research: Experiences from a comparative study of business computing. In: Kramer K. (ed.)

The information systems research challenge: Survey research methods, Harvard Business School Press, Boston, 3, pp299-315.

Avison D.E. and Fitzgerald G. (1988) *Information systems development, methodologies, techniques and t-ools*. Blackwell Scientific, Oxford.

Avison D.E., Powell P. and Adams C. (1994) Identifying and incorporating change in IS. *Systems Practice*,7, 2, pp143.

Avison D.E. and Myers M.D. (1995) Information systems and anthropology: an anthropological perspective on IT and organisational culture. *Information Technology and People*, 8, 3, pp43-56.

Avison D.E. and Fitzgerald G. (1995) *Information Systems Development: Methodologies, Techniques and Tools*. 2nd. ed., McGraw-Hill, London.

Barker-Bausell R. (1991) *Advanced Research Methodology*. The Scarecrow Press, Metuchen, New Jersey.

Barsalou L.W. (1992) *Cognitive Psychology: An overview for cognitive scientists*. Lawrence Erlbaum Associates, New Jersey.

Batiste J. and Jung J. (1984) Requirements, Needs, and Priorities: A structured approach for Determining MIS Project Definition. *MIS Quarterly*, 8, 4, pp 215-227.

Beard R. (1969) *Risk Theory*. Methuen, London.

Beck U. (1992) *Risk Society: Towards a New Modernity*. Sage, London.

Beedle M., Devos M., Sharon Y., Schwaber K. and Sutherland J. (1999) SCRUM: An extension pattern language for hyperproductive software development. In: Harrison N., Foote B. and Rohnert H (eds) *Pattern languages of program design 4*. Addison-Wesley.

Bell F. and Oates B. (1998) *Two frameworks for understanding and evaluating IS methodologies*. In: Matching Technology with Organisational Needs, Proceedings of the 3rd UKAIS Conference, Lincoln University, McGraw-Hill, pp321-330.

Bennet P., Cropper S. and Huxham C. (1992): Hypergames. In: Rosenhead J. (ed) (1992) *Rational analysis for a problematic world, problem structuring methods for complexity, Uncertainty and Conflict*. Wiley, Chichester.

Bertaux D. (1981) From the life history approach to the transformation of social practice. In: Bertaux D. (ed.) *Biography and society: the life history approach in the Social Sciences*. Sage, London.

Bicheno J. (1994) *The quality 50: A guide to gurus, tools, wastes, techniques and systems*. PICSIE Books, Buckingham.

Biggs S.F., Rosman A.J. and Sergenian G.K. (1993) Methodological issues in judgment and decision-making research: Concurrent verbal protocol validity and simultaneous traces of process. *Journal of Behavioral Decision Making*, 6, pp187-206.

Block R. (1983). *The politics of projects*, Yourdon, New York.

Bloome D. and Sheridan D. (1993) Reading Mass-Observation Writing: Theoretical and methodological issues in researching the Mass-Observation Archive. *Mass-Observation Archive Occasional, Chapter 1*, University of Sussex Library, UK.

Bloomfield B.P. (1992) Understanding the social practice of systems developers, *Journal of Information Systems*, 2, pp189-206.

Bohlmann 1909: Theory of Risk, Transactions of International Congress of Actuaries, Vienna 1909. [Referenced in Beard (1969) – original unobtainable]

Boland R. and Hirschheim R. (eds.) (1987) *Critical issues in information systems research*. Wiley, Chichester.

Boland R. and Greenberg R. (1988) Metaphorical structuring of organisational ambiguity. In: Pondy L., Boland R. and Thomas H. (eds) *Managing ambiguity and change.* Wiley, Chichester, pp17-36.

Boritz J.E. (1986) The effect of research method on audit planning and review judgements, *Journal of Accounting Research*, 26, pp335-348.

Brannon L. (1996) *Gender: Psychological perspectives,* Allyn and Bacon, London.

Brooks F.B. (1982) *The mythical man-month, essays on software engineering.* Addison-Wesley, London.

Calder A. and Sheridan D. (eds.) (1984) *Speak for yourself: A Mass-observation anthology, 1937-49*, Jonathan Cape, London.

Camden (1987) *Guidelines to the establishment of Hazards Analysis and Critical Control Points (HACCP),* Camden Food and Drink Association 1987, Technical manual No. 19.

Caplan P. (2000) 'Eating British beef with confidence': A consideration of consumers' responses to BSE in Britain. In: Caplan P. (ed) (2000) *Risk Revisited.* Pluto, London, pp 184-203.

Carley M. (1980) *Rational techniques in policy analysis.* Gower, Aldershot.

Case T. and Smith L. (1995) *Managing Local Area Networks.* McGraw Hill, London.

Chambers A.D. and Court J.M. (1991). *Computer Auditing*, 3rd ed. Pitman.

Chapman C.B. (1984) Model and Situation Specific O.R. Methods: Risk Engineering Reliability Analysis of L.N.G Facility, *Journal Of Operational Research,* 35, 1, p27.

Chapman C.B. (1990) Risk Management, *Project Management*, 18, 1, p5.

Checkland P. (1981) *Systems Thinking, Systems Practice*. Wiley, Chichester.

Ciechanowicz Z. (1997) Risk analysis: Requirements, conflicts and problems, Computer and Security, 16,3, pp223-232.

Chipman (1996) Still far too sexy a topic, *Behavioral and Brain Sciences*, 19, pp248-249.

Churchman C., Ackoff R. and Arnoff E. (1957) *Introduction to Operations Research*. Wiley, New York.

Clark C. (1958) *Brainstorming - the Dynamic New Way to Create Successful Ideas*. Doubleday, Garden City, New York.

Connell N. and Powell P. (1992). *Measuring success and failure in the commercial application of expert systems: 'Hard' measures for 'Soft' systems*. Artificial Intelligence in Operations Research, MacMillan, p349-357.

Couger D., Higgins L. and McLntyre S. (1993) (Un)Structured Creativity in Information Systems Organisations, *MIS Quarterly*, 17, 4, pp375-397.

Couger D. (1995) *Creative Problem Solving and Opportunity*. Boyd and Fraser, Massachusetts.

Crossland (1992) Engineering Risk. In: The Royal Society (1992) *Risk Analysis Perception and Management*, The Royal Society, UK.

Crozier R. and Ranyard R. (1999) Cognitive process models and explanations of decision-making. In: *Decision-making cognitive models*, Ranyard R., Crozier R. and Svenson O. (eds), Routledge, London.

Daft R.L. and Lengel R.H. (1984) Information richness: A new approach to managerial behaviour and organization design, *Research in Organizational Behaviour*, 6, pp191-233.

Day S. (2000) The politics of risk among London prostitutes. In: Caplan P. (ed) (2000) *Risk Revisited.* Pluto, London, pp 29-58.

de Bono E. (1969) *The mechanism of mind.* Penguin, Harmondsworth, Middlesex.

de Bono E. (1970) *The use of Lateral Thinking.* Penguin, Harmondsworth, Middlesex.

de Bono E. (1977) *Lateral Thinking: A textbook of creativity.* Penguin, Harmondsworth.

de Marco T. (1979) *Structured analysis and systems specification*, Prentice Hall, Englewood Cliffs, New Jersey.

de Neufville R. and Stafford J.H. (1971) *Systems analysis for engineers and managers.* McGraw-Hill, New York.

Douglas M. and Wildavsky A. (1982) *Risk and culture: an essay on the selection of technical and environmental dangers*, University of California Press, Los Angeles.

Dowker A. (1996) How important is spacial ability to mathematics?, *Behavioral and Brain Sciences*, 19, pp251.

Downs E., Clare P. and Coe I. (1988) *Structured systems analysis and design method*, Prentice Hall, London.

Easterby-Smith M., Thorpe R. and Lowe A. (1996) *Management research: An introduction*, Sage, London.

Eden C. (1992): Using Cognitive Mapping for strategic options development and analysis (SODA). In: Rosenhead J. (ed) (1992) *Rational Analysis for a Problematic World, Problem Structuring Methods for Complexity, Uncertainty and Conflict.* Wiley, Chichester.

Epstein H. (1996) Omissions relevant to gender-linked mathematical abilities, *Behavioral and Brain Sciences*, 19, pp251-252.

Equinox (1999) *Living dangerously: The complex science of risk.* Channel 4 Television, London.

Ericsson K. and Simon H. (1980) Verbal reports as data, *Psychological Review*, 87, pp215-251.

Ericsson K. and Simon H. (1984) *Protocol analysis*. MIT Press, Cambridge M.A.

Ewusi-Mensah K. and Przasnyski Z. (1994) Factors contributing to the abandonment of information systems development projects, *Journal of Information Technology*, 9, pp185-201.

Ewusi-Mensah K. and Przasnyski Z. (1995) Learning from abandoned information systems development projects, *Journal of Information Technology*, 10, pp3-14.

Fagan M.E. (1976) Design and code inspections to reduce errors in program development, *IBM Systems Journal*, 15, 3, pp182-211.

Farbey B., Targett D. and Land F. (1994) A Note in Evaluating Investments in IT, *Journal of Information Technology*, 9, pp238-243.

Fazlollahi B. and Tanniru M. (1991) Selecting a requirement determination methodology - contingency approach revisited, *Information and Management*, 21, pp291-303.

Feldman J. (1997) Regularity-based perceptual grouping, *Computational Intelligence*, 13, 4, pp582-623.

Ferguson T. Olthof T. and Bronneberg L. (1985) The experience and resolution of inconsistency in children, European Bull, *Cognitive Psychology*, 5, (3-4), pp378-388.

Finley P. (1994) *Introducing Decision Support Systems*. NCC Blackwell, Oxford.

Fitzgerald B. (1996) An investigation of the use of systems development methodologies in practice. In: Coelho J. et al. (eds*) Proceedings of the 4th ECIS*. Lisbon, pp143-162.

Fitzgerald B. (1997) The nature of usage of systems development methodologies in practice. In: Avison D.E. (ed), *Key Issues in Information Systems, Proceedings of the 2nd UKAIS Conference*, McGraw Hill.

Fitzgerald G. (2000) Adaptability and Flexibility in ISD. In: Hackney R. and Dunn D. (Eds), *Business Information Technology Management: Alternative and Adaptive Futures*, pp13-24. Macmillan , Basingstoke.

Fletcher B. (1991) *Work, Stress, Disease and Life Expectancy*. Wiley, Chichester.

Flynn D.J. (1992) *Information Systems Requirements: Determination and Analysis*. McGraw-Hill, London.

Flynn D.J. and Warhurst R. (1994) An empirical study of the validation process within requirements determination. *Information Systems Journal*, 4,3, pp185-212.

Forester T. and Morrison P. (1990). *Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing*, Basil Blackwell, Oxford.

Fortune J. and Peters G. (1995) *Learning from Failure, the systems approach*. Wiley, Chichester.

Friend J.K. and Hickling A. (1997) *Planning under pressure: the strategic choice approach*. Butterworth-Heinemann, Oxford.

Gabbay D. and Hunter A. (1991) Making Inconsistency Respectable: A logical framework for inconsistency reasoning, *Lecture notes in Artificial Intelligence*, 535, pp19-32, London Imperial College.

Gable G. (1994) Integrating case study and survey research methods: an example in information systems, *European Journal of Information Systems*, 3, 2, pp112-126.

Gabor D. (1968) *Technological forecasting in a social frame*. Science of science foundation, London.

Gajpal P.P., Ganesh L.S. and Rajendran C. (1994) Criticality analysis of spare parts using the analytic hierarchy process, *International Journal of Production Economics*, 35, pp293-297.

Galliers R. (1987) IS planning in the UK and Australia - a comparison of current practice, *Oxford Surveys in IT*, 4, pp223-255.

Galliers R. (1992) *Information Systems Research, Issues, Methods and Practice*. Blackwell Scientific Publications, Oxford.

Galliers R. (1993). Towards a flexible information architecture: integrating business strategies, information systems strategies and business process redesign, *Journal of Information Systems*, 3, pp199-213.

Gane C. and Sarson T. (1979) *Structured Systems Analysis*. Prentice Hall, Englewood Cliffs, New Jersey.

Ganzach Y. (1994) Inconsistency and uncertainty in multiattribute judgement of human performance, *Journal of Behavioural Decision Making*, 7, pp193-211.

Ganzach Y. (1995) Negativity (and positivity) in performance evaluation: Three field studies, *Journal of Applied Psychology*, 80, 4, 491-499.

Gasson S. (1998) Framing design: A social process view of information systems development. In: Proceedings of the 19th International Conference on Information Systems (ICIS '98), Helsinki, Finland, December 1998, pp224-236.

Geary D. (1996) Sexual selection and sex differences in mathematical abilities, *Behavioral and Brain Sciences*, 19, pp229-285.

Geschka H. (1996) Creativity techniques in Germany, *Creativity and Innovation Management*, 5,2, pp87-92.

Giddens A. (1991) *Modernity and Self-Identity: self and society in the late modern age.* Polity Press, Cambridge.

Gillam B. (1992) The status of perceptual grouping 70 years after Wertheimer, *Australian Journal of Psychology*, 44, 3, pp157-162.

Gladden (1982) Stop the life-cycle, I want to get off, *Software Engineering notes*, 7, 2, pp35-39.

Glass R. (1991) *Software conflict: Essays on the art and science of Software Engineering.* Yourdon, New York.

Grey S. (1995) *Practical Risk Assessment for Project Management.* Wiley, Chichester.

Griffiths M. (1997) The National lottery and scratch cards, *The Psychologist*, 10, 1, pp23-26.

Grindley K. (1992) *Information technology review*, Price Waterhouse.

Groth J. and Peters J. (1999) What blocks creativity? A managerial perspective, *Creativity and Innovation Management*, 8, 3, pp179-187.

Hall P. (1980) *Great planning disasters.* Weidebfeld and Nicholson, London.

Hard C.J., Thompson B.J. and Edwards H.M. (1995) The use, limitation and customisation of structured systems development methods in the United Kingdom, *Information and Software Technology*, 37, 9, pp467-477.

Hawking S. (1995) *A brief history of time.* Bantam, London.

Heath C., Larrick R.P. and Wu G. (1999) Goals as Reference Points. *Cognitive Psychology*, 38, 1, pp79-109.

Hendrickx L. and Vlek C. (1991) Perceived control, nature of risk information and risk taking: An experimental test of a simple taxonomy of uncertainty, *Journal of Behavioral Decision Making*, 4, pp235-247.

Herzberg F. (1966) *The Motivation-Hygiene Theory - work and the nature of man.* World publishing company.

Hogue J. (1993) A framework for the examination of management involvement in Decision Support Systems. In: Sprague R. and Watson H., *Decision Support Systems, Putting Theory into Practice*, 3rd ed., Prentice-Hall, pp41-56.

Honderich T. (ed) (1995) *The Oxford Companion to Philosophy*, Oxford University Press, Oxford.

Howard N. (1992): Metagame Analysis. In: Rosenhead J. (ed) (1992) *Rational Analysis for a Problematic World, Problem Structuring Methods for Complexity, Uncertainty and Conflict.* Wiley, Chichester.

Huff S.L. (1989) Information technology and the future organization, *Business Quarterly*, 54,1, pp94-96.

Hunter A. (1996) *Uncertainty in Information Systems: An introduction to techniques and applications.* McGraw-Hill, London.

Hutchison C. and Rosenberg D. (1994) The organisation of organisations: Issues for next-generation office IT, *Journal of Information Technology*, 9, 2, pp99-117.

Jackson M.A. (1983) *Systems development*, Prentice-Hall, Englewood Cliffs, NJ.

Janis I. and Mann L. (1977) *Decision making; A psychological analysis of conflict, choice and commitment*. The Free Press, New York.

Janis I. (1982) *Groupthink*, 2nd ed. Houghton-Mifflin, Boston.

Jantsch E. (1967) *Technological Forecasting in Perspective*. A report for the Organisation for Economic Co-operation and Development (OECD).

Jayaratna N. (1994) *Understanding and Evaluating Methodologies, NIMSAD: A systemic framework*. McGraw-Hill, UK.

Jepsen L.O., Mathiassen L. and Nielsen P.A. (1989) Back to thinking mode: Diaries for the management of information systems development projects, *Behaviour and Information Technology*, 8, 3, pp207-217

Johnson G. and Scholes K. (1993) *Exploring Corporate Strategy*. Prentice Hall.

Jones J.W. and McLeod R. (1986) The structure of executive information systems: An exploratory analysis, *Decision Sciences*, 17, pp220-249.

Jones J.W., Saunders C., and McLeod R. (1988) Information media and source patterns across management levels: A pilot study, *Journal of Management Information Systems*, 5, 3, pp71-84.

Jones M. and Harrison A. (1996) IS project team performance: An empirical assessment, *Information Management*, 31, pp57-65.

Kahneman D. and Tversky A. (1979) Prospect theory: An analysis of decision under risk. *Econometrica,* 47, 2, pp263-291.

Kashima Y. and Maher P. (1995) Framing of decisions under ambiguity, *Journal of Behavioural Decision Making*, 8, pp33-49.

Kerr N.L., MacCoun R.J. and Kramer G.P. (1996) Bias in Judgement: Comparing Individuals and Groups, *Psychological Review*, 103, 4, pp687-719.

Keyes J. (1992) Changing the Basics in Software Development, *Software Magazine*, 12,1, pp38-56.

Keyes J. (1993) *Software Engineering Productivity Handbook.* McGraw-Hill, New York.

Killworth P. (2000) A risky cease-fire: British infantry soldiers and Northern Ireland. In: Caplan P. (ed) (2000) *Risk Revisited.* Pluto, London, pp184-203.

Klein G.A. (1993) A recognition-primed decision (RPD) model of rapid decision making. In: Klein G.A, Orasanu J., Calderwood R. and Zsambok C.E.(eds) (1993) *Decision Making in Action: Models and Methods.* Ablex, Norwood, New Jersey, pp138-147.

Klein G.A., Orasanu J., Calderwood R. and Zsambok C.E. (eds) (1993) *Decision Making in Action: Models and Methods.* Ablex, Norwood, New Jersey.

Klein H.K and Myers M.D. (1999) A set of principles for conducting and evaluating interpretive field studies in information systems, *MIS Quarterly*, 23, 1, pp67-93.

Kling R. (1980) Social analysis of computing, *Computer Surveys*, 12, pp61-110.

Knight F. (1921) *Risk, uncertainty and profit.* Houghton Mifflin, Boston.

Knottnerus D. (1994) Expectation states theory and the analysis of group processes and structures, *Current Perspectives In Social Theory*, supplement 1, pp49-74.

Kockerlakota N. (1996) Reconsideration-Proofness: A refinement for infinite horizon time inconsistency, *Games and Economic Behaviour*, 15, pp33-54.

Kolodner J. (1993) *Case-based reasoning*. Morgan Kaufmann, San Mateo, CA.

KPMG (1992) *Runaway computer systems*. KPMG Peat Marwick.

Land F. (1982) Adapting to changing user requirements, *Information and Management*, 5, 2, pp59-75.

Laudon K. and Laudon J. (1996) *Essentials of Management Information Systems, Organisation and Technology* (2nd Ed.). Prentice-Hall, New Jersey.

Lederer A. and Nath R. (1991). Managing Organizational Issues in Information System Development, *Journal of Systems Management*, 42, 11, pp23-39.

Lubbe S., Parker G. and Hoard A. (1995) The profit impact of IT investment. *Journal of Information Technology*, 10, 44-51.

Lucy T. (1992) *Quantitative Techniques*, 4th ed. DP Publishing, London.

Laucer T.W. (1996) Software project managers' risk preference. *Journal of Information Technology*, 11, 4, pp 287-296.

Luthans F., Hodgetts R. and Rosenkrantz S. (1988) *Real Managers*. Ballinger Publishing Company, Massachusetts.

Lyytinen K. and Hirschheim R.A. (1987) Information systems failures: a survey and classification of the empirical literature, *Oxford Surveys in Information Technology*, 4, pp257-309.

Lyytinen K. Mathiassen L. and Ropponen J. (1996) A framework for software risk management, *Journal of Information Technology*, 11, 4, pp275-286.

Mangan R. (1994) A study in overwork, *Nursing Times*, 90, 44, pp22-23.

Mann L., Burnett P., Radford M. and Ford S. (1997) The Melbourne Decision-Making Questionnaire: An instrument for measuring patterns for coping with decisional conflict, *Journal of Behavioural Decision-Making*, 10, pp1-19.

Martin J. (1976) *Principles of Data-Base Management*, Prentice Hall.

Martin C., Vu H., Kellas G. and Metcalf K. (1999) Strength of discourse context as a determinant of the subordinate bias effect, *The Quarterly Journal of Experimental Psychology*, 52A, 4, pp813-839.

Markham C. (1987) *Practical Consulting*. Institute of Chartered Accountants, London.

Mayer R.E. (1996) *Thinking, problem solving, cognition, 2nd ed.* Freeman, New York.

McFadzean E. (1998) The creativity continuum: Towards a classification of creative problem solving techniques, *Creativity and Innovation Management*, 7, 3, pp131-139.

McFadzean E. (1999) Creativity in MS/OR: choosing the appropriate technique, *Interfaces, 29, 5, pp110-122.*

Mead M. (1928) *Coming of age in Samoa*. Pelican, Middlesex. [1971 reprint]

Meek B.L. and Heath P.M. (1981) *Guide to good programming practice*, Ellis Horwood, Chichester.

Menzies-Lyth I. (1988) *Containing anxiety in institutions: selected essays*. Free Association, London.

Michalis L. and Douglas M. (2000). Dangerization and the end of deviance: The institutional environment, *British Journal of Criminology*, 40, pp261-278.

Milburn M. (1978) Sources of bias in the prediction of future events, *Organisational Behaviour and Human Performance*, 21, pp17-26.

Mizuno S. (ed) (1988) *Management for quality improvement: The 7 new QC™ tools.* Productivity.

Mulligan N.W. (1999) The effects of Perceptual Inference at encoding on organization and order: Investigating the roles of item-specific and relational information, *Journal of Experimental Psychology,* 25, 1, pp54-69.

Mumford, E.(1983) *Designing human systems for new technology: The ETHICS method,* Manchester Business School, Manchester, UK.

Nadeau M. (1995) Not lost in space. *BYTE Magazine*, June 1995.

Naur P. (1983) Program development studies based on diaries. In: Green T.R. (ed) *Psychology of computer use.* Academic Press, London, pp159-170.

Neuman D. (1994) *Social research methods: Qualitative and quantitative approaches,* 2nd ed. Allyn and Bacon, London.

Neuman D. (1997) *Social research methods: Qualitative and quantitative approaches*, 3rd ed. Allyn and Bacon, London.

NAO (1990) *Managing computer projects in the national health service*, Report by the Controller and Audit General, National Audit Office.

Obolensky N. (1995) *Practical Business Re-engineering: Tools and techniques for achieving effective change.* Kogan Page, London.

O'Callaghan F.V. and Callan V.J. (1992) Young adult drinking behaviour: A comparison of diary and quantity-frequency measures, *British Journal of Addiction*, 87, pp723-732.

Olle T.W., Sol H.G. and Verrijn-Stuart A.A. (eds) (1982) *Information systems design methodologies: A comparative review*. North Holland, Amsterdam.

Olle T.W., Hagelstein J., Macdonald I.G. (1991) *Information Systems Methodologies: A framework f*
or understanding (2nd ed). Addison-Wesley, Harlow, UK.

Pondy L.R., Boland R. and Thomas H. (eds) (1988) *Managing Ambiguity and Change*. Wiley, Chichester.

Pinto J. and Slevin D. (1987) Critical Success Factors in Successful Project Implementation, *IEEE Transactions on Engineering Managemen*t, EM 34, pp22-27.

Poole M.S. (1990) Do we have any theories of group communication? *Communication Studies*, 41, 3, pp237-247.

Powell P. (1992). Information Technology Evaluation: Is IT Different?, *Journal of Operational Research Society*, 43, 1, pp29-42.

Proctor T. (1995) Computer produced mind-maps, rich pictures and charts as aids to creativity, *Creativity and Innovation Management*, 4, 4, pp43-50

Puccio G. (1999) Creative problem solving preferences: Their identification and implications, *Creativity and Innovation Management,* 8, 3, pp171-178.

Reinhold A. (1996) Rationality through conflict and confrontation: An alternative to the traditional rational-choice approach with illustrations from decision-making in British Airways. Unpublished PhD thesis, London School of Economics and Political Science, University of London.

Reubenstein H.B. and Waters R.C. (1991) The Requirement Apprentice: Automated Assistance for Requirements Acquisition, *IEEE Transactions on Software Engineering*, 17, 3, pp226-240.

Rosenhead J. (ed) (1992) *Rational analysis for a problematic world: Problem structuring methods for complexity, uncertainty and conflict*. Wiley, Chichester.

Rosenhead J. and Mingers J. (eds) (2001) *Rational analysis for a problematic world revisited: Problem structuring methods for complexity and conflict*, 2nd ed. Wiley, Chichester.

Rottenstreich Y. and Tversky A. (1997) Unpacking, repacking and anchoring: Advances in support theory. *Psychological Review*, 104, 2, pp406-415.

Royal Society (1983) *Risk analysis*. The Royal Society, UK.

Royal Society (1992) *Risk analysis perception and management*. The Royal Society, UK.

Sauer C. (1993) *Why information systems fail: A case study approach.* Alfred Waller, Maidenhead.

Schein E.H. (1991) What is culture?: Reframing organizational culture. Sage, Newbury Park, CA.

Schneider S.L. (1992) Framing and conflict: Aspiration level contingency, the status quo and current theories of risk choice, *Journal of Experimental Psychology: Learning, Memory and Cognition*, 18, pp1040-57.

Sellen A. (1994) Detection of everyday errors. *Applied Psychology: An International Review*, 43, pp 475-98.

Shafir E. (1999) Belief and decision: The continuing legacy of Amos Tversky, *Cognitive Psychology*, 38, 1, pp3-16.

Shaw M. and Gains B. (1993). Group knowledge elicitation over networks, *Research and Development in Expert Systems*, pp43-62, Oxford BHR Group.

Sheridan D. (1996) Damned Anecdotes and Confabulations: Mass-Observation as a Life History. *Mass-Observation Archive Occasional Chapter No. 7*, University of Sussex Library, UK.

Sloman S.A. (1998) Categorical inference is not a tree: the myth of inheritance hierarchies, *Cognitive Psychology*, 35, pp1-33.

Slovic P. and Tversky A. (1974) Who accepts Savage's axiom?, *Behaviour Science*, 19. pp368-373.

Sprague R. H. and McNurlin B. C. (1993) *Information systems management in practice.* Prentice-Hall, New Jersey.

Stanovich K.E. and West R.F. (1999) Discrepancies between normative and descriptive models of decision-making and the understanding/acceptance principle, *Cognitive Psychology*, 38, pp349-385.

Steen-Sprang L.M. (1999) *Prospect theory, uncertainty and decision-making setting: How individuals and groups make decisions under uncertainty.* Paper presented at 95th Annual American Political Science Meeting, Atlanta, September 2-5, pp1-45.

Stephens C. (1993) Five CIO's at work: Folklore and facts revisited. *Journal of Systems Management*, 44, 3, pp34-40.

Stewart R (1991) The use of social paradigms in the analysis of team behaviour during organisational change. In: Proceedings of the United Kingdom Systems Society Conference, Plenum, NY, pp377-382.

Strotz R.H. (1956) Myopia and consistency in dynamic utility maximisation. *Rev. Economic Studies*, 23, 165-180.

Suedfeld P., De Vries P., Bluck S., Wallbaum A. and Schmidt P. (1996) Intuitive perceptions of decision-making strategy: Naïve assessors' concepts of integrative complexity, *International Journal of Psychology*, 31, 5, pp177-190.

Szajna B. and Scamell W. (1993) The effects of information system user expectations on their performance and perceptions. *MIS Quarterly*, 17, 4, p493-516.

Teigen K.H. (1988) The language of uncertainty, *Acta Psychologica*, 68, pp27-38.

Tversky A. and Kahneman D. (1973) Availability: A heuristic for judging frequency and probability, *Cognitive Psychology*, 5, pp207-232.

Tversky A. and Kahneman D. (1974) Judgement under uncertainty: Heuristics and biases. *Science*, 185, p1124-1131.

Tversky A. and Kahneman D. (1981) The framing of decision and the rationality of choice, *Science*, 221, pp453-458.

Tversky A. and Kahneman D. (1992) Advances in prospect theory: Cumulative representation of uncertainty, *Journal of Risk and Uncertainty*, 5, pp297-323.

Tversky A. and Koehler D. (1994) Support theory: A nonextensional representation of subjective probability, *Psychological Review*, 101, pp547-567.

Tversky A. and Fox C. (1995) Weighing risk and uncertainty, *Psychological Review*, 102, 2, pp269-283.

Vesely S. (1970) A Time-Dependent Methodology for Fault Tree Evaluation. *Nuclear Engineering and Design*, 13, pp337-360.

Vollmeyer R., Burns B.D. and Holyoak K.J. (1996) The impact of goal specificity on strategy use and the acquisition of problem structure, *Cognitive Science*, 20, pp75-100.

Von Neumann J. and Morgenstern O. (1944) *Theory of games and economic behaviour.* Princeton University Press.

Waddington C.H. (1977) *Tools for thought.* Paladin Frogmore, St Albans, UK.

Walsham G. (1993) *Interpreting information systems in organisations.* Wiley, Chichester.

Ward J., Griffiths P. and Whitmore P. (1990) *Strategic planning for information systems.* Wiley, Chichester, UK

Wastell D.G. and Newman M. (1993) The behavioural dynamics of information systems development: A stress perspective, *Accounting, Management and Information Technology*, 3, 2, pp121-148.

Wastell D.G. (1996) The fetish of technique: methodology as a social defence, *Information Systems Journal*, 6,1, pp25-40.

Wastell D.G. (1999) Learning dysfunctions in information systems development: overcoming the social defences with transitional object, *MIS Quarterly, 23, 4, pp*581-600.

Watson R. and Brancheau (1992) Key issues in information systems management: An international perspective. In: Galliers R. (1992) *Information Systems Research, Issues, Methods and Practice*, Blackwell Scientific Publications, pp 112-131.

Wehner D.M. (1987) Transactive memory: A contemporary analysis of the group mind. In: Mullen B. and Goethais G.R. (1987) *Theories of group behavior.* Springer-Verlag, New York, pp185-205.

Weick K. and Roberts K. (1993) Collective mind in organizations: Heedful interrelating on flight decks, *Administrative Science Quarterly*, 38, pp 357-381.

Weick K. (1993) The collapse of sense-making in organizations: The Mann Gulch disaster,

Administrative Science Quarterly, 38, pp628-652.

Wertheimer M. (1923) Untersuchungen zur lehre von der Gestalt, *Psychologischo Forshung* 4, pp301-350.

Westrum D. (1988) Organisational and inter-organisational thought. World Bank Workshop on Safety Control and Risk Management, Washington, DC, 16-18 Oct,1988.

Westrup C. (1993) Information systems methodologies in use. *Journal of Information Technology*, 8, 267-275.

Willcocks L. and Lester S. (1993) How organisations evaluate and control information systems investment: Recent UK survey evidence. IFIP WG8.2 Working Conference on ISD: Human, social and organisational aspects, Noorwijkerhout, Netherlands, May 17-19.

Willcocks L. and Margetts H. (1994) Risk assessment and information systems, *European Journal of Information Systems*, 3, 2, pp127-139.

Wright G. and Ayton P. (eds) (1987) *Judgmental forecasting.* Wiley, Chichester.

Wyer R. (1970) Information redundancy, inconsistency and novelty and their role in impression formation, *Journal of Experimental Social Psychology*, 6, 111-127.

Wynekoop J.L. and Russo N.L. (1995) Systems development methodologies, *Journal of Information Technology*, Summer, pp65-73.

Wynekoop J.L. and Russo N.L. (1997) Studying systems development methodologies: an examination of research methods. *Information Systems Journal*, 7, 1, pp47-65.

Yourdon E. and Constantine (1979) *Structured design: Fundamentals of a discipline of computer program and systems design.* Prentice-Hall, Englewood Cliffs, NJ.

Yu J. and Cooper H. (1983) A quantitative review of research design effects on response rates to questionnaires, *Journal of Marketing Research*, 11, pp36-44.

Zave P. (1991) An insiders evaluation Of PAISLey: An executable specific language, *IEE Transactions on Software Engineering*, 17, 3, pp212-222.

Zsambok C.E. and Klein G. (1997) Naturalistic decision making. Lawrence Erlbaum, New Jersey.