



Human Decision-Making Under Uncertainty in the Upstream Oil and Gas Industry

Steve Mackie

BSc – Macquarie University

MBA – University of South Australia

This thesis is submitted in fulfilment of the requirements for the degree of Doctor of Philosophy at the Australian School of Petroleum, Faculty of Engineering, Computer and Mathematical Sciences, The University of Adelaide

July 2007

Table of Contents

Abstract	vii
Declaration	viii
Acknowledgements	ix
Papers and Presentations	xi
Chapter 1: Introduction	1
1.1 Background to Thesis	2
1.2 Outline of Thesis	6
Chapter 2: Normative and Behavioural Decision-Making in the Upstream Oil and Gas Industry	11
2.1 Introduction	12
2.2 Theoretical Background	12
2.2.1 Normative Decision Making	13
2.2.2 Behavioural (or Descriptive) Decision-Making	17
2.2.3 Decision Type	26
2.3 Application in the Upstream Oil and Gas Industry	30
2.3.1 Normative Decision Making	30
2.3.2 Behavioural (or Descriptive) Decision-Making	35
2.3.3 Decision Type	38
2.4 Summary	40
2.4.1 Normative Decision Making	40
2.4.2 Behavioural (or Descriptive) Decision-Making	41
2.4.3 Decision Type	42
2.5 Research Questions	43
Chapter 3: The Theory of How Decisions Should Be Made	47
3.1 Aim	48
3.2 Individual Decision-Making	48
3.2.1 Decision-Making Processes	51
3.2.2 Decision-Making Under Uncertainty as a Probabilistic Process	59
3.2.3 Implementation	60
3.3 Decision Outcome	61
3.4 Decision-Making Tools	63
3.5 Team Decision-Making	64
3.6 Summary – Theoretical Decision-Making Model	68
Chapter 4: Research Design	71
4.1 Outline	72
4.2 Phase 1a: Determine the processes oil and gas	

	companies should use to make decisions	73
4.3	Phase 1b: Identify the processes oil and gas companies say they do use to make decisions.	76
	4.3.1 The Researcher	77
	4.3.2 Interpretive Paradigms	78
	4.3.3 Strategies of Inquiry	79
	4.3.4 Collecting, Analysing, Interpreting and Evaluating the Data	81
4.4	Phase 2: Develop an oil and gas decision-making Taxonomy and determine the decision types.	81
4.5	Phase 3 – Compare and contrast theoretical and “real world” models to determine good decision-making processes.	84
4.6	Phase 4 – Develop prescriptions for good decision-making and tailoring decision-making process to decision type.	85
Chapter 5: How Oil and Gas Companies Say They Make Decisions		87
5.1	Introduction	88
5.2	Data Collection	88
	5.2.1 Participants	88
	5.2.2 Procedure	89
5.3	Data Analysis	90
	5.3.1 Roles and Responsibilities	91
	5.3.2 Decision Types	98
	5.3.3 Decision-Making Processes and Tools	101
	5.3.4 The Human Side of Decision-Making	108
	5.3.5 Learning Feedback	112
5.4	Data Interpretation and Evaluation	117
	5.4.1 Hierarchical Decision-Making in Oil and Gas Companies	117
	5.4.2 Trust Heuristic	121
5.5	Conclusions: “Real World” Oil and Gas Decision-Making Model(s)	122
	5.5.1 Individual or Core Decision-Making Process	122
	5.5.2 Hierarchical Approval Process	123
	5.5.3 Portfolio Management Processes	124
Chapter 6: Taxonomy Development		127
6.1	Introduction	128
6.2	Implementation	130
	6.2.1 Procedure	130
	6.2.2 Materials	133
	6.2.3 Participants	134
6.3	Results	135
	6.3.1 Additive Tree-Fitting	136
	6.3.2 Additive Clustering	137
6.4	Discussion	138
6.5	An Oil and Gas Decision-Making Taxonomy	143

6.6	Conclusions	148
Chapter 7: Decision Types		149
Chapter 8: Prescriptions for Good Decision-Making		157
8.1	Introduction	158
8.2	Hypothesis One	156
8.3	“Real World” and Theoretical Models	161
	8.3.1 Similarities Between the Models	161
	8.3.2 Differences Between the Models	162
8.4	Possible Changes	169
	8.4.1 What is Systematically Desirable? – Static (Procedural) and Dynamic (Functional) Changes	170
	8.4.2 What is Culturally Feasible – Attitudinal Changes	174
8.5	Prescriptions for Good Decision-Making	176
8.6	Summary	178
Chapter 9: Processes Used in the “Real World” for Decision Types		179
9.1	Introduction	180
9.2	Hypothesis Two	182
9.3	Case Study Analysis	184
	9.3.1 Single Process	185
	9.3.2 Differing Processes	193
	9.3.3 Polarised Processes	195
9.4	Changes in Decision Process Given Changes in Decision Taxonomy	198
	9.4.1 Changes in Complexity	198
	9.4.2 Changes in Constraints	199
	9.4.3 Changes in Ambiguity	201
	9.4.4 Changes in the Structure of the Environment of Information	203
9.5	Do Companies Actually Make Decisions the Way they Say they do?	204
9.6	Further Prescriptions for Good Decision-Making	205
9.7	Conclusions	206
Chapter 10: Conclusions and Recommendations		209
10.1	Introduction	210
10.2	Answering the Research Questions	210
10.3	Further Research	217
10.4	Conclusion	220
Bibliography		221

LIST OF FIGURES	Page
1.1 Structure of Thesis	6
2.1 Typical Utility Curve	14
2.2 A Hypothetical Value Function	19
2.3 Russo and Schoemaker's pyramid of choice approaches	27
2.4 A Decision Support Framework for Major Accident Hazard Safety	39
3.1 Three Factors Determine Decision Outcome	50
3.2 Decision-Making Process	52
3.3 Decision Analysis Process Flowchart	52
3.4 Decision Analysis Cycle	53
3.5 Four Stages of the Decision Process	53
3.6 Nutt's Discovery Process	55
3.7 Nutt's Idea Imposition Process	55
3.8 Eight Step Multiobjective Decision-Making Process	56
3.9 Multilevel Theory of Hierarchical Decision-Making	66
3.10 Theoretical Model of How Companies Should Make Decisions Under Uncertainty	70
4.1 Research Program Phases	72
4.2 Checkland's Soft Systems Methodology	74
5.1 Triangle of Decision Recommendations	118
5.2 Triangle of Decision Perspective	119
5.3 Balanced Hierarchy of Decision-Making	120
5.4 The Trust Heuristic	121
5.5 A "Real World" Oil and Gas Decision-Making Under Uncertainty Model	125
6.1 Graphical User Interface Showing Similarity Scale	132
6.2 Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using tree-fitting algorithm	136

6.3	Best tree-fitting result with 5 clusters represented by the different colours and is explained in section 6.5	137
6.4	Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using additive clustering algorithm	137
6.5	Best clustering result of 7 clusters shown on multidimensional-scaled representation	138
6.6	Percentage of Variance Accounted For (VAF) versus Precision Measure	140
6.7	Number of Clusters versus Precision Measure	140
6.8	Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using clustering algorithm	141
6.9	Optimal clustering result of 4 clusters shown on multidimensional-scaled representation	141
6.10	Oil and Gas Decision-Making Taxonomy Template	148
7.1	Decision to Develop a Discovery	150
7.2	Optimising Production Decision	151
7.3	Reserves Estimation Decision Type	152
7.4	Klein's Naturalistic Decision-Making for Emergencies	153
9.1	Tailoring Decision Process to Decision Type	183
9.2	Characterisation of Axe-Type Decision	186
9.3	Klein's Recognition-Primed Decision Model – Naturalistic Decision-Making	187
9.4	Characterisation of Funnel-Type Decision	189
9.5	Funnel-Type Decision-Making Process	189
9.6	Characterisation of Matchbox-Type Decision	190
9.7	Matchbox-Type Decision-Making Process	191
9.8	Characterisation of Shears-Type Decision	192
9.9	Shears-Type Decision-Making Process	192
9.10	“Go” / “No Go” Block Decision Process	196
9.11	Complex Block Decision Process	197

LIST OF TABLES	Page
3.1 Decision Process versus Outcome	51
3.2 Matrix of process and method (after Barker, 2001)	63
4.1 Interpretative Paradigms (after Denzin and Lincoln, 2005)	79
4.2 Advantages and Disadvantages of Structured and Semi-Structured Interviews	80
6.1 Similarity Matrix	132
6.2 Survey Participants	134
7.1 Summary of Primary Decision Types	154
8.1 Measures of “Goodness”	160
9.1 Number of Decision Types Discussed	181
10.1 Prescriptions for Good Decision-Making	216

LIST OF APPENDICES	Page
1. Papers Published during Research	A1.1
2. Outline of Semi-Structured Interview	A2.1
3. Request to Participate in Semi-Structured Interviews	A3.1
4. Transcripts of the Digitally Recorded Semi-Structured Interviews	A4.1
5. Summary Notes of the non Digitally Recorded Semi-Structured Interviews	A5.1
6. Decision Scenarios	A6.1
7. Submission for approval of the University of Adelaide’s Human Research Ethics Committee	A7.1
8. Participant Request	A8.1
9. Information Sheet	A9.1
10. Consent Form	A10.1
11a. MATLAB Data Collection Algorithms	A11a.1
11b. MATLAB Data Analysis Algorithms	A11b.1
12. Decision Process and Decision Type	A12.1

ABSTRACT

Business under-performance in the upstream oil and gas industry, and the failure of many decisions to return anticipated results, has led to a growing interest over the past few years in understanding the impacts of current decision-making tools and processes and their relationship with decision outcomes. Improving oil and gas decision-making is thus, increasingly, seen as reliant on an understanding of what types of decisions are involved and how they actually are made in the “real world”.

There has been significant work carried out within the discipline of cognitive psychology, observing how people actually make decisions. However, little is known as to whether these general observations apply to decision-making in the upstream oil and gas industry. Nor has there been work on how the results might be used to improve decision-making in the industry.

This research is a step towards filling this gap by developing two themes – decision-making process and decision type. It distils a “real world” oil and gas decision-making model together with a theoretical decision-making model. Comparing and contrasting the two models yields several prescriptions for improved decision-making in the upstream oil and gas industry.

This research also documents the development of an oil and gas decision-making taxonomy that lays a decision space within which to judge the processes of decision-making. The taxonomy builds on established ideas in the human decision-making literature, but is itself novel, and involves four different dimensions: 1) complexity; 2) task constraint; 3) value functions; and 4) structure of the information environment.

A primary observation is that decision-making processes are tailored to the various types of decisions. It is argued that maximising the chances of a good outcome in “real world” decisions requires the implementation of such tailoring.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Steven I Mackie

Date

Acknowledgements

Whilst the work documented in this thesis is my own – and I take full responsibility for it – it certainly did not come into being without the help and support of many others. I would, therefore, like to take the opportunity to thank those who contributed.

First, recognition needs to go to my supervisors, Prof. Steve Begg, Dr. Chris Smith and Dr. Matthew Welsh. Each contributed in their own unique way. The work crosses several faculty and school boundaries (School of Petroleum, Graduate School of Management and School of Psychology) and thus allows for marvellous opportunities – all new ideas come at the boundaries. It also requires dedicated effort from the people to break through the silos. Funding for the research comes from an Australian Research Council grant (ARC linkage LP0453894). This is financially supported by BHPBilliton and Santos. Appreciation must go to them. The grant was obtained by submission from Prof. Begg, Prof. Reidar Bratvold (University of Stavanger) and Assoc. Prof. Michael Lee (University of California – Irvine) – thanks. The research also called for volunteer participants in several rounds of interviews. In an industry that is already stretched with limited resources, the fact that these people gave their time and ideas willingly speaks volumes. Due to confidentiality it is impossible to thank them all individually, which is what I would like to do, but must settle for a general: “Thanks Guys!” I especially appreciated the candid comments and suggestions of my examiners.

Now to the motivators and finishers. My late mother always pined “one day I would like a doctor in the house.” Mum this is for you. Finally, and by far the most important, thanks must go to Violet, who not only supported me through the entire ordeal but was the greatest sounding board, editor and finisher!! She has to be the best eternal companion anyone could ask and pray for – someone of like thought and aspiration.

Professor Higgins was wrong!

You have got to let a woman in your

life¹ to be successful!!

To the two women in my life –

Violet – my eternal companion

Norma – my mother

¹ Taken from George Bernard Shaw's 1913 play, Pygmalion

Presentations and Papers

The research project has generated the following presentations and papers.

PRESENTATIONS (in reverse chronological order)

1. **Decision Type: A Key to Realizing the Potential of Decision-Making Under Uncertainty**, presented at the Australian Petroleum Production and Exploration Association annual conference, April 2007
2. **Human Decision-Making in the Upstream Oil and Gas Industry**, presented at the Annual General Meeting of the Petroleum Exploration Society of Australia (SA Branch), March 2007
3. **PhD Progress Presentation – Year End 2006 Status Report**, presented to BHPBilliton (PhD sponsors via ARC Linkage Grant), November 2006
4. **Realizing the Potential of Decision-Making Under Uncertainty**, presented at the American Association of Petroleum Geologists International Conference, November 2006
5. **An Oil and Gas Decision-Making Taxonomy**, presented at the Society of Petroleum Engineers Asia Pacific Oil and Gas Conference and Exhibition, June 2006
6. **PhD Progress Presentation – Year End 2005 Status Report**, presented to Santos (Ph.D. sponsors via ARC Linkage Grant), February 2006
7. **Would You Know A Good Decision If You Saw One?**, Presented to Santos (PhD sponsors via ARC Linkage Grant), August 2005
8. **Human Decision-Making in the Oil and Gas Industry**, presented at the Centre for Improved Business Performance, Australian School of Petroleum, University of Adelaide, March 2005
9. **Group Heuristics and Biases**, presented at the Centre for Improved Business Performance, Australian School of Petroleum, University of Adelaide, February 2005

PAPERS (Appendix 1)

1. **Mackie, S.I., Welsh, M.B. and Lee, M.D.**, 2006, An Oil and Gas Decision-Making Taxonomy, SPE paper 100699.
2. **Mackie, S.I., Begg, S.H., Smith, C.S., and Welsh, M.E.**, 2007, Decision Type: A Key to Realizing the Potential of Decision-Making Under Uncertainty, *AAPEA Journal*, Volume 22, Number 1, pp 307 – 317. Won Best Paper Award.

CHAPTER 1

INTRODUCTION

This chapter serves as an introduction to the research project and seeks to outline the primary themes that guide the work. This research project brings together literatures from both the general field of judgment and decision-making under uncertainty and the upstream oil and gas industry. It adds to the debate between how decisions *are* made under uncertainty and how they *should* be made. The research into understanding human decision-making in the oil and gas industry has two central innovative components. The first is that emphasis should be given to studying the processes that lead to a decision, and not solely the outcome of the decision. The processes are analysed from both a “real world” as well as a theoretical perspective. The second innovation involves the development of a novel taxonomy for characterising different decision-making types and analyses the process involved in making decisions of different types. The conclusions are a series of prescriptions for optimal decision-making in the oil and gas industry.

1.1 BACKGROUND TO THESIS

Decision-making is a basic human cognitive ability, and is probably the most important and pervasive human cognitive practice. It is not surprising, therefore, that understanding human decision-making processes has been a central enterprise for the cognitive sciences (Gigerenzer et al., 1999; Kahneman et al., 1982; Klein, 1998), as well as the focus of applied research across disciplines such as psychology, economics, business, marketing, and the health sciences (Arkes and Hammond, 1986). Understanding and improving most fields of human endeavour relies on an understanding of what types of decisions are involved, how they are made, and how they should be made optimally and successfully.

The upstream oil and gas industry is characterised by projects that involve a series of increasingly expensive investments that subsequently generate revenue streams that are highly uncertain, and in some cases never recover the cost of the investments. The magnitude of these investments frequently amounts to

hundreds or thousands of millions of dollars. These projects are characterised as very high risk and have “frequently been given the dubious distinction of being the ‘classic’ example of decision-making under uncertainty” (Newendorp and Schuyler, 2000).

Business under-performance in the upstream oil & gas industry, and the failure of many decisions to return expected results (Brashear et al., 2000; Brashear et al., 1999; Cottrill, 2003; Durham, 2004; Goode, 2002; Rose et al., 2003), has led to a growing interest in:

- Understanding the impacts of current decision-making processes and outcomes, and
- Improving these processes and outcomes.

Perhaps the first problem within upstream oil and gas industry decision-making relates to the many different types of decisions that are made. These involve variable factors such as levels of risk, amounts of time and resources available, “sizes” of decision, and levels of flexibility available to deal with the resolution of chance factors as decisions are implemented. Currently, in the upstream oil and gas industry, no structure or classification scheme for decision type exists, let alone any knowledge for how to select appropriate tools, data and processes according to the type of decision. This research establishes such a taxonomy.

Much of the interest, within the upstream oil and gas industry, has centred on promoting the development and use of so-called normative techniques (or decision analysis). These set down how people should ideally make decisions under uncertainty in a way that is consistent with their objectives (Howell and Tyler, 2001; Jonkman et al., 2000; Macmillan, 2000; Rose, 2001b; Rose et al., 2003; Simpson et al., 2000). The upstream oil and gas industry eagerly tests and adapts the principles unearthed in normative decision-making under uncertainty (Newendorp and Schuyler, 2000; Rose, 1987; Watson, 1998) because theoretically, these normative techniques, if correctly applied, should yield improved decisions (Savage, 1954; von Neumann and Morgenstern, 1947). This

laboratory-type approach (Bailey et al., 2000; Ball and Savage, 1999; Galli et al., 1999) of the upstream oil and gas industry places it at the forefront in the use of decision analysis, save perhaps for the finance industry (Schuyler, 1997).

As previously mentioned, however, most upstream oil and gas portfolios fail to yield their anticipated results. Why, if theoretically the use of decision analysis should yield optimal decisions, does this not occur? Simon (1956) suggests that this is caused by the inability of the implemented technique to account for the non-rational or non-optimal ways in which people think and behave. Although quick to test normative approaches, the industry has been slow to adapt what could be termed the “softer,” or human, side of decision-making under uncertainty.

There has been much work carried out, within the discipline of cognitive psychology, in observing how people actually do make decisions under uncertainty. However, little is known as to whether these general observations apply to decision-making in the upstream oil and gas industry. Plous (1993, p. 258) observed: “One of the limitations of judgement and decision research is its reliance on laboratory experiments conducted with college students.” Hence a key to unlocking the potential of the upstream oil and gas sector lies in determining whether the theoretical results of cognitive psychology apply to the “real world” of the upstream oil and gas industry.

Finally the question is asked; what determines whether a decision is “good?” Generally, in the oil and gas industry, a decision is thought to be “good” if its outcome is “good.” Outcome, however, is influenced by a variety of variables, one of which is the decision process, i.e., outcome is directly related to the decision process but is also influenced by other things not directly related to the decision. For example, outcome is subject to a large element of chance (uncertainty) as well as to the effectiveness of implementation, rather than by the processes and information used up to the point at which the decision is made (Bratvold et al., 2002; Russo and Schoemaker, 2002). By considering both processes and out-

comes, it becomes possible to confront the challenge of building explanatory and predictive accounts of human decision-making in complicated “real world” situations, such as those found in the upstream oil and gas industry.

The context for this research is taken from a conference held to celebrate the 75th anniversary of the Harvard Business School. The conference is entitled “Decision Making: Descriptive, Normative and Prescriptive Interactions” and is reported in a volume by the same title (Bell et al., 1988). Quoting the editors:

“It was clear that mathematicians (decision theorists) are interested in how people *should* make decisions Psychologists are interested in how people *do* make decisions . . [while] a third interest group is interested in *how do you improve the quality of decisions in practice.*”
(Bell et al., 1988, p. ix)

Hence the context of discussion is to review normative decision-making (how people should make decisions), as well as descriptive decision-making (how people do make decisions), and by comparing and contrasting them, finally look at prescriptive decision-making (how do you improve the quality of decisions in practice), specifically as it applies in the upstream oil and gas industry.

In summary then, this research’s ultimate aim is to improve returns on project evaluation and resource allocation in the upstream oil and gas industry by improving decision-making. It contributes to the literatures of both decision-making under uncertainty and upstream oil and gas industry by addressing the following key questions:

1. Which processes should upstream oil and gas companies use for decision-making under uncertainty?
2. Which processes do upstream oil and gas companies say they use in their decision-making under uncertainty?
3. Which criteria are essential for decision-making under uncertainty to be defined as “good”?

4. What is a useful structure or classification scheme for decision-making under uncertainty that defines the various types of decisions made in the upstream oil and gas industry?
5. Do upstream oil and gas companies actually do what they say they do in making decisions under uncertainty?
6. Do the decision-making processes change depending on the type of decision being made?

As an early foray into what may be termed behavioural decision-making in the upstream oil and gas industry, this research is necessarily broad in its context. Its aim is to cover the full spectrum of questions to facilitate development of models and prescriptions of better decision-making that can then be further tested with deeper, more directed, research.

1.2 OUTLINE OF THESIS

The thesis is laid out in 10 chapters. The overarching structure of the work is shown in Figure 1.1.

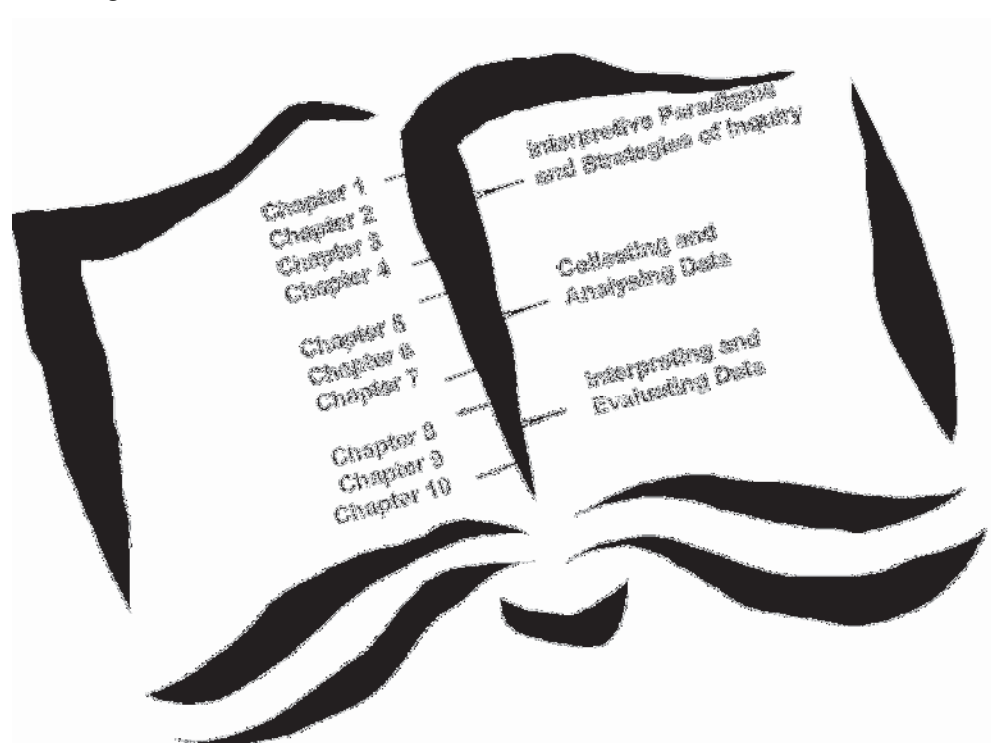


Figure 1.1 – Structure of Thesis

This chapter, Chapter 1, serves as an introduction by laying the ground and outlining the primary themes that guide the work.

The aim of Chapter 2 is to explore the broad theoretical literature on normative and behavioural decision-making under uncertainty. It also looks at how this literature has been applied in the upstream oil and gas industry. This is undertaken in order to highlight the gaps in the existing literature that the research questions are distilled from. It reviews normative and descriptive decision-making under uncertainty leading to the concept of prescriptive decision-making – how to improve the quality of decisions in practice. The primary research questions form the framework around which the review is undertaken.

Whilst Chapter 2 looks at the literature in general surrounding the theories of normative and behavioural decision-making and how they have been applied in the upstream oil and gas industry, Chapter 3 is a more focussed literature review and reports a theoretical decision-making model, which defines how decisions under uncertainty are best addressed by using specific processes, from the current literature. The chapter looks at processes, outcomes and tools to develop a holistic theoretical model of decision-making under uncertainty.

Chapter 4 lays out the design of the research project and the various methodologies used for the study. The overarching epistemological orientation for the first theme of the research, *decision process*, is Checkland's soft systems methodology (Checkland, 1981; Checkland and Scholes, 1999; Jackson, 2003). The second theme of the study, *decision type*, covers several fields of investigation and various methodologies are used for each field. These two themes are drawn together into a phased program of investigation which leads to prescriptive recommendations.

The aim of Chapter 5 is to identify how decisions under uncertainty are actually made in the upstream oil and gas industry. This task is addressed via “real-world” interviews. It looks at the current processes that exist within the industry to tease out what these mean in decision-making under uncertainty. The “real world” model of decision-making under uncertainty that is developed from the features discussed in the interviews is placed within the framework of behavioural decision-making under uncertainty.

To further refine how decisions under uncertainty in the upstream oil and gas industry are made and how they should be made, Chapters 6 and 7 review the second theme of the research; decision type. Chapter 6 documents the development of an upstream oil and gas decision-making taxonomy, which acts as a “level playing field” upon which to conduct the comparison. This chapter is laid out in a traditional methods/results/analysis/conclusions structure. It addresses how the taxonomy fits within the theoretical framework previously discussed. The taxonomy is developed from the model-based (Bayesian) stream of psychology research and not from the hypothesis-based research stream. Although the taxonomy is developed using upstream oil and gas decisions, the taxonomy itself is generic enough to be used in other “similar” industries.

Having established the dimensions underlying decision type, Chapter 7 simply documents the primary decision types, along with examples from the upstream oil and gas industry.

Chapter 8 brings together chapters 3 and 5 by comparing and contrasting the “real world” model with the theoretical model – how decisions under uncertainty are being made versus how they should be made in the upstream oil and gas industry. The chapter also reconsiders the question of “goodness.” It looks at the various processes that fit a matrix of good/bad decision/outcome to assist in defining what is required for a decision to be called “good” in the upstream oil and gas industry. Distilling the key factors that are important in oil and gas decision-making yields various prescriptions that should be adopted as well as

what tools and processes should be used for optimal decision-making in the industry.

Whilst the previous chapter dealt with the question of decision-making processes as a whole, Chapter 9 then links the two key themes of the research – decision-making process and decision type. It unlocks what processes are used for various decision types and shows that in the upstream oil and gas industry decision-making process is tailored to decision type.

The final chapter, Chapter 10, summarises the information gathered from the research and provides the answers to the research questions posed earlier. It sets out the overall conclusions, suggests future research avenues, and discusses the theoretical contributions of the research project and the effectiveness of the methodologies used in this work.

CHAPTER 2

NORMATIVE AND BEHAVIOURAL DECISION-MAKING IN THE UPSTREAM OIL AND GAS INDUSTRY

2.1 INTRODUCTION

This chapter presents a literature review of normative and behavioural decision-making for the current study. Firstly the existing theory-motivated academic literature on judgment and decision-making is enunciated. This is then followed by a review of the practice-motivated research of how the theory is used in the “real world” of the upstream oil and gas industry. These two fields, the theory-motivated and the practice-motivated, are summarised so as to highlight the gaps from which key research questions are drawn.

The review is conducted almost entirely within the framework of the “traditional . . . theories . . . which focus on choice and decision-making behaviours” (Hastie, 2001, p. 654) whilst other frameworks, such as cognitive algebraic theories and cognitive computational theories are only touched on lightly, if at all. Within this framework, decision-making is defined as conscious, irrevocable allocation of resources in order to achieve a desired objective. Decision-making is conscious because it does not include reflexive or involuntary acts. It is irrevocable because even if the mind is changed later, the resources – for example, time, money and willpower – are committed. There must also be two or more alternatives from which to choose, otherwise decision-making is not necessary. This framework is then applied to the upstream oil and gas industry, where both the internal and external environments are characterised as highly uncertain. Hence the research is focussed on exploring decision-making under conditions of uncertainty with the aim of improving that decision-making.

2.2 THEORETICAL BACKGROUND

The aim of this section is to review the theoretical development of academic research within the field of judgment and decision-making. Although the present research project does not primarily aim to add to this field of endeavour, it is critical to understand it in order to explain the concepts and findings within the “real world” of the upstream oil and gas industry.

2.2.1 Normative Decision-Making

There is a strong linkage between the fields of economics and decision-making. In fact, research in the decision-making sphere has its roots in economic theory with most of the founding work in decision-making coming from economic researchers (Allais, 1953; Edwards, 1954; Ellsberg, 1961; Grayson, 1962a, b; Keeney and Raiffa, 1976; Lichtenstein and Slovic, 1971; Luce, 1959; Markowitz, 1952; Newendorp and Campbell, 1971; Savage, 1954; Simon, 1956; Tversky, 1969; von Neumann and Morgenstern, 1947).

At the heart of classic economic theory is the assumption that people, individually, not corporations, make decisions in the marketplace based on two principles, self-interest and rationality (logic), in order to maximise utility. Decision-making concerning itself with maximising utility and using logical rules for this maximising has been termed objective or normative decision-making and makes up what is called the 'first branch' of decision-making (Bell et al., 1988).

The concept of utility maximisation can be traced back to 1738 when Daniel Bernoulli encapsulated people's attitude to risk in a mathematical structure by proposing an answer to the St Petersburg Paradox², raised by his cousin, Nicholas Bernoulli in 1713. N. Bernoulli wanted to know how much people would pay to play a simple game which had two rules: (1) a fair coin is tossed until it lands on tails, and (2) the reward is \$2.00 (approximate translation) on the first toss, \$4.00 on the second, \$8.00 on the third, etc. D. Bernoulli's answer (Bernoulli, 1738) reasoned that the value, or as he called it, utility of money, or wealth, declines according to the amount already possessed (or won – see Figure 2.1).

² "It is a paradox because the expected value of the game (the average payoff you would expect if the game were played an endless number of times) is infinite, yet very few people are willing to pay huge sums of money to play." Plous, S., 1993, *The Psychology of Judgment and Decision Making*: New York, McGraw-Hill. p 79

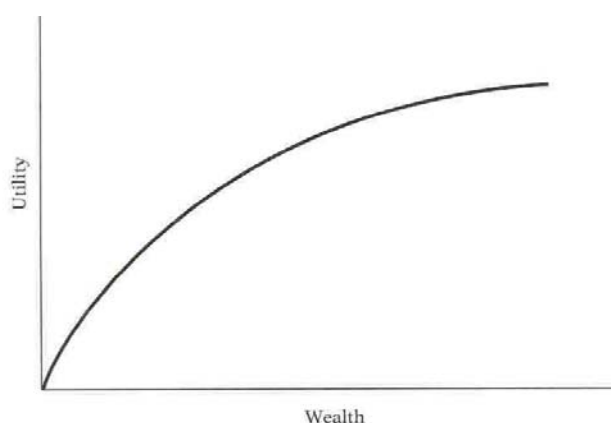


Figure 2.1 – typical utility curve

What may be considered the first normative decision-making theory, the **expected utility theory**, was proposed by von Neumann and Morgenstern (1947) while they were mathematically investigating solving games of chance. In fact, the theory is found as an appendix to their book. They argued that in order to achieve rational decision-making six axioms needed to be followed. They were:

1. Ordering of alternatives. When making decisions, rational decision makers should compare two or more alternatives and, based on some list of predefined criteria, have a preference for one of the alternatives above the others or they should state explicitly that they have no preference.
2. Dominance. The rational decision maker bases their preference on the alternative which has strongest overall dominance across all the criteria. Dominance, for individual criteria, occurs when an alternative results in the maximum value for that criterion. Overall dominance occurs when an alternative has dominance for all criteria.
3. Cancellation. If the outcomes of alternatives are exactly the same then the rational decision maker will not choose either alternative. They will only choose an alternative when it has the maximum value.

4. **Transitivity.** When comparing alternatives, a rational decision maker who prefers alternative I to alternative II and alternative II to alternative III, will then prefer alternative I to alternative III.
5. **Continuity.** This principle relates to a combination of alternatives such that a rational decision maker will always choose to gamble on the outcome of the best alternatives. They will not settle for something less. Of course the odds for the gamble must represent positive expected value.
6. **Invariance.** The rational decision maker will not change their preference regardless of the way or order in which the alternatives are presented.

These axioms are seen as the basis of normative decision-making. As the axioms were written mathematically, researchers were in a position to test them objectively. And test them they have; Plous (1993) argues that more research has occurred on this theory than any of the resulting theories.

Initially, research centred on generalising this theory. Two of these generalisations have relevance to the research to be described in this work in that they introduce the concepts of subjective probabilities and randomness. These concepts are critical to understanding and assessing uncertainty. The first of the problems many researchers found with expected utility theory was how to weight objectives when the outcome had never occurred before. In von Neumann and Morgenstern's theory all objectives were weighted by the frequency of their outcomes. Savage (1954) overcame this problem by allowing the use of subjective probabilities, which reflected "beliefs," rather than relative frequencies, to describe the weights involved. This generalisation was termed the **subjective expected utility theory**.

The second concept, randomness, required researchers to mathematically explain why a person would choose one thing on one day and a totally

different thing on another day. The original basic assumption was that objective weighting remained static. Luce (1959) resolved this impasse by using the concept of randomness³, resulting in what became known as the **stochastic expected utility theory**. The weighting was not deterministic – one single value – but could be any point on a probability density function, thus being stochastic in nature.

Although the groundwork was laid over 50 years ago the real breakthroughs in using decision analysis have come in the last few decades with the advent of computers. Drawing on the systems engineering models developed during the Second World War together with sensitivity analysis modern decision analysts seek to “transform opaque decision problems into transparent decision problems by a sequence of transparent steps” (Howard, 1988). The development has been in terms of how to solve decisions by focusing on “real world,” practice-motivated models. The central focus has been on determining decision alternatives (Howard, 1988; McNamee and Celona, 1987) and specifying the attributes by which the evaluation will be measured (Keeney, 1988) (Keeney and Raiffa, 1976). Corner and Kirkwood (1991) and Keefer et al. (2004) offer a summary of the various methodologies that have been developed. One of the interesting features of this development has been the linkage of the concept of utility with that of risk attitude (Howard, 1988), thus drawing together the economic framework of the mid 1900’s and the concepts of probability theory.

At its heart normative theory or the subjective expected utility framework says that:

“if the preferences of a decision maker satisfied the axioms, then the decision process could be summarized with a numerical expected utility function relating concrete outcomes to behavioral preferences; first the choice behavior, then an

³ Plous uses the example of stochastic modelling enabling researchers to rationally explain why people may prefer soup one day and salad the next – the preferences of soup and salad were treated probabilistically rather than as fixed. Ibid. p. 83.

application of the theory to infer what utilities and beliefs are consistent with those preferences.” (Hastie, 2001, p. 658)

But Hastie (2001) enunciates two limits to this framework. The first is that the framework is not complete – much happens outside the framework prior to information coming into it that is not properly described. And second it does not provide a description of the human decision-making process.

2.2.2 Behavioural (or Descriptive) Decision-Making

There has been a great deal of work carried out over the last 20 to 30 years, within the cognitive psychology discipline, in observing how people actually do make decisions under uncertainty. This research, which forms the ‘second branch’ of decision-making under uncertainty (Bell et al., 1988), first commenced when researchers noticed that although von Neumann and Morgenstern stated that their theory described how optimal decisions were to be made, it was quite apparent that several of the axioms were violated by people as they made their decisions. Allais (1953) and Ellsberg (1961) both showed that the cancellation principle was violated on some occasions. Tversky (1969) demonstrated that the intransitivity principle could also be violated. Lichtenstein and Slovic (1971) demonstrated that even preferences can be totally reversed depending on how they are elicited – a complete violation of the intransitivity principle.

Recognising that people were making decisions in such a way that they appeared to disobey rational theory gave rise to an important question. Was it that these results demonstrated that people disobeyed economic theory in their apparent non-optimal decisions, or was it that there were inadequacies in the decision-making theories themselves?

The first research looking at how people actually made decisions came in 1954, when Edwards published a review of economic literature on choice, but also included the psychological contributions that had been made

since von Neumann and Morgenstern had published (Edwards, 1954). But the breakthrough in thinking came with the introduction of the concepts of **satisficing** and **bounded rationality**. Simon (1956) observed that decision-makers fell short of 'maximising utility,' as invoked by economic theory, stating: "evidently organisms adapt well enough to 'satisfice'; they do not, in general, 'optimize'" (Simon 1956, p129). He showed that optimisation, the objective of the expected utility theory, required perfect information in all areas whereas people were happy to use less than perfect information – they put boundaries on their rationality.

Although Simon stated that he was researching 'normative decision-making' his insights led to the separation of the decision-making field into two branches – **normative** or **objective decision-making** (first branch) and **descriptive** or **behavioral decision-making**, which became known as the second branch. The basic difference is that normative decision-making describes how decisions *should* be made in order to achieve 'utility maximisation,' while descriptive decision-making simply describes how decisions *are* made by people. People tend to make decisions by choosing such that they satisfy their most important needs even if they do not have all the information, and their choice is not the maximised solution – "it's good enough" – they satisfice rather than maximise. Satisficing, however, is not the only difference. Decision makers may actually be unaware that they breach the rules of logic.

Simon's work⁴ expanded during the next 20 to 30 years and became the central theory underpinning decision-making and economic research. The dominant theory to come from this work was **Prospect Theory**, published in 1979 by Kahneman and Tversky (1979). They resolved the impasse between utility maximisation and satisficing, as well as fitting the models to observation, by asserting that utility was really subject to viewpoint, that is,

⁴ For which he was awarded the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel in 1978.

whether the “value,” as they termed it, was a gain or a loss when viewed from a defined reference point. The various utility theories all assume that absolute wealth is the value whereas prospect theory states that changes in wealth are the carriers of value. Together with this observation, they noted that the value function for losses was different than that for gains; specifically, that a loss was weighed more heavily than an objectively equal gain when decisions were made. This is represented by the greater steepness of the loss part of the utility function shown in Figure 2.2.

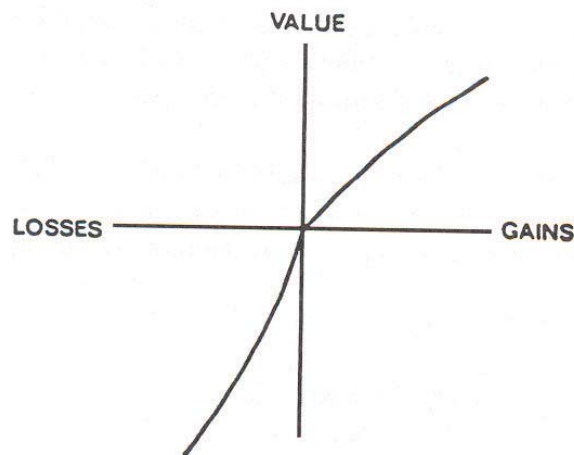


Figure 2.2 – A hypothetical value function

The application of this theory lead to the concept of **framing**. Defining, or framing, the reference point so that an outcome was viewed as a gain would create a risk-averse state in the decision maker (a desire to reduce the risk involved in the decision), whereas, if the outcome were viewed as a loss, a risk-seeking attitude (a desire to include risk in the decision) would develop.

Kahneman and Tversky’s research, however, did not end with Prospect Theory. Their original objective was to ‘fix’ the human problems in applying normative theories. They did not set out to present an alternative theory. In fact, however, they are perhaps better known for their

development of the **heuristics and biases** school of thought⁵. They found that when people are faced with a risky decision, they would often simplify the decision process by relying on heuristics or “rules of thumb”⁶, as they called them (Kahneman et al., 1982). In most cases these heuristics yielded nearly optimal solutions using much less time and energy than alternative, normative decision processes. There were, however, many situations where the heuristics led to major biases – systematic deviations from the answers that would result from normative decision-making – resulting in sub-optimal solutions (Glovich et al., 2002; Kahneman and Tversky, 2000). These biases are cognitive in nature, and stem from human thought processes, using the mind’s more highly developed ability to compare things (relativity) rather than its, less developed, ability to estimate absolutes. Other biases, such as motivational biases, also lead to less than optimal decision-making, but are not specifically considered in this research project.

The three original heuristics that Tversky and Kahneman uncovered (1974) were termed representativeness, availability, and adjustment and anchoring. Many others have been added since but can generally be seen within the optic these three provide.

1. Representativeness refers to the way in which people assess the frequency of two events by how representative one event is of the other. Several biases, however, have the potential to occur when this heuristic is used. Given that data exists about an event, some judge

⁵ For which they were awarded the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel in 2002. Technically Kahneman was the only recipient because Tversky had died in 1996. Kahneman made the following comment when awarded the prize, “The work for which I’m honoured is work I did collaboratively with a close friend and a very famous psychologist, Amos Tversky, who died in 1996. Certainly we would have gotten this together, and that’s one of the things that this means to me today.” http://www.princeton.edu/pr/home/02/1009_kahneman/hmcap.html

⁶ It is semantically important to point out that there are two meanings to the word “heuristic.” The first, being that used by Kahneman and Tversky, is “rule of thumb” and this implies a non-formal approach. Later researchers, especially Gigerenzer, used the same term with its second meaning, “approximate algorithm”, suggesting a more formal approach.

that those data are not representative of their situation, even when they are – people tend to ignore the base-rate data. In a similar vein, many people are insensitive to the sample size. An excellent example of this is seen in scientific research where results are based on small samples and the sample is said to be representative of the whole. Yet another bias lies in people’s misconception of chance – they expect that a sequence of data generated by a random process will look random, even when the sequence is too short for those expectations to be statistically valid. Kahneman and Tversky called this the “law of small numbers” (1972). These actions are biases because they disobey the overall statistical reality of regression to the mean. But the real problem lies in the way people view this reality.

“Chance is commonly viewed as a self-correcting process in which a deviation in one direction induces a deviation in the opposite direction to restore equilibrium. In fact, deviations are not corrected as a chance process unfolds, they are merely diluted” (Tversky and Kahneman, 1974, p. 1125).

So although regression to the mean does occur, it is over a long run of events and not on any single event.

Probably the most well known experiment, illustrating the effect of the representativeness heuristic on people’s reasoning that was conducted by these researchers was the “Linda Question” (Tversky and Kahneman, 1982). Kahneman and Tversky used this constructed question to test people’s ability to understand that if one event was a subset of a second event it could not be more likely than the second event. The vast majority of subjects, however, broke this logical law, based on what they perceived to be a more likely association. This phenomenon was called the conjunction fallacy (Tversky and Kahneman, 1983) because the conjunction of two events is always less likely than the chance that the two events occur independently.

2. The availability heuristic describes the tendency people have to base estimates on how many events of a particular type they can remember, that is, how many instances are available to memory. This is based on the assumption that people can recall more frequent events more easily than infrequent events. Hence those events that are more available are judged as being more likely. The biases that develop, then, relate to the way in which people have events available to their memories. Events are not always available to memory because of the number of times that the event has occurred. Sometimes it is because the event has more salience to the person. Or it could simply be a matter of 'out of sight – out of mind' leading to the unpacking effect (Fischhoff et al., 1978). An instance of the unpacking effect is called the planning fallacy. Research suggests that, when asked to give estimates of time and cost, people envision just one scenario where things go according to plan and do not take into account any contingencies or alternative scenarios where things might go wrong. This fallacy leads to underestimates of time and cost (Buehler et al., 2002).

3. The final heuristic described by these landmark researchers is termed anchoring and adjustment. When asked to give an estimate people commonly will use a single number as a starting point, known as the anchor, and then adjust from there to reach their estimate. The biases develop when firstly people will rely too much on the anchor. One piece of interesting work (Quattrone, 1982) demonstrates that even unreasonable or irrelevant anchors are given the same weight as meaningful ones. A bias develops when there is insufficient adjustment from the anchor. The tendency for people to be overconfident has been associated with motivational biases (Morgan and Henrion, 1990) but there is also a cognitive bias related to the anchoring and adjustment heuristic. Wason (1960) documents one

other bias, the confirmation trap, which tends to be included in any discussion of heuristics and biases. This bias occurs when people tend to seek confirmatory information for what they think is true and fail to search for disconfirmatory evidence.

One of the basic assumptions underlying the heuristics and biases paradigm is that biases are bad; in order to achieve optimal decision-making some process of 'debiasing' needs to be added to the decision process. There have been many suggestions on how to de-bias decisions (Bazerman, 2002; Goodwin and Wright, 2001; Plous, 1993; Russo and Schoemaker, 1989, 2002).

With so much research into the heuristics and biases paradigm there are bound to be areas of criticism. One of the first to be raised centred on the fact that the research had been dominated by experiments using undergraduate students and used general knowledge questions (Beach et al., 1987). Could the results truly be correlated to real decision makers operating in the "real world"? Or would someone who was an expert working on "real world" matters use heuristics to obtain a positive outcome? Gigerenzer (Gigerenzer, 1991; Gigerenzer and Hoffrage, 1995) has addressed this question. The nub of his assertion is that people process information according to frequency (frequentists) rather than using probabilities. Gigerenzer has shown that responses to many of Tversky and Kahneman's questions yield better results when they are couched in terms of frequency rather than in terms of subjective probabilities (Gigerenzer, 1991). It is critical, however, to also recognise that this only occurs where the heuristics used to make the decision match the information structure of the environment. The difficulty lies in predicting such matches between the heuristic and the environment. Gigerenzer has published a list of heuristics – different from Kahneman and Tversky's⁷ – that form what he terms, the **adaptive toolbox**. He sees these tools as

⁷ This is where the definitional distinction referred to in the previous footnote is helpful.

being very helpful in making decisions (Gigerenzer and Todd, 1999; Gigerenzer et al., 1999). The difference between Kahneman and Tversky's and Gigerenzer's approaches is that although both assert that heuristics are used to make complex decisions quicker, Kahneman and Tversky assert that the biases reduce optimal decisions and are therefore 'bad,' that is, they do not result in maximisation. There must be a process of de-biasing. Gigerenzer, on the other hand, asserts that when these heuristics match their environment they are inherently 'good,' that is, they achieve maximisation, and the resulting decisions should not be 'debiased.' Could it be that Kahneman and Tversky and Gigerenzer are simply looking at different types of decisions? Those that fit Gigerenzer's point of view hold that satisficing is one heuristic for optimising – specifically when there is a sequential search for alternatives. Whereas Kahneman and Tversky address different types of decisions and therefore find that different methods apply. In this case the differences in the types may be centred in the way the human mind handles frequencies as opposed to subjective probabilities. In the context of this research, many decisions made in the oil and gas industry are required to be made with very little data and require subjective probabilities. Gigerenzer's frequentist approach may, therefore, not be applicable. That said, he did raise the concept of experts using better heuristics; expertise being one of the environmental structures.

Another methodology of descriptive decision-making, that deals directly with expertise, was developed when, under US Government contract to investigate decision-making for the US army, Gary Klein (1998) began researching how fire-fighters made critical decisions. He commenced using Soelberg's (1967) decision analysis model but found that the concept of a decision being a reasoned choice between at least two alternatives was not followed by the fire-fighters. Klein found that there was never any evidence for this model – most fire-fighters never considered two (let alone multiple) options. Rather they always came up with just one course of action.

“I had been so fixated on what they were not doing that I had missed the real finding: that the commanders could come up with a good course of action from the start” (Klein, 1998, p. 17).

He determined that the fire-fighters were using their ‘experience’ to identify a reasonable course of action defined for the situation as the first thing they thought of and called this process “recognition-primed decision-making”. Eventually he defined the integrated recognition-primed decision model as a model of descriptive decision-making, that he has named **naturalistic decision-making** (Gigerenzer would term this satisficing). This model is very different from previous thinking. The key elements of the model involve the interplay of time pressure, high stakes, experienced decision makers, inadequate information, unclear goals, poorly defined procedures, dynamic conditions and teams (Klein, 1998; Klein and Weick, 2000). As would be expected, there are key differences between naturalistic decision-making and other descriptive decision-making models.

The key difference relates to the alternatives available to make the decision. In other decision-making models the alternatives are available before the decision is made – they are listed in a parallel fashion. They may have to be sought for but all exist prior to the point at which the decision is to be made. Due to the nature of what may be seen as a special class of descriptive decision-making, naturalistic decision-making’s alternatives are serial. In other words, one decision needs to be made before another can be framed – sequential decision-making.

A second difference relates to how to benchmark the decision. In other decision-making models the aim is to achieve an optimal decision either by normative or prescriptive methods. In each case, a good decision is judged to have occurred based on the process used and not necessarily the outcome. The quality of naturalistic decision-making is, however,

judged more by the outcome – a good decision is one where the outcome is good. How is this judged? Klein defines a good outcome as the one that would occur if an expert made the decision.

In the context of the present research, this work demonstrates the difficulty in generalising all decision-making theories and processes. The adaptive toolbox and naturalistic decision-making would not have arisen had the other methodologies been able to answer their context-specific questions. It is argued that perhaps the type of decision – as defined by its attributes – brings about the differences. And once having defined the type of decision, different processes can be matched to the type to lead to optimisation.

2.2.3 Decision Type

In discussing whether Naturalistic Decision-Making had helped or hindered integrated decision science, Cooksey makes the following pertinent comment:

“In decision research, we should not be thinking ‘either-or’ but ‘which, when and why’ with respect to philosophical, theoretical, and methodological stances and with respect to learning from a wide range of disciplines.” (Cooksey, 2001, p. 362)

Essentially, the point is that discussions or arguments about which decision-making school of thought to follow are not helpful. The real focus should be to think about which decision-making methodology to use and when and why that would be best. The premise of this research project is that there are optimal processes and tools (Cooksey’s “which”) to use for certain types of decision-making (Cooksey’s “when”). The secondary premise is that Cooksey’s “why” can be answered by showing, from “real world” observation, that decision-making tools and processes are tailored to the type of decision. When this occurs there is a much greater likelihood of optimal decision-making.

In order to look at the “which, when and why” of decision-making it will first be necessary to determine the decision type. This will require categorising or classifying decisions – something not yet covered in and detail in the literature.

Russo and Schoemaker (2002) have published what they term a pyramid of choice approaches (Figure 2.3). They assert that:

“. . . . decision-makers ought to use the simplest technique sufficient for the task at hand. . . . we present four types of choosing techniques (intuition, rules of thumb, decision weighting and value analysis) in a pyramid to indicate that higher approaches are used less frequently than lower one and for more important decisions. The techniques at the lower levels of the pyramid are rapid and often executed automatically with little attempt to follow a deliberate process. The higher ones are more time-consuming and costly, but yield greater accuracy and reliability in complex environments.” (Russo and Schoemaker, 2002, p. 134)

NOTE:

This figure is included on page 27 of the print copy of the thesis held in the University of Adelaide Library.

Figure 2.3 – Russo and Schoemaker’s pyramid of choice approaches (Russo and Schoemaker, p. 135)

The implication for the present study is that decision type is somehow linked to the importance of decisions and the level at which they should be

investigated. There is also a strong assertion that the way decisions are or should be made is clearly linked to the type of decision.

A few industry-based taxonomies of decision-making have been published to date (Boonstra, 2004; Buckingham and Adams, 2000a, b; Nutt, 2001; Ullman, 1995). Addressing similar needs in the information systems, nursing, engineering and strategic decision-making fields, these studies can be helpful in coming to more clearly understand what elements are critical to the typing or classification of decision-making.

Boonstra (2004), in looking at information systems (IS), used Mintzberg's typology (1976) to characterise seven types of IS decisions from a phase-based or process-based perspective. He also empirically derived four categories for an attribute-based approach. He then identifies five factors that result in major differences in IS decision-making processes. Boonstra suggests:

“. . . . that managers deciding on IS applications should be aware of these factors in order to design a process that fits best with the specific circumstances: *no single process should be considered universally applicable.*" (Boonstra, 2004, p.1, italics added)

This work highlights the need to understand decision type in order to prescribe the best process for that type. The second thought, worthy of stressing, is the idea that 'one size fits all' in developing a decision-making process is not considered valid. Both these conclusions strongly support the need to develop a taxonomy of decision type.

In the nursing industry, Buckingham and Adams (2000a, b) have also recently looked at developing a taxonomy for decision-making. In developing their taxonomy they strove to demonstrate the underlying similarities of the various decision-making theories and hence the universality of decision-making processes. Although approaching the

taxonomy question from a theoretical perspective it clearly demonstrates the need for a taxonomy so that decision types can be defined against which to judge the goodness of a decision-making process.

Nutt's (2001) work in strategic decision-making also clearly demonstrates the need to determine decision type in order to improve the decision-making process. He empirically derived nine decision types from a database of over 400 strategic decisions. He then linked his decision types with tactics which best suited that type. Finally he demonstrated that the type/tactic interaction directly related to the success. Use of a good tactic but on the wrong decision type inevitably lead to failure whereas use of the same tactic but on a decision type where it was demonstrated to be the best, resulted in a greater chance of project success.

Another example from the engineering industry highlights one of the problems of taxonomies. Ullman's (1995) taxonomy of engineering decisions shows that it is possible to have a taxonomy that is too complex. Ullman's system views decisions as being made in ascending complexity and shows 11 dimensions. His taxonomy consists of defining a descriptor for each dimension. Although a very detailed classification, it means that virtually every decision is unique and therefore the taxonomy is of no help in determining an optimal decision-making process – because, each time a decision is to be made the process leading to the optimal decision would also be unique. The counterpoint can equally be true – too broad a classification can result in grouping too many decision types together, again leading to non-optimal decision-making processes.

2.3 APPLICATION IN THE UPSTREAM OIL AND GAS INDUSTRY

The forgoing section dealt with enunciating the primary academic research answers that have come from controlled laboratory experiments that reveal both the processes that are believed to result in optimal decision-making as well as the basic behavioural and cognitive processes. But this research project is focused on improving decisions in the “real world” of the upstream oil and gas industry and takes what may be called the Pasteur heuristic – studying the phenomenon of judgment and decision-making with the primary motive being its improvement. This section of the review will, then, be look at how the academic theories have been applied in the upstream oil and gas industry with an aim to uncover areas that need improvement. This application-motivated research forms the ‘third arm’ of the decision-making research area and is termed prescriptive decision-making (Bell et al., 1988).

2.3.1 Normative Decision-Making

In the upstream oil and gas industry the majority of interest has centred on promoting the development and use of so-called normative, or decision analysis, techniques (von Winterfeldt and Edwards, 1986). These techniques demonstrate how people should ideally make decisions under uncertainty, in a way that is consistent with their objectives, such that they achieve a maximised outcome (Cozzolino, 1977, 1978; Howell and Tyler, 2001; Jonkman et al., 2000; Macmillan, 2000; Rose, 2001b; Rose et al., 2003; Simpson et al., 2000). The upstream oil and gas industry eagerly tests and adapts the principles and methods unearthed in normative decision-making (Newendorp and Schuyler, 2000; Rose, 1987; Watson, 1998) because, if correctly applied, these normative techniques should yield maximised decisions (Savage, 1954; von Neumann and Morgenstern, 1947). This laboratory-directed approach (Bailey et al., 2000; Ball and Savage, 1999; Galli et al., 1999) of the upstream oil and gas industry places it, along with the finance industry, at the forefront of the use of decision analysis (Schuyler, 1997).

The use of normative decision-making in the upstream oil and gas industry has tended to be project- and even people-specific. As a theory, principle or process is documented in the decision-making arena, it is quickly adapted into the upstream oil and gas industry by a specific person. If it “works” – that is, it is easy to implement and adds value – it is retained. If it does not work, it is discarded in favour of the next new idea. The vast majority of the research in the upstream oil and gas decision-making area has been focused on the application of decision analysis. Authors such as Capen (1992; 1974; Capen et al., 1971; Capen et al., 1976), Grayson (1960; 1962a; 1962b), Newendorp (1975; Newendorp and Campbell, 1971; Newendorp and Schuyler, 2000), Rose (1992a; 1998a; 2001b), Megill (1988; 1992b) and Howell (Howell and DuBois, 2003; Howell and Tyler, 2001) have all taken findings from theoretical research and applied them successfully in the oil and gas industry.

The first implementation in the upstream oil and gas industry of normative decision-making tools and processes was related to the bidding sales for Gulf of Mexico acreage held in the mid to late 1950's. One company, Atlantic Richfield, had been extremely ‘successful’ in the mid 1950's in that they won every piece of acreage they bid on. The problem with winning all the bids was that their budgets were stretched for the next few years in order to undertake all the consequential exploration and development work. Their research and development group began working on normative decision-making as it related to bidding for exploration acreage. This research, undertaken by Capen, Clapp and Campbell, eventually coined the phrase “the winner’s curse” (Capen et al., 1971). In a quirky touch, this was later adapted back into the finance industry (Thaler, 1992). Capen, himself, described the work as “quantitative, not qualitative” (AAPG, 2004) and much of his subsequent research was along the same lines (Capen, 1976; Capen and Clapp, 1974; Capen et al., 1976).

This work showed that a set of rules could be developed that, if strictly adhered to, could optimally answer the bidding question. In the context of the current research this implies that once a specific type of problem can be defined – bidding for acreage in this case – a set of tools and processes can be determined which, if strictly adhered to, has the potential to lead to optimal decision-making.

The next type of decision that seemed to lend itself to decision analysis was one of the most capital-intensive portions of the upstream oil and gas industry, drilling. Grayson (1960) published the first book linking normative decision-making to the oil and gas industry – *Decisions under Uncertainty: Drilling Decisions by Oil and Gas Operators*. The key element of the work was it was the first attempt to apply statistical methods to drilling decisions and utility theory to individual decision-making in the drilling area. He later published on both these topics (Grayson, 1962a, b).

Again Grayson's work reinforced the idea that there were a set of normative rules and data that if strictly applied could result in an optimal decision. What was implicit was that the set of rules applied to a specific decision type – drilling.

In 1967 Newendorp published his PhD thesis based on the application of utility theory to investment decisions in the oil and gas industry. He then expanded this work and published on the concept of expected value (Newendorp and Campbell, 1971) and finally extended his research to include the application of concepts of value of information and simulation. His work led to the publication of the first text on decision analysis in the upstream oil and gas industry – *Decision Analysis for Petroleum Exploration* (Newendorp, 1975). Schuyler, a student of Newendorp's, comments in discussing his update of this classic text:

“This widely-cited book remains the standard text and reference in the field. This book introduces the reader to ways of applying statistical decision analysis concepts to the analysis of risk and uncertainty in petroleum exploration investment decisions.” (<http://www.maxvalue.com/dape.htm>)

Schuyler (1999) has remained a prime advocate of decision analysis in petroleum exploration for the last twenty years, publishing over 35 articles that deal with the various nuances of the topic. His work centres on promoting decision analysis and the idea that ‘the numbers are right’ (Schuyler, 2005). In doing this he shows that the general approach could be termed ‘one size fits all,’ that is, if you are able to follow this process for each and every decision you will get the optimal answer. But it is interesting to note that his research is focussed on certain topics. Viewing his work from the perspective of the present research, these topics can be seen as separate decision types and what he is actually doing is stating what decision processes may lead to optimal decision-making for a specific type of decision.

Two other authors – Rose and Megill – and their co-workers have proliferated discussion in one of the key areas of decision analysis as it is applied in the largely exploration part of the upstream oil and gas industry. This is the relationship between risk analysis and economics in petroleum exploration. Both have sought to objectify the assessment of resources and the impact of those assessments on the economics of exploration (Megill, 1971, 1988, 1992a, b; Rose, 1987, 1994, 1996a, 1998a, 2001b; Rose et al., 2003). Megill in his 1995 presentation to the annual meeting of the American Association of Petroleum Geologists (AAPG) discussed the evolution of the concept of risk analysis. He concluded that:

“the principal prompter of a rapid evolution was the advent of sealed bid sales with bonus bidding. When explorers asked for millions of dollars, management wanted to know more and more about the details, so a

logical, more formal methodology had to be developed. Faster computers also aided in the new risking. AAPG's school entitled Evaluating and Managing Risk has been singularly instrumental in spreading the new methodology." (Megill, 1995, p. 89a)

Although there are some companies that have not adopted or adapted the methodology referred to here, this approach has been the most widely accepted. This is probably because it has been the most successful in saving petroleum companies millions of dollars, largely at the exploration stage. But they have won/lost much larger sums at the development and production stage, where decision analysis is less applied.

Within the context of this research, however, this work can be viewed as documenting a decision-making process that has the potential to lead to the optimal decision when dealing with 'exploration risk'-type decisions. In fact, more recent commentary by Rose argues that the methodology espoused for the exploration should be applied within development and operations; but it has not been taken up as enthusiastically. Could it be that the processes that may lead to an optimal decision in one (exploration) are not the same processes that may lead to an optimal decision in the other? The question of decision type is referred to in sections 2.2.3 and 2.3.3.

Another area that has received some attention lately due to the ability of desktop computing to deal with the calculations necessary has been the development of portfolio optimisation. Originally discussed by Markowitz in 1952 (Markowitz, 1952) as it applied to the stock market, the concept was introduced to the petroleum industry in 1991 (Hightower and David, 1991). It is being primarily adapted to the petroleum industry by Howell and his co-workers during the last five years (Allan, 2001; DuBois and Howell, 2000; Howell and DuBois, 2003; Howell and Tyler, 2001). But once again this literature deals with what could be called a specific type of

decision-making. Once more it shows that the upstream oil and gas industry has produced some uniquely tailored normative decision-making processes, which are related to specific types of decision-making.

A recent series of papers discussing the benefits of implementing normative decision-making tools as “best practice” (Begg et al., 2001; Jonkman et al., 2000; Lamb et al., 1999, Rose et al., 2002; Simpson et al., 2000) is quite enlightening. For the first time research in the oil and gas industry has claimed to demonstrate that there is a positive correlation between business performance and using “best practice” in decision analysis. This work claims to demonstrate that the application of normative decision-making will lead to maximisation of utility if the “best practice” decision analysis processes are adhered to.

2.3.2 Behavioural (or Descriptive) Decision-Making

As previously mentioned many upstream oil and gas projects have often failed to yield their anticipated results. Why then does this occur if the use of decision analysis should theoretically yield maximised decisions? One possible reason is thought to result from the inability of the implemented technique to account for the non-rational or non-optimal ways in which people think and behave (Simon, 1956; Rose, 2004). Another possible reason is that decision analysis is not applied, or if applied, applied incorrectly. Building on Simon’s conclusions, the work of Kahneman and Tversky in the mid 1970’s provided the framework of heuristics and biases from which a torrent of research has come, affecting research in economics (Camerer et al., 2004), law (Connolly, 1986), medicine (Evans and Patel, 1989), management (Bazerman, 2002) and political science (Tetlock, 2002). But there has not been much more than a passing interest in the oil and gas industry. Although quick to test normative approaches, the industry has been slow to analyse the existence and impact of the cognitive biases from what could be termed the ‘softer,’ or human, side of decision-making.

Possibly the first attempt to look at cognitive biases came in 1976 when Capen documented the results of research on overconfidence where he surveyed a group of petroleum engineers during his Distinguished Lecture tour in 1974-75. He indicates that he was motivated to conduct the experiment after he became aware of the work of the Stanford Research Institute's Decision Analysis Group. In his research, Capen presented the Society of Petroleum Engineers members with a series of questions requiring numerical answers with ranges that described their personal uncertainty. Because this was the first foray into descriptive decision-making in the industry it is worth noting his conclusions in entirety:

“1. A large number of technical people have little idea of what to do when uncertainty crosses their path. They are attempting to solve 1976 problems with 1956 methods.

2. Having no good quantitative idea of uncertainty, there is an almost universal tendency for people to underestimate it. Thus, they overestimate the precision of the own knowledge and contribute to decisions that later became subject to unwelcome surprises.

A solution to this problem involves some better understanding of how to treat uncertainties and a realization that our desire for preciseness in such an unpredictable world may be leading us astray.”
(Capen, 1976, p. 843)

Capen's work explored the overconfidence bias and in his paper he describes a methodology of removing the bias via a feedback system. The bias, however, was never completely removed. Although never explicitly stated he did, however, indicate that there must be a motivational bias that was not allowing the overconfidence bias to be totally removed because he quoted evidence that the bias was removed in weather forecasters the more feedback they received (Murphy and Winkler, 1977).

Rose expanded Capen's work. Throughout the 1980's and 1990's he taught a risk analysis course which, in order to obtain attendees' attention, was always started with a very similar experiment to Capen's. He concluded in one of his papers that:

“Many biases exist in the mental processes by which most people make risk decisions. These biases tend to produce significant inconsistencies Exploratory performance can be improved through constructive postmortem analysis of geotechnical predications, review of exploration tactics versus declared strategy, and year-to-year comparison of exploration performance parameters. Performance trends can then be used to discount or enhance future prospects, modify corporate stances and procedures, and highlight functions that need improvement.” (Rose, 1987, p. 1)

Over time he developed this remediation or feedback system to assist in determining estimates for prospect and play analysis. Although he claimed that optimal decision-making could be achieved by recognising the biases and then setting up a system of debiasing (Citron et al., 2002), it could be argued, given industry conservatism, that he took a pragmatic approach that is really a “satisficing” product to move the industry forward. Rose, however, never separated the biases in his analysis. He amalgamated them and coined the phrase “prospector myth” (Rose, 2000) to encompass them all. The pertinent question that remains is, can the results of the biases be properly dealt with if the biases and their effects remain amalgamated? For example, Pieters claims that much of the “prospector's myth” is actually the result of framing. He states:

“Understanding these frames and how they occur can lead to methods that would help reduce or eliminate these biases in risky decision-making when multi-million dollar oilfield investments are being undertaken.” (Pieters, 2004, p. 1)

A key assumption underlying this research project is that each decision type must be clearly understood before the tools and processes that lead to optimal decision-making can be determined. The amalgamation of different decision biases into one single “prospector myth” may be initially successful but really only for the decision type that it best represents. This assertion is demonstrated by the fact that although Capen initially highlighted the decision-making problem to the engineering or development and production side of the industry, it is Rose’s methodology that has been universally accepted by the exploration or geoscience side of the industry. Could this be because the tools and processes suggested by Rose for use in exploration actually relate to a certain type of decision for which these tools and processes lead to optimal decision-making?

It has been left to Begg, Bratvold and Welsh, to champion the messages of decision-making by bringing both normative processes and descriptive findings to the engineering fraternity in recent years (Begg et al., 2003; Bratvold et al., 2002, 2003; Welsh et al., 2004; Welsh et al., 2005). Initial attempts to work at the crossover between naturalistic decision-making and the upstream oil and gas industry, specifically the concepts of intuition and expertise, have been undertaken (Dinnie et al., 2002; Malhotra et al., 2004) but still require further research and analysis.

2.3.3 Decision Type

The only previous effort to develop a framework or classification of oil and gas decision-making, that has been found, was attempted by the United Kingdom Offshore Operators Association (UKOOA). In 1999 the association published a set of industry guidelines (UKOOA, 1999), which were designed to assist operators with a more open, transparent, soundly based and context-appropriate decision-making process as it related to offshore health, safety and environment (HSE). Called the Decision Support Framework for Major Accident Hazard Safety (Figure 2.4), it

looked at decision context and the basis for making decisions, and even made some recommendations for optimal methodologies.

NOTE:

This figure is included on page 39 of the print copy of the thesis held in the University of Adelaide Library.

Figure 2.4 – A Decision Support Framework for Major Accident Hazard Safety (UKOOA, 1999)

The framework is set up as a matrix and covers a spectrum of decisions ranging from those that are dominated purely by engineering (top left of the matrix) to those that have some form of societal value (bottom right of the matrix). The right hand side of the matrix seeks to list, in increasing complexity (downwards), the context associated with the decision, whilst the left hand side of the matrix documents some recommended means of calibrating or checking the decision.

This framework or taxonomy, however, addresses only the more surface-engineering based decisions and is termed a 'first attempt' by the authors. Accident hazard safety evaluation may be regarded as the most downstream of the upstream oil and gas industry and hence this framework does not address many of what may be termed the more upstream of upstream decisions. This highlights the need for a more

generic decision-making taxonomy that can be used at all levels within the upstream oil and gas decision-making spectrum.

2.4 SUMMARY

2.4.1 Normative Decision-Making

This review demonstrates that the upstream oil and gas industry has successfully gleaned, implemented, and in some cases, uniquely applied, normative decision-making processes. This development has been project-specific. As a normative theory, principle, tool or process is documented by judgment and decision-making literature, it has been quickly tailored for use within the upstream oil and gas industry. If its use has been thought to add value it has been retained and reformed. If it fails to add value the tool or process is discarded and the search begins for the next new one.

The basic assumption underlying all normative decision-making is that its use, if properly and fully applied, yields maximised decisions in all cases. Theoretically, it is believed that implementing “best practice” tools and processes will yield maximised utility in the long run. But this has failed to occur in the oil and gas industry (Cottrill, 2003). Why? Some authors believe this gap has occurred because companies have not implemented the best normative tools and processes. But even those companies which do implement best-practice normative tools and practices still under-perform the theoretical maximum utility. It is part of the hypothesis of this research that part of the reason the gap occurs is because companies have failed to take into account the human side of decision-making. Of course the other part could be that the companies have failed to fully and correctly implement best practice, even when claiming they have.

2.4.2 Behavioural (or Descriptive) Decision-Making

In reviewing descriptive decision-making and its interface with the upstream oil and gas industry, several questions or concerns – gaps – have been highlighted. The first is the reliance on laboratory experiments using college students (Plous, 1993). A key to unlocking the potential of decision-making in the upstream oil and gas sector lies in determining if the theoretical results of cognitive psychology, derived from laboratory research, is applied in the “real world” of the industry. Clearly research into human decision-making in the oil and gas industry needs to be both theory-based as well as practice-based – undertaken in the “real world” with the subjects being actual industry professionals. This research will need to compare and contrast how upstream oil and gas companies do make decisions – as determined in the “real world” – and how they should make them – as determined by theoretical literature.

The second gap revolves around the impact that cognitive and other biases have on oil and gas decision-making. Initially it is important to determine whether this impact depends on the type of decisions. By more rigorously defining decision type it is hoped to bring together the various aspects described. Understanding decision type better should provide better understanding of why the different approaches have been chosen and possibly indicate which tools and processes should be used in order to yield optimal decisions.

It is, therefore, critical to determine the different decision-making types that exist in the upstream oil and gas industry. It has been argued that several different decision-making methodologies have arisen because of the inability of the other methodologies to answer context-specific questions. The research is part of an ongoing tradition of establishing the fit between method and environment (process and context), which has been the core issue for decision theorists for centuries. In order to determine the tools and processes that lead to optimal decision-making it will be necessary to

determine the type of decision by categorising decisions – something not yet covered to a great extent in the decision-making literature and not at all in the upstream oil and gas decision-making literature.

2.4.3 Decision Type

Previous research in other industries has shown that decision-making can be improved by classifying decisions into decision types (Nutt, 2001). Once the decision types are established, research has shown that a prescriptive decision-making approach, which combines both normative and descriptive decision-making, can be determined which has the potential to lead to optimal decision-making (Bell et al., 1988).

However, there is no such taxonomy or classification scheme for decision-making in the upstream oil and gas industry against which the shoulds and dos of decision-making can be compared. An objective, then, to assist in improving decision-making in the industry must lie in developing an oil and gas decision-making taxonomy. The aim of the taxonomy is to define decision type in such a way as to enable selection of appropriate tools, data and processes that will lead to optimal decision-making according to the type of decision.

In order for the taxonomy to be generic it will need to be constructed using some recognised scientific methodology. Taxonomies that were derived in other industries were not constructed using the same process in each case. Most were empirically derived or simply constructed by trial and error. Empirically derived taxonomies, although excellent for their specific task, may not be useful across the broad spectrum of decisions that are apparent on the playing field of upstream oil and gas decision-making.

2.5 RESEARCH QUESTIONS

This chapter has reviewed literature from both the normative and behavioural (or descriptive) branches of the decision-making spectrum and talked about their use in the upstream oil and gas industry. Several gaps in the research have been revealed. These distil into two primary themes; decision process and decision type. The summary identifies two key research hypotheses to be tested.

Firstly, upstream oil and gas companies should use processes that take into account the human aspects of decision-making in order to make “good” decisions. Secondly, upstream oil and gas companies tailor their decision-making processes to match the decision type.

The key research questions that will assist in testing these hypotheses are therefore:

1. Which processes should upstream oil and gas companies use for decision-making under uncertainty?
2. Which processes do upstream oil and gas companies say they use in their decision-making under uncertainty?
3. Which criteria are essential for decision-making under uncertainty to be defined as “good”?
4. What is a useful structure or classification scheme for decision-making under uncertainty that defines the various types of decisions made in the upstream oil and gas industry?
5. Do upstream oil and gas companies actually do what they say they do in making decisions under uncertainty?
6. Do the decision-making processes change depending on the type of decision being made?

First: Which processes should upstream oil and gas companies use for decision-making under uncertainty?

The literature review has shown that the upstream oil and gas industry has rapidly assimilated the positive results of decision analysis. Even though this was initially on a project-by-project basis, in the last 20 years it has become commonplace across most oil and gas companies. Research has also prescribed normative tools and processes as “best practice.”

But this review has also shown that applying these tools and processes does not always lead to decisions that maximise utility – the objective of normative decision-making. Further review of the literature directed towards decision-making processes is required.

Second: Which processes do upstream oil and gas companies say they use in their decision-making under uncertainty?

Research to date has revealed that many upstream oil and gas companies are using a variety of decision-making processes. The literature has linked company outcome and success to the level of use of decision analysis but has not determined if this is true for various types of decisions. The research appears, however, not to have reviewed the human side of decision-making in as much depth. Hence an objective for further research is to look at the human side of decision-making and document what processes upstream oil and gas companies say they are using.

Third: Which criteria are essential for a decision-making under uncertainty to be defined as “good”?

The literature espouses focusing on the decision-making process rather than the outcome of the decision to determine whether a decision is “good.” If there were no uncertainty, the use of outcome would be successful. Whilst there is uncertainty, many outcomes are needed to judge the forecasts and the processes used to judge individual decisions. Because any research into

decision-making has, at its heart, the desire to improve decision-making, the concept of “good” must be linked to improvement. The literature is divided on what “good” means and so it is also necessary to define what makes a “good” decision is in terms of normative, descriptive and prescriptive decision-making.

Fourth: What is a useful structure or classification scheme for decision-making under uncertainty that defines the various types of decisions made in the upstream oil and gas industry?

All research to date in the upstream oil and gas decision-making sphere has been either project-specific or industry-wide. No research has been undertaken to determine if it is possible to separate the decision-making spectrum into different decision-making types. Research from other industries has shown that being able to separate out specific decision types has allowed the matching of specific tools and processes to facilitate better outcomes. Hence further research within the upstream oil and gas industry should focus on distilling out the various decision-making types

Fifth: Do upstream oil and gas companies actually do what they say they do in making decisions under uncertainty?

Having established the theory of how companies should make decisions under uncertainty and then determine, in a behavioural sense, what they say they do, it is possible to determine if they are actually doing what they say they are doing. If they are not, this may be a reason for the suboptimality of their decision-making and prescriptions can, therefore, be made to assist in moving suboptimal decisions towards more optimal decisions.

Sixth: Do the decision-making processes change depending on the type of decision being made?

Once an oil and gas decision-making taxonomy has been determined it is then important to determine if the processes used by upstream oil and gas companies are modified from the generalised model for the various decision types. There is no oil and gas literature, and very sparse general decision-making literature, in this area of research.

CHAPTER 3

THE THEORY OF HOW DECISIONS SHOULD BE MADE

3.1 AIM

Whilst the previous chapter reviewed the various literatures on decision-making under uncertainty, and determined the gaps in that literature that needs addressing, the aim of this chapter is to report a theoretical model of how oil and gas companies should make their decisions under uncertainty based on a more focussed literature review. The discussion moves from general decision-making to the more specific oil and gas, team decision-making, drawing together the critical elements or “root definitions”, as Checkland (1981) calls them. The chapter concludes that the multiobjective decision-making framework (Begg, 2004; Chankong and Haimes, 1983; Goiciecha et al., 1982; Rudduck et al., 2006; Suslick et al., 2001; Szidarovszky et al., 1986) best describes how individuals should make their decisions and the multilevel theory of team decision-making (Hollenbeck et al., 1998; Hollenbeck et al., 1995; Humphrey et al., 2002; LePine et al., 1997) best depicts how these decisions are drawn together and endorsed by the company. Although there is a tension between decision process and decision outcome (and good process and good outcome are very strongly linked), it is seen that primary importance should be assigned to process with secondary importance given to outcome – without totally ignoring it.

3.2 INDIVIDUAL DECISION-MAKING

Whilst most authors (see for example, Campbell et al., 2001; Clemen and Reilly, 2001; Nutt, 2002; Russo and Schoemaker, 2002; Skinner, 1999) state that the object of reviewing decision-making is to facilitate making better decisions, few actually define what good decision-making is. Intuitively, a good decision is thought to be one for which the result or outcome is good. Focusing on the outcome, in this manner, is common practice in “real world” decision-making simply because the “real world” is a results-based environment. In the oil and gas industry, as with almost all other industries, the company’s outcome is related to its share price. All investors use share price as their measure of

success in a company. Increasing share price (improved outcome) generates and disseminates rewards.

In virtually all cognitive psychology research into heuristics and biases in individual decision-making (Glovich et al., 2002; Kahneman et al., 1982; Kahneman and Tversky, 2000), the experiments deal with what may be termed static situations. This means that the correct answer is known, without uncertainty, and the research question is posed in such a way as to uncover whether cognitive biases either exist or don't exist – that is, whether people's responses differ systematically from the optimal solution. The optimal solution, however, never changes. This style of decision is herein termed static decision-making. The decision is almost always viewed as being the point at which one alternative is chosen above another.

Decision-making in the “real world” could, conversely, be termed dynamic decision-making and, of necessity, includes uncertainty about the correct solution. Here the answer is not known and may never be known. A good example of this is seen in attempts to forecast natural events. Although the decision is made at the point where one alternative is chosen above another, the dynamic nature of forecasting means that chance events may subsequently change the outcome from that envisaged during the decision process. As the “real world” is also one where uncertainty is always present, making the right decision (given the information available at the time) does not guarantee the desired outcome. Specifically, after the decision is made, how it is implemented and the impacts of chance both still play a role in the final outcome. Russo and Schoemaker argue convincingly that the outcome of a decision is linked to not just deciding, but also to implementation and to chance (Figure 3.1). These authors propose that the “best hope for a good outcome is a good decision process followed by good implementation” (Russo and Schoemaker, 2002, p. 5).

Begg et al. (2003) recommend seeing the distinction between the deciding and the outcome. Recognising the upstream oil and gas industry as a classic example of the uncertain world, they observe:

“if you listen carefully to ordinary speech or to decision reviews and look-backs in E&P companies, this distinction is not observed. If a bad outcome follows an action, people say that they made a bad decision, and vice versa.” (Begg et al., 2003, p. 2)

Their argument is that if the outcome and the deciding are separated, it is then possible to focus on the decision-making process and that this will lead to better decisions. This is based on the assumption that process and outcome are very strongly linked and pursuing a good process will lead to achieving a good outcome in the long run.

NOTE:

This figure is included on page 50 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.1 – Three Factors Determine Decision Outcome (after Russo and Schoemaker, 2002)

Bratvold et al. (2002) reinforce the idea that by considering both processes and outcomes, it becomes possible to confront the challenge of building explanatory and predictive accounts of human decision-making in complicated “real world” situations, such as those found in the oil and gas industry. To reinforce this

distinction they use Russo and Schoemaker's (2002) matrix of decisions and outcomes (Table 3.1).

Table 3.1 – Decision Process versus Outcome

Process	Outcome	
	Good	Bad
Good	Deserved success	Bad break
Bad	Dumb luck	Poetic justice

The use of Russo and Schoemaker's (2002) four catchphrases is helpful in distinguishing the differences. They even go so far as to postulate that promotion within E&P companies is often linked to good outcomes and many decision-makers who have a good outcome, but have used a bad decision-making process, are actually promoted, whilst some, who have used a good process but have suffered a 'bad break' due to chance, are let go. They argue that good decision-makers are those who use a good decision-making process and that these are the employees whom companies should strive to retain.

This discussion highlights the tension between a good decision-making process and a good outcome. The three elements that contribute to a decision outcome as shown in Figure 3.1 will be covered in greater detail in the following sections.

3.2.1 DECISION-MAKING PROCESSES (**Deciding**)

The element most strongly linked, in people's minds, to decision outcome is the decision-making process - that is, the 'deciding' part of Figure 3.1. Given this belief and the goal of this thesis (to determine if there is a link between decision types and processes in order to improve decision outcome) 'deciding' seems the logical place to start a discussion of factors influencing these outcomes.

Reviewing several of the published decision-making processes shows them to contain very similar elements. Campbell et al. (2001) propose five

stages (Figure 3.2), namely: formulate questions; plan analysis; examine data and premises; perform analysis; and make decision. The process is sequential and designed such that the problem situation is correctly understood prior to actually making the decision.

NOTE:

This figure is included on page 52 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.2 – Decision-Making Process (after Campbell et al., 2001)

Clemen and Reilly (2001), by comparison, propose a decision analysis flowchart with seven stages (Figure 3.3). While their first four stages largely correspond to the five elements given by Campbell et al, a major differences lies in the fact that Clemen and Reilly recommend adding some form of post decision analysis, which they term sensitivity analysis, and also add the implementation stage to the end of the decision-process.

NOTE:

This figure is included on page 52 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.3 – Decision Analysis Process Flowchart (after Clemen and Reilly, 2001)

Skinner (1999), also writing about decision analysis, sees the process as a cycle where each stage gives insight to the next, with the cycle repeated until a clear course of action is obvious. It is then that an implementation plan is developed (Figure 3.4).

NOTE:
This figure is included on page 53 of the print copy of
the thesis held in the University of Adelaide Library.

Figure 3.4 – Decision Analysis Cycle (after Skinner, 1999)

Russo and Schoemaker (2002) distil Clemen and Reilly's seven stages down to four key stages (Figure 3.5) framing; gathering intelligence; coming to conclusions; and learning from the experience. In addition to succinctly summarising the process, they add a feedback loop to the process so that learning from both the implementation and the outcome is included. This feedback, however, cannot change the decision, instead assisting in making future decisions. They also argue that interim information may require the decision maker to step back to an earlier

NOTE:
This figure is included on page 53 of the print copy of
the thesis held in the University of Adelaide Library.

Figure 3.5 – Four Stages of the Decision Process (after Russo and Schoemaker, 2002)

stage and rework the problem. This makes their process an excellent summary of what is herein termed a dynamic systems decision-making process.

An alternative to the top-down, theory-based approach taken above, however, is to start by looking not at the theoretical distinctions between different portions of a decision-process but rather by looking at decisions as they are made and constructing decision processes from the bottom up. Working from a database of over 400 decisions made by senior managers across North America and Europe, Nutt (2002) proposes that there are a multitude of decision-making processes but that there are two of key interest. The first he terms the “discovery process,” which he proposes is a “‘think first’ approach that increases the chance of being successful,” whilst the other is “called an ‘idea-imposition’ process and is linked to failed decisions” (Nutt, 2002, p. 45). The idea or decision being imposed by the decision maker. He argues that although both processes have the same stages it is the order in which they are undertaken that leads to success or failure. Essentially thinking first will heighten the chance of success whilst imposing a preconceived idea will most likely lead to failure. This “thinking first” idea is similar to what the other authors termed framing in that it requires contextualisation, but it also requires as many different solutions – multiple working hypotheses – to be gathered as possible before one is chosen. Nutt argues that most failures in decision-making occur because one solution is chosen quickly and the rest of the effort and energy is spent justifying the decision rather than seeking out other alternatives. His two processes are shown in Figures 3.6 and 3.7.

Synthesising all of the models yields three essential phases in the deciding system:

1. Framing – this is where the decision is defined and the objectives and alternatives searched out;

2. Modelling – where each alternative is evaluated against the objectives and the objectives weighted according to their ability to distinguish the best answer;
3. Assessing – where trade-offs are evaluated and sensitivity – where the weights are changed to see if varying them may significantly change the predicted outcome – is checked.

NOTE:

This figure is included on page 55 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.6 – Nutt's Discovery Process (Nutt, 2002, p. 46)

NOTE:

This figure is included on page 55 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.7 – Nutt's Idea-Imposition Process (Nutt, 2002, p. 49)

In the “real world” of the oil and gas industry, a decision is rarely made using only one measuring criteria and indeed should not be. Generally it is made using multiple objectives. A process, then, that takes this multiobjective nature of the decision into account needs to be used. Several authors have described, in various ways, what may be termed a multiobjective decision-making process (Begg, 2004; Chankong and Haimes, 1983; Goiciehea et al., 1982; Rudduck et al., 2006; Suslick et al., 2001; Szidarovszky et al., 1986). In the proposed process the three phases are synthesized and subdivided into eight steps for ease of execution (Figure 3.8).

NOTE:

This figure is included on page 56 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.8 – Eight Step Multiobjective Decision-Making Process (after Begg, 2004)

The processes involved at each of these steps are detailed below.

Stage 1 – Framing

Step 1 – Decision Context: Each of the processes discussed previously start with this step. As most of the reviewed authors indicate (Campbell et al., 2001; Clemen and Reilly, 2001; Nutt, 2002; Russo and Schoemaker, 2002; Skinner, 1999), this is the time to identify and frame the decision as well as determine who will actually make it. Knowing the frame is

important because the objectives and weightings which will occur later in the process should be those of the company which should (legally in the case of public companies) be that of the owners. Several of the authors also talk about the need to make sure that the “right” problem or decision is being addressed. Too often decisions are made only to find out that they were addressing the incorrect problem.

Step 2 – Identify the Objectives: Once the context is clear then the objectives can be determined – these being the goals or dimensions against which various choices or alternatives can be measured. The process is termed a multi-objective decision-making process because it is assumed there is more than one objective as is usually the case in oil and gas decision-making. As well as specifying the objectives it is important to enunciate the way they are to be measured. The creation of a hierarchy of objectives is also a useful detail, aiding in determining the weights that may be assigned later in the process. The identifying of objectives may be iterative with step 3 as some objectives may yield alternatives whilst some alternative may point to the need for further objectives. What is critical here, as Nutt (2002) points out, is to actually list objectives, their measuring scales and to establish the direction to be taken ahead of determining the alternatives or choices. Nutt’s Idea-Imposition process (Nutt, 2002) shows that the chance of failure is increased if step 3 occurs ahead of step 2. If the choices or alternatives are decided prior to objectives being set, then the process will spin off into justification of, rather than exploration of, choices. As each objective will likely have different scales it is also important to find ways to change the scales to a common value scale. This will enable the modelling process to be undertaken effectively and efficiently.

Objectives can exist before the decision context is framed. For example, a company may state that their objective is to make a 15% return on capital. They would then look for alternatives which could satisfy this objective.

Step 3 – Generate the Alternatives: In this step, the various choices or options that could satisfy the context and objectives are generated, by means such as creative thinking and benchmarking. Although this stage may be perceived as taking a disproportionately long time; the investment in time is seen as worthwhile once the modelling stage commences (see Nutt, 2002; Russo and Schoemaker, 2002).

Stage 2 – Modelling

Step 4 – Evaluate the Alternatives: Once both the objectives and alternatives have been generated, the various alternatives can be rated or measured against the stated objectives. Again, caution is needed because it is still easy to move from Nutt's Discovery Process to his Idea-Imposition Process at this stage (Nutt, 2002). One method that can be used to guard against this is to rate objective by objective rather than alternative by alternative. In other words, each alternative is rated for its ability to satisfy a single objective, prior to moving to the next objective and rating each alternative for that objective. This guards against deciding on an alternative without fully evaluating it against its alternatives.

Step 5 – Weigh the Objectives: In order to determine which alternative best meets all the objectives it is necessary to weight the objectives according to the priorities they hold – as it relates to the specific decision to be made. This is accomplished by first ranking them and then assigning the weights to reflect the relative importance of each objective.

It is also possible to have these weights specified in advance – say as part of a company's desired objectives.

Step 6 – Calculate the Weighted Outcome: The final step in the modelling stage is simply to sum the weighted values for each alternative. The

provisional decision rule, at this stage, is to choose the highest weighted value.

Stage 3 – Assessing

The decision at this stage is provisional. A third stage is included to allow for several methods of checking that the alternative with the maximum weighted value is, in fact, the best choice.

Step 7 – Make Trade-offs: The various objectives can be split into different classes. For example, costs and benefits, or risks and returns. The weighted scores of the alternatives for each of the classes of objective can then be cross plotted to determine whether particular alternatives are dominant across all classes. An alternative is dominant when it has the highest weighted value no matter what the change in weighted scores.

Step 8 – Sensitivity Analysis: The primary purpose of this step is to check the robustness of the decision, that is, to see if the chosen alternative changes for a viable change in weights. An objective can be chosen for which the weights are then varied systematically from those used in the original modelling. The weight is varied and the other objectives weights are prorated. The final scores are then plotted against the changing weights to again look for dominance of an alternative on the changed weighting.

3.2.2 Decision-Making under Uncertainty as a Probabilistic Process (Chance)

Having proposed that a decision-making process is critical to success, it is also important to review the other elements affecting the decision outcome. It is important to recognise that identifying “good” decision-making necessitates viewing decision-making as a probabilistic process. It is only “in the long run” that the good decision makers are identified as those who have more successes than failures. No author argues that

implementing their particular decision-making process will yield good outcomes every time, just that there is a better chance of a good outcome. Although, when chance is involved, no individual outcome can be predicted with certainty, a good decision process is argued to yield a higher likelihood that the objective is achieved (a good outcome) on any individual decision. It also means that the cumulative effect of the “long run” is the “best” outcome. That is, it is argued that one can use outcome as a measure of goodness after many decisions have been made. This, however, would often require an impractical time horizon to be used. Given this, the decision-making process should be the primary measure of decision “goodness” but with the recognition that, wherever the “long run” outcomes can be incorporated they should be, in order to control the impact of chance.

Therefore, it is asserted that if a good process is used more consistently then the results of decisions will, in the long run, be more consistently good and the probability of obtaining a good outcome from an individual decision is increased.

3.2.3 Implementation (Implementing)

The final element influencing the decision outcome is the way in which the decision is implemented. Even when a decision is made using the best process and chance is on the decision-maker’s side, the outcome may still be suboptimal because of the way the decision is implemented. To assist in overcoming this impediment to good outcome, the decision or judgement implementation can be analysed and the results fed back to the decision-maker. It has been demonstrated that when this occurs better judgements are made in the future (Murphy and Winkler, 1984; Tomassini et al., 1982). These feed-back loops have been the centre of focus for oil and gas companies in order to improve decision-making (Johns et al., 1998). A comparison between US weather forecasters (Murphy and Winkler, 1977) and US doctors (Christensen-Szalanski and Bushyhead, 1981) shows that

the feedback needs to be immediate and continuous in order to see improvement. When there is a time between the decision and the feedback there is the chance that the improvements will not materialise. Immediate and continuous feedback is difficult in the oil and gas industry when, for example, the judgement is the amount of recoverable reserves. That number is never really known until the field is depleted⁸. Hence the feedback may be many decades away from the decision.

It is important, then, that the theoretical model contain several feedback loops. It is recommended that one be undertaken for each of the three decision-making elements:

- Process – where the process used is compared to the theoretical model,
- Implementation – where the way the decision is implemented is compared to how the decision-maker recommended that it be implemented, and
- Outcome – where the actual outcome is compared with the estimated outcome.

3.3 DECISION OUTCOME

Having reviewed the various elements that contribute to the outcome, it is now important to shift the focus to an examination of the outcome itself. It has been argued, above, that having a clearly defined decision-making process along with the learning mechanism of feedback loops will, in the long run, yield better decisions. It would be incorrect, however, to assert that the success of a decision should not rely at all on the outcome. The “real world” is an outcome focused environment and too many “bad break” stories will not be accepted for long, whereas “dumb luck” will tend not to be punished. That is, the outcome is important, because the oil and gas industry is a business and must concern itself

⁸ Some may argue that the true reserve number is never truly known! Is reserves growth real or not? Beliveau, D., 2003, Reserves Growth: Enigma, Expectation or Fact?: SPE 84144.

with the bottom line. This view is summarised by the old colloquial phrase: “the operation was a success but the patient died.” Brown (2005) uses this phrase to title a discussion where he analyses why some decision outcomes fail when the analysis is successful. He makes some recommendations to abate the problem but still there are instances when good decision analysis will end in bad outcomes.

The game of Russian roulette demonstrates that it is important to consider the possible outcomes. If the analysis makes a mistake and gives zero value to life then the game may be played. Clearly some outcomes are not desirable and should be avoided.

In the oil and gas industry many decisions involve very high costs, for example, the decision to develop an offshore field, which may cost up to US\$1billion. Regardless of the excellence of a decision-making process, some decisions simply cannot afford to fail or a company will go bankrupt and, thus, be unable to make more decisions. In this way, the oil and gas industry, along with other “real world” environments differs from probability theoretic approaches that assume infinite number of decisions and therefore the chance to “trade” out of the negative outcome over time.

Finally, in the oil and gas industry, where the outcome is almost always uncertain, the size of the outcome is extremely important. A well may discover hydrocarbons but it may be of insufficient size to be deemed economic. On the other hand, the discovery may be extremely large, a “company maker!” Clearly then some sized outcomes are more desired than others. So a decision may be technically successful but economically a failure. In this industry, then, success must be viewed from a commercial viewpoint. Oil and gas exploration and development is a business and not a science.

There is, therefore, a real tension that exists between the decision-making process and the decision outcome. The theoretical model must take this tension into account. It is argued, herein, that priority must be given to the process.

3.4 DECISION-MAKING TOOLS

Barker (2001) argues that process should take precedence in decision-making. But he also effectively introduces the methodology or the use of tools. He effectively presents a simple matrix that links the decision-making method, the use of a process and the effectiveness of the decision-making (Table 3.2). He concludes that the best decisions are made using advanced methods and tools, but importantly, directed by a process.

Table 3.2 – Matrix of process and method (after Barker, 2001)

<p>NOTE: This table is included on page 63 of the print copy of the thesis held in the University of Adelaide Library.</p>
--

This work highlights the need for the use of method or tools as well as a process.

In the upstream oil and gas literature Macmillan (2000), Jonkman et al. (2000) and Simpson et al. (2000) demonstrate a statistical link between the use of advanced risk analysis techniques and tools and better business performance and inferred causality. The more advanced the techniques and tools are the better the business performance is. These advanced tools are termed Decision & Risk Analysis (D&RA) by these authors and consist of:

a fully integrated, multi-disciplinary probabilistic approach based on ranges for the base parameters on the field geology, reservoir properties (porosity etc), steel costs, manpower costs, facilities downtime and development scenarios. D&RA also includes the propagation / aggregation of uncertainty through the various concatenated models, and through the various decision levels (Jonkman et al., 2000, p. 4).

They observed that although there are:

a multitude of D&RA products available [they] are not being used in most companies. The conservative attitude in the E&P industry may be related to lack of specialized human resources post reorganizations and insufficient appreciation of the “value” of the new technology (Jonkman et al., 2000, p. 8).

In Barker’s matrix their observations equate to “advanced method.” What is critical to note is that the authors implicitly agree that using advanced risk analysis techniques leads to better decisions. But Barker’s matrix shows that making decisions with advanced methods can result in either poor or good outcomes, depending on whether the decision is directed by a process. This, however, was not reviewed or analysed by the aforementioned authors.

The theoretical model, by comparison, should specify the use of advanced decision-making tools or decision analysis while also illustrating the process.

3.5 TEAM DECISION-MAKING

The discussion, to date, deals with what may be termed individual decision-making. Few decisions in organisational contexts, however, are made solely by individuals. Decisions in the oil and gas industry, like many other industries, are made by individuals working in groups or teams. In fact early work on the benefits of team decision-making were recognised in the oil and gas industry (Sneider, 1999, 2000a, b). Within organisations an individual person is usually charged with having responsibility for making the decision. The outcome of the decision is then judged in terms of “good” or “bad,” “right” or “wrong.” But, due to the highly complex nature of the industry, a single person rarely has sufficient information to make the decision. They therefore need to combine or integrate differing recommendations from diverse, usually subordinate, staff. The decision-making process can therefore be considered as having two steps. The first step is the individual, or core, decision made by an individual staff member. Having been made using the processes previously documented (sections 3.2 – 3.4), this decision then becomes a recommendation. The second step consists of having

that recommendation endorsed or approved by the organisation. A theoretical model that describes this style of decision-making is termed the multilevel theory of team decision-making (Hollenbeck et al., 1998; Hollenbeck et al., 1995).

Building from Brunswik's (1940; 1943; 1955; 1956) lens model of individual decision-making and Brehmer and Hagafors' (1986) extension of that into a model of staff decision-making, Hollenbeck et al. argue that hierarchical decision-making has four main levels. The theory also proposes the most significant factor that leads to success at each level. These are termed *core variables*. For the various levels they are:

1. *Decision Level* – this is the lowest level in the hierarchy and relates to the many decisions that an individual may make. An example from the oil and gas industry may be as simple as which reflector a geophysicist is to interpret in a seismic interpretation project. The core variable that governs success at this level is said to be *decision informity*; meaning that the staff have access to all relevant information available to assist in making the decision. The previous discussions (sections 3.2 – 3.4) describe the other literature on this level.
2. *Individual Level* – the next level relates to the individual professional; success at this level is dependent on *individual validity*, which is the actual judgement made by the professional based on all the decisions they have had to make. Extending the geophysical interpretation example, this is the final interpretation.
3. *Dyadic Level* – within the team there are many one-on-one relationships. These exist between the individual team members and the individual members and the team leader. The dyadic level relates to these individual one-on-one relationships. Decision-making success at this level is predicated on *dyadic sensitivity*, which is the ability of the team leader to correctly weigh the value of each individual recommendation. Continuing with the oil and gas example, this is the point where the team leader is reviewing all the individual interpretations, be they geophysical, geological,

or otherwise, and deciding on what level of importance is placed on each piece.

4. *Team Level* – finally at the total team level full integration of all the weighted individual contributions leads to the best possible decision. This consists of the escalation of the three core variables to the team level. Decision informity escalates to *team informity*; individual validity to *staff validity*; and dyadic sensitivity to *hierarchical sensitivity*. For the oil and gas team this is the final team integrated outcome of the entire interpretation project. All team members *must* feel free to *provide* and *receive* input. In such a receptive environment, group wisdom can take place (Stanfield, 2000).

Hollenbeck et al. summarised their model, including several non core variables, as follows (Figure 3.9)

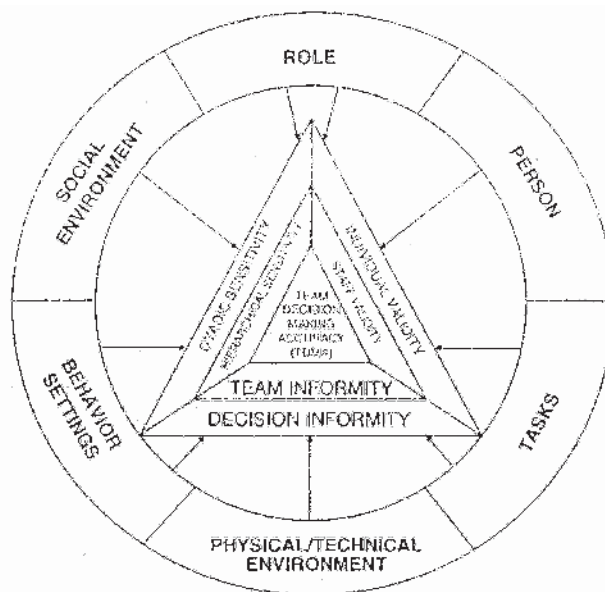


Figure 3.9 – Multilevel Theory of Hierarchical Decision-Making
(Hollenbeck et al., 1995, p. 299)

Studies to test the validity of the multilevel theory have also added to the general understanding of team decision-making (Humphrey et al., 2002). Much of the research has focussed on the team level of each of the core variables and more specifically the way the team weights the judgements of its members. Of the four

core variables three have been found to explain between 25% and 65% of the team's decision quality (Hollenbeck et al., 1995). These are the three team level core variables:

1. Team informity – having enough relevant information available to the team to make their judgements
2. Staff validity – how the professional staff actually make their judgements, and
3. Hierarchical sensitivity – arriving at the optimum weighting for the various team members.

Therefore, the more these variables can be influenced the greater the likelihood of success in decision-making.

Further research has shown the value of feedback to the team (Hollenbeck et al., 1998). Even when shown accurate outcome feedback in a timely manner teams still are unable to optimise the weighting of each other's judgements for a successful team outcome. Their current weighting appears to be related to the team members' confidence; but confidence is rarely related to ability. The research indicates that trust is a better weighting function, particularly that built by past experiences (Costa, 2003). This trust is from the team leader down to the member of the team. Den Hartog (2003) has also shown that the opposite, the team member trusting the team leader, is also relevant. Slovic's (1993) work, however, shows that such trust is hard won and easily lost. An excellent way to dramatically improve hierarchical sensitivity is to give direct feedback on the value of each team members' contribution in such a way as to avoid distracting social and confidence cues – usually some computer-mediated communication rather than face-to-face. This trust process itself is even subject to the cognitive bias heuristics (Nooteboom, 2003).

The upstream oil and gas literature documents the use of portfolio optimisation or portfolio management as a critical part of the successful team decision-making process (Allan, 2001; DuBois and Howell, 2000; Howell and DuBois, 2003;

Howell and Tyler, 2001). The key argument is that if individual projects are assessed independent of each other and then the final metrics added together for all the individual projects, any dependencies which exist between the projects is not accounted for. This is documented as leading to suboptimal decision-making. Optimal decision-making, it is argued, results from reviewing how each individual project effects the outcome of the entire portfolio. Hence the choice of project should be determined by optimisation of the entire portfolio rather than the optimisation of each of the individual projects within the portfolio (Rose et al., 2002).

3.6 SUMMARY – Theoretical Decision-Making Model

Any research into decision-making has, at its heart, the desire to improve decision-making outcomes. Therefore, it is important to make sure that there is a clear distinction between the quality of the decision and the outcome. This distinction is necessary in order to avoid the trap of seeing a poor outcome as resulting from a poor decision and vice versa. Having separated the decision from the outcome it then becomes possible to focus on the decision-making process as well as the implementation of the decision.

That said, any final theoretical model of a decision-making process should incorporate the outcome, thus bringing to bear not just the decision-making stage but also the implementation stage as well as a time horizon that allows for observations of “long run” probabilities (portfolio optimisation), which are the best indicator of whether the process is, in fact, good.

There is also a subtle distinction that must be made between static decisions – those where the answer never changes, and dynamic decisions – those where the answer is generally never known; sometimes even after the decision is made and implemented. Upstream oil and gas decisions are generally of the second kind and fit within the context of forecasting under uncertainty.

It is also important to recognise that decisions in the oil and gas industry are generally made by teams within a hierarchical framework. As such, not only must the focus be on the individual decision-making process but also on the process whereby those decisions are either endorsed or approved – within teams and via portfolio optimisation.

Synthesising the arguments from the previous sections, the overarching root definitions of the final theoretical model are listed below and schematically shown in Figure 3.10.

- The individual decision-making process should use the multiobjective decision-making model and contain the following four phases:
 1. Framing – this is where the decision is defined and the objectives and alternatives searched out and where all available information is brought forward;
 2. Modelling – where each alternative is evaluated against the objectives and the objectives weighed against their ability to distinguish the best answer;
 3. Assessing – where trade-offs are evaluated and sensitivity is checked; and,
 4. Feedback.
- Advanced risk analysis and decision-making tools (including portfolio optimisation) must be included in the modelling stage.
- A successful team decision-making process will focus on:
 1. Team informity – making sure sufficient relevant information is available
 2. Staff validity – hiring professional staff who have the ability to make quality judgements, and
 3. Hierarchical sensitivity – setting up processes around trust which facilitate the team arriving at the optimum weighting for the various team members.

- It is important to include several feedback loops, one for each of the following elements, in a timely manner:
 1. Implementation – where the way the decision is implemented is compared to how the decision-maker recommended that it be implemented,
 2. Approval – where the approval process used is compared to the model, and
 3. Decision – where the decision is compared with the outcome.
- If a good process is used more consistently then the results of the decisions will, in the long run, be more consistently good and the probability of obtaining a good outcome from an individual decision is increased.
- It is important to recognise that there is a difference between the decision-making process and the decision outcome. Priority must be given to the process but without ignoring the possible outcomes.

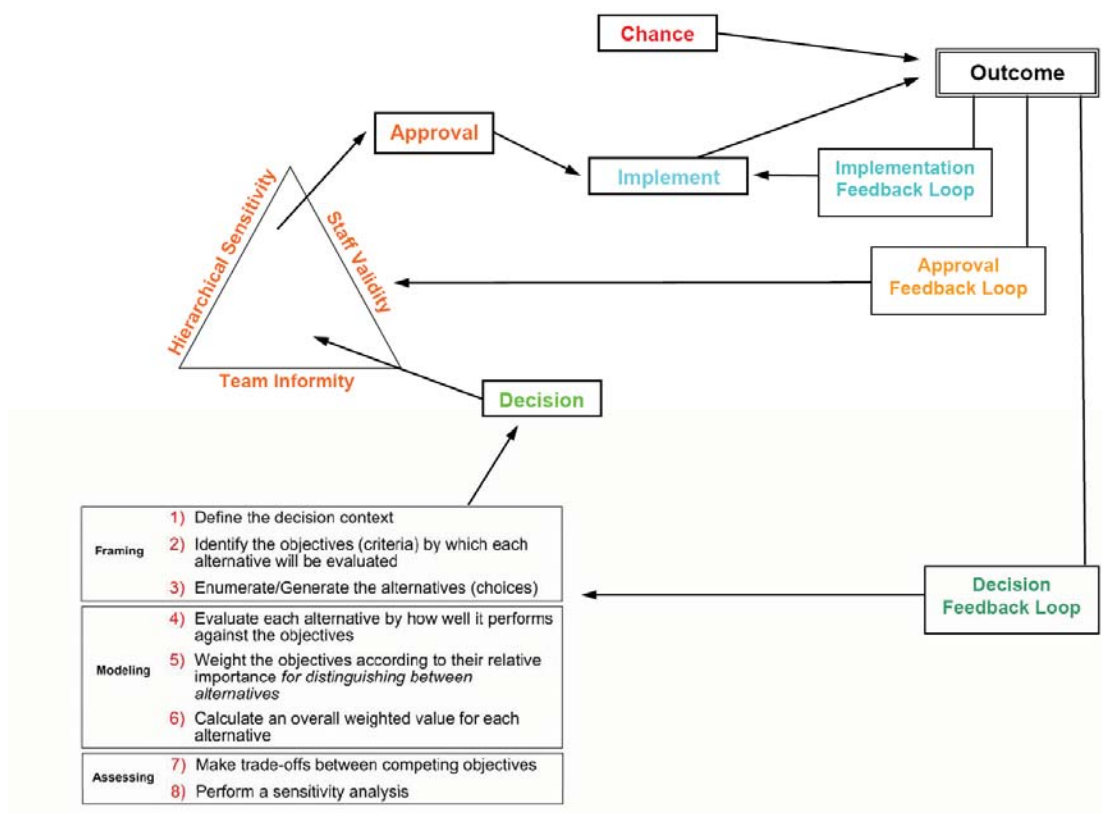


Figure 3.10 –Theoretical Model of How Companies Should Make Decisions Under Uncertainty

CHAPTER 4

RESEARCH DESIGN

This chapter lays out the phased nature of the research program and documents the various methodologies used in each phase of the research, describing the methods used and why they were chosen. Discussion of the implementation and results of the work, however, is taken up in the chapters relating to the individual phases.

4.1 OUTLINE

The overriding driver of this research is improving the human side of decision-making under uncertainty in the upstream oil and gas industry. It has two major themes; decision process and decision type. The research is therefore undertaken as a four-phase program with the results of each of the being incorporated into the following phase. The overall program is outlined in Figure 4.1.

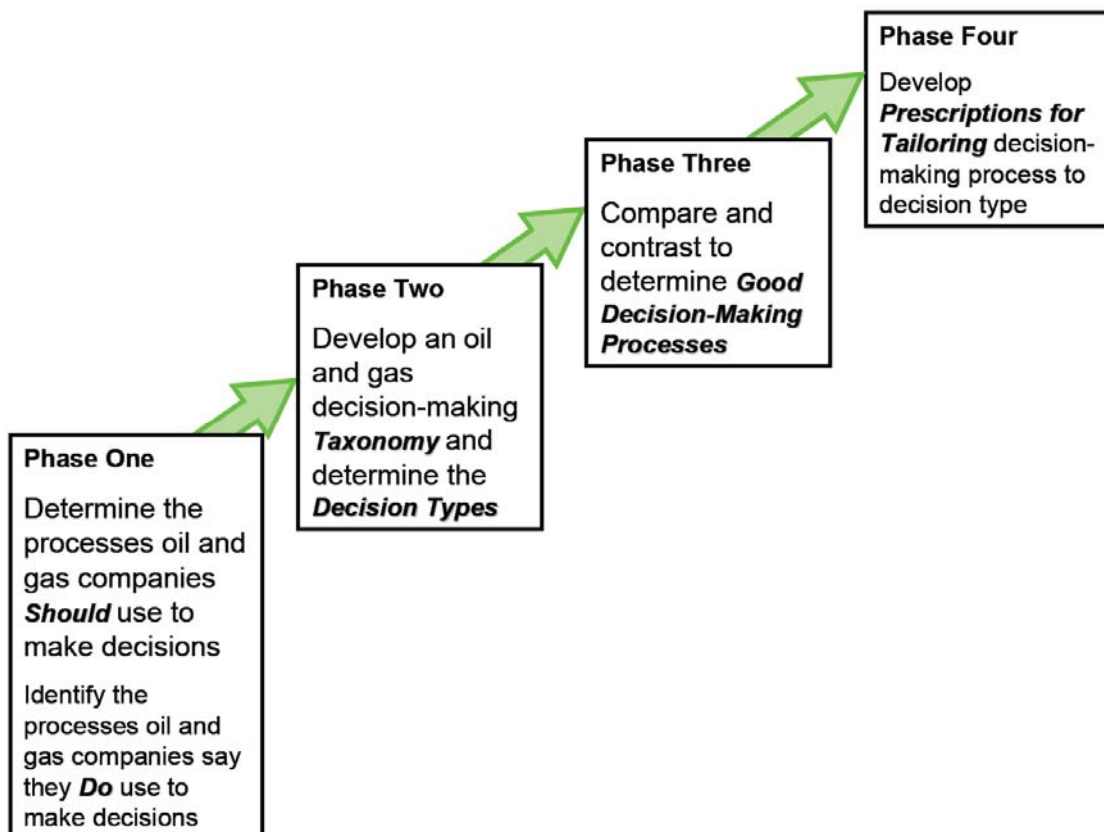


Figure 4.1 – Research Program Phases

4.2 PHASE 1A – *Determine the processes oil and gas companies should use to make decisions.*

The first theme of the research is decision process. Whilst objectivity is considered to be important in the research, implementing the results must, of necessity, be subjective because they are to be prescriptive to real people in the “real world”. Hence a subjective methodology that seeks for a prescriptive intervention in the ill-structured situations that comprise decision-making in the “real world” of the oil and gas industry is required. The methodology should seek to put equal emphasis on answering what to do as well as how to do it.

Commencing in 1969, Checkland, working in the Department of Systems Engineering at Lancaster University, developed what has come to be known as soft systems methodology (Checkland, 1981; Checkland and Scholes, 1999; Jackson, 2003). This methodology grew out of a perceived need for a practical alternative to the hard systems thinking of management science that was dominated by the goal-seeking paradigm of the time. The resulting methodology is a practical science that seeks to balance the relationship-maintaining paradigm of management science (Vickers, 1970) with a goal-seeking paradigm. It is therefore apt for finding a balance between what to do and how to do it.

The methodology has evolved over time but at its core it is a systematic learning cycle. A simple summary is shown in Figure 4.2. In essence the method compares and contrasts two worlds – the “real world” (stages 1, 2, 5, 6 and 7) and the world of systems thinking about the “real world” or theoretically constructed models (stages 3 and 4). This methodology thus enables the comparison and contrasting of “real world” decision-making with theoretical model(s) of decision-making.

Checkland (1981) says that stage one consists of seeing a situation where there is a “sense of unease.” This lies at the extreme end of a spectrum of seeing or

even feeling a problem situation. Stage two consists of describing the situation in such a way as to gain a sense for the holistic nature of the problem.

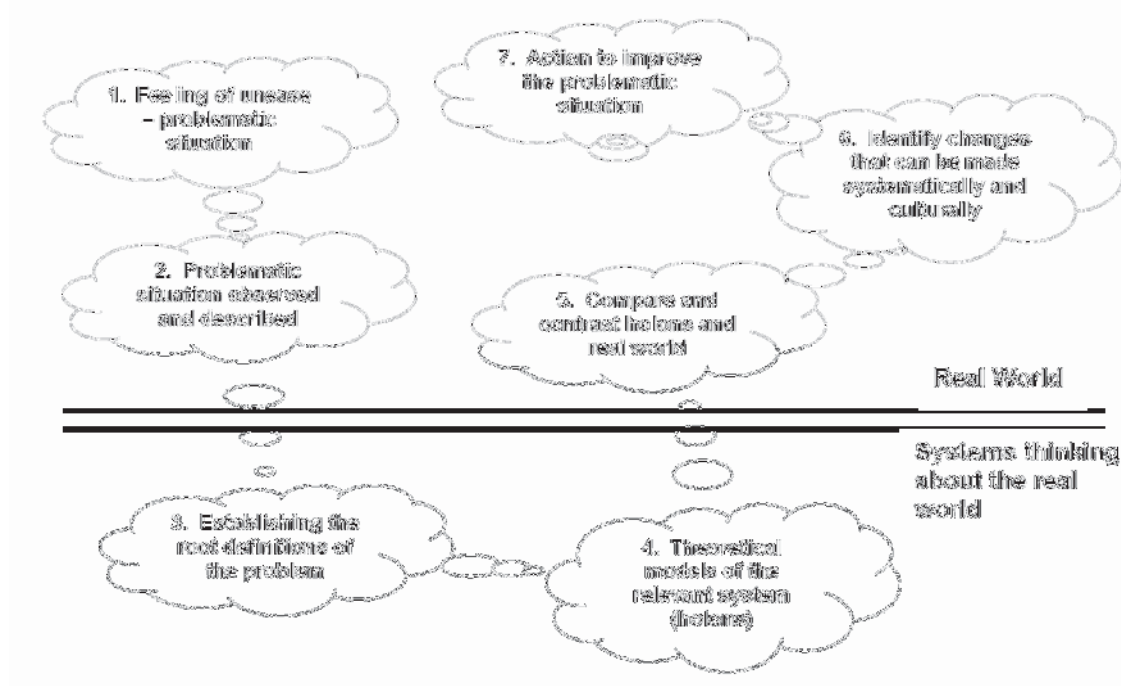


Figure 4.2 – Checkland’s Soft Systems Methodology (after Checkland, 1981)

Having established that a problem situation exists and teasing out what that situation may look like, the approach moves “below the line” to systems thinking. Stages three and four consist of describing one or several conceptual models of systems that match the root definitions of the problem. The models are not models of the “real world” but rather of some theoretical world. So as not to confuse them with models of the “real world” Checkland uses the term “holon” to describe them.

The final three stages cross back “above the line” into the “real world” and consist of comparing and contrasting the “real world” picture formed in stage two with the theoretical models described in stage four. From this analysis and synthesis areas for change become apparent and actions are formulated to enable necessary changes.

This methodology is used as the overarching methodology, or epistemological orientation, for the first part of the research. The two keys for its implementation, in this research project, are the need for a description of decision-making in the “real world” of the oil and gas industry (a “real world” model) – how companies say they do make decisions – and a theoretical model of how that should happen – how companies should make decisions.

The determination of what tools and processes should be used in decision-making is undertaken via a review of current literature (Chapter 3). While there has been a large amount of material published on how decisions should be made, this has often been in very general terms. Comparatively little has been published that is specific to decision-making in the oil and gas industry.

In conveying the information and concepts that have been established in the general area of decision-making, the review thus focused on the analysis and synthesis of the general material in terms of its potential applications within the petroleum industry, the aim being to review the literature in such a way as to present the themes and trends in decision-making research and then raise questions and identify areas to be explored.

The aim of this phase is to develop a series of “root definitions.” These are descriptions of the human activity and according to Checkland:

“. . . have the status of hypothesis concerning the eventual improvement of the problem situation by means of implemented changes which seem to both systems analyst and problem owners to be likely to be both feasible and desirable.” (Checkland, 1981, p. 167)

With the root definitions in place a conceptual or theoretical model of the system is defined against which to measure the “real world”.

Whereas Chapter 2 served as a general literature review for the entire thesis, Chapter 3 documented a more specialised review of prescriptive decision-making

theory, so as to establish a theoretic model against which to compare the way in which oil and gas industry companies say they actually do make their decisions.

4.3 PHASE 1B – *Identify the processes oil and gas companies say they do use to make decisions.*

While it is possible to speak of examining how “a company makes decisions”, in reality, of course, companies do not make decisions – people do. Thus, in order to determine the workings of any decision process, the people involved must be observed. Finding out what decision-making tools and processes are used by “real world” oil and gas companies, thus fits squarely within the realm of social science - observing the behaviour of individuals in specific environments. Although it is not the intent of this chapter to be a complete review of social science theory, some discussion is necessary to clarify the positive and negative aspects of the construct in order to better understand the analysis of the data.

The first question confronting any social research is the qualitative versus quantitative debate. That is, should the research address things that can be broken down and thereby measured and analysed to determine causal relationships – the “what?”; or should it address the holistic nature of interrelationships and seek to address the values and processes – the “why?” Arguments exist that see these two poles as totally opposite but it has also been argued that these two methodologies are, in reality, simply different ways of viewing the same phenomena (Bryman, 1988).

In order to determine what tools and process are currently used in the oil and gas industry, it is necessary to use a methodology that fits directly within the qualitative school and, as such, will deal directly with that school of thought. Therefore, Denzin and Lincoln’s (2005) five phase model for qualitative research is used as the underlying construct.

4.3.1 The Researcher

It has been commonly asserted that human beings can not objectively observe a social process. Rather, they invariably bring their own values, belief systems and cognitive frameworks into play as they observe. Whilst this is acknowledged, the history of achievement using such methodologies shows that there must be some benefit in using them.

In the early days of social research, the basic assumption is that the researcher used “value-free inquiry” (Denzin and Lincoln, 2005) but this has been shown to be incorrect. History has also shown, however, that researchers who are not sufficiently aware of the organisational or cultural context of their research area had difficulty interpreting the findings (Kirk and Miller, 1986). Archer (1988), therefore, argues that the researcher needs to have the appropriate background in order to undertake the research. This would require investigators to have sufficient knowledge to be a “co-conversant,” that is, they would have a common language and a shared understanding of the field. Whyte (1984) refers to the need for “intimate, habitual, intuitive familiarity with things” whilst Miles and Huberman list the following as indicators of “good qualitative-researcher as instrument” (Miles and Huberman, 1994, p. 38):

- Some familiarity with the phenomenon and the setting under study.
- Strong conceptual interests.
- A multidisciplinary approach, as opposed to a narrow grounding or focus in a single discipline.
- Good “investigative” skills, including doggedness, the ability to draw people out, and the ability to ward off premature closure.

The multidisciplinary background of the author is seen to meet these criteria. He has greater than 25 years of experience in the upstream petroleum industry functioning in both regional and field specific geoscience. As well as running his own successful consultancy he has worked for multinationals and local explorers. He has also been forming,

managing and developing asset teams associated with exploration and development geoscience for the last 15 years.

4.3.2 Interpretative Paradigms

The researcher is “bound within a set of epistemological and ontological premises which – regardless of ultimate truth and falsity – become partially self-validating” (Bateson, 1972, p. 314). The personal beliefs about ontology, that is, the nature of reality in the world to be researched; epistemology, that is, the relationship between the researcher and the world being researched; and methodology, that is, how to obtain knowledge of the world being researched, form the paradigm under which the research takes place. It is important to state the paradigm(s) being used in the research project.

This research project is undertaken within the positivist and constructivist paradigms as listed among the Denzin and Lincoln’s seven paradigms in Table 4.1. It seeks to understand the world as consisting of multiple realities where the researcher and the researched interact and shape each other, which can be investigated using natural methods. The “goodness” of the research is judged in terms of validity (internal and external) as well as its credibility and take-up by industry.

Snow and Thomas (1994) developed six categories of strategic management research by developing a matrix of goal versus purpose. They noted the key methodologies to be used within each class of research. This work has elements of description and explanation, primarily addressing the “what”, “how” and “why” questions, in both theory building and theory testing. Snow and Thomas’ recommended methodologies are observation and interview for this type of research.

4.3.3 Strategies of Inquiry

Taking into account that the research objective of this portion of the study is to determine “how” and “why” oil and gas companies do make decisions and the interpretive paradigm of the researcher, the most successful, and therefore recommended, strategy is interviewing.

Table 4.1 – Interpretative Paradigms (after Denzin and Lincoln, 2005)

Paradigm	Ontology	Epistemology	Methodology	Criteria	Form of Theory	Type of Narration
Positivist / Post positivist	Relativist	Interpretive	Interpretive, Naturalistic	Internal, external validity	Logical-deductive, grounded	Scientific report
Constructivist	Relativist	Subjectivist	Naturalistic	Trustworthiness, credibility, transferability, confirmability	Substantive - formal	Interpretive case studies, ethnographic fiction
Feminist	Materialist -realist	Subjectivist	Naturalistic	Afrocentric, lived experience, dialogue, caring, accountability, race, class, gender, reflexivity, praxis, emotion, concrete grounding	Critical, standpoint	Essays, stories, experimental writing
Ethnic	Materialist -realist	Subjectivist	Naturalistic	Afrocentric, lived experience, dialogue, caring, accountability, race, class, gender	Standpoint, critical, historical	Essays, fables, dramas
Marxist	Materialist -realist	Subjectivist	Naturalistic	Emancipatory theory, falsifiability, dialogical, race, class, gender	Critical, historical, economic	Historical, economic, sociocultural analysis
Cultural Studies	Materialist -realist	Subjectivist	Naturalistic	Cultural practices, praxis, social texts, subjectivities	Social criticism	Cultural theory as criticism
Queer Theory	Materialist -realist	Subjectivist	Naturalistic	Reflexivity, deconstruction	Social criticism, historical analysis	Theory as criticism, autobiography

There are two primary interviewing techniques; structured and semi-structured. A matrix of the advantages and disadvantages of the two techniques is shown as Table 4.2 (Smith, 1999). Semi-structured

interviewing is chosen as the primary data-gathering technique chiefly because it facilitates focussing on specific areas of information and allows for the freedom to expand details of the data being gathered. The disadvantages are recognised but planned to be overcome by seeking to obtain a large number of interviews across various levels of company hierarchy and by ensuring confidentiality via confidentiality agreements as required.

Table 4.2 – Advantages and Disadvantages of Structured and Semi-structured Interviews
(after Smith, 1999)

NOTE:

This table is included on page 80 of the print copy of the thesis held in the University of Adelaide Library.

Having decided on semi-structured interviewing as the correct methodology it is then necessary to design the interview. Oppenheim (1992) correctly summarises: “Too often, surveys are carried out on the basis of insufficient design and planning or on the basis of no design at all.” To avoid this criticism, several semi-structured interviews were reviewed (Alexander and Cotton, 2005; Macmillan, 2000; Oppenheim, 1992; Smith, 1999) to gain insight into their process and design. On the basis of this analysis, the critical elements that needed analysis of “real world” decision-making were determined to be:

- The decision-making experience level of the interviewee;
- Decision types;
- Decision-making tools and processes; and
- Learning feedback loops.

Questions were formulated around each of these areas to probe the way the interviewee actually made decisions as well as to determine if the company has a prescribed process for doing so. An innovative idea was to use one to three decision scenarios to help interviewees see how they were making decisions. These scenarios were also used in developing the taxonomy (discussed in Chapter 6). This was followed up by questions relating to one or more decisions the interviewee had made that they felt comfortable talking about.

The final outline of questions used is appended (Appendix 2). Although it appears as a structured interview, when administered it is rarely followed word-for-word or even primary theme to primary theme, hence it is correctly termed an outline rather than a prescriptive interview.

4.3.4 Collecting, Analysing, Interpreting and Evaluating the Data

Phases 4 and 5 in Denzin and Lincoln's (2005) five-phase model deal with the collection, analysis, interpretation and evaluation of the data. This is discussed in Chapter 5.

4.4 PHASE 2 – *Develop an oil and gas decision-making Taxonomy and determine the Decision Types.*

Chapter 2 revealed that most taxonomies are developed through either inspection or empirical observation. This means that they become increasingly useful for the specific objectives they were formulated to address, but that it is difficult, if not impossible, to transfer the findings to other areas. The goal of this research, however, is that – whatever taxonomy is to be developed – it must be developed as objectively as possible so that it can be generic and thus be

useable in all areas of the oil and gas industry, and transferable to other decision-making environments as well.

The decision to develop the taxonomy as objectively as possible narrowed the choice of methodologies. As with all taxonomies, the root question related to being able to place objects, or in this case, decisions, in more or less homogenous groups in such a way that the relationships within and between the groups could be examined. Which elements are similar and which are dissimilar, and the need to decide which dimensions are the “best” ones to use can be very subjective tasks; but, whichever dimensions are chosen, it is critical to be able to reproduce the classification objectively.

In the upstream oil and gas industry there are so many diverse decision elements which could make up a taxonomy that the temptation to sacrifice objectivity for subjective insights or empirical evaluation is great. In order to avoid these possible prejudices a methodological approach used in mathematical psychology – relying on pair-wise similarity measurements (Shepard, 1974, 1980) – was used.

This approach assumes that, by having expert decision makers compare typical oil and gas decisions, the basic similarities that form the underlying structure of oil and gas decision-making can be uncovered. Comparing various decisions to each other in a pair-wise comparison should, thus, reveal how tightly different decisions cluster together in the minds of the analysts. Mathematical analysis of the clusters of decisions should then uncover what generic dimensions explain the observed pattern of similarities.

It is then necessary to actually view the results in such a fashion as to make meaningful observations. Goldstone (1999) indicates that there are two main representational approaches in the field of cognitive modelling of similarity: “dimensional” and “featural.” In the first, dimensional representation, the stimuli are represented by locations in a multi-dimensional space. This is done by

assigning each stimulus under consideration – in this case the decision – a value on one or more continuous dimensions in such a way that the similarity between any two stimuli represented in this space is equivalent to the distance they are apart in the representational space. That is, those stimuli that are similar to each other lie near one other and those that are dissimilar are more widely separated from each other in the displayed space (Carroll and Arabie, 1980; Shepard, 1964). This method, however, is best used to represent low-level perceptual stimuli such as changes in colour and lengths of lines rather than the complex decisions that form the individual stimuli of a decision-making taxonomy.

The second method, featural representation, is more suited to high-level conceptual stimuli (Carroll, 1976; Tenenbaum, 1996; Tversky, 1977; Verbeemen et al., 2004) because it represents data in a discrete, presence/absence or agreement/disagreement fashion. Here the similarity between two stimuli is a weighted measure of their common or distinctive features.

Given the complex nature of oil and gas decisions, featural representation is regarded as a more appropriate method for assessing similarity between decision pairs. It should therefore be used in developing a decision-making taxonomy based on multi-featural decision tasks.

Within featural representation, however, there remain two primary approaches – the additive tree approach and the additive clustering approach (Shepard, 1980). In the additive tree, or tree-fitting, approach the data are modelled to represent objects associated with terminal nodes and strictly nested structures. Hence a hierarchy is imposed such that the final result looks similar to the classic Linnaean “tree structure” taxonomy used to represent relationships amongst differing species. In the additive clustering approach, by comparison, the stimuli are not constrained to a single cluster, but each can arbitrarily overlap – that is, a single stimulus can simultaneously belong to multiple clusters.

The two approaches have different strengths and weaknesses. A tree model, for example, can represent a higher number of total features but a lower number of shared features, which may be appropriate in representing well known stimuli. Any taxonomy of the upstream oil and gas industry, however, will have very imprecise elements and more overlap between those elements. Conceptually then, the additive clustering approach should be the most useful. Both approaches, however, are used to analyse the data in this experiment such that all possible solutions are seen prior to deciding which method provided more intelligible results.

Chapter 6 describes the detailed implementation of this methodology – data collection, analysis and interpretation – and the resultant decision-making taxonomy. The developed taxonomy is, thereafter, used in Chapter 7 to distil and document the primary types of decision observed in the oil and gas industry.

4.5 PHASE 3 – *Compare and contrast, the results of Phases 1A and 1B, to determine good decision-making processes.*

Phase 2 of the research program equates to stages 5, 6 and 7 in Checkland's methodology. Having identified the "real world" picture – how companies do make decisions – and determining the theoretical model – how they should make their decisions, the final phase compares and contrasts these findings. From this analysis and synthesis needed changes become apparent and prescriptions are formulated to enable necessary changes. This becomes a prescription of how oil and gas companies can learn to make optimal decisions.

The comparison of "real world" and theory can be done in four main ways.

1. Where the "real world" "problems" are obvious, the conceptual model is used to develop questions about the original situation and thereby lead to suggestions for improvement.
2. Where the "real world" is in the past, the comparison is accomplished by reconstructing the system and seeking ways to implement the theory in real life.

3. Sometimes the contrasting actually raises strategic issues rather than tactical ones. The comparison is then done at a very general level rather than on what could be considered point by point.
4. Finally a model of the “real world” is made in exactly the same dimensions, as nearly the same form, as the theoretical model. The two are then directly overlaid and mismatched areas are highlighted.

The fourth method is primarily used in this research project, although elements of the other three are also discussed.

The comparison and contrasting is undertaken so as to develop a series of prescriptions for good decision-making in the oil and gas industry. But the final prescriptions must be “feasible and desirable,” Checkland’s stages 6 and 7.

Three kinds of changes are possible:

- Changes in structure,
- Changes in procedures, and
- Changes in attitudes

It is important to remember that the research project actually seeks to make change such that current decision-making outcomes can become more optimal. This is not the absolute theoretical maximisation that normative decision-making seeks as its goal, but rather a “best” or “good” outcome based on implanting decision-making in the “real world” of the oil and gas industry. This is further explained in Chapter 8.

4.6 PHASE 4 – Develop *Prescriptions for Tailoring Decision-Making Process to Decision Type.*

The development of prescriptions for good decision-making for the various decision types is undertaken using case-study analysis. As well as collecting generalised information and data, each semi-structured interview also produced several case studies – such as one of the decisions discussed herein – be it the decision scenarios provided by the researcher or the interviewees’ own “stories.”

Quantitative research, such as that undertaken in the development of the taxonomy, relies on a representative sample of the population in order to make conclusions. Qualitative research, on the other hand, aims to enable replication so that a general theory can be drawn from results, rather than from generated statistics (Miles and Huberman, 1994). On this point, Yin (1989) makes the excellent observation that the cases studied should be thought of as multiple experiments rather than a collection of data points. The set of “experiments” is then used to help determine a general construct of, in this specific case, how decisions are made.

According to Yin (1989) there are three primary methods for case study analysis; pattern-matching, explanation-building and time-series analysis. The first two methodologies are used in this final phase of the research. Firstly, patterns of decision-making processes are sought for the various decision types. The search is centred on the hypothesis that decision processes are tailored to decision type. Secondly, where there is no direct pattern matching, explanations are sought so they can be built into a final assessment of how the tailoring occurs in reality. The goal of the analysis is to capture both the “phenomenon (the real-life event) and its context (the natural setting)” in order “to address ‘how’ and ‘why’ questions about real-life events” (Yin, 2004, p. xii). The analysis is presented in Chapter 9.

CHAPTER 5

HOW OIL AND GAS COMPANIES SAY THEY DO MAKE DECISIONS

5.1 INTRODUCTION

The aim of this chapter is to describe a “real world” oil and gas decision-making model distilled from qualitative analysis of semi-structured interviews with oil and gas personnel. The qualitative methodology chosen to identify how oil and gas companies make decisions was described in Section 4.3, whereas this chapter focuses on data collection, analysis and interpretation.

5.2 DATA COLLECTION

As previously discussed (Section 4.3), semi-structured interviews were chosen as the methodology to investigate how companies make their decisions. An interview outline is appended (Appendix 2).

5.2.1 Participants

In recognition of the fact that company decisions are made by individuals in the persons of company senior executives, these managers were targeted to participate in the interviews. Senior decision makers – that is, those of middle-manager level and above (geoscience or engineering managers to Chief Executive Officers) – of both large and small publicly listed companies as well as governmental officials from across the Australian oil and gas industry were invited to participate via e-mail (Appendix 3).

Senior executives, understandably, have little time to dedicate to this type of research and although some may have personal interest in the research area, the majority do not. The perceived problems of time and interest and their impact on “cold calling” to obtain the participants, was countered by using the researcher’s extensive personal network of senior executives and sponsors of the research. The network had been built up over many years as part of the oil and gas industry in Australia and from it came 32

agreements to interviews. Interestingly, there were no negative responses – all people who were invited to participate did so.

The 32 interviewees had a collective total of over 780 years of industry experience – an average experience level of just over 24 years. They work for companies having staff numbers ranging from ten to tens of thousands and market capitalisations ranging from several million dollars to several hundred billion dollars. The local Australian companies are listed in the ASX 200, whereas the multinational companies are mainly listed in the S&P 500.

5.2.2 Procedure

Prior to being interviewed, each participant was forwarded a copy of the interview outline to assist in preparation. Most read through the outline ahead of the interview but several indicated that they had not deemed it necessary; instead preferring their answers to be “off the top of their head.”

Confidentiality is, of course, required at all levels of the interview and analysis process – particularly in light of potentially sensitive company decisions being discussed in the interviews. This was assured, on an individual basis, with each participant at the start of the interview. Where required by an interviewee’s company a written legal confidentiality agreement was also signed prior to the interview.

In all cases the interviews were conducted in the interviewee’s office so that the interviewee felt at ease in familiar surroundings. This, it was hoped, would enable the participant to feel more comfortable in opening up about their decision-making.

In essence, most of the interviews followed the order of the major points

laid out in the outline (Appendix 2). In some cases, however, either the order was changed or questions deleted or included at the discretion of the researcher in light of the interviewee's previous comments. This flexibility served to uncover elements of the decision-making considered important by the interviewee.

Most interviews were digitally recorded. Where legal restrictions existed, or at the participant's request, written notes were taken instead. In all, 20 interviews were digitally recorded and 12 were recorded using hand written notes. The transcribed recordings, together with the written notes were edited, for confidentiality reasons, to ensure that the final transcripts would prevent individuals or companies from being identified. Participants were then allowed to review the revised transcripts in order to reassure them that no confidential or identifying information was included and that they were comfortable in having the transcript used.

Of the 20 recorded interviews, 19 participants gave permission to have their final transcript used in the research. One participant withheld his approval due to his concern that, even after editing, his role in the company, and the company itself, would be readily identified from the transcript. All 12 interviews recorded with hand written notes were approved for use

Transcripts of the 19 digitally recorded, de-identified interviews are appended (Appendix 4) along with the typed notes of the 12 non recorded interviews (Appendix 5).

5.3 DATA ANALYSIS

The aim of this section is to extract key themes or concepts from the interviews in order to discover how people in companies generally make their decisions. The

themes and concepts are uncovered by analysing the main areas of discussion in the interviews:

- the roles and responsibilities, or structure, in decision-making;
- the various types of decisions;
- the processes and tools used by decision makers;
- the human side of decision-making; and
- learning feedback concepts.

Each theme is enunciated using short, insightful and revealing excerpts from the interviews. It should be noted, however, that not all comments related to the area of discussion are included. Rather, those excerpts which are pithy and directly to the point are selected. Each quote is followed by the participant's identifying letter, or code. This code is also used in Appendix 4 and 5.

5.3.1 Roles and Responsibilities

The first observation about the roles and responsibilities associated with decision-making in companies is that it is perceived by the participants as a group-based activity. The following quote reflects the general consensus of most interviewees:

- *"I found in industry, especially the oil industry, most decisions are made in groups." (G)*

This immediately raises a real issue. If group decision-making is the norm in the oil and gas industry, how can the vast majority of decision-making research, which assumes decision-making to be an individually based activity, be applied to the oil and gas industry? While this idea of group decision-making certainly warrants further investigation, looking more deeply into what the participants said reveals that sometimes, although decisions are, initially, described as a "group decision", they are often actually made by an individual – with the group undertaking a review

process. In other cases, the group provides input to an individual who then makes the final decision. This is evidenced by the following excerpts:

- *“I never draw that decision as the final decision without consulting with my team” (A)*
- *“I expect my guys to do all the analysis and all the investigation and then I look at the information and make a balance in what is in front of me in terms of yes that makes sense or no that doesn’t make sense and then make a decision” (D)*

Where interviewees stated that decisions are made by a group, they generally clarified this to mean that the group gives input and the highest ranking person (either in or outside the group) takes accountability for the decision that the group comes to. One interviewee stated:

- *“So that decision will not be made by me in isolation. It will be made as a strategic collective. I’ll provide the recommendation to the group and ultimately for that high level strategic decision the person with the broadest perspective will say yes.” (I)*

whilst another claimed:

- *“The final decision would be made by one person, but it would have input from a great number of people The more difficult the decisions, the more people involved in the input” (S)*

and most see that:

- *“The ultimate decision is usually made by the VP or CEO of the company.” (F)*

Perhaps the weakest link in the chain decision-making in the upstream oil and gas industry is the imposition of the vice president or chief executive officer’s own intuitions and biases on the decision.

In essence, although most consider that decision-making in the oil and gas industry is group based it is ultimately an individually based activity which has group input, that is, the group frames the issue, collects the data it deems appropriate, sets up the options. Even if an individual 'makes' the final decision they are bound by the group processes.

Hence, the theories documented by decision-making under uncertainty literature should hold in the oil and gas industry.

That said, the discussions around group and individual decision-making do reveal something about how decisions are made in oil and gas companies.

Note these comments:

- *“Decision-making goes through that chain of command and I think that sort of filters my decision.” (D)*
- *“Your involvement in the decisions really reflects your organisation and your position in the organisation. I’ve been in roles from providing a bit of information, to roles of deciding, to roles of being disempowered.” (H)*

That is, the interviewees regarded decisions as being made in a very structured, hierarchical manner. In fact, many participants indicated that there is a current trend to move the decisions “higher up” the organisation, which is counter to some company claims. For example:

- *“There have been a number of changes in terms of moving the responsibility of the decision up to higher levels.” (N)*

This raises several issues. Firstly, should decisions be made at the level where the information is gathered and analysed by the technical experts or

should they be made further “up” the organisation? One participant strongly advocates:

- *“Decisions should be taken where the knowledge is greatest but I don’t think a lot of organisations believe in that. They believe in hierarchy.” (H)*

Others gave several key reasons why they believe the decision should be taken at the lower level. The primary reasons revolved around time; and in business terms, “time is money.” The delay in passing decisions up the chain does have an economic cost. In addition, there is also a social or emotional impact. The more levels that are involved, the longer it takes to make the decision and the more frustration mounts, at the lower levels, whilst this is occurring. One interviewee indicates that:

- *“. . . the higher the level the decisions have to be made usually means they aren’t made very quickly” (N)*

Another asserts:

- *“People don’t understand why it takes too long . . . at higher levels it becomes difficult to feedback why things are taking so long.” (N)*

There are, however, other ways of viewing the perceived dilemma. Some interviewees recognised that what they termed technical or tactical decisions, are actually made at the lower levels and the hierarchy is simply there to determine if some strategy, unknown at the lower level, should be invoked. Consider this response:

- *“We’ll make very strong technical recommendation to do a piece of work and then it’s not going to get looked at technically again as it goes up the decision chain, so the decision’s effectively been made at that*

level. It's only turned over if there's a deeper strategic imperative at the higher level." (F)

It could, therefore, be viewed that the hierarchy does perform a valuable function. Note this critical observation:

- *"Interestingly different people's strategy may be at different levels tactics depending on where you are in the organisation. What may be a tactic for me could be a strategy for someone lower down the organisation . . . as your planning horizon moves out (broadens) you generally move further up the organisation." (I)*

Of course, the number of levels in the hierarchy is dependent on the size of the company. The general view is that small means fast but not necessarily rigorous. As one participant, from a smaller company, commented:

- *"For a company our size we believe we do it very rigorously" (Q)*

If the hierarchy does add value by "seeing the bigger picture", how do smaller companies make up for the lack of staff?

- *"If you had to make a decision you'd get someone in and they'd do 90% of the work and then you'd make a value judgement" (R)*

This strategy raises another issue. Specifically, the fact that there are consultants who can do the work is good, but do they actually have the same objectives as the company?

On the other hand, how can larger companies reduce the time it takes to make the decision? A participant recommended:

- *“Constrain resources to actually only do those things that matter” (A)*

One further concern emerges: if technical staff are required to pass their project through so many levels of the hierarchy in order to receive approval, they may inflate the positive aspects of the project (or deflate the negative ones) in order to have it approved. This raises the issue of motivational biases. One participant revealed that peer reviews are implemented to reduce this bias:

- *“The technical community doesn’t have the pressure to gild the lily so management can make a better decision in the hard light of day.” (I)*

With such a strong emphasis on hierarchical decision-making, managers find ways to make their decisions across a broad range of fields of knowledge whilst not having to know everything themselves about those fields of knowledge. The interviews reveal that in order to achieve this managers rely very heavily on trust and respect. Examples of this include:

- *“I talked with people who I had a lot of respect for.” (J)*
- *“We wouldn’t do it unless we had absolute faith in the individuals across the chain of influence. . . . Its getting somebody whose opinion you’re sure you can rely on” (Q)*
- *I believe in good people, good tools, good process, good logic; the whole bit. But it helps a hell of a lot if you know some people. You understand their risk tolerance and their judgement.” (H)*

One manager even called trust:

- *“ – the classic ‘smell test’” (Q)*

Trust appears to be developed through experience. A few executives state:

- *“Building trust is all about doing as you say and also delivering to expectations.” (A)*
- *“Who does the proposal come from and the credibility of that person, the experience of that person.” (H)*
- *“I trust them through experience. I’d know if they were going to give me a quick straight answer. . . . Someone who would give me a more pragmatic answer. There’s an experience level, a trust level and a whole lot of values.” (Q)*

As stated, experience is intrinsically tied up with trust. In fact one participant even sees experience as a criterion to divide decision types:

- *“Experience-based decisions” (K)*

In essence, experience plays out as important in the very human side of the industry because, in Gigerenzer’s terms, the fast and frugal heuristic tool box of seasoned veterans is well equipped. Hence the need to hire the “right” person is regarded as vital; as demonstrated by the statements of a couple of the participants:

- *“The idea of getting the right person on the right jobs at the right time” (K)*
- *“More experienced people tend to cut to the chase sooner; they don’t need to build from the ground up on each and every decision. They have enough credibility checks to know what incremental analysis is required to reach a decision.” (A)*

In summary, most people in the oil and gas industry believe that their decisions are group decisions. In reality, they are individual decisions with group input or review. Hence, theory and research on decision-making under uncertainty does apply to the industry. One of the more “real life” aspects of decision-making in the industry is that it is hierarchically based. Decisions are closely linked to the level of seniority or responsibility a person has in the company hierarchy. In order to make timely decisions in this type of environment, people use a trust-based heuristic that is, in part, related to experience. Put another way, decisions are made by groups but taken by individuals. Due to increasing levels of financial accountability the decision taker is found at the level of the hierarchy that is commensurate with the financial risk/commitment being made. This hierarchy of accountability will slow down decisions which have to pass up and down through the layers. Trust is a dynamic for reducing costs which, in this case, are the checks and balances that those who are finally accountable have in place for those who supply input.

5.3.2 Decision Types

One of the central theses of this research is that, as decision processes are tailored to decision types, better outcomes will result in the long run. The concept of decision type, however, is given little thought by most of the participants. Most state that they intuitively understand that there are different types of decisions but few are able to enunciate what some of those types are. A series of comments reinforce the idea that all decisions are not the same and the processes and tools that are used to make them should be tailored. Note the following observations:

- *“They try to go for the ‘one-size-fits-all’ solution but gas is different to oil. Oil is opportunistic and gas is strategic. You can apply the same tools and processes to both businesses but not all the time.”*
(L)

- “. . . the impact of the decision and fit-for-purpose criteria. The more difficult or the higher impact or value, then the more work you do . . . the fit-for-purpose criteria has you choose different tools for different levels of detail.” (S)
- “A decision involving a choice between two alternatives is a completely different process than a decision involving the choice of many alternatives.” (T)
- “If it’s a high risk activity, decision for the organisation, then the organisation tends to invest more in making the decision-making process more consistent and defined and clearer and if it’s a lower risk activity you can have a bit of fuzziness.” (B)

When relating the concept to their own decision-making, most see the different types of decisions as being related to the various roles they have within the organisation. For example:

- “. . . they’re driven by the roles.” (B)

Those who talk about decision types as being different from their job roles usually divide decisions based on just one criterion. Two are discussed. The first being rational versus irrational; irrational being used here not in the sense of illogical but rather in the sense of not using a structured, objective process. Some good examples are:

- “Emotional decisions rather than rational decisions.” (N)
- “I won’t say its intuitive but . . .” (Q)
- “. . . other decisions are not as rigorous and defined.” (B)

The second revolves around complexity, or magnitude or size, of the decision. An interesting finding from the interviews is that participants do pick up one of the dimensions identified in the taxonomy – complexity (Chapter 6). The following are examples:

- *“It’s a more complicated decision where other parties or other departments have to bond. It becomes more complex.” (N)*
- *“It’s because it’s a fairly complex decision you have gone to some form of formal process driven decision” (K)*
- *“The more complex the decision the more useful it is to consult and get ideas.” (B)*
- *“Decision types are the magnitude of importance.. . . because of the size and the nature of it.” (F)*

One participant links the idea of decision types with that of feedback. He indicates that there are two types of decisions based on how quickly feedback is obtained:

- *“I test my decision-making, I test my judgement on the fast loop, the stuff where I do get feedback, and then get the confidence back to test the slow loop, where you’re not getting feedback, or you’re getting very, very scarce feedback.” (O)*

Several interviews revealed intuition as a type of decision-making. Some participants even referred to popular literature and the growing interest in intuitive decision-making, which is seen as either a subconscious process or as a “heart” process:

- *“It’s more or less a subconscious process.” (Q)*

- *“Here was a pretty life-changing event that I felt that I made a decision just like that – it all happened in the heart.” (J)*

Primarily, however, it is referred to by the participants as a gut process:

- *“I’m exposed to this many times – I get a feel for what’s going on. It was a really gut thing.” (J)*

Such gut feel dynamics have been noted before in oil and gas decisions (Naughton, 2003). It is these dynamics which lead to what Rose calls the “Prospector Myth” (Rose, 2000).

Although the participants find it difficult to divide out types of decisions “off the top of their heads”, all say that they approach what they call, types of decisions, in very different ways.

5.3.3 Decision-Making Processes and Tools

The first thing most participants recognised is that good decisions generally relate to a good decision-making process, not just to a good outcome. The act of making the decision is definitely separated, in the minds of the interviewees, from the actual outcome. For example, one participant summarises:

- *“You can have an absolutely stellar outcome which is great and the shareholders love you – and there’s nothing wrong with that – but that’s not a quality decision, it’s just a good outcome.” (L)*

But the actual decision-making process used varies greatly. Some thought their company’s processes were rigorous and, although leading to generally good outcomes, took a little too long:

- *“I think its rigorous, its onerous and therefore most things that come through are pretty good decisions. I think we’re now slower than our competitors.” (K)*

Others had a matrix type process:

- *“We have a decision-making matrix where at different levels, different teams get activated.” (M)*

Whilst others had processes that had evolved over a long period of time.

- *“Now it took a long time for them to evolve to the stage they’re at today, and they’re still evolving.” (L)*

And finally one participant saw the decision-making process he used in much the same terms as an emergency ward in the hospital, that is, prioritising treatment on the basis of relative severity:

- *“The analogy I use for my job is medical triage” (T)*

So although process is recognised as important, how companies document and communicate a process for their employees to use is not entirely clear. The following points are distilled in order to develop some form of “real life” model. Although not every participant discussed every step, it is believed that the elements hereinafter discussed represent a good consensus of all the interviews.

Determining the aim

The primary aim of decision-making is seen in terms of either maximising:

- *“What’s the best place to direct those resources to maximise value?” (M);*

or optimising certain outcomes:

- *“A recipe type list for the optimisation . . . ” (C);*

but no one in the interviews enunciates what that means in reality. The impression given is that normative maximisation is being referred to, even when the word optimise is used. That is, the value that the outcome will be compared to is the theoretical maximum rather than any optimum

calculated under “real world” constraints. In reality it is a vague commitment to ‘do our best,’ which eventually leads to satisficing.

Taking time to frame the decision

Several of the participants strongly advocated the need to really think about the problem situation before even commencing the decision-making activity. This was generally termed “framing the decision” as stated in the following examples:

- *“Our problem was not starting with the articulation of the question properly . . . so we always think about efficiency and effect before we set off on a process.” (A)*
- *“We didn’t frame the question. I think quintessentially the most serious starting point of decisions-making is appropriately framing the question you’re trying to answer and to make sure it’s a question worth answering.” (A)*
- *“Certain quality assurances should be done before you make a decision – to frame the decision.” (H)*

Determining the objectives and their relative weights

Having framed the question the next step participants describe is to set some objectives around which to base the decision. As one interviewee succinctly comments:

- *“Number one – set the objectives.” (G)*

Most also comment that it is unusual for decisions made under uncertainty to have just one or two objectives. Although all indicate that the primary objective is usually some form of financial utility, other objectives are also indicated in the decision. For example:

- *“NPV’s tend to favour short term projects so something that was a strategic entry into an area or a long term view we might say we’re prepared to suffer a very low EMV if it suited our other strategic reasons. We would subjectively weight some other objectives higher than the monetary objective.” (Q)*

This comment also makes clear the need for the weighting of the objectives with the participant describing the weighting in terms of subjective input.

Seeking alternatives that achieve the objectives

The next step would be for a search for alternatives or choices that would satisfy the objectives:

- *“What are the alternatives for this?” (G)*

An interesting negative comment shows the importance of actually spending time and creativity to develop such alternatives. When speaking of a failure, for example, one argued it was:

- *“Because I don’t think we felt there were other alternatives – so we felt we just had to go.” (J)*

Checking other possible solutions

Because of the uncertainty involved in oil and gas decisions, application of sensitivity analysis is evident. One interviewee uses the terms:

- *“. . . range of scenarios . . . contingency plans . . .”
(K)*

The primary method most use to manage uncertainty, however, is to review all the possible outcomes and make sure any downside is covered. The way the answers are given, however, shows remarkable similarity to the traditional classical rational or normative model and therefore the comments may, in fact, be the interviewees simply stating what they

believe the “right” answer is from the text book(s). A variety of comments were:

- *“Make sure we’ve considered all the issues . . . the full range of possible outcomes and both technical, commercial, financial sense and then make your call.” (Q)*
- *“You do need to think about what the downsides are as well.” (A)*
- *“A good decision would be one whereby consequences of the decision are well thought out apart from not just the actual project itself but its implications on the business beyond just the decision by itself.” (G)*

Cautions

Although the majority of participants acknowledge the need for a process to enhance decision-making, much of the discussion surrounding processes relates to cautions that are considered necessary to manage uncertainty. Caution is evident in many comments.

What resources are available is actually a constraint on the optimisation of the solution. As one participant comments:

- *“You actually can only ever make decisions for the resources at your disposal.” (A)*

Although resources can be a constraint, the primary constraint appearing in the interview transcripts is time. These occur in two complementary contexts. Firstly, if more time were available to make the decision, most participants felt that they could make better decisions. For example:

- *“The lessons that you learn from these campaigns is that if you don’t do enough planning up front, and*

you do get yourself in a twist . . . you haven't got enough time to make the right decisions." (M)

or

- *"I don't think it was a good decision because I had all the alternatives mapped out but I rushed into it because of time pressure . . . there was an unreasonable requirement to make a decision in a short period of time." (H)*

The second context in which interviewees referred to time was in relation to change, the basic observation being that: as time moves on, circumstances change. Hence, a decision that may have achieved the desired objectives today may not do so at some time in the future – or vice versa. As a participant stated:

- *"Its also external environment as well . . . things change over time. XXXXX has been a remarkable success and much of that success was actually driven by the external environments changing after the decision was made." (I)*

These two critical aspects of the constraint of time need to be considered when making decisions.

A methodology that was recommended by several interviewees is summarised by:

- *"The more accountable you are for your decisions the more rigorous one tends to be in the process. . . . Accountability leads to better process." (A)*

Thus, it is thought that the more accountable people are for their decisions the better the decisions will be in the long run. A question that remained unresolved, given the comments available, however, was understanding how to manage the accountability.

Another risk mitigation methodology recommended by a few participants related to:

- *“Consistency of the evaluation process.” (O)*

Many decisions made by oil and gas companies are not necessarily related to whether to do a project or not – absolute decisions – but rather which project to do – comparative decisions. Consistency in approach and method are, therefore, viewed as very important in assisting to make these decisions - as evidenced by the following:

- *“Managing really known and unknowable risks – as long as you manage to consistently then at least you would have a consistent framework to evaluate.” (O)*

Tools

The majority of those who contributed to the discussions of decision-making prompted by the interview questions used tools of some fashion to assist in their decision-making. These tools ranged from: white boards and brainstorming sessions; through the ubiquitous Excel™ spreadsheets; to other proprietary and third party software. The following comment reflects the reason given for the use of such tools – turning data into information:

- *“There are a series of tools that allow us to assimilate the data in a form that turns data into information against which strategic decisions can be discussed.” (I)*

It is worth noting, however, that not all contributors believed in these sorts of helps. As one remarked:

- *“XXXXX doesn't have many books or written things, that's part of our culture – we try to avoid paperwork.” (Q)*

In summary, decision-making processes are seen as critical to making good decisions. These processes, which follow the rational model described in the literature, are portrayed as consisting of:

1. determining the aim,
2. taking time to frame the problem,
3. determining objectives and their relative weights,
4. seeking alternatives that achieve the objectives, and
5. checking other possible solutions.

Even given a good, consistent and accountable process in place, however, there are cautions that should be recognised. These include the constraints associated with time and change. Tools are viewed by the interviewees as filtering mechanisms that turn data into usable information. Thus, their use is restricted to “fit-for-purpose” – particular tools being used turn data into information of the type needed for a particular decision.

5.3.4 The Human Side of Decision-Making

Turning from what may be termed an analytical review of decision-making processes and tools, we return to a primary research avenue of this project - to analyse the human side of decision-making. As one contributor highlighted:

- *“At the end of the day it’s all about the people, right, you’ve got a process and you expose people to that process.” (O)*

Biases – motivational and cognitive

The bulk of discussion on the human side of decision-making, however, relates to biases, and more specifically, motivational biases. The following comments tend to indicate that, even when a consistent process is used, many decision-makers (or those who have input into the decision) tend to

change the “numbers” so that the optimal choice is the one they have a bias towards. Note the following:

- “. . . big motivational or emotive biases in our industry . . . people like to see their work finished – drill a well. So there’s a lot of sandbagging or emotion put in this and people like to see their work pay off or be tested.” (N)
- “Personal emotional investment in the project ran beyond good commercial judgement.” (L)
- “I guess, in reality, a good decision is one that results in a favourable outcome. Now that’s a bit flippant because it might be a favourable outcome, but for the wrong reasons. But still, you’ve made effectively a good decision and you will, as an individual, twist it to say: well yes it was my call to get into that block or that country. And even if your call was based on data that wasn’t what actually made the thing work, you still say you made a good decision.” (F)
- “The lack of opportunities influences your motivational bias. The issue then becomes, does the actual technical evaluation get modified, anticipating that motivational bias or not, and you’ll only ever know that if you do a post mortem. But if you don’t know how bad you are, then you can keep going . . . the longer it goes on the more people defend their existing positions.” (G)

These participants actually identified such behaviour as bias but others couch the bias in terms of “strategy.” Such as:

- *“The computer models, the data analysis, the hard data analysis, there was a lot of intelligent, competent people providing insight into what these numbers show, but the numbers don’t accurately reflect the benefit of making a decision in a strategic context.” (I)*

Of course, it is perfectly valid to argue that something may be a strategic objective that should receive more weighting; but this should occur during the decision-making process, as either part of the objective weight setting or as part of the sensitivity analysis. To argue it, after the fact, as is observed here, demonstrates that conscious manipulation exists. Cognitive biases are assumed to be subconscious. Therefore this activity is most likely the result of motivational biases.

A good summary of both these types of biases, motivational and cognitive, is:

- *“Your head is giving you every warning sign in the book and you know you’re getting those warning signs but you override them. You override them for the psychology of human nature, you know, because it’s the path of least resistance.” (J)*

Debiasing

Although not explicitly stated, one comment summarises the general belief that decision makers need to beware of the biases and strive to debias their decisions before implementing them:

- *“There are inherent dangers in approaching decision-making in anything but a well understood way. And so if you’ve characterised our decisions that’s fine but on top of that the process can actually invade*

and bias our decisions and one needs to be cautious about that.” (A)

Risk Perception

Another aspect of the human side of decision-making deals with individuals' attitude to risk. One profound, judgemental observation captured this idea:

- *“You either sit still and you die, or you take some risks and you die trying” (Q)*

Further exploration of this concept needs to be directed at whether the risk attitude is solely that of the individual or reflects that of the company. In other words should an employee use their own (implicit) utility curve to analyse decisions or does the company have one? What about prospect theory? Has the company defined the frame from which to determine if the decision is a gain or a loss?

Communication

A very important point about human activity systems is that they require very good communication. The only way to transform data into information in someone else's mind is via communication. The best summary of this from the interviews was:

- *“Get them talking to each other. Getting that functional excellence and the cross-functional communication is the key to good decision-making.” (L)*

If the communication is poor, misunderstanding will be rife and, as mentioned previously, frustration will increase. As one participant noted:

- *“I'd say we have some very good processes. I'd say sometimes they get overridden for sometimes good strategic reasons, sometimes possibly good strategic*

reasons but we're not in on the strategy so we don't always understand." (F)

There is strong recognition that biases exist in human decision-making and there is a need to find ways to debias the decision prior to implementation. Overarching all interpersonal interaction is the constant need for clear and concise communication.

Finally, a few participants broached the possibility of a link between the way people make decisions and their personality, as demonstrated by these comments:

- *"Some people on a personal level really struggle to make decisions and whether they're personal decisions, some people find it very hard to make decisions on day to day things – you know classic procrastinators. They don't like making decisions until it's forced upon them." (N)*
- *"There are people who make their decisions, even in the exploration production business based on beliefs . . . I make decision on the facts. I'm an analytical type person so, give me the facts, lay them out dispassionately, and evaluate them. Make sure that you've got the facts right and apply the principles." (G)*

5.3.5 Learning Feedback

All participants saw the need for some form of:

- *"Learning as you go along." (Q)*

or a:

- *". . . lessons learned thing." (P)*

The learning is seen as part of a:

- “. . . *cycle of improvement.*” (P)

As one participant says, when referring to decisions that did not have the desired outcomes:

- “*You could call those bad decisions but its part of the learning curve.*” (A)
- “*You’re always looking to do it better and you’re always taking on board feedback . . .*” (B)

is the way one participant summaries the aim of feedback – learning from previous decisions and, thus, continuously improving the decision-making process. The interviews highlight a real need for such feedback in addition to revealing other interesting ideas and practices described below.

Virtually all participants agree with the need for feedback and perhaps the best summary of the reason for it is:

- “. . . *things come out a bit strange.*” (K)

The feedback comes both during implementation:

- “*We’ll feed that back and optimise the current well,*” (K)

as well as after the decision outcome is known:

- “*As part of the project development we integrate lessons learned from our previous developments into our project scope.*” (M)

One participant insightfully observed the need to set up what he called “signposts” as part of the decision. These signposts allow the decision maker to check that the implementation is on track to obtain the desired outcome. If there are differences between expectations and observations

at these signposts the decision maker can then determine whether to continue or not.

- *“You may see a certain number of signposts, particularly for larger decisions, more strategic decisions, that move you down a particular path and you make a decision to head down strategy A. As you progress down that strategy, the signposts may change that say hey, I’ve got a problem here and I need to step back and reassess the decision I made 6 or 12 months ago.” (I)*

The research thesis, that decision process should be tailored to decision type, is also supported by the participants as it applies to implementation feedback with one participant having observed different types of feedback depending on the type of decision.

- *“When it comes to more cerebral, vague, value-based prospectivity assessment-based issues, then we do less of a linkage between the decision and the implementation.” (G)*

A series of comments on this learning process pitch it more as a peer review process.

- *“I’ve got fresh eyes and I’ve got no emotional baggage around this project, that is the value of peer review. . . . You need to have someone that you look at and view as your peer and have common respect for each other.” (L)*
- *“We had people from our joint venture partner come along to those peer reviews as well and provide their guidance there.” (M)*

In essence, the idea of a peer review is to obtain feedback from respected, dispassionate individuals prior to making the next decision. Within a company framework the peer is viewed as being both unbiased and respected. By contrast, if the feedback process is undertaken with a manager, there may be some motivational bias present in the conduct of the review.

- *“You can fool your boss but you can’t fool your peers. . . .Be brave enough to actually call someone in with a dispassionate view, fresh eyes, who has got every bit as much experience in this industry as you do, and will tell you whether you’ve fallen in love with a dog. Don’t let your dogs become your pets.” (L)*

Another noteworthy aspect of this learning cycle relates to the dynamic nature of the business.

- *“We do check our performance but things get muddy a bit here because we keep buying things!” (R)*
- *“We do look back on the actuals against what we’ve predicted but circumstances change whilst its all going on.” (Q)*

This is a very important point that should not be overlooked. Several cases were cited of decisions that had very positive outcomes as a result of oil price rises during the implementation. This raises the issue that it is important, in feedback cycles, to not just compare the actual outcome with the desired outcome but to also look at what factors may have changed during the implementation. Making allowance for change is a critical. In colloquial terms, it is necessary to ensure you are:

- *“. . . comparing apples with apples.” (Y)*

As well as the critical need to be objective, feedback cycles are seen as also being very human and subjective. They can, therefore, cause both positive and negative effects such as: frustration, respect, trust and forgiveness.

- *“The process generates frustration if they don’t get feedback.” (M)*
- *“People respect feedback – you build trust and forgiveness from being explicit and expeditious every step of the way.” (A)*

An overwhelming number of interviewees saw the positive effects of feedback loops, or peer reviews, or learning cycles, as far outweighing the negative effects and a vital need to implement them, as part of an ongoing learning cycle, into the decision-making process. There remained, however, some perceived downsides to be guarded against:

- *“One of the downsides of review and review and review is conservatism gets built in.” (K)*
- *“We’re supposed to have post mortems after every project. But that’s still seen as an administrative event rather than a learning event.” (G)*
- *“As long as the process does not overtake the doing. You’re continually worrying about this improvement and not doing anything.” (P)*

In summary, feedback loops are seen as a positive element of the decision-making process. Participants maintain that feedback loops work best when conducted along the lines of a volunteer peer review rather than a management-imposed approval process. The dynamic nature of the oil and gas business also needs to be factored into the review so as to make the outcome meaningful. Becoming too conservative and administrative is viewed negatively by participants, but these negative

aspects can be overcome by focussing on the learning, discovery or explorative nature of the process itself.

5.4 DATA INTERPRETATION AND EVALUATION

The analysis of interview transcripts yields several key points about how decisions are made in oil and gas companies. This analysis is now interpreted and evaluated to distil a “real world” oil and gas decision-making model: that is, a representation of how decisions are actually being made in oil and gas companies. Two constructs are assumed in the interpretation and evaluation and need to be noted. First, the “real world” model itself is built from all the comments combined and is not distilled from what is common to all comments. Second, the concept of decision type is not used at this stage of the interpretation but it will be used later on to compare to the “real world” model that is built (see Chapter 9).

5.4.1 Hierarchical Decision-Making in Oil and Gas Companies

Questions like: can a company make a decision?; or statements to the effect: don't individuals make decisions!; raise the issue of group versus individual decision-making. As shown previously (section 5.3.1), decision-making in oil and gas companies is generally seen by the participants as a team or group process. Despite this view, however, closer analyses have revealed that decision-making is, ultimately, an individually based activity which has input from a team.

The style of the group based process, however, is quite distinct. The groups are making decisions that are being judged in terms of whether they are “good” or “bad.” Success or failure is a shared interest the team members have in common. That is, if the decision succeeds the whole team is seen as succeeding, and vice versa. Although the team consists of interdependent people, usually technical professionals who have

specialised knowledge, they influence each other in making the decision. The prime characteristic of the team in the oil and gas industry, however, is its hierarchical nature. The team leader, or manager, makes the final recommend or decision. The models and theories that may be applicable, therefore, are those that relate to hierarchical decision-making. That said, it is still important to see that at the discrete decision level, the human side of the decision-making is still individually based.

The interviews revealed that various types and numbers of decisions are made at differing levels within an oil and gas company. Based on a thorough reading of the transcripts, there appear to be three general levels. Beginning with the lowest these are, in ascending order: tactical or operational; then strategic; and, finally, policy.

If the number of decisions observed at each level is taken into account, a triangle of decision recommendations is developed (Figure 5.1) – with many more tactical decisions when compared with policy ones.



Figure 5.1 – Triangle of Decision Recommendations

Alternatively, if the decisions are viewed from the amount of perspective – that is, how much of “the picture” can be seen by the decision maker – needed to make the decision, rather than the number of decisions, the interviews indicate an inverted triangle of decision perspective (Figure 5.2).

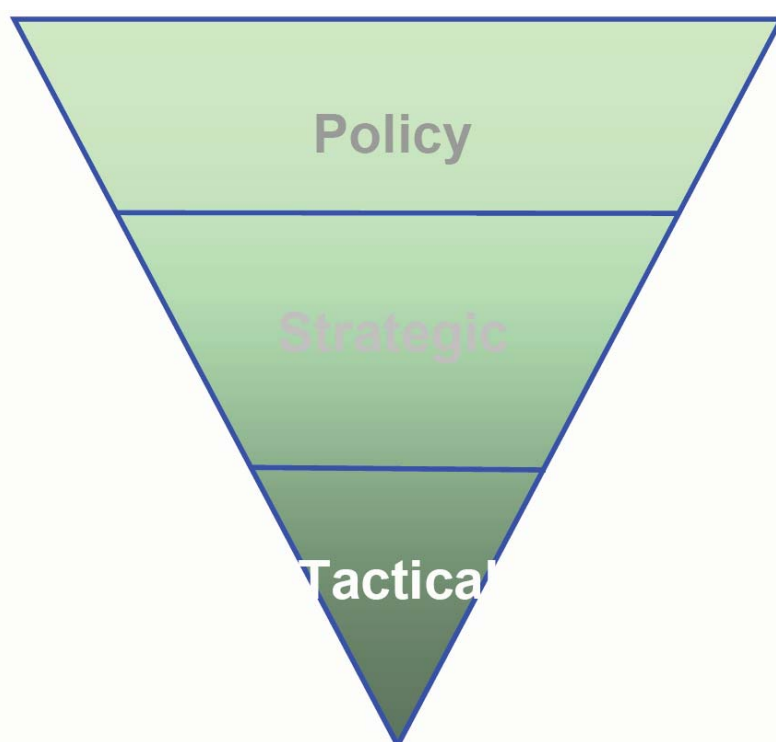


Figure 5.2 – Triangle of Decision Perspective

From the interviews, it appeared to be common practice for companies to require that the majority of decisions be “passed up the chain.” This is viewed by those higher up the hierarchy as necessary for “strategic perspective” to be brought to bear in the decision; but is viewed with frustration by those lower down the hierarchy because of the amount of time it takes to make the decision - along with a feeling of “what am I here for anyway!” This is evidence that the company’s objectives are not being clearly specified to all levels of the company. Taking into account the definition of a decision – that is, the irretrievable allocation of resources to

achieve a desired objective (Skinner, 1999) – these apparent dichotomies can be resolved. Rather than making decisions at the level where the strategic perspective is greatest, or where input is received, it should be possible to make the most practical decision at the lowest level where the resources are under the individual's control – that is, where the decision-maker is the person who has control of the resources. In order to achieve this simplified and balanced model of decision location within the hierarchy, however, it is necessary to have clear and concise communication throughout the hierarchy. Rather than communication just being from the bottom up, with lower levels communicating their reasoning for recommending a certain decision, it is also necessary for reciprocal feedback from the top down with higher levels communicating their policy, strategy and objectives in a clear and concise way to the lower levels. At the same time communication from the bottom up needs to be clear and concise with regard to the available and required resources. This yields a balanced hierarchy of decision-making (Figure 5.3).

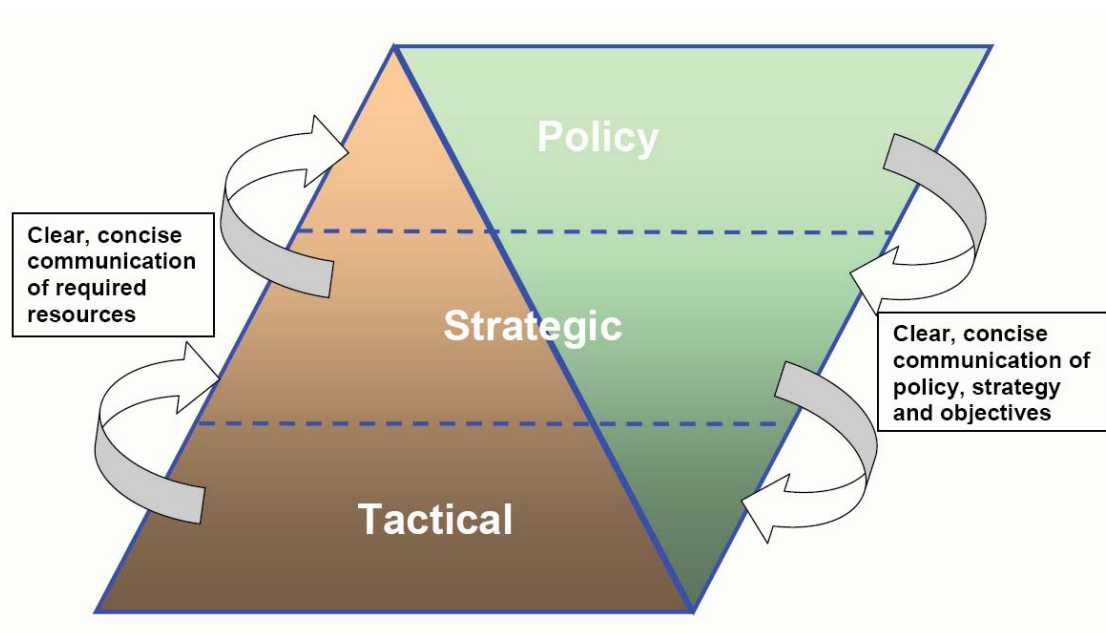


Figure 5.3 – Balanced Hierarchy of Decision-Making

5.4.2 Trust Heuristic

Another vital aspect of hierarchical decision-making in the oil and gas industry, strongly highlighted in the interviews, is the trust heuristic. Several interviews reveal that, in order to make timely decisions in this type of environment, people higher up the hierarchy have developed what is herein termed the trust heuristic. This heuristic is visually portrayed in Figure 5.4.

If the person making the recommendation is trusted by the decision maker the recommendation is approved. If, however, the recommender is not trusted by the decision maker the recommendation is questioned. Where the stakes are high the decision-maker tends to give the data to a trusted subordinate to make the decision for them. This trust is built up incrementally through experiences with the person.

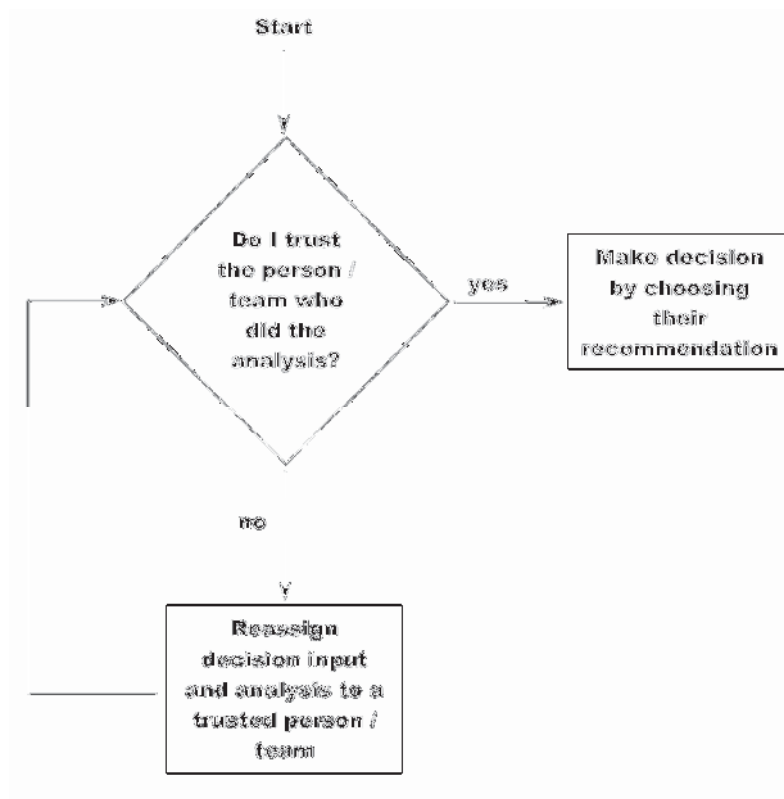


Figure 5.4 – The Trust Heuristic

5.5 CONCLUSIONS: “Real World” Oil and Gas Decision-Making Model(s)

This chapter set out to document a “real world” oil and gas decision-making model from data and information gained in the qualitative, semi-structured interviews. That is, attempting to answer, in simple terms, the question: how do oil and gas companies make their decisions? Thinking in terms of Checkland’s (1981) soft system methodological terms, this chapter records the development of the “above the line” or “real world” model.

The interviews highlighted a nested structure of decisions being made within decisions. Actual individual or core decisions were made and then passed on to upper levels of the hierarchy. These people, in turn, made their decision by either approving or disapproving the decision made at the lower level or passing it on to an even higher level. This upward movement of decision-making continued until a final approval (or disapproval) is given.

Two models are needed to account for these, somewhat, independent processes. The first covers the individual or core decision-making process, while the second deals with the approval, or hierarchical, decision-making process; the individual decisions being nested within the hierarchical approval process.

5.5.1 Individual or Core Decision-Making Process

The individual decision-making process is best described as a linear process consisting of:

- determining the aim,
- taking time to frame the problem,
- determining objectives and their relative weights,
- seeking alternatives that achieve the objectives,
- checking other possible solutions, and finally
- making the decision.

The process is, however, heavily modified by constraints; the primary ones being time and change of environment but also the availability of appropriate tools, which are used in a “fit-for-purpose” way for filtering data into usable information.

Furthermore, biases, both cognitive and motivational, exist in individual decision-making, highlighting the need to find ways to debias decisions. A key aspect of any remedy for bias is constant, clear and concise communication – particularly of feedback, which serves to sift out biases in the long run.

Although learning feedback, or the learning cycle, may be seen as the connection between the two nested models, most interviewees believed that the success of a learning cycle is dependent on the level of the hierarchy at which it is initiated. If the feedback is initiated from, or carried out at, the lower level of the hierarchy it is termed a peer review whereas, if it is initiated from the higher level of the hierarchy it is termed an approval process. The feedback loops are argued by participants to work best when conducted as volunteer peer reviews rather than as a management imposed approval process. It is thus best to see them as sitting within the individual decision-making process and not part of the hierarchical process.

5.5.2 Hierarchical Approval Process

The primary purpose of the hierarchical process is to deal with how the team or group interact together to arrive at the final decision (if it cannot be made at the individual level). The key determinant in this process, as seen by the participants, is the weighting of the recommendations (the individual core decision) that come to the higher levels of the hierarchy. The weighting is a function of the level of trust and confidence the team leader has in the individuals who are making the various

recommendations.

Another critical consideration, highlighted by the participants, deals with the need for a balanced hierarchy of decisions. That is, the need for information to flow in both directions – technical information upwards and strategic information downwards. This facilitates decisions being made at the lowest point where the resources needed to implement the decision are available and enables individuals to clearly understand the company's aims and objectives, which is important because they are making decisions on behalf of the company, not themselves.

5.5.3 Portfolio Management Process

Portfolio management processes have been recently introduced into the upstream oil and gas industry as a methodology to take into account dependencies between projects. It is interesting, given this recent innovation, that most interviewees did not discuss this approach at all. The majority of responses which talked of portfolios simply used the word to mean a group of projects rather than the dependencies between the projects. Only two talked of portfolio management and their responses were almost opposite:

- *“We don't do that. It's not occurring. . . . It's just words. There are tools around. The issue is not tools. The issue is how they're being used.” (G)*
- *“We recently completed a portfolio analysis, so I'm actually very comfortable that we've got a very . . . strong working level. I'm very comfortable that we know what's possible out of our portfolio, because we've got a consistent framework and we think we have an idea of what we would be able to achieve.” (O)*

Given this level of response it is concluded that portfolio management has yet to become main stream in its practical application. It is therefore left out of the “real world” oil and gas decision-making under uncertainty model presented as Figure 5.5.

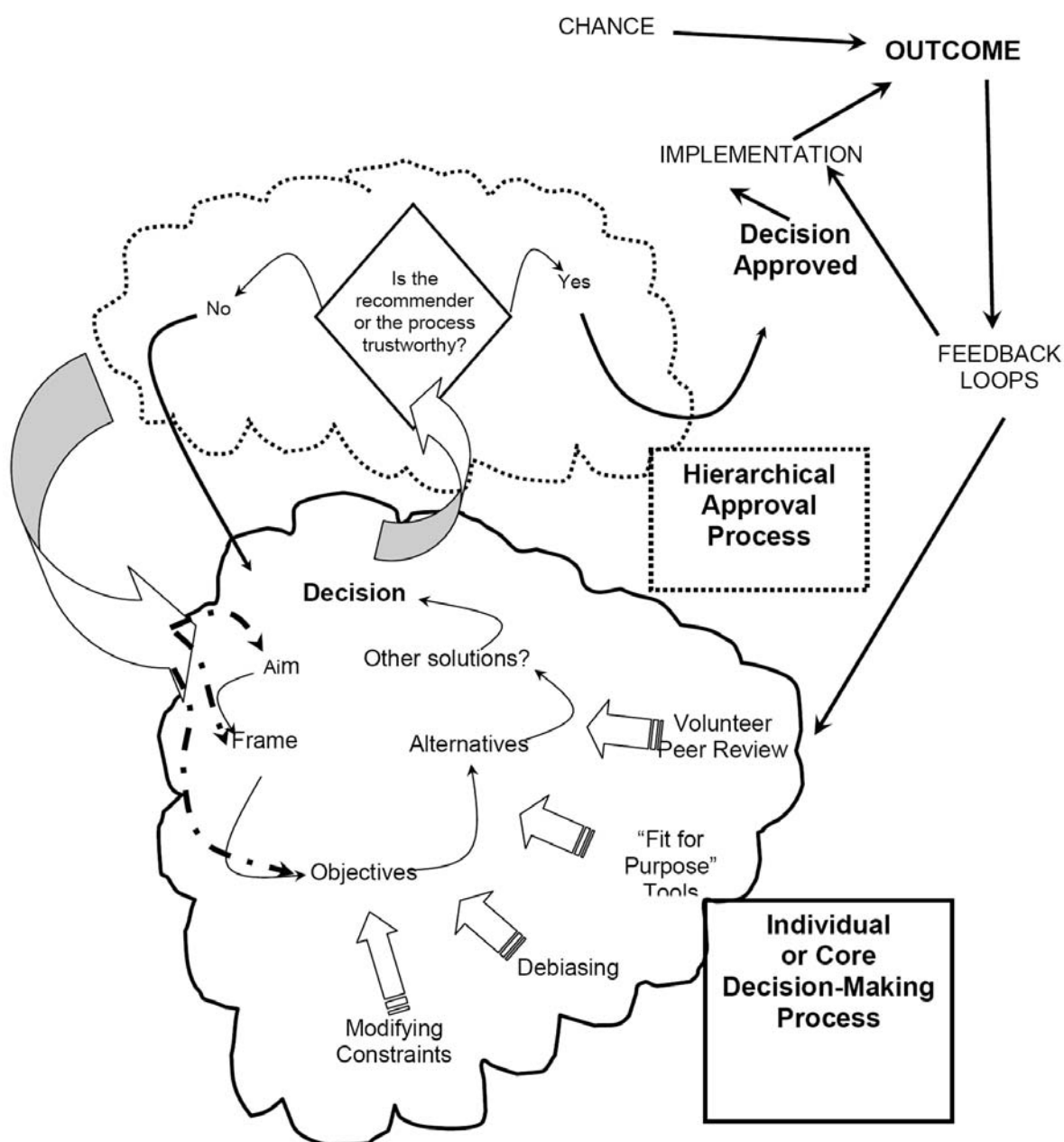


Figure 5.5 – A “Real World” Oil and Gas Decision-Making Under Uncertainty Model

CHAPTER 6

TAXONOMY DEVELOPMENT

6.1 INTRODUCTION

In commenting on decision research, Cooksey makes the following pertinent comment:

“In decision research, we should not be thinking ‘either-or’ but ‘which, when and why’ with respect to philosophical, theoretical, and methodological stances and with respect to learning from a wide range of disciplines.” (Cooksey, 2001, p. 362)

Essentially, the argument is that discussions or arguments about which decision-making school of thought to follow are not helpful. The real focus should be to think about which decision-making methodology to use as well as when and why that would be the best. The primary premise is that there are optimal processes and tools (Cooksey’s “which”) to use for certain types of decision-making (Cooksey’s “when”). The secondary premise is that Cooksey’s “why” can be answered by showing, from both laboratory and “real world” experiments, that when decision-making tools and processes are tailored to the type of decision, optimal decision-making will result.

But in order to look at the “which, when and why” of oil and gas decision-making it is first necessary to determine the decision type. This means there is a need to categorise or classify decisions – something not yet covered in the upstream oil and gas decision-making literature.

Previous work, to develop a framework or classification of oil and gas decision-making, was attempted by the United Kingdom Offshore Operators Association (UKOOA). In 1999 the association published a set of industry guidelines (UKOOA, 1999), which were designed to assist operators with a more open, transparent, soundly-based and context-appropriate decision-making process as it related to offshore health, safety and environment (HSE). Called the Decision Support Framework for Major Accident Hazard Safety, it looked at decision context as the basis for making decisions, and even made some recommendations for optimal methodologies. This framework (Figure 2.4) or

taxonomy, however, addresses only the more surface engineering-based decisions, or what may be termed the most downstream of the upstream oil and gas industry, and does not address many of what may be termed the more upstream of upstream decisions. It is also focussed more on risk mitigation than value creation. This highlights the need for a more generic decision-making taxonomy that can be used at all positions within the upstream oil and gas decision-making spectrum.

Outside the upstream oil and gas industry a few taxonomies of decision-making have been published to date (Boonstra, 2004; Buckingham and Adams, 2000a, b; Nutt, 2001; Ullman, 1995). Addressing similar needs in the information systems, nursing, engineering and strategic decision-making fields, these taxonomies were constructed using empirical or other observational means and are thus specific to their industry. They are not directly transferable to the oil and gas industry. They can, however, be helpful in more clearly understanding what dimensions are critical to the classification of such decisions. Those taxonomies that had a minimal number of dimensions are reported as being the most useful, while those with more or more complicated dimensions have not been as successful. By observation an appropriate number of dimensions is approximately four.

This chapter documents the development of an oil and gas decision-making taxonomy that seeks to lay a decision space within which to judge the processes and tools of optimal decision-making in order to address Cooksey's "which." It should be remembered, however, that the aim of developing such a taxonomy has, at its heart, the desire to know how to select appropriate tools, data and processes for optimal decision-making according to the type of decision – the "when" and "why".

The methodology used to develop the taxonomy was previously introduced in section 4.4 and will not be repeated here.

6.2 IMPLEMENTATION

6.2.1 Procedure

A three-phase exercise was developed to uncover the generic dimensions that would make up a decision-making taxonomy using pair-wise similarity comparison.

Phase one was aimed at preparing everything necessary for smooth data collection and analysis. Firstly 20 typical upstream oil and gas decision scenarios were constructed (Appendix 6). The scenarios were designed to cover as full a spectrum of the upstream oil and gas industry decisions as possible and came from the personal experience of the researcher, modified so as not to break confidentiality.

Next, a graphical user interface was developed that could be used to present the scenarios to the participants in a pair-wise fashion and to record their responses. The interface and analysis processes were developed using the MATLAB software (Welsh, 2005a, b) and were loaded onto a laptop computer to facilitate individual testing. MATLAB was used because the data-analysis routines chosen for use had previously been written in that program (Lee, 1999).

As the data being collected required human interaction, approval of the University of Adelaide's Human Research Ethics Committee was obtained (Appendix 7).

Participants were solicited via an open e-mail request (Appendix 8) to those working in the oil and gas industry in Adelaide. Respondents were accepted on a "first come – first served" basis. The aim was to obtain at least 30 participants to allow for the collection of statistically sufficient data to enable statistically meaningful conclusions to be drawn.

Data collection formed the second phase. Once 30 individuals had responded, appointments were made and the exercise was undertaken on an individual basis. At the commencement of the exercise the participant had the purpose explained both vocally and via an Information Sheet (Appendix 9). When understood, consent was then obtained using a standard consent form (Appendix 10). The participant undertook the exercise on their own but with the researcher available to clarify any misunderstandings. The goal was to have as little discussion with the researcher as possible once the exercise had begun. For each trial, subjects were shown, on the laptop monitor, two of the scenarios and asked to compare their “similarity” on a 5-point scale, using the custom designed graphical user interface (Figure 6.1). As they recorded their answer, via a mouse click, the next pairing was shown. This continued until they had completed 38 such comparisons at which time the exercise was concluded and their answers stored. The exercise took, on average, 50 minutes to complete.

At the conclusion of all 30 surveys, the data collected were placed in a 20 by 20 similarity matrix (Table 6.1) – each cell in the matrix represents the normalised similarity measure between the two decisions shown. The data gathering routines were written such that there were six samples for each pair-wise comparison. The six responses were averaged and normalised to create the individual similarity measure within the similarity matrix. The higher the number in the matrix the more similar the scenarios were considered to be to each other, with a similarity score of 1 indicating that the scenarios were adjudged identical by all participants. It should be noted, however, that the similarity scores of 1 seen in Table 6.1 for the self-comparisons (Scenario 1 with itself, etc) were not provided by participants but rather filled in by the algorithm.

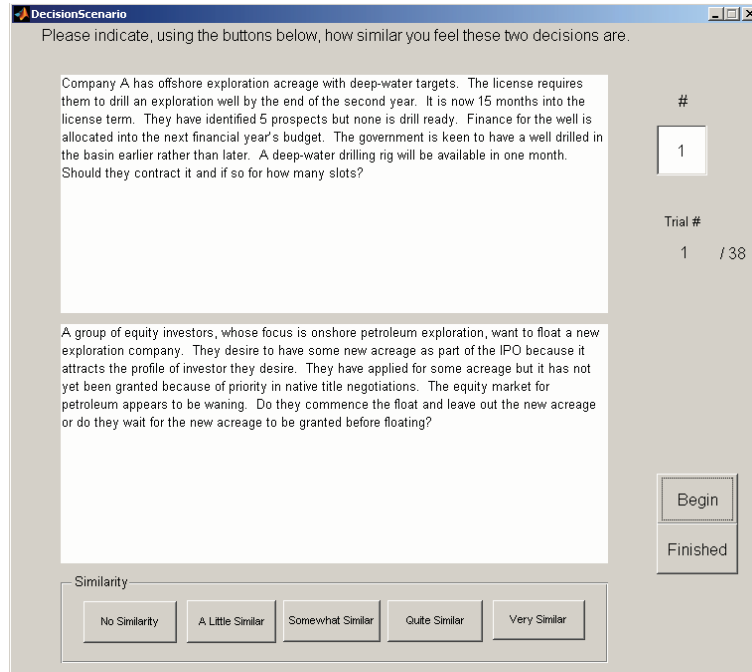


Figure 6.1 – Graphical User Interface showing similarity scale

Table 6.1 – Similarity Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.000	0.375	0.168	0.543	0.043	0.458	0.333	0.418	0.043	0.375	0.125	0.375	0.293	0.543	0.168	0.125	0.250	0.375	0.168	0.168
2	0.375	1.000	0.793	0.418	0.168	0.333	0.208	0.333	0.293	0.543	0.000	0.500	0.250	0.500	0.125	0.083	0.293	0.168	0.333	0.250
3	0.168	0.793	1.000	0.333	0.000	0.293	0.208	0.333	0.500	0.500	0.043	0.833	0.208	0.333	0.208	0.293	0.333	0.125	0.168	0.043
4	0.543	0.418	0.333	1.000	0.000	0.458	0.500	0.458	0.625	0.043	0.168	0.250	0.208	0.583	0.168	0.208	0.500	0.250	0.043	0.168
5	0.043	0.168	0.000	0.000	1.000	0.125	0.333	0.333	0.043	0.750	0.625	0.083	0.583	0.293	0.418	0.208	0.083	0.125	0.208	0.375
6	0.458	0.333	0.293	0.458	0.125	1.000	0.833	0.333	0.708	0.125	0.125	0.458	0.583	0.458	0.125	0.125	0.458	0.250	0.168	0.250
7	0.333	0.208	0.208	0.500	0.333	0.833	1.000	0.458	0.833	0.083	0.043	0.625	0.418	0.500	0.250	0.208	0.418	0.375	0.168	0.375
8	0.418	0.333	0.333	0.458	0.333	0.333	0.458	1.000	0.168	0.250	0.583	0.293	0.500	0.500	0.293	0.375	0.168	0.333	0.375	0.625
9	0.043	0.293	0.500	0.625	0.043	0.708	0.833	0.168	1.000	0.168	0.043	0.625	0.168	0.458	0.333	0.418	0.418	0.293	0.250	0.168
10	0.375	0.543	0.500	0.043	0.750	0.125	0.083	0.250	0.168	1.000	0.458	0.208	0.375	0.293	0.750	0.583	0.375	0.293	0.333	0.750
11	0.125	0.000	0.043	0.168	0.625	0.125	0.043	0.583	0.043	0.458	1.000	0.125	0.375	0.293	0.208	0.293	0.208	0.333	0.293	0.583
12	0.375	0.500	0.833	0.250	0.083	0.458	0.625	0.293	0.625	0.208	0.125	1.000	0.375	0.418	0.208	0.043	0.293	0.168	0.250	0.458
13	0.293	0.250	0.208	0.208	0.583	0.583	0.418	0.500	0.168	0.375	0.375	0.375	1.000	0.375	0.250	0.208	0.083	0.458	0.333	0.418
14	0.543	0.500	0.333	0.583	0.293	0.458	0.500	0.500	0.458	0.293	0.293	0.418	0.375	1.000	0.293	0.500	0.543	0.583	0.418	0.293
15	0.168	0.125	0.208	0.168	0.418	0.125	0.250	0.293	0.333	0.750	0.208	0.208	0.250	0.293	1.000	0.583	0.333	0.333	0.458	0.500
16	0.125	0.083	0.293	0.208	0.208	0.125	0.208	0.375	0.418	0.583	0.293	0.043	0.208	0.500	0.583	1.000	0.417	0.625	0.583	0.500
17	0.250	0.293	0.333	0.500	0.083	0.458	0.418	0.168	0.418	0.375	0.208	0.293	0.083	0.543	0.333	0.417	1.000	0.583	0.292	0.208
18	0.375	0.168	0.125	0.250	0.125	0.250	0.375	0.333	0.293	0.293	0.333	0.168	0.458	0.583	0.333	0.625	0.583	1.000	0.583	0.500
19	0.168	0.333	0.168	0.043	0.208	0.168	0.168	0.375	0.250	0.333	0.293	0.250	0.333	0.418	0.458	0.583	0.292	0.583	1.000	0.542
20	0.168	0.250	0.043	0.168	0.375	0.250	0.375	0.625	0.168	0.750	0.583	0.458	0.418	0.293	0.500	0.500	0.208	0.500	0.542	1.000

Three tests for data consistency were built into the routines. Firstly, each participant had at least one pair-wise comparison shown more than once. This facilitated analysis of the respondent's consistency in their answers. In this exercise, over 40% over respondents chose exactly the same level

of similarity the second time they were presented with the same pair-wise comparison. If this measure were expanded to allow one measure of similarity difference the level rose to 60%. Given the extremely imprecise nature of the data, this test-retest reliability was considered sufficiently high to warrant no further action.

Secondly, two scenarios were written as near duplicates of each other. This was designed to ensure that, if the respondents that were presented with the pair-wise comparison between them were answering appropriately, these two scenarios should have the highest similarity measure. This proved correct as the highest similarity measure (0.833) did occur between these two scenarios.

Finally, previous research (Lee, 1999) has shown that it is possible for two similarity matrices to be identical in terms of their individual entries but to have differing precision. This affects the reliability in the number of dimensions that can be placed on the final outcome. As multiple data were collected for each cell in the similarity matrix the average standard deviation of the entire matrix is used to represent the data precision. For this exercise the precision measure is 0.22. This indicates that the data is particularly imprecise – which was expected for this sort of exercise where no correlation was seen prior to the commencement of testing. The software routines used to analyse the data use this precision factor in such a way as to make sure that imprecise data, such as that collected in this exercise, are not over-fitted by an unjustifiably complex model.

6.2.2 Materials

The set of specific MATLAB software algorithms (Welsh, 2005b) written for the data collection are appended (Appendix 11a)

6.2.3 Participants

As stated previously, all 30 individual participants were volunteers from within the local oil and gas industry. Table 6.2 summarises the relevant data for the group. 67% were male and 33% were female. 53% of participants had less than 5 years of experience (years since undergraduate graduation), 20% had between 5 and 10 years, 7% had between 10 and 15 years and 20% had greater than 15 years of experience. The two major disciplines were split almost equally – 47% having a geosciences background and 53% having an engineering background. These statistics indicate that the volunteer group was fairly representative of the industry in general. The only difference would be that the less than 5 years experience group is more dominant in the survey than in the industry while the greater than 15 years experience group is underrepresented. This, however, is not considered critical to the results.

Table 6.2 – Survey Participants

Identifier	Gender M – Male F – Female	Experience (# of years)	Background G – Geoscience E – Engineering
1	F	< 5	E
2	M	>15	G
3	M	< 5	E
4	M	< 5	E
5	M	> 15	E
6	F	5 – 10	E
7	M	< 5	G
8	F	< 5	G
9	F	< 5	G
10	M	< 5	E
11	M	> 15	E
12	M	> 15	E
13	M	< 5	G
14	M	< 5	E
15	F	< 5	E
16	M	< 5	E
17	M	5 – 10	G
18	M	5 – 10	E
19	M	10 –15	E
20	M	> 15	E
21	F	< 5	G
22	F	< 5	G
23	F	< 5	G
24	M	< 5	G
25	F	< 5	E
26	M	> 15	E
27	M	5 – 10	G
28	M	10 –15	G
29	M	5 –10	G
30	F	5 –10	G

6.3 RESULTS

The results of the experiment were analysed using Shepard's (Shepard, 1980) multidimensional scaling, additive tree-fitting and additive clustering techniques in order to determine which decisions were similar to each other and why. Although the theory for the analysis comes from Shepard's work the practical algorithms used to analyse the data and display the results, together with the measures of complexity, all come from work previously published by Lee (Lee, 1999).

Determining which cluster best represents the data is achieved using optimisation. Of course in these techniques finding the best model is a difficult combinatorial optimisation problem, and the best answer cannot always be guaranteed. After each iteration a probability measure is made of the result and is compared with the previous result to determine which has the better probability measure. In the algorithms this measure occurs after each individual iteration in the search for individual similarities. Running the algorithm a second time will often result in another unique solution. In order to determine the optimised solution a simulation algorithm was written that enabled the individual routine to be run numerous times (100 in this case) and the most optimal overall answer saved as the result. Although the algorithms for the individual "runs" were those recorded by Lee (Lee, 1999), the multiple simulation routines were written for this research (Welsh, 2005a) and are appended (Appendix 11b).

Lee (1999) also discusses the use of the Variance Accounted For (VAF) and Bayesian Information Criterion (BIC) as quantitative measures of the complexity of the result in determining the optimal number of clusters. The BIC is basically a VAF measure that has been penalised for complexity, and so, in that sense, subsumes the VAF. Therefore, in this 20-scenario case, the models can vary from the maximum complexity and highest VAF occurring when all 20 scenarios are viewed as being totally independent and the result is 20 dimensions, through to the minimum complexity (as to number of clusters) and lowest VAF occurring when all 20 scenarios are viewed as being totally dependent and the result will

be 1 dimension. Neither of these results, of course, is practical in developing the taxonomy. Rather than use an empirical route of running the model with each solution of number of dimensions (i.e., 20 then 19 then 18, etc) the BIC is used as a Bayesian statistical measure of the preferred result with the model having the minimal BIC being regarded as optimal. Following Ockham's Razor⁹ each new model is only considered after reviewing the trade-offs between accommodating the original data and the complexity of the resultant model as measured by the BIC.

6.3.1 Additive Tree-Fitting

Using the additive tree-fitting algorithm, the optimal number of clusters is five at which point approximately 55% of the variance in the data is accounted for (Figure 6.2). The five clusters are shown on a tree-fitting structure in Figure 6.3.

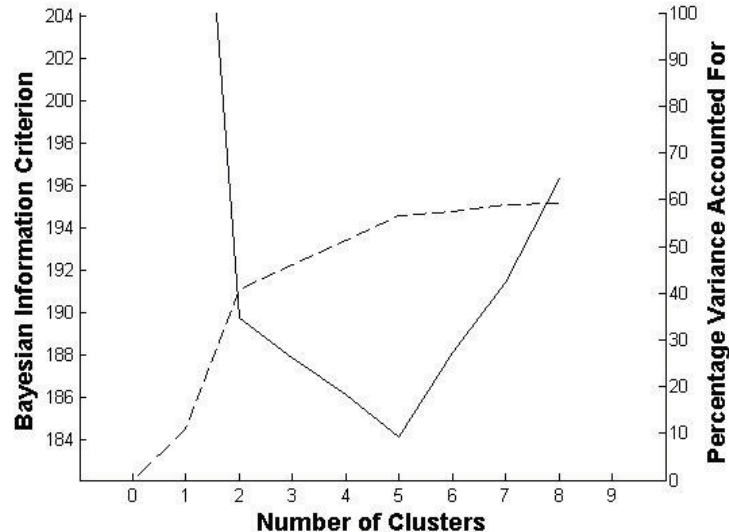


Figure 6.2 – Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using tree-fitting algorithm.

⁹ Ockham's Razor states that entities should not be multiplied beyond necessity – Hamlyn, D.W., 1987, *The Penguin History of Western Philosophy*: London, Penguin

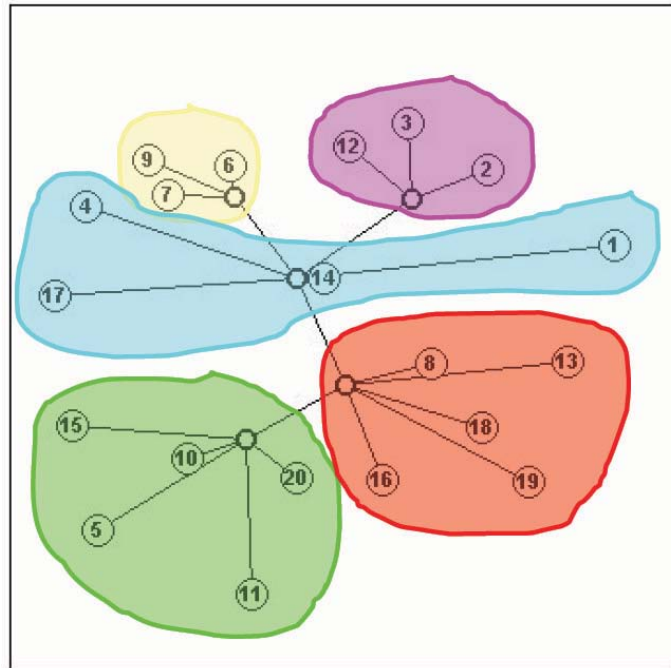


Figure 6.3 – Best tree-fitting result with 5 clusters represented by the different colours and is explained in section 6.5.

6.3.2 Additive Clustering

Using the additive clustering algorithm, the optimal number of clusters increases to seven at which point approximately 65% of the variance in the data is accounted for (Figure 6.4). Although a featural methodology, the seven clusters are best shown on a multidimensional scaling structure (a dimensional methodology construct) in Figure 6.5 (A –G).

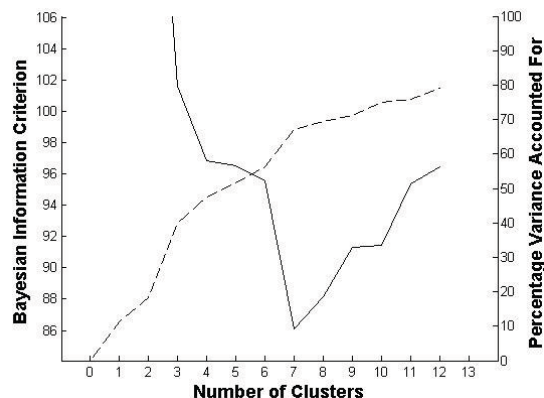


Figure 6.4 – Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using additive clustering algorithm.

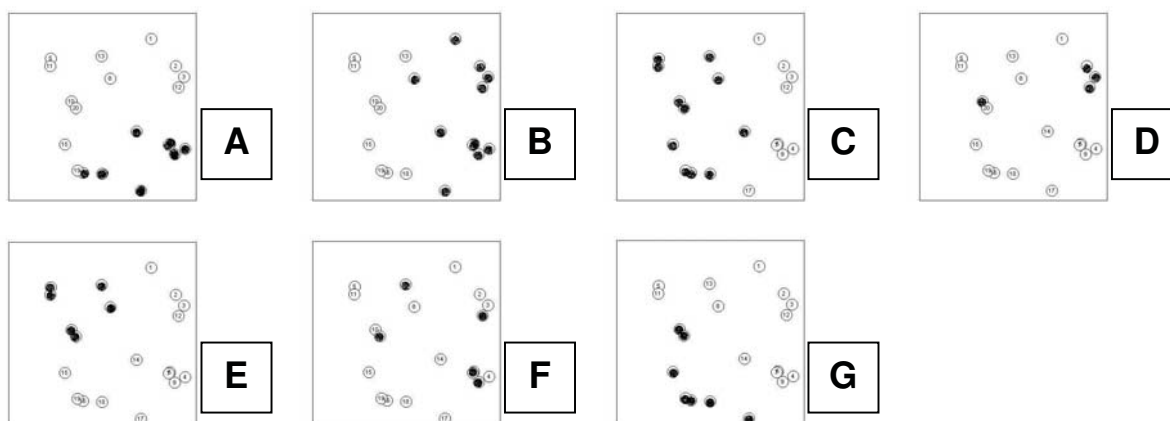


Figure 6.5 – Best clustering result of 7 clusters shown on multidimensional-scaled representation

6.4 DISCUSSION

The aim of using similarity analysis from pair-wise comparisons of decision scenarios was to identify the possible, generic dimensions of a decision-making taxonomy. Specifically it was believed that if certain decisions were similar to each other, that is, grouped into one cluster, they might contain a similar element that, in turn, described a dimension along which decisions could be classified.

Reviewing the five clusters that resulted from the tree-fitting analysis shows a basic similarity within the clusters. The decision scenarios that fall within the **green** cluster all have to do with situations that have an impact on the company's relationships outside itself. Those decisions within the **red** cluster all relate to the effects of change – an old system being replaced by something new. The **blue** cluster has a series of decisions that concern the need to fix or rectify some previous decision. Several of the decision scenarios were associated with various elements of obtaining new acreage and these decisions fell within the **yellow** cluster. Finally, one of the most often-discussed decision types characterises the **purple** cluster – those relating to the creation of a ranking for capital allocation.

Although a unique conclusion was never envisioned, the tree-fitting similarity analysis yields something very usable, namely, a series of five decision types. But the true test of a taxonomy is whether its types are unique and, thus, if other decision scenarios were created would they naturally fit within the established clusters or would new clusters evolve. Given the clusters observed here, it seems probable that the latter is more likely to be the case. The results, therefore, are not considered generic enough to use across the entire upstream oil and gas spectrum, although they do give direction to the development of a taxonomy. Perhaps the major drawback to the tree-fitting algorithms is that they assume that the clusters are made up of unique elements, that is, that the individual decision scenarios cannot exist within more than one cluster. The stricture that the decision scenarios must remain unique to a cluster restricts the model to the extent that it only accounts for 55% of the variance in the data.

The theoretical framework suggests that using the additive clustering algorithms, which allow the scenarios to overlap in arbitrary ways, should result in a more robust model. Statistically this is the case, as using this modelling technique increases the level of variance accounted for by 10% - up to 65% - in yielding the optimal result. This result suggests that increasing the number of clusters from five to seven whilst also allowing the individual decision scenarios to occur in as many clusters as required better reflects the data. It is, then, critical for the various clusters developed via the clustering algorithms to be analysed to determine if there is a unique element that groups them together. This is not as straightforward as the tree-fitting analysis.

The first thing that was noticed in the additive clustering data was that, even though the statistics indicate that seven clusters were required to optimally reflect the variety in the data, several of the clusters are, to a large extent, subgroups of other, larger clusters. For example, cluster "E" is subsumed entirely by cluster "C". Similarly cluster "F" is nearly subsumed by cluster "A" and "G" is nearly subsumed by "C." The data precision measure of 0.22 – the average standard

deviation of the similarity matrix – very strongly controls the optimal solution for the number of clusters. Reducing the measure to 0.10, which is the equivalent of saying that the data are more precise than they are, yields 20 clusters as the optimal result. That is, each scenario is sufficiently different from each other to be considered its own cluster. Although valid, this is not helpful in developing the required taxonomy. Freeing up the precision measure to, say, 0.50 reduces the number of clusters to one. Figures 6.6 and 6.7 display the relationship between number of clusters and variance in the data that is accounted for (VAF) against the precision measure obtained by reanalysing the data at various precision measures. These data show that there is a linear relationship between the variance in the data and the precision measure.

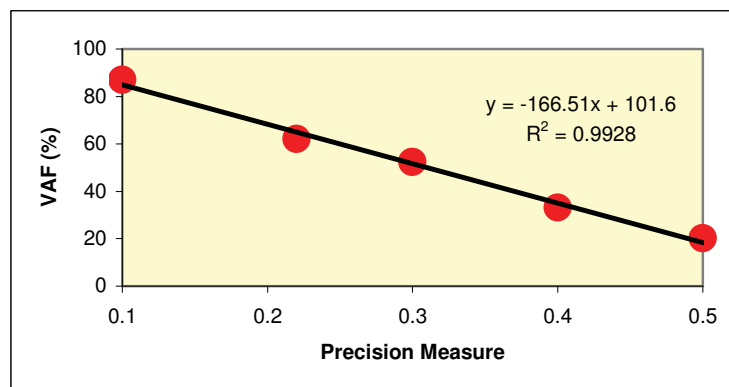


Figure 6.6 – Percentage of Variance Accounted For (VAF) versus Precision Measure

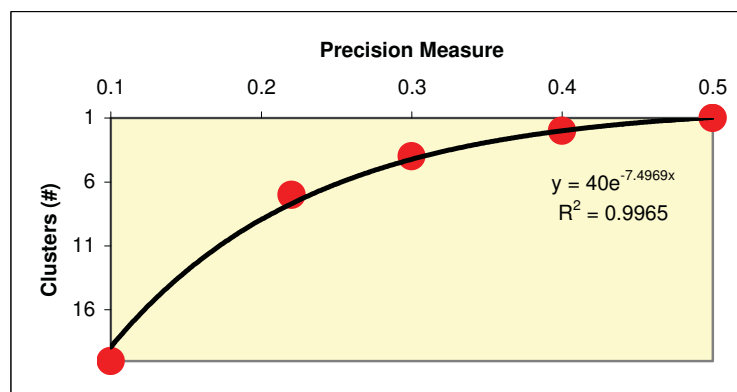


Figure 6.7 – Number of Clusters versus Precision Measure

It was therefore decided to experiment with the resolution at which the scenarios are represented in the hopes of finding a taxonomically usable

characterisation. Knowing that using a precision measure of 0.22 yielded an optimum of 7 clusters and although accounting for 65% of the variance in the data, was practically unusable and that using a precision measure of 0.5 yielded 1 cluster and accounted for just under 20% of the variance in the data but equally unusable, it was decided to reanalysis the data assuming a VAF of 50% which would yield a precision measure of 0.30989. This reduced the optimal number of clusters to down to four as shown in Figure 6.8.

The optimal four clusters would then be “A” (with no change in make up), “B” (with a very slight change in make up), “C” (with no change in make up) and “D” (with a slight change in make up) as shown in Figure 6.9.

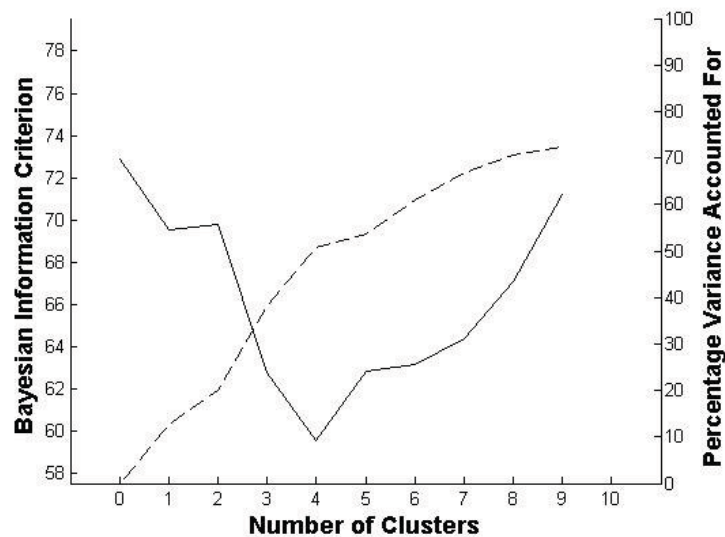


Figure 6.8 – Bayesian Information Criterion (left hand scale, solid line) and Percentage of Variance Accounted For (right hand scale, broken line) values for the similarity data using clustering algorithm

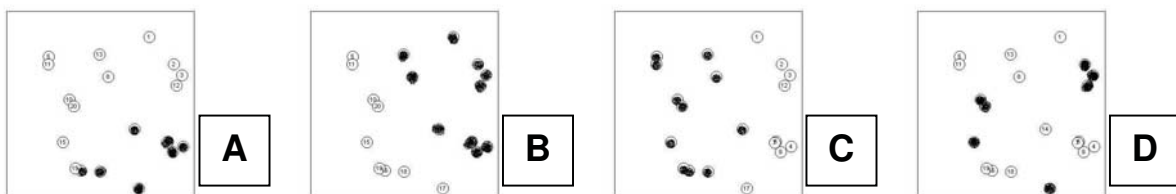


Figure 6.9 – Optimal clustering result of 4 clusters shown on multidimensional-scaled representation

The search for the dimensions now becomes much more straightforward. The element that ties the decision scenarios of **Cluster “A”** together can best be expressed in terms of complexity. Both the UKOOA decision framework (UKOOA, 1999) and Russo and Schoemaker’s “pyramid of choice approaches” (Russo and Schoemaker, 2002) can be seen as describing levels of complexity in decision-making. They commence with the lowest level of decision being the intuitive or oft-repeated decision – done so many times that no “thinking” is required. There are no decisions of this level of complexity in the scenarios. However, the next level of complexity consists of those decisions that can be reached by straightforward or heuristic procedures. The decision scenarios of Cluster “A” all fit within this level of complexity whilst all the other decision scenarios are much more complex.

Cluster “B” consists of decision scenarios which all have a singular constraint. Whatever decision is being undertaken, there will be factors that constrain the choices available to the decision maker. These interact with one another to determine which alternatives are possible and feasible. The primary constraints that are ubiquitous within the oil and gas industry are time and capital. Cluster “B” consists of decision scenarios in which there is only one constraint, primarily capital. All decision scenarios that fall outside cluster “B” have multiple constraints.

In order to make a choice between two or more alternatives the decision maker will require some value function, or measure of the level of achievement of objectives on a common scale, that measures the relative worth of the alternatives against one another. In all of the decision scenarios that make up **Cluster “C”** multiple, sometimes conflicting, objectives that must be weighed against one another are required to determine the ‘right’ choice. No one single objective can be used. By comparison, all the decision scenarios that fall outside cluster “C” can be solved using singular objectives.

Finally, all “real world” decision-making involves a process of acquiring information, often sought to resolve uncertainty in existing information. This usually requires time, and may expend other resources. The usefulness of such searches, then, depends critically on the availability of information, and the patterns or relationships between the information items. All of the decision scenarios within **Cluster “D”** can be viewed as requiring complex searches because they are “one offs,” i.e., the situation will only ever arise once and so the decision to be reached will be unique. All the decision scenarios outside cluster “D” can be considered repeatable. That is, the decision situation is not unique and the acquisition of information to make the decision can take the same form each time.

In summary, the four generic dimensions that have been chosen to define the clusters of decision scenarios are:

- Complexity,
- Task Constraints,
- Ambiguity, and
- Environment Information Structure

6.5 AN OIL AND GAS DECISION-MAKING TAXONOMY

An innovative component of the theoretical framework of this research involves developing a decision-making taxonomy for characterising decision-making situations in the upstream oil and gas industry. This taxonomy, although building on established ideas in the human decision-making literature, is itself novel, and involves four different components, which are now reviewed and expanded.

1. Complexity: Humans routinely make decisions that can be described as having different levels of complexity. This dimension can be thought of in terms of what Russo and Schoemaker (Russo and Schoemaker, 2002) call their “pyramid of choice approaches.” In describing why they use a pyramid they state:

“We have placed these choices in a “pyramid” to indicate that higher approaches are used less frequently than lower ones [and for more important decisions than are lower ones]. The techniques at the lower levels of the pyramid are rapid and often executed automatically with little attempt to follow a deliberate process. The higher ones are more time-consuming and costly, but yield greater accuracy and reliability in complex environments.” (Russo and Schoemaker, 2002, p. 134)

Similarly in the oil and gas industry, this dimension covers the entire spectrum from some decisions, which are simple, to others, which are highly complex. The complexity can result from the number of processes, with multiple outcomes, that need to be undertaken to come to a decision. But it can equally arise due to a single process that is highly intricate.

2. Task Constraints: Whatever type of decision is being made, in the “real world” it is almost always subject to multiple constraints. These include, most particularly, time and resource constraints, but there are other constraints that make various decisions uniquely different from each other. This dimension is therefore a series of discrete entities. At the simplest level the constraints impact decisions on an individual basis but as decisions become more complex it is likely that there are multiple constraints coming into play. It is, however, critical that arbitrary constraints are not taken as real constraints. These may include the age-old “capital constraint” argument – arguing that there is not enough money to do a project when in reality it is available but simply means someone else (outside the regular decision-making stream) has to approve allocating it. Possible constraints, all discrete entities, could include:

- **Time** – Time constraints can impact decisions in differing ways. For example, there may be a cut-off, after which certain choices are no longer available. Alternately, time can interact with other constraints such that the passage of time alters the value of alternatives.
- **Capital** – Money, or other resources, can limit which choices, of those potentially available, can actually be afforded. For example, a small

company may know of a field with great potential but have insufficient funds to go-ahead by itself, even though that would result in the greatest benefit to the company.

- **Availability** – In a world of limited resources, some options may not be made available to some people – simply due to tyrannies of distance or politics. These limitations can reduce the options available to a decision maker just as a lack of money or time can, and can interact with these limitations.
- **Technology** – Related to the above constraint of complexity, this refers to the limits on what technology can do in terms of the outcomes of the decision. Some problems may actually be insoluble with current technology.
- **Size** – Some decisions could be constrained by the size of the decision. This could be related to complexity but it could also be independent. Some decisions may be very large but still remain rather simple.
- **Impact** – Some decisions are only taken if they are judged to have small impacts (instrumentalism). Or the opposite – where only a decision expected to have a large impact and “be seen” is made.
- **Staff** – Certain levels of staff numbers are required in order to make and implement some decisions.
- **Skill** – The company may have the staff numbers but some decisions cannot be made unless the staff has a certain level of skill.
- **Political** – This refers to the State being a constraint on decision-making. Native title curbing access to some onshore land in Australia is an example of a political constraint.
- **Risk Attitude** – The decision maker may not be willing to take certain levels of risk and therefore place a constraint on the decision.

3. Ambiguity: “real world” decisions can usually succeed or fail in numbers of different ways, with different penalties and rewards for different outcomes. Value functions allow multiple objectives to be compared by transferring an

attribute scale to a common scale. In order to make a choice between two or more alternatives, as is required of a decision maker; they require some value function that measures the relative worth of the alternatives against one another with respect to the stated objectives. Hence a value function is required if the multiple objectives or degree of “wealth” is important. In fact, a single decision maker will often have multiple, conflicting objectives that must be weighed against one another to determine the ‘right’ choice. Although these various objectives are all discrete entities, when the weighting of multiple functions are required there arises a large ambiguity around the objectives and values as the decision maker seeks to objectify their stated objectives and values. Some of the value functions that are common include:

- **Utility** – The most commonly used type of value function is utility, where the economic value of a project is calculated using estimates of the various parameters that affect such and compared with its cost and discounting measures. This is generally the primary standard against which decisions are measured.
- **Environmental** – Companies have reconciled their understanding of the fact that their ongoing operations do not exist in isolation from their surrounding environments, and that negative impacts and inefficiencies arise from thinking of the environment as a pure “cost” versus a competitive “profit” centre. In response, many upstream oil and gas companies have implemented, or are in the process of adopting, innovative approaches to maximising environmental sources of value, such as environmental impact assessment (EIA), and environmental management systems (EMS).
- **Social** – this function involves being clear about the company’s as well as society’s purpose and taking into consideration the needs of all the company’s stakeholders – shareholders, customers, employees, business partners, governments, local communities and the public. There is a moral or ethical dimension to this function as well.

- **Personal** – Personal value functions are those of the people involved in the decision process. In addition to the assumed goal of maximising utility, people are often engaged in politicking to better their own standing in the company. Thus, decisions are also made according to which outcome will most benefit the decision maker, not just the company. It is important to make sure these are not part of the objectives.

4. Environment Information Structure: A key dimension of any complete decision-making taxonomy, but one that is often overlooked, involves the information structure of the environment in which the decision is made. All “real world” decision-making involves a process of acquiring information, often sought to resolve uncertainty in existing information. This usually requires time, and may expend other resources. The usefulness of such a search, then, depends critically on the structure of the information availability, and the patterns or relationships between the information items. For example, if each new piece of information is novel and useful, then further search is useful whereas finding more and more data that supports the same conclusion (i.e., where high dependencies exist) is less useful and dictates a different optimal search procedure. These observations apply even if a decision is not subject to time or resource constraints or has a value function with large rewards and penalties for successful and unsuccessful outcomes. For this reason, characterising the information structure of a decision-making environment plays a central role in understanding how decisions should be made. An added complexity is that although, in general, the information structure may relate to the decision type this is not necessarily the case.

The decision-making taxonomy, then, has four subjective dimensions – three that are continuums (complexity, ambiguity and environment information structure) and one that is discrete (task constraint). In order to display the taxonomy as a template upon which varying decision types can be presented it is necessary to display the discrete dimension as the number of constraints increases. The

proposed taxonomy template is shown as Figure 6.10. Any new decision-making scenario can thus be mapped in terms of the properties along each of these four dimensions and thus be characterised as belonging in a particular area of the oil and gas decision-making taxonomy.

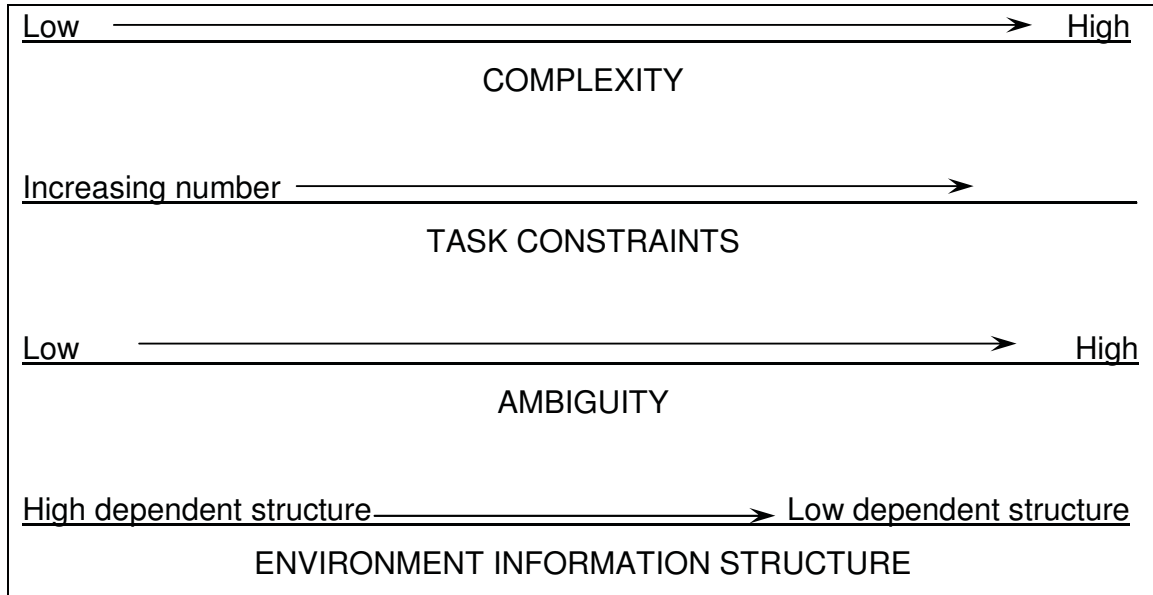


Figure 6.10 – Oil and Gas Decision-Making Taxonomy Template

6.6 CONCLUSIONS

This chapter documents a decision-making taxonomy that provides a “framework” in the decision-making space within which to place the processes and tools of optimal decision-making. The decision-making taxonomy builds on established ideas in the human decision-making literature, but is itself novel, and involves four different components: complexity; task constraint; ambiguity; and the information structure of the environment. A variety of decision-making scenarios can be considered in terms of their properties along each of these four dimensions in order to be characterised. Most importantly, scenarios at different places in the taxonomy will likely involve different decision-making tools, data and processes for the achievement of optimal decision-making.

CHAPTER 7

DECISION TYPES

Chapter 6 documented the development of a decision-making taxonomy comprised of four different components: complexity; task constraint; ambiguity; and the information structure of the environment. The decision-making template described in Chapter 6 allows decisions to be characterised in terms of their properties on each of these four dimensions.

In this chapter, the decision-making template is expanded upon and used to type a variety of decisions from both the oil and gas industry and other fields. This process of “typing” decisions is regarded as a necessary first step in the ultimate goal of matching decisions of differing types to appropriate decision processes.

For example, the decision to **develop an oil and gas discovery** may be subject to: a long, rigorous, complex investigation (high complexity); involving multiple objectives (high ambiguity); the investment of billions of dollars as well as many other task constraints (high task constraints); and have each new piece of information reduce uncertainty (low dependent structure). This decision would, therefore, be characterised on the template as shown in Figure 7.1.

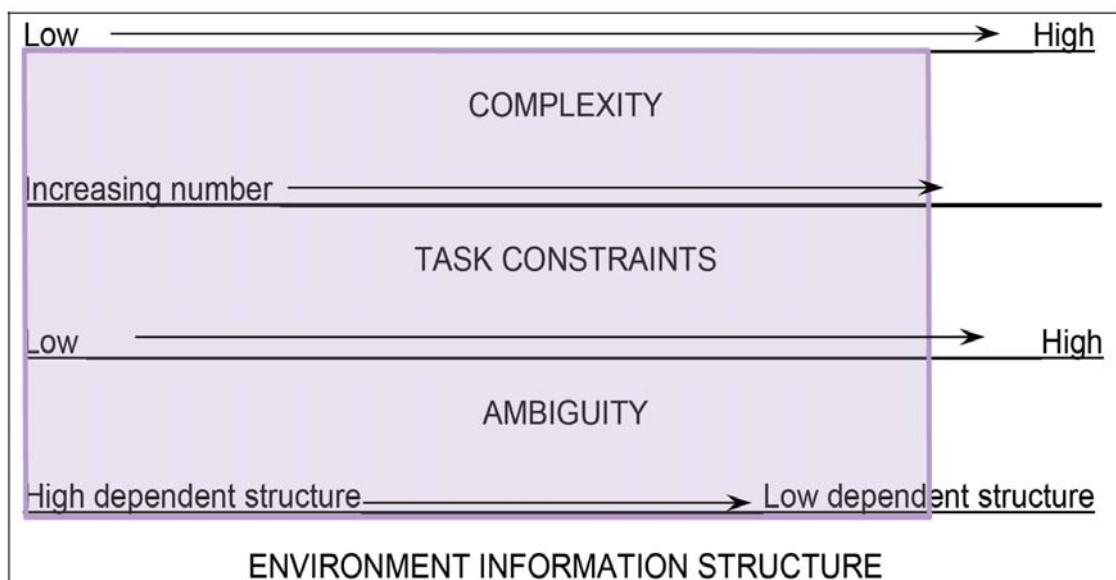


Figure 7.1 – Decision to Develop a Discovery

By comparison, decisions around **optimising the production from an existing oil well** are likely to be made quickly and simply on a daily basis (low complexity); with additional data collection tending to yield the same predictions (high dependent structure); have only a single, clear consequence (low ambiguity); and be relatively unconstrained due to the low cost of making small alterations to production (low task constraints). A decision of this type would, therefore, be characterised on the taxonomy template as shown in Figure 7.2.

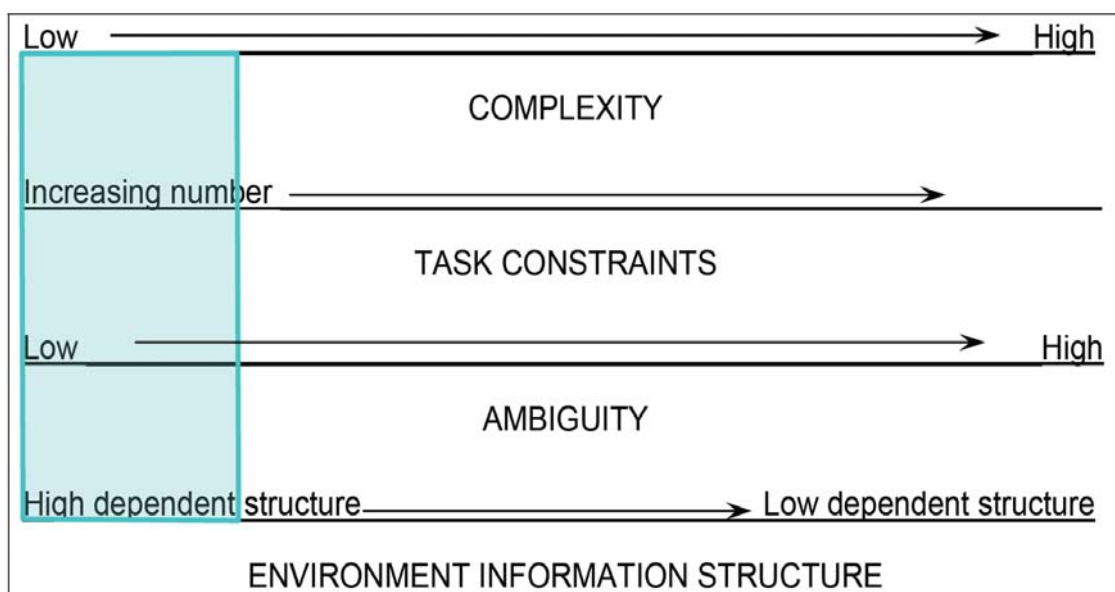


Figure 7.2 – Optimising Production Decision

Another common oil and gas decision is **reserves determination**. This type of decision is highly complex because it involves a series of smaller decisions along with the need to meet various stakeholder interests. However, both constraints and ambiguity are usually low. Finally, the first time reserves have been determined for a discovery there will be a low dependency structure (although this could become higher the more times the reserves are updated). Figure 7.3 is a representation of this decision type on the taxonomy template.

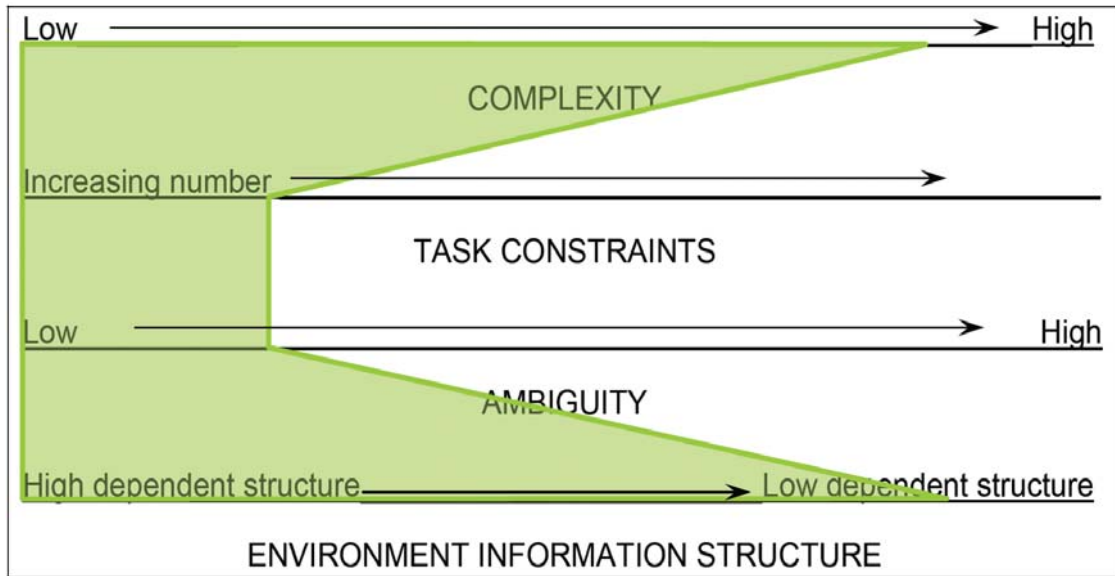


Figure 7.3 – Reserves Estimation Decision Type

To show the generality of the oil and gas decision-making template, Figure 7.4 is a representation of decisions of the type described by Klein as “naturalistic decision-making” (Klein, 1998) – that is, decisions of the type undertaken by expert decision makers in “real world” environments such as emergency and military services. These decisions are highly complex, involving many factors and where time is short. The most critical task constraint in such environments tends to be time so, while there may also be resource and personnel management factors to be considered, constraints are regarded as low. Ambiguity is also quite low as, generally speaking, a single value objective will predominate. For example, a fire fighter’s primary concern will be to extinguish the fire, thereby protecting property – although in certain fire situations this may change to saving lives or livestock, which may lead to the sacrifice of property to the fire. In each case, however, the fire fighter will have a single, primary objective and decide accordingly. Finally, naturalistic decision-making operates in high dependency environments. It relies on the decision maker recognising the key attributes of a situation and applying known solutions. That is, pausing to collect additional information is unlikely to alter the decision to be made, so naturalistic decision makers tend not to spend time searching for data, instead

relying on their pre-existing domain knowledge.

In the oil and gas industry, a number of decisions fall within what Klein (1998) would call naturalistic decisions and thus match the template pattern shown in Figure 7.4. These include decisions that require experienced decision makers and involve time pressure, high stakes and inadequate information. For example, those associated with operational emergencies such as taking a 'kick' whilst drilling or striving to finish acquiring offshore seismic data as the weather rapidly changes.

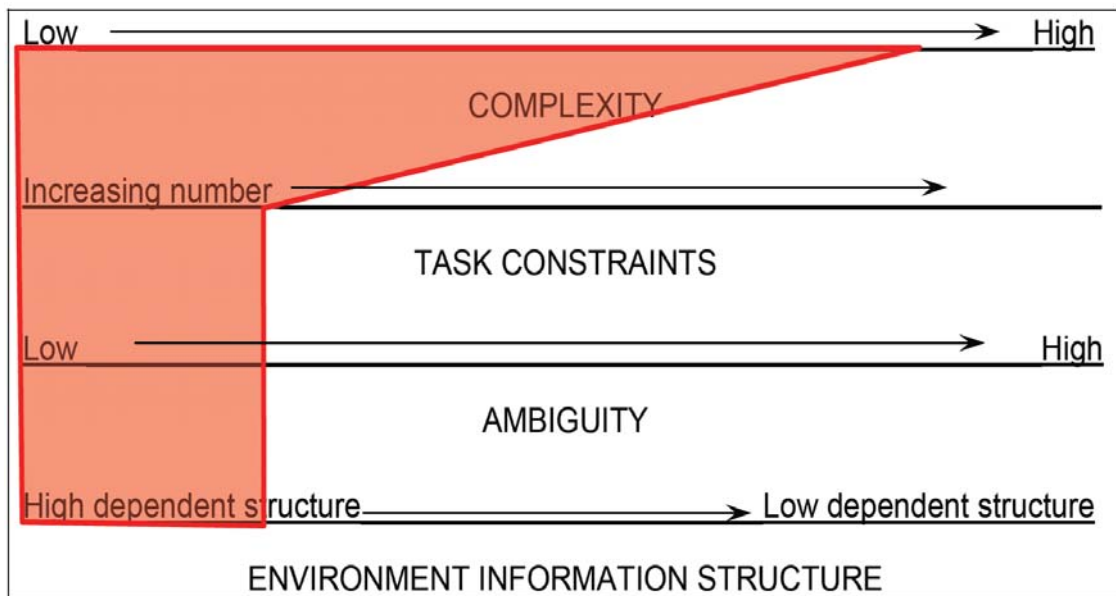
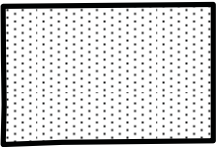
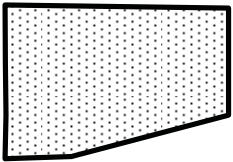
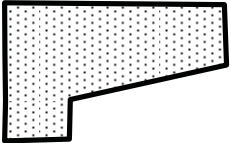
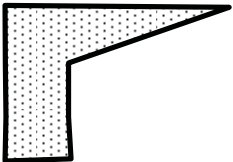
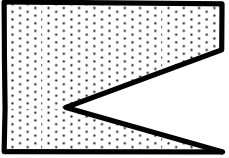


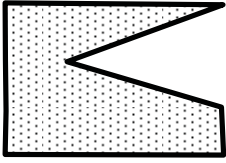
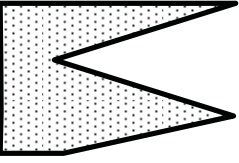
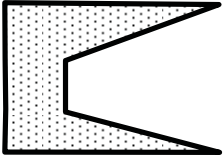
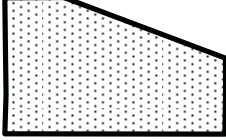
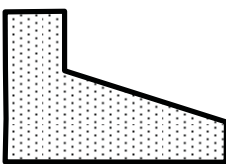
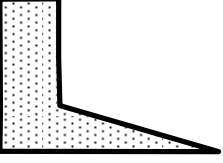
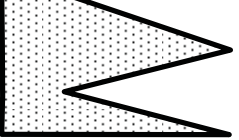
Figure 7.4 – Klein's Naturalistic Decision-Making for Emergencies

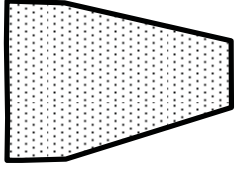
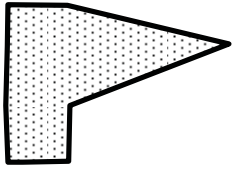
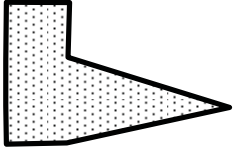
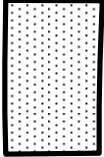
As each dimension of the taxonomy is a continuum the template allows for an infinite number of decision types. To make the use of the taxonomy as a conceptual tool more practical, however, sixteen primary decision types can be envisioned. These sixteen primary decision types occur when only the end points of the dimensions of the decision-making taxonomy are used in the characterisation. These are documented in Table 7.1. The table lists a name for each primary decision type, based on various tools – a reflection of the need to match appropriate tools to decision types. This is followed by a caricature of the

decision type obtained by plotting each on the decision-making taxonomy template. Key descriptors of the elements of the decision are then listed. And, finally, some example decisions from the upstream oil and gas industry which match the decision type are listed.

Table 7.1 – Summary of Primary Decision Types

Name	Shape	Description	Upstream O&G Examples
Block		High Complexity Multiple Constraints High Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Field development ▪ Future company strategy ▪ Company acquisition
Flag		High Complexity Multiple Constraints High Ambiguity High Dependency Structure	<ul style="list-style-type: none"> ▪ Near-field development ▪ One off changes to standard routines
Pennant		High Complexity Multiple Constraints Low Ambiguity High Dependency Structure	<ul style="list-style-type: none"> ▪ Block bid
Axe		High Complexity Single Constraint Low Ambiguity High Dependency Structure	<ul style="list-style-type: none"> ▪ Emergencies
Pliers		High Complexity Multiple Constraints Low Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Import drilling rig ▪ Tie exploration, development and marketing plans together

Clamp		High Complexity Single Constraint High Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ License award
Shears		High Complexity Single Constraint High Ambiguity High Dependency Structure	<ul style="list-style-type: none"> ▪ Staff recruitment ▪ Inter"silos" rewards ▪ Bid assessment
Crescent		High Complexity Single Constraint Low Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Budgetary cycles ▪ Permit bidding ▪ Company floats ▪ New technical IT ▪ Reserves
Fastback		Low Complexity Multiple Constraints High Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Implement new production system ▪ Change technical interpretations ▪ Job change
Boot		Low Complexity Single Constraint High Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Hire staff
Sock		Low Complexity Single Constraint Low Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ Data management
Clippers		Low Complexity Multiple Constraints Low Ambiguity Low Dependency Structure	<ul style="list-style-type: none"> ▪ New play follow-up ▪ Transfer staff ▪ Time allocation

<p>Funnel</p>		<p>Low Complexity Multiple Constraints High Ambiguity High Dependency Structure</p>	<ul style="list-style-type: none"> ▪ Expand production systems
<p>Pointer</p>		<p>Low Complexity Multiple Constraints Low Ambiguity High Dependency Structure</p>	<ul style="list-style-type: none"> ▪ Royalties ▪ Bureaucracies
<p>Hoe</p>		<p>Low Complexity Single Constraint High Ambiguity High Dependency Structure</p>	<ul style="list-style-type: none"> ▪ Implement new untested technologies
<p>Matchbox</p>		<p>Low Complexity Single Constraint Low Ambiguity High Dependency Structure</p>	<ul style="list-style-type: none"> ▪ Capital allocation ▪ Routine well workovers ▪ Inventory ranking

CHAPTER 8

PRESCRIPTIONS FOR GOOD DECISION-MAKING

8.1 INTRODUCTION

Having distilled a theoretical decision-making model (Chapter 3) and constructed a “real world” decision-making model for the oil and gas industry (Chapter 5), it is possible to compare and contrast these models to determine areas for improvement. This chapter will first look at what measures can be used to determine “goodness.” It will then review the two models looking at the similarities and differences, seeking to analyse, synthesise and evaluate them. The findings are then used to understand what changes can be prescribed for the way people in oil and gas companies make decisions.

Given the work is undertaken using a systems methodology, the first series of prescriptions deal with structural change. These range from organisational change to changes in functional responsibility – the static parts of the system. A second series of changes looks at the more dynamic parts of the system. These are the procedural prescriptions. Finally, as the study deals with a human activity system, prescriptions in attitudes are addressed. People act according to their attitudes and perceptions. Even though structural and procedural prescriptions may be implemented, unless people’s attitudes are also changed, little improvement may occur. Hence the discussion centres on what is feasible as well as what is desirable.

This chapter addresses the first theme of the research, that of decision process, hence the constructs imposed on the development of the “real world” model, those of seeing the model as a combination of all comments and not bringing to bear the concept of decision type, are also present in this chapter. The next chapter overlays the second theme of the research, that of decision type.

8.2 HYPOTHESIS ONE – upstream oil and gas companies should use processes that take into account the human aspects of decision-making in order to make “good” decisions.

Although the aim of decision-making is generally thought to be obvious, many times it is not always apparent. Decision-making under uncertainty literature is divided on what “good” decision-making is. This results from ambiguity about the definition of the word “good” (Bratvold et al., 2002). Normative decision-making, for example, has utility maximisation as its base assumption (Skinner, 1999). Theoretically, there is a solution to any decision that maximises utility. Hence the definition of “good” from a normative perspective would be if the decision process, if accurately implemented, yielded maximum utility. In a mathematical sense, this utility maximisation is generally considered as an optimisation problem. Hence, the objective of decision-making is often stated as optimising the expected value or utility of the decision.

On the other hand, the descriptive side of decision-making, in seeking to understand how people actually do make decisions, has determined that people are not optimisers – but rather satisficers, and they suffer from logic problems (Simon, 1956). Hence the definition of “good” from a descriptive decision-making perspective would be if the decision-maker achieved a satisfactory outcome. Stirling (2003) argues that optimisation, however, is simply “the mathematical instantiation of individual rationality.” He further asserts that in group decision-making it is not possible to simultaneously optimise the decisions of all individuals. He develops a normative set of equations that assume that “good” decision-making is that which satisfices. But his satisficing can be viewed essentially as constrained optimisation.

In this discussion several terms are used to indicate the aim. These terms include maximising, optimising and satisficing. The three terms do not refer to the same thing. In mathematics, maximisation is the process of finding the

maximum, either local or general, of a function. In classic economic theory, the stated aim of maximising utility lies in obtaining the absolute best theoretical answer. Optimising, although referring to the same principle in mathematics as maximising, is generally used to mean ‘the best or most favourable’ (Delbridge et al, 1990) and incorporates the fact that there may be constraints. Hence maximising may be viewed as optimising without constraints. The present usage of Simon’s term, satisficing, is to select the first option that meets minimum standards, as opposed to taking the time needed to choose the best possible option. These three terms describe a spectrum of results ranging from absolute theoretical best through to meeting minimum standards. Hence, when a decision maker says they want to make a good decision, what are they actually saying? Do they want to make a decision that maximises utility, optimises utility or satisfies utility? In this research project it is asserted that the aim of good decision-making is to optimise. The term is used in “the best or most favourable” sense. The question, then, is what is optimised? Table 8.1 summarises the three primary measures and their definitions.

Table 8.1 – Measures of “Goodness”

Measure of “Goodness”	Definition
Maximising	The very best answer theoretically possible
Optimising	The best or most favourable answer
Satisficing	The first option that meets minimum standards

As reviewed in section 3.2, whether a decision is good or not is often improperly judged by its outcome; but the outcome is not solely related to the decision. In the development of the theoretical model the assumption was made that the best decision was judged primarily on process, making sure that the most negative outcomes are insured against. Hence the measure of “good” decision-making is where 1) the process is optimised, 2) negative outcomes guarded against, and 3) positive outcomes are enhanced or captured.

8.3 “REAL WORLD” AND THEORETICAL MODELS

8.3.1 Similarities Between the Models

If the assumption is made that the theoretical model best describes optimal decision-making, then the more similar the two models are, the better the “real world” decision-making. Similarities between the two models exist at two levels:

- Macro structure
- Micro structure

The first observation that is made about the two models occurs at the macro level. Both have very similar structures. Each consists of an individual decision-making process followed by some form of approval process. This then leads to implementation, an outcome and some form of feedback. The advantage of having such similar structures is that it facilitates analysis. If the two models had very disparate structures, much of the review would be focussed on why they were so different. Whereas, in this case, because the structures are so similar, the review can be centred on what may be called fine tuning highlighted by differences.

Even at the next level down, the individual process level, the models are still fairly similar. The ideas of frames, objectives, alternatives, modelling and assessing are all present. What adds more to the similarity is that the order of the phases is also very similar. This is very positive because it allows each stage of the individual process to be compared to determine how and where to make changes.

Several reasons for such similarity may exist. Firstly it could be that the interviewees simply responded the way the literature says they should and therefore any “real world” model is simply a copy of the theoretical model. This reason does not appear to be the case, in this instance, because

there are sufficient differences as to imply that the participants did not refer to the literature as their guide.

Deeper inspection shows that the models themselves, were built in a very similar fashion and that this may be why they are similar. The “real world” model is distilled from the various interviews and is built from a series of “good ideas,” or “real world” practises. In other words, it is what is built when all the elements of an oil and gas decision-making process are added. The model is not what is common to all those interviewed but rather is a piecing together of all the various practises. The theoretical model is similarly built from three primary models. The foundation consists of the three elements of a decision outcome; the decision, the implementation and chance. The decision is then subdivided into two processes; an individual decision-making process and a hierarchical approval process. The model is developed from difference sources. No one process or model fully described the situation.

Based on the type and breadth of data obtained during the interviews both reasons appear to be unlikely in this instance. Therefore, the similarities are present because they are valid or real. These similarities show, therefore, that “real world” experience at the macro level aptly follows the theoretical model.

8.3.2 Differences Between the Models

The models can differ in two ways and both lead to suboptimality. Firstly, elements present in the “real world” model may be absent in the theoretical model. The addition of “extras” to the decision-making process means that either the theory has not been fully tested and expanded or that people like doing more than is theoretically necessary for optimal decisions.

Secondly, elements of the theoretical model may be absent from the “real world” model. Again if optimality is assumed to exist in the theoretical model then if any elements of the theoretical model are absent in the way people actually make decisions, may lead to suboptimal decision-making.

Both types of differences between the two models exist at the micro structural level in several areas:

- Elements of process
- Key influences
- Linkage between the individual decision-making process and the hierarchical approval process
- Defining aims, frames and objectives
- Criteria within the hierarchical approval process
- Implementation of the individual decision-making process
- Application of portfolio management

The first series of differences deals with elements of the processes that are present in the “real world” model but absent in the theoretical model. Such differences can be ascribed to practicalities seen by the “real world” participants that are overlooked within theoretical frameworks. Or they can be seen a cultural additions that yield no real benefit. The real question, therefore, is whether these differences add to the quality of the decision or whether they are like cognitive heuristics, used to simplify the decision but subject to suboptimality. The differences include the various influences on the individual decision-making process, the relationship between peer reviews and approval reviews, and finally the predefinition of aims, objectives and frames.

Within the individual decision-making process the “real world” model has four key influences, namely, modifying constraints, debiasing, “fit-for-purpose” tools and volunteer peer review. These influences are not

explicitly named within the theoretical model. A key observation from the semi-structured interviews is that the participants, by and large, talked about these influences more than they did the actual basic elements of the process, namely, framing, modelling and assessing. Each of the influences can have a critical impact on the decision depending on how they are recognised and the modifications implemented. A good example is the idea of debiasing. Within the normative economic model there is no recognition of cognitive bias. This, in part, lead to the development of the behavioural economic models and associated research (Kahneman et al., 1982). Raising the awareness level of the biases that may be present is intended to assist in modifying decision-making and increase the likelihood of more positive outcomes (Welsh et al., 2006). The same is true for each of the other influences.

The concept of constraints modifying the way the decision is made is integral to the primary research theme of decision type. Constraints form a significant dimension of the taxonomy and therefore greatly modify the way the decision process should be formed. This is the central discussion point of Chapter 9.

The idea of what tools to use in what part of the decision process has been addressed by several researchers (Jonkman et al., 2000; Lamb et al., 1999; Macmillan, 2000; Simpson et al., 2000). What is interesting in the “real world” model is that the participants believed that the higher level tools, advocated by these researchers, were not necessary at the lower levels of decisions sometimes addressed by oil and gas companies. This idea, advocated by the participants, is that decision-making tools should be tailored to match the decision type. The interviews point to oil and gas personnel using tools in a “fit-for-purpose” fashion and the concept of tailoring is therefore advocated strongly from a pragmatic perspective. The research of Simpson et al. (2000) has demonstrated a statistical link

between the use of higher level tools and company performance. Their work, however, did not look at whether the same higher level tools are necessary for all types of decisions because it viewed all decisions as being the same. Which tools should be used for which decision types is also discussed in more detail in Chapter 9.

In the “real world” model, the arrow that links the individual decision-making process with the hierarchical approval process is, essentially, some form of review. In the model it is seen as a management imposed approval review. One of the primary ideas developed by many of the participants in the interviews was that such a review should not be confused with a peer review. Voluntary peer reviews are seen as extremely beneficial. The root of the benefit lies in the idea that “two heads are better than one.” And this is especially true if the other head understands the situation and is a respected peer. Voluntary peer reviews, or brainstorming, can and should occur throughout the entire decision-making process; both during the individual process and the approval process. There should, however, never be the actual linkage between the two processes. A management-imposed review is a formal recommendation and approval process. By this time all ideas are solidified and defence is the principle aim, whereas a voluntary peer review occurs prior to any solidification of ideas and therefore assists in expanding possibilities, fostering optimisation.

Within the theoretical model the aim, frame and objectives are understood to be determined by the decision-maker(s), who act on behalf of their organisation. In the “real world” model, however, the participants argue that, in their minds, better decision-making will occur within companies if the companies predefine some or all of these critical elements. In much of the literature on why decisions fail (Hammond et al., 2002; Nutt, 2002; Russo and Schoemaker, 1989, 2002), one of the key themes is that

people spend a great amount of time and effort on solving the wrong problem. It is difficult to determine what the correct problem is ahead of any outcome, especially when the outcome is subject to uncertainty. However, those who were interviewed clearly resonated with the idea that the aim and objectives should be predefined by the corporation and should be those of the owners. Thus, whenever a situation arises where a decision needs to be made, the decision maker already knows the aims of the corporation and frames the decision within those aims and objectives. In some areas this is general practise within oil and gas companies. For example, most companies have a predefined “hurdle rate” used for all decisions and often this is varied as part of the assessing stage of the individual decision-making process. Having this predefined objective simplifies framing of the decision and usually yields more optimal decisions. On the other hand, many of the more complex decisions being made by oil and gas companies are being made without such disclosed aims and objectives. The frame, then, that is used to make the decision could be flawed.

In seeking to answer whether these differences are “good” or “bad,” a review of the participants’ discussions in their interviews leads to the conclusion that because of good outcomes the above mentioned elements or, what may be termed, extras, are inclusions in the decision-making process that will lead to optimisation.

The second set of differences relates to elements of the process that are present in the theoretical model but absent in the “real world” model. These include the approval feedback loop, the various criteria relating to approval, the lack of portfolio management and in a general sense the absence of the framing stage. One way of seeing such differences would indicate that either the practice of decision-making is not fully developed or understood – short cuts are being institutionalised – or that decision

theorists have not tested their theories fully in the “real world.” A second, and more preferred interpretation, is that because decision makers are not fully cognisant of all decision theories their practical implementation of the decision-making process is suboptimal.

Even though those being interviewed saw feedback as critical to improving the decision-making culture within their companies, not one mentioned feedback on the actual approval process. The feedback that was spoken about related to how the decision was implemented and the actual outcome of the decision. The theoretical model has three primary feedback loops, the implementation feedback loop, the decision feedback loop and the approval feedback loop. If there is no way to give feedback on the approval process most employees will feel trapped by something they have no control over. This is strongly expressed in some of the interviews when timing of approval is seen as frustrating. If there was a method to acknowledge and alleviate this frustration, the overall success of the process would be improved. It is therefore recommended that more communication of the steps within the approval process be undertaken, especially from the approval groups within the organisation.

A second difference also occurs in the approval process. In the “real world” model, approval is centred on the trust value. This is either trust in the individual making the recommendation and or trust in the process of recommendation. In the theoretical model, however, several criteria are used for approval. Those that are noted as being the most critical are:

- staff validity, that is, how much information the team has to make the decision and have it approved
- team informity, which relates, in part, to the trust heuristic used in the “real world”; and finally

- hierarchical sensitivity, which is the ability the whole team, not the leader, has to weigh their various input to make the final approved decision.

Comparison of the “real world” and theoretical models shows that there are two criteria that are not being used in the “real world.” Theoretical experiments (Hollenbeck et al., 1995) have shown that up to 64% accuracy can be predicted on decision outcome when all three criteria are used. Whereas if just team informity (or trust) is used this drops to 24%. Even though this research is primarily done using decisions that are not subject to uncertainty, it is asserted that it would be beneficial for “real world” decision-making under uncertainty models. These models should be expanded to allow for all criteria to be used as part of the approval process. Some form of team involvement in the actual approval process, rather than just leaving it to the leader, should see more optimal decisions being made. As to the question of staff validity, the introduction or expanded use of value of information techniques should also lead to improvement. If the amount of information needed to make the decision is actually discussed and agreed in the very early stages of the process then objectives become clearer and outcomes more successful.

One of the most obvious differences between the two models is the distinct lack of portfolio management in the “real world.” The theory of portfolio management argues that risk and uncertainty can be decreased as individual projects are viewed as part of a holistic portfolio. Determining “good” decisions for individual projects is related more to the change in the portfolio outcomes than to the individual project metrics. The projects are not independent of each other. All projects in the upstream oil and gas industry have dependencies between them. Not recognising these results in suboptimality (Al-Harthy et al., 2006). The lack of use of portfolio management may be linked to the newness of the methodology – it has only really been used successfully over the last 5

years. As such it is recommended that the process be more widely adopted and adapted within the industry.

The final difference deals with the way the individual decision-making process is implemented in the “real world.” Most interview participants demonstrate that the framing stage of the process is left out. The decision makers appear to jump straight to the modelling stage. This may occur for several reasons. Firstly, the oil and gas decision maker is more adept at modelling – they come from a modelling world, being geologists, geophysicists or engineers – and therefore they do what they do best – modelling – and leave out what they do not do well – framing. Another explanation may be that because the oil and gas industry focuses on outcome, shortcuts are believed important. Many participants discussed the need for companies to predefine the framing stage. This may indicate that they, as decision makers, believe that the frame is defined and therefore jump right into the modelling without determining if the frame has been defined as they assumed. Whatever the reason the behavioural observation is that most decision makers leave out the framing stage and therefore the risk is extremely high that they are solving the wrong problem(s).

8.4 POSSIBLE CHANGES

There are three areas where change in a system that involves humans can be enacted. The first two really deal with the systems themselves. These are the systems the humans use to achieve the outcome. In the current context these are the decision-making processes. Changes at this level can be either static, that is, they deal with the procedural aspects of the system, or they can be dynamic, that is, they deal with the functional aspects of the process. Simply because these changes are desirable does not make them implementable. This is where the third area of change becomes important. When dealing with

systems that interface with humans, people's attitudes are vitally important if change is to be enacted. People act according to their attitudes and perceptions are usually created by rewards and penalties. Even though structural and procedural prescriptions may be desirable, unless people's attitudes are also changed, little improvement in decision-making may occur.

8.4.1 What is Systematically Desirable? – Static (procedural) and Dynamic (functional) Changes

Based on the interview analysis several modifiers were added to the individual decision-making process. These include debiasing, "fit-for-purpose" tools, modifying constraints and peer review. The first series of recommended changes, therefore, relate to these modifiers. The actual decision-making process should be a prescribed workflow, which, apart from the basic elements of framing, modelling and assessing, has place for each of the modifiers.

Cognitive debiasing has been the subject of some research and recommendation (Welsh et al., 2006; Welsh et al., 2005). Essentially it has been shown that if decision makers recognise that they are susceptible to cognitive bias, they can form standardised ways of removing, or at least allowing for, the bias in their judgements. Hence, from a procedural perspective, it is important that decision-makers undertake such training programs and then that they be alert to their bias. Functionally, the best prescription is that decision-makers regularly participate in feedback learning cycles or loops that help show what level of bias may be present in past decisions so that improvement can occur into the future (Johns et al., 1998). It is therefore recommended that a procedure be put in place in the decision-making process that allows for regular look backs.

Technical debiasing has also received some review. The most successful methodology is reality checking. This is where the geotechnical and

economic parameters are reviewed against statistical expectations looking for exceptions. Research has shown that this is more powerful in improving decision-making than cognitive debiasing (Rose, 1985; 1987; Johns et al., 1998; Citron et al., 2002).

“Fit-for-purpose” tools have not been researched as much as debiasing. In fact, as has been previously discussed, current research (Jonkman et al., 2000; Macmillan, 2000; Simpson et al., 2000) recommends using the highest level risk analysis tools, such as, portfolio analysis, option theory, preference or utility theory, as well as quantitative and qualitative analysis for optimal decision-making. There is an underlying assumption that these tools be used no matter what type of decisions is being made. “Fit-for-purpose” is not so much a technology but rather awareness that the decision maker’s analytical efforts should be commensurate with the importance of the business question at hand.

One of the unique findings of this research has been the recognition by decision makers that optimal decisions may be made by tailoring tools to meet the decision type. The interviews also revealed that the ability to decide on what tools are “fit-for-purpose” is related to the experience of the decision maker. Hence not only must the type of decision be understood but also the experience of the decision maker. It is therefore recommended that a procedure for typing decisions be first put in place and then decision makers can assess their experience in such decisions prior to deciding on what tools are used for the decision.

As discussed previously, constraints form a major part of the taxonomy by which decisions are typed. The other three dimensions are complexity, ambiguity and information environment. Prescriptions that deal with the changes in taxonomy are discussed in Chapter 9.

Much has been discussed about peer reviews. The critical point raised by this research is that such reviews should be voluntary and initiated by the decision maker. What is prescribed is that such reviews should exist and should take place long before the decision is solidified. A peer is seen as the equivalent, in terms of experience and profession, as the decision maker. Voluntarily asking such a person to review and comment on work to date allows the decision maker to be made aware of factors that may not have been considered or some that have been given too much emphasis, prior to actually forming their decision. The interviewees also expressed the need for “experienced eyes” to be cast over the decision. Too often this experience is seen as being given during the actual approval process. This, however, is not what is required to facilitate better decisions. The idea would be to have the experience brought to bear prior to the solidification of the decision. It is recommended that the idea of what may be termed, mentoring reviews, should also be canvassed. Mentors are seen as having more experience than peers and not part of the approval process. Therefore they can bring extra experience to bear on the decision-making process. As with peer reviews, however, it is critical that mentors and their input is voluntarily called for by the decision maker and not imposed by management. This is because such imposition may be interpreted by the decision maker as a lack of trust on the part of management. Procedurally, then, the decision-making process should call for peer and or mentor reviews whilst the decision is being framed, modelled and assessed. From a functional point of view, how peer and or mentor reviews are conducted should be left to the decision maker so that the decision maker gets the optimal response in ideas and personal assurance of management confidence. This could range from impromptu requests through to full day workshops. The key elements of the reviews are their voluntary nature and that they occur far enough before the decision is made to allow changes to be made.

The next area of prescription deals with the inclusion of an approval feedback loop in the decision-making process. Such feedback is not now present in most oil and gas decision-making processes. This feedback is centred specifically on the actual approval process and not on the decision and or the implementation feedbacks that are reported as already being part of the current process. In order to review an approval process it is first critical that such a process is documented. Hence the procedural part of the prescription calls for a decisions approval mechanism to be documented. This documentation should include discussion of why the decision was or was not approved and specifically define the process used for the approval. It would be beneficial if the documentation were both quantitative and qualitative. Such quantification facilitates objective feedback. This feedback is seen as being more beneficial for those decisions that have more than one cycle up the hierarchy. Many of the interviewees expressed concern that they were “left out of the loop” or frustration at “the time it takes” to receive approval whenever the approval process moved higher up the approval hierarchy. Both these feelings would be counteracted by clear and concise documentation of the entire approval process. Thus, functionally, if the approvers (decision takers) are not totally removed from the original proposers (decision makers) better decision-making may occur.

One of the key mismatches, that leads to suboptimal decision-making in the oil and gas industry, is that people not organisations make decisions, unless the organisation makes extremely clear its frames – aims and objectives – employees can easily substitute their personal aims, objectives and preferences instead. Hence one further addition to the decision-making process that should be prescribed is the need for the organisation to predefine the aims and objectives. From a functional perspective, this can be monitored on an ongoing basis to determine if the aims and objectives are clearly understood and implemented.

The final prescription area deals with the criteria used to approve a recommendation (decision). Currently, in the “real world,” trust is used as the primary determinant. Theoretical research, however, has shown that in order to achieve more optimal decisions, two other criteria need to be added. The first deals with how much information the team presents in order to have the recommendation approved, whilst the second relates to the ability of the whole team, not the leader, to weigh their various inputs to make the final approved decision. Approval of an individual project should also be reviewed within a holistic portfolio context so that dependencies and the resulting changes in risk and uncertainty to the entire portfolio are more clearly understood. From a procedural perspective, then, it is recommended that as part of the addition of approval documentation all three criteria be discussed and documented together with the implementation of portfolio optimisation.

Another procedure that can be prescribed is the implementation of regular value of information analysis to determine the value of data required in the approval process. Functionally, there is large scope for implementation of such a prescription. Virtually all approvals in the oil and gas industry are made hierarchically. Yet theory has shown that the more the team has the ability to weigh all aspects of the decision input (rather than just the leader), the better the decision will be. Further research is warranted that reviews research on consensus teams and how they make decisions (see Davis, 1973, 1992; Steiner, 1974; 1983) to determine its applicability to this function.

8.4.2 What is Culturally Feasible? – Attitudinal Changes

With several changes recommended for the improvement of the decision-making process, the most vital or critical issue lies in how to have such changes accepted. Just because a process is reengineered does not

mean that it will be accepted and implemented by people. For example Welsh et al. (2006) showed that even education on biases loses its effect after time. The greatest change occurs early after the education but the improvement in decision-making lapses back to what may be seen as an entropy state that is less than optimal.

Virtually all researchers into improving decision-making (Gigerenzer et al., 1999; Hammond et al., 2002; Kahneman et al., 1982; Nutt, 2002; Russo and Schoemaker, 2002) state that better decisions can be made if decision-making processes are improved. The present research supports these conclusions. However the real question is how this can be implemented within a human system. People rarely continue to do something just because it is “good.” Hence there is a need to encourage the adoption of the recommended prescriptions so that the changes are enacted and continued.

In the oil and gas industry, most employees are rewarded with bonuses based on decision outcomes and not decision processes. Part of section 3.2 (see Table 3.1) discusses the improvement in outcome over the long run, with the separation of process and outcome and the employment of good decision-making processes (Bratvold et al., 2002). Relating this to the oil and gas industry, it is essential to understand that most of the “major” decisions in the industry will not have known outcomes for many years. Hence industry-based rewards, which reward interim outcome, run the risk of rewarding “dumb luck” or penalising “bad breaks”.

In order to implement the recommendations discussed thus far, it is recommended that a final change be enacted. This change would be that people are rewarded for applying a defined decision-making process by removing the penalties associated with bad outcomes. It is recognised that in oil and gas companies overall success is measured in terms of

share price (an outcome). However, it has also been argued that, where uncertainty is involved, decision process is the best measure of decision quality “in the long run.” It is argued that if this change is implemented then the attitudes towards decision-making will also change for the better because people will be focussed on the process but not to the extent of blindly following a process because they are told to, or incentivised to. It will thus be easier to implement the other changes because they form part of the process. It is also recognised that rewarding outcome is actually a motivational activity and that its removal may result in removing motivation and actually result in deterring risk taking. To overcome this possibility it is also recommended that successful outcomes be celebrated by the team.

8.5 PRESCRIPTIONS FOR GOOD DECISION-MAKING

Based on the forgoing discussions, several prescriptions have been enunciated and critiqued, and are now recommended. They are highlighted as dot points. The prescriptions are listed in three levels of improvement priority – three ticks being the highest priority through to one tick being the lowest priority. It is strongly recommended that all prescriptions be implemented over time. The priority relates to the order of implementation and is assessed based on analysis of the level of response from the interviewees and other researchers.

- ✓✓✓ That rewards for adhering to decision-making processes be implemented, penalties based on outcomes be removed and that instead of rewarding outcome it should be celebrated by the team.

- ✓✓✓ That peer or mentor reviews form part of the decision-making process and that such reviews be voluntary and initiated by the decision maker early in the decision-making process. They can range, in style, from impromptu requests through to full day workshops.

- ✓✓✓ That reality or plausibility checks be used routinely to debias technical and / or economic estimates in decision-making.
- ✓✓ That the actual decision-making process be a prescribed workflow, which, includes the basic elements of framing, modelling and assessing, as well as debiasing, “fit-for-purpose” tools, modifying constraints and peer review.
- ✓✓ That the approval process be documented and that a learning cycle be implemented that deals specifically with the hierarchical approval process. The documentation is both quantitative and qualitative and should be within the context of portfolio optimisation.
- ✓✓ That decision makers undertake training programs that alert them to possible biases. As well as face-to-face formal training this best occurs through feedback loops that help show how to separate the bias from the chance factor in past decisions so that improvement can occur into the future.
- ✓ That the organisation predefines its aims and objectives in order that the employees can act as agents of the organisation and not as individuals.
- ✓ That mechanisms be found to facilitate using value of information analysis, “options thinking” or value of flexibility as part of the approval process in order to determine what data is needed for the approval of decisions.
- ✓ That further research is made into how consensus teams allow team members to weight the value of their input into the final decision approval.

8.6 SUMMARY

This chapter has compared and contrasted the “real world” and theoretical decision-making models and has found areas for further improvement in oil and gas decision-making processes. Review of the similarities and differences has resulted in several prescriptive changes to decision-making processes which are aimed at optimising oil and gas decisions. The impact of separating decisions into their various types and a review of whether companies actually do what they say they do on these prescriptions is analysed and discussed in Chapter 9.

CHAPTER 9

PROCESSES USED IN THE “REAL WORLD” FOR DECISION TYPES

9.1 INTRODUCTION

The “real world” (Chapter 5) and theoretical (Chapter 3) models of decision-making that may be applicable for the oil and gas industry, focussed primarily on decision processes. As well as having a primary research theme centred on decision processes in human decision-making in the oil and gas industry, this research also addresses a second theme, that of categorising decisions according to their type. It is important, therefore, to review the interaction between the two research themes – decision process and decision type in order to uncover further prescriptions for good decision-making. This is undertaken using data collected from the semi-structured interviews in the form of case study analysis.

In addition to yielding general information and data on decision process, each interview also resulted in one or more case studies for analysis; an individual case study is deemed to be the discussion of a single, unique decision made by the participant. This was either from interviewees’ own experience or a discussion of one or two of the 20 decision scenarios used for the taxonomy development (Chapter 6). Where the discussion centred on one of the decision scenarios, these scenarios were presented to the participant on full page “flash cards” so the participant could have continual visual prompting whilst discussing the decision. 39 case studies were obtained from the 31 interviews. 13 of the 16 primary decision types were discussed by the interviewees (Table 9.1). In some instances only one case study for a decision type was obtained (for example, Pennant and Clamp Types described in Chapter 8) whilst at the other end of the spectrum, 11 case studies were obtained for one particular decision type (Block Type). In most instances, however, 2 or 3 case studies were obtained for the primary decision type. The number of case studies for each decision type is thought to reflect the percentage of decisions of that specific type within the oil and gas industry context. The block-type decision is the most difficult to make of all the decision types. The higher number of case studies for this type reflects

the level of difficulty in oil and gas decisions, due to uncertainty. On the other hand, no cases were discussed for two types (Flag and Hoe Types). This is not because these decision types are not realistic within an oil and gas context; there are oil and gas decision scenarios that can be invoked for these types (see Table 7.1); but it is more likely that there are simply less of them in the industry. All 39 case studies, summarised in terms of the primary decision type together with the “real world” processes used to make the decision by the participant, are listed in Appendix 12 and form the basic data used for this chapter.

Table 9.1 – Number of Decision Types Discussed
(colours relate to the process used – see Section 9.3)

Primary Decision Type	Number of Case Studies
Block	11
Flag	0
Pennant	1
Axe	3
Pliers	3
Clamp	1
Shears	3
Crescent	3
Fastback	1
Boot	2
Sock	1
Clippers	3
Funnel	3
Pointer	1
Hoe	0
Matchbox	3

9.2 HYPOTHESIS TWO – Decision Process is Tailored to Decision Type

Having established a methodology to determine decision type (Chapter 6 and 7) together with “real world” and theoretical models of decision-making in the oil and gas industry (Chapters 3, 5 and 8), it is now possible to determine what influence decision type has on decision process.

The basis for the hypothesis comes from outside the oil and gas industry. Nutt (2001) made a simple observation. From his database of strategic decisions he empirically derived nine decision types. He then linked his decision types with tactics which best suited that type. Finally he demonstrated that the type/tactic interaction directly related to the success of the decision. Uses of a good tactic but on the wrong decision type inevitably led to failure, whereas use of the same tactic on another decision type resulted in the greatest chance of success. Simply stated, if decision type is matched with an appropriate decision tactic, better decisions result.

Restating this concept for the “real world” of oil and gas decision-making – when decision-making processes are tailored to the type of decision, optimised decision-making will result or, in other words, higher levels of congruent process promote better outcomes.

This observation has clear parallels with the ideas presented by Simon (1990) who argues that non-rationality in decision-making is contributed to not just by our internal characteristics or computational capabilities but also by the external environment – that is, the information structure of the environment in which the decision is being made. He summarised these findings using an analogy of a pair of scissors.

“Human rational behaviour . . . is shaped like a pair of scissors whose two blades are the structure of the task

environments and the computational capabilities of the actor.” (Simon, 1990, p 15)

The idea that decision process should be tailored according to decision type is conceptually linked with Simon's satisficing scissors. Two components are necessary in order for optimised decision-making to occur – decision type and decision process. Just as scissors need to have both blades engaged in order to work effectively, so too optimised decision-making requires the tailoring of decision process to decision type (Figure 9.1). This tailoring of decision-making processes to decision type will, necessarily, have to be undertaken in a conscious and justifiable way.

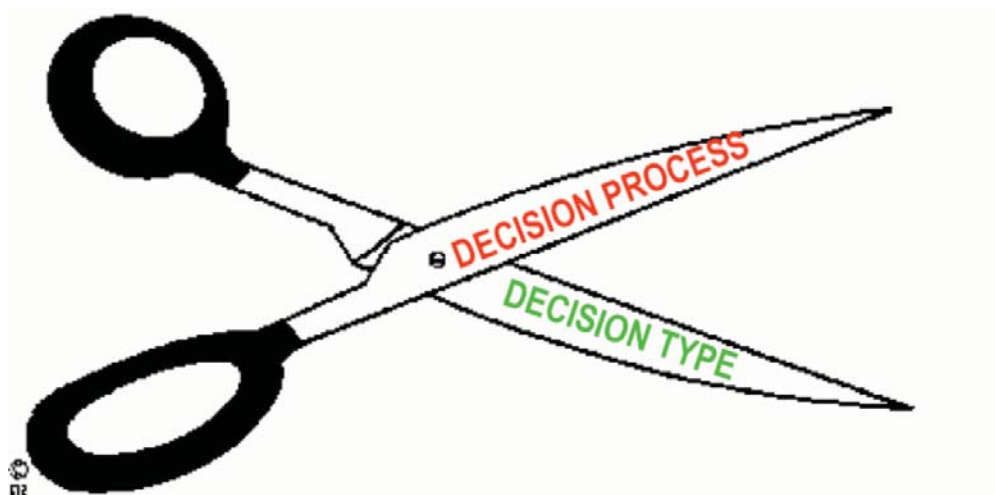


Figure 9.1 – Tailoring Decision Process to Decision Type

The first step towards better understanding the linkage between decision-making process and decision type is to determine if individuals in the “real world” do tailor their decision-making processes to the decision type. If they do, are there unique processes for each decision type? How are the decision-making processes modified for each type? The vast majority of the case studies analysed are hypothetical – they describe hypothetical scenarios. Therefore no actual outcomes exist for these cases. They become excellent points of observation to answer these questions.

9.3 CASE STUDY ANALYSIS

Looking back to the discussion of decision type in the interviews (Section 5.3.2), the concept was new to most participants. Although most intuitively understood that there are different types of decisions, they also found it difficult to separate and define these diverse kinds of decisions. It is important to note, however, that the participants also intuitively understood that they would not use the same tools and processes on the different types of decisions – whatever these types were. Hence within the “real world” of oil and gas decision-making there is a basic understanding that all decisions are not the same and that the processes used to make the decision will not be the same but few could define this more precisely. This is born out strongly by the 39 case studies. Very few followed one single process to make their decisions.

In developing a “real world” decision-making model (Figure 5.5) it would be, thus, incorrect to say that each participant followed every item within the final model. The model is distilled using all the available data from the semi structured interviews. If the individual steps within this model are reviewed for each case study discussed in the interviews it becomes obvious that even the “real world” model is not completely honoured in each case.

Given there is no “*one size fits all solution*” (*L*) perhaps the next question that needs to be addressed relates to whether the interviewees use a specific decision process for the various decision types. Appendix 12 lays out the case studies in a matrix of the decision type, as represented by its caricature, together with a brief discussion of how the interviewee undertook the various key steps of the individual or core decision-making process, as defined in the “real world” model. The hierarchical approval process is not listed in Appendix 12 because it is seen to be constant within all the interviews. The approval process is dictated by whatever “delegation of authority” process the company has set up.

Table 9.1 is a listing of the number of case studies conforming to each of the 16 archetypal decision types identified in Chapter 7. It is assumed that any less than 3 case studies per type would not be representative of the processes used. There are 8 primary decision types where 3 or more case studies have been collected. 4 of the 8 are undertaken by the interviewees using a **single** decision-making **process**, which is unique to each type. 3 are embarked on using **differing** decision-making **processes** with some elements of the process in common. Finally, decisions made for 1 decision type are taken using two diametrically opposed or **polarised** decision-making **processes**. Each of these decision types will now be discussed in terms of the decision taxonomy and the process used to make the decision.

9.3.1 Single Process

Axe – Close examination of the three case studies conforming to this primary decision type revealed that the participants used a single process to make the decision. The decision type is characterised (Figure 9.2) as being highly complex. By and large the most critical task constraint is time, constraints are therefore low. However there may also be resource and personnel management factors to be considered. Ambiguity is generally quite low. Generally a single value objective will predominate. Finally, the decisions are made in high dependency environments. They rely on the decision maker recognising the key attributes of a situation and applying known solutions. That is, additional data is unlikely to alter the decision to be made, so the decision makers tend not to spend time searching for a variety of alternatives, instead relying on their pre-existing domain knowledge. It could also be that if the decision maker spent too much time in the search, the outcome would be “bad.” All participants undertook these decisions using Klein’s Recognition-Primed Decision Model or Naturalistic Decision-Making (Figure 9.3). Although it should be noted that, while they used this model, none of the participants was aware that such a model existed. The Recognition-Primed Model is outcome-

focused because a successful outcome is the measure, according to Klein, as to whether the decision was successful. In the interviews the decision scenarios used were all theoretical and so no outcome can be used to determine success. It is equally important, however, to see that the model is also a good example of process-driven decision-making. Klein argues that the key to success in Naturalistic Decision-Making lies in the expertise of the decision maker. If the process were used by a less experienced decision maker, non-optimal outcomes would almost certainly result. In the oil and gas industry, decisions that require experienced decision makers and involve time pressure, high stakes and inadequate information are generally those associated with operational emergencies. When faced with decisions of this type, if Klein's recognition-primed decision model is used as the decision-making process, optimised decision-making should result. It is, therefore, critical to have experts on hand during projects that are subject to this type of emergency. This is an excellent example of where the decision process is tailored to the decision type.

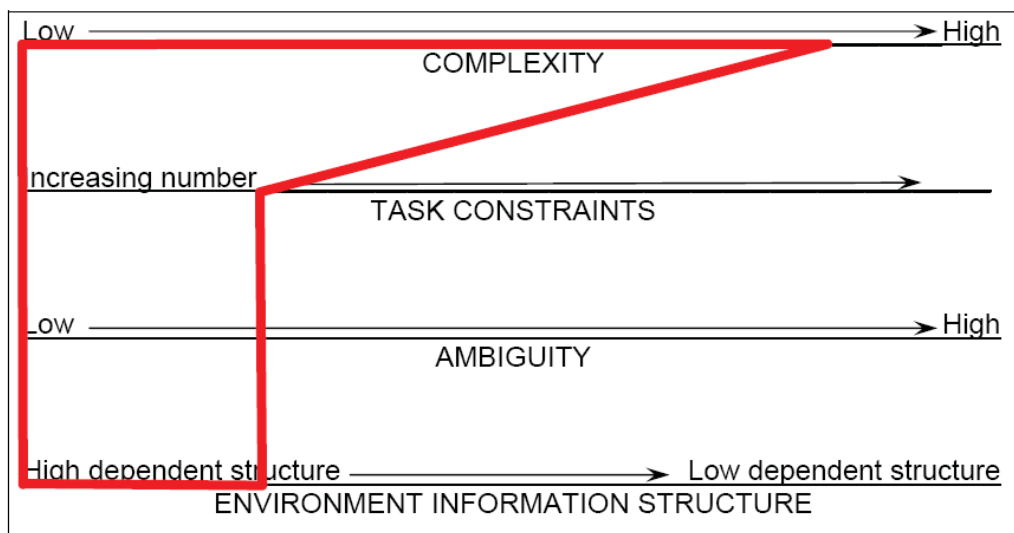


Figure 9.2 – Characterisation of Axe-Type Decision

NOTE:

This figure is included on page 187 of the print copy of the thesis held in the University of Adelaide Library.

Figure 9.3 – Klein’s Recognition-Primed Decision Model
– Naturalistic Decision-Making (Klein, 1998, p. 91)

Funnel – Three case studies relate to the funnel decision type. These types of decisions are characterised as being less complex in nature but having many constraints and needing to be made with multiple objectives, thus leading to high ambiguity. Like the axe-type decisions they also are made in high-dependency environments (Figure 9.4). These types of situations rely on the decision maker recognising the key attributes of a situation and applying known solutions. The participants who discuss this decision type all respond with a very similar decision-making process that can be mapped as shown in Figure 9.5. This process centres on group discussion. In framing the decision, the participants seek to investigate the situation by discussing it with others. If, however, the decision-maker

is experienced in the field they appear likely to simply “jump to” a conclusion and immediately start implementing it. Of the case studies discussed none explicitly set objectives or uncovered alternatives. There was no modelling of various alternatives or any sensitivity analysis. Finally, no learning feedback seems to occur either. In other words the decisions simply consist of getting together and discussing the problem situation with others and finding a solution during that discussion. As the environment is highly dependent the discussion will be focussed on finding a similar situation from the past and implementing that course of action.

The funnel decision type therefore differs from the axe-type decision in that in the funnel-type more people are involved in making the decision. It also differs because of the greater number of constraints and higher ambiguity. The observations that the decision type involves greater constraints and ambiguity, and that more people are used to make the decision, has not been shown to be causal but it is true for each case study. However it can be argued that because the information required to make the decision exists in a highly dependent environment, having more people involved will more likely lead to finding a previous situation that had a successful outcome. Of course, this can only occur if the people involved in the discussion have sufficient experience to bring to the table such previous situations. In the oil and gas industry these types of decisions appear to revolve around expanding or building on previously made decisions, for example, the decision of whether to and how to expand a production system.

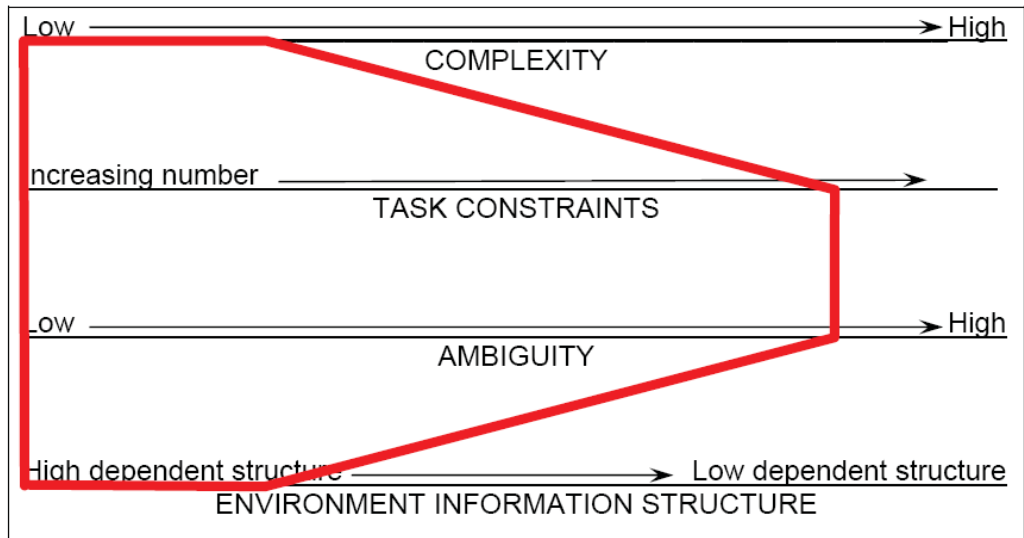


Figure 9.4 – Characterisation of Funnel-Type Decision

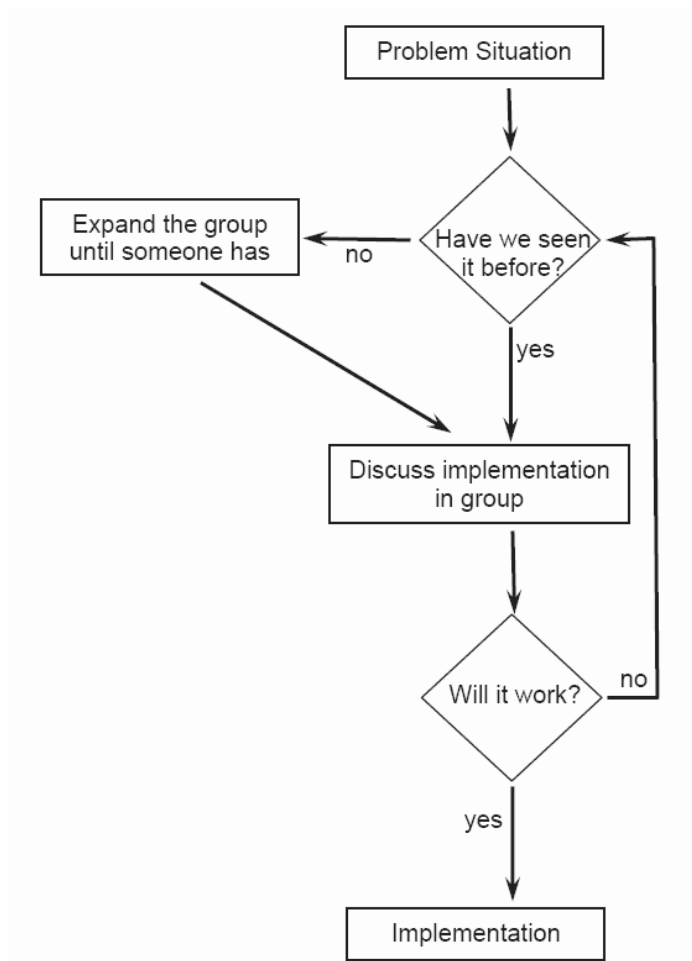


Figure 9.5 – Funnel-Type Decision-Making Process

Matchbox – this primary decision type is characterised by low complexity, little constraints, one value function and a highly dependent environment of information structure (Figure 9.6). It could be said to be the simplest of all the primary decision type. The interviews give 3 case studies of this type. They reveal that the participants see that in these cases the framing and objectives have already been defined or are known. The modelling phase is undertaken by a simple ranking system being set up. This is based on the known frame and objectives. Finally the decision is made according to the ranking. No sensitivity or feedback is discussed by any participant (Figure 9.7). Examples from the oil and gas industry of this type of decision were inventory ranking and routine workovers.

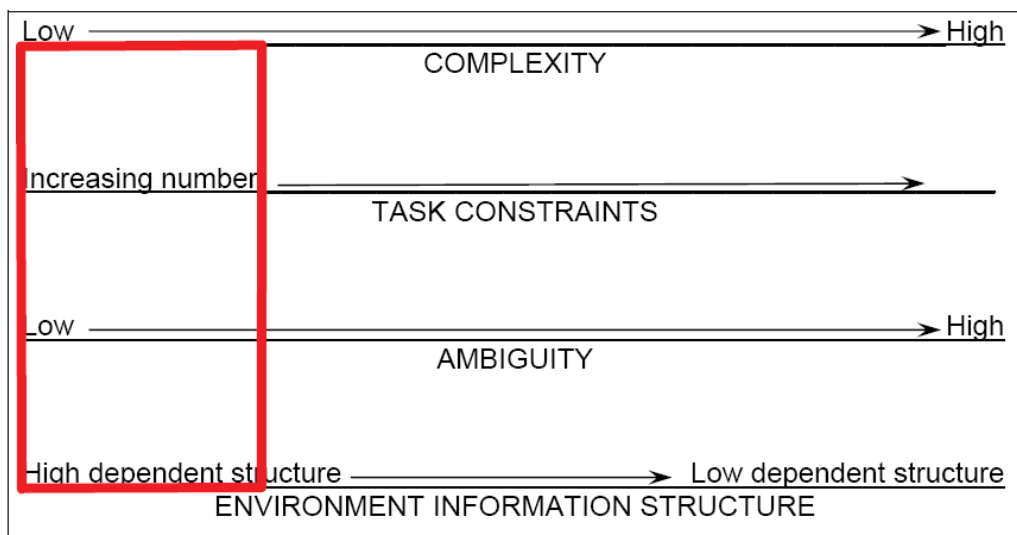


Figure 9.6 – Characterisation of Matchbox-Type Decision

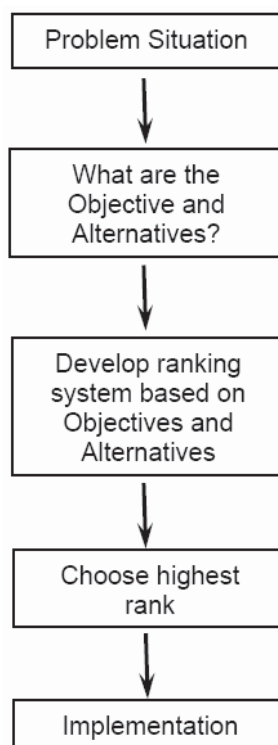


Figure 9.7 – Matchbox-Type Decision-Making Process

Shears – Once again, three case studies were gathered from the participants. Bid assessments and staff recruitment are examples of this type of decision in the oil and gas industry. The decision type is characterised by being highly complex and having high ambiguity because of the many value functions and weighting of those functions required to make the decision. On the other hand there are fewer constraints and the environment of information is highly dependent (Figure 9.8). To undertake these types of decisions the participants reveal a process that assumes the framing, as previously defined either via corporate objectives or work program requirements, and alternatives. The modelling is high level and uses a large number and diverse range of tools. Sensitivity is evaluated using scenarios. However, feedback learning cycles are not discussed by any of the participants so it is difficult to determine if such a feedback loop occurs. It is assumed that it does because of the high level of modelling

required and therefore the advantage of having a learning feedback cycle (Figure 9.9).

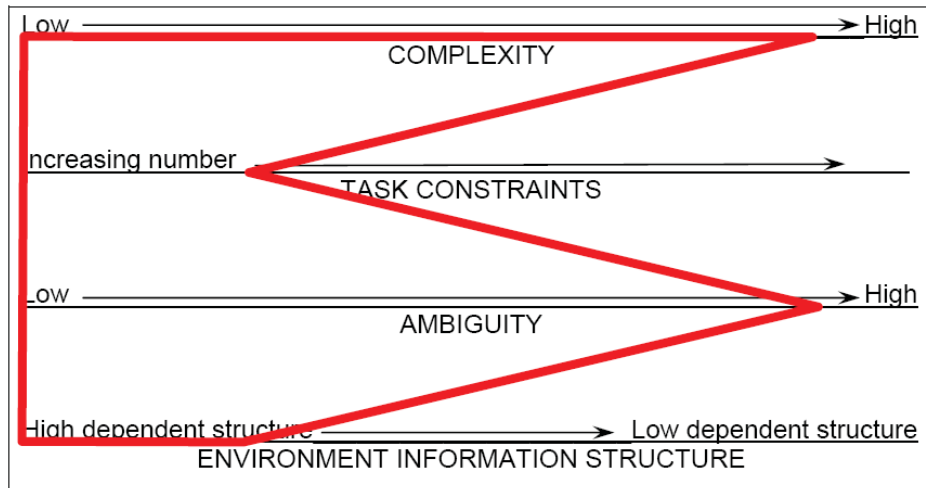


Figure 9.8 – Characterisation of Shears-Type Decision

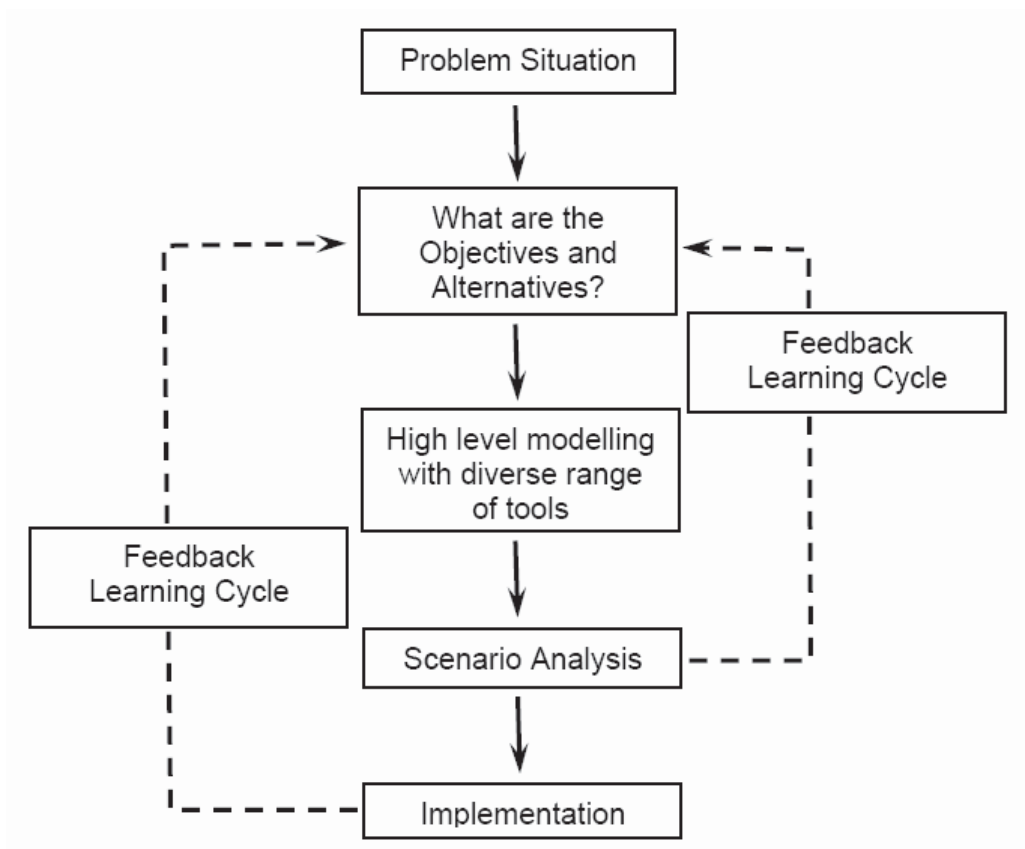


Figure 9.9 – Shears-Type Decision-Making Process

Summary

Although each of these four decision types uses a unique decision process to make the decisions, each decision type and process is very different from the others. It could be argued, however, that the decision processes appear to be subsets of each other – the axe-type process being a subset of the funnel-type process and the matchbox-type process being a subset of the shears-type process. One element of the decision taxonomy is common to these four decision types. This is the highly dependent nature of the environment of information structure. Although all other three dimensions of the taxonomy vary from type to type, the information required to make the decision is generally known or knowable by the decision-maker. Some information and data gathering may be required but ostensibly it would not reduce the risks involved in making the decisions, because it would be “more of the same.” The question that remains unanswered is whether this information structure is a result of who the decision maker is – is the information known because of the experience of the decision maker – or is it a function of the decision situation itself? The interviewees that participated in these case studies had many years of experience and so it is not possible, given the current experimental structure, to determine which of the two alternatives is valid. Further research will be needed to tease this out.

9.3.2 Differing Processes

Clippers – These types of decisions are characterised by relatively simple levels of complexity, many constraints, usually one value function and a low dependency structure of information. Examples of the decision type include deciding on how to follow-up a new play discovery; or transferring staff; or even how to allocate personal time during times of heightened constraints. The three cases studies of this type reveal some similarities in how the participants approached the decision. Firstly, group discussion is used to frame the decision but this ranged from very formal to very

informal. Many alternatives are developed in order to find the optimum decision. As there are many alternatives, various formal and informal decision-making tools are brought to bear on the subject but no sensitivity is undertaken. In contrast with the previous series of decision types, this decision type has several different processes for learning feedback. One participant undertook a short term formal review whilst another used a medical triage process and finally the third did not undertake any feedback. It is these differences that reveal that, although most of the decision-making process is common, the changes in the learning feedback render the overall processes distinct.

Crescent – Crescent type decisions are characterised as being highly complex but with few constraints and usually one value function and therefore little ambiguity. They have low dependency information structure. There are many examples of this type of decision in the oil and gas industry. Decisions within the budgetary cycles or permit bidding or company floats and even reserves determinations would fit within this decision type. The three case studies describing decisions of this type show some similarities but many more differences in the processes used to make the decision. The two stages of the process that are similar in each case study are 1) the need for many alternatives and 2) a high level of modelling. Each participant, however, used very different methods for framing the decision, undertaking sensitivity analysis and, finally, learning through feedback.

Pliers – Decisions like whether to import a drilling rig or whether to tie exploration and development work plans together are examples of pliers-type decisions. They are very complex and have many constraints. They usually only have one or two value functions and therefore have little ambiguity, but have a low dependency structure of information. Of the three case studies analysed, no one process used was similar in any way

to another. That is, each participant approached the situation from a different perspective as if the three decisions were not related in any way.

Summary

Each of the three decisions types listed above under the heading “multiple processes” had two dimensions of the decision-making taxonomy in common. All three had low ambiguity and low levels of dependency in the information structure. The complexity and constraint dimensions, however, varied from type to type. Hence, even though the ambiguity and dependency dimensions of a decision are similar, decision makers still approach the situation differently. This would indicate that the primary dimensions of the taxonomy are complexity and constraints.

9.3.3 Polarised Processes

Block – The most discussed decision type is overwhelmingly the block-type decision. Some examples from the oil and gas industry of the decisions discussed include:

- Field development
- Future company strategy
- Company acquisition

Their preponderance amongst the case studies thus, perhaps indicates the fact that these types of decisions are the most difficult and multifaceted within the decision-making taxonomy, leading participants to desire to discuss them; or it could be that they dominate the number of case studies because these types of decisions dominate the number of decisions made in the oil and gas industry. These types of decisions are characterised as being very complex, having many constraints, multiple value functions leading to high ambiguity and having low levels of dependency in the information structure. Analysis of the 11 case studies collected describing decisions of this type reveal two almost diametrically opposed processes used by the various participants. At one end of the spectrum the process

consists of concatenating all the alternatives into a simple “go” / “no go” process, making the decision and then implementing it, whilst at the other end of the spectrum the decision process is formalised right across the various decision stages. The one key difference was clearly stated by one of the participants as:

- *We need to add the big picture early in the decision-making process so as to expand alternatives. (Z)*

All stages of the individual decision-making process are undertaken during the second process, whilst in the first the stages are immediately concatenated down into a single “yes” / “no” type. They are very similar to Nutt’s two decision processes (Nutt, 2002). The “go” / “no go” process is similar to Nutt’s idea-imposition process, and the complex process is similar to Nutt’s discovery type process. Models of the two processes are shown in Figures 9.10 and 9.11.

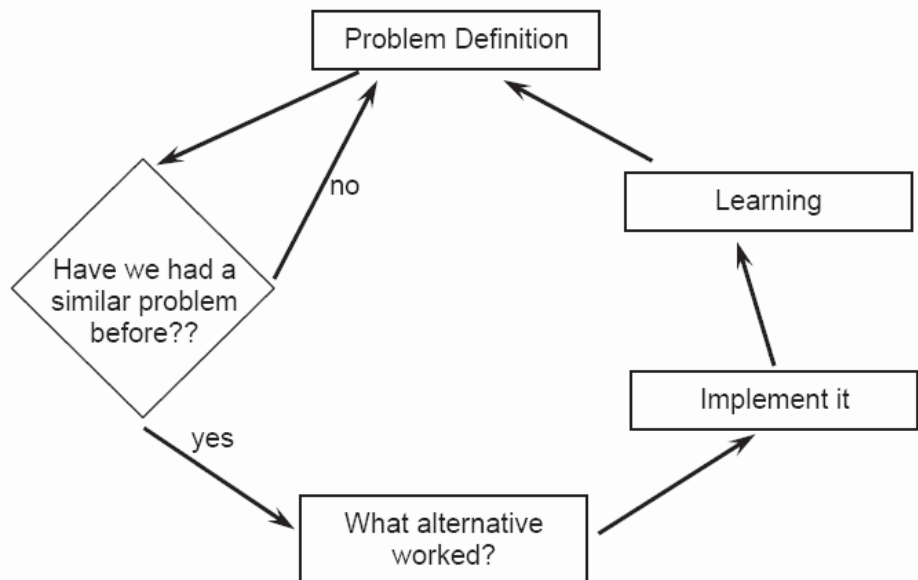


Figure 9.10 – “Go” / “No Go” Block Decision Process

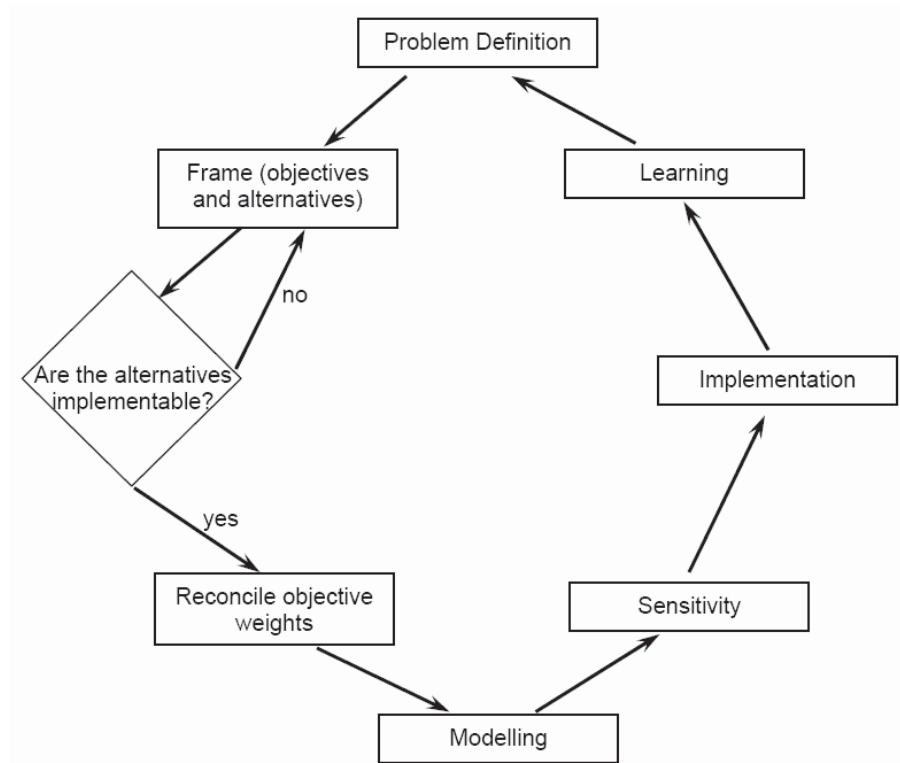


Figure 9.11 – Complex Block Decision Process

Summary

In summation, the individual participants naturally invoked the two polarised process streams. It is, therefore, argued that some – those who used the “go” / “no go” process – were susceptible to cognitive biases. By using the availability heuristic, they tried to simplify the decision-making process even when they had the time to do much more complex analysis. The business adage that “time is money” was quoted by several participants as the reason they felt the need to simplify the decision. Many also talked of “the 80:20” rule as being sufficient justification. None, however, consciously noticed that they were simply bringing to mind those decisions that they had previously made that they thought were similar and they thought had been successful. They failed to bring to mind the full spectrum of all decisions – multiple working hypotheses – and see the base rates of success and failure of the process.

9.4 CHANGES IN DECISION PROCESS GIVEN CHANGES IN DECISION TAXONOMY

The analysis of interview data presented in the previous section suggests that the hypothesis - that decision process is tailored to decision type - is true. For some of the decision types a single, unique process is used by all interviewees. Whereas, for other types, the processes are varied but not necessarily the same. What is clearly noted from the analysis of the interviews is that, as the properties of a decision vary along the different dimensions of the decision-making taxonomy, the processes used to make that decision also change. These changes are now discussed.

9.4.1 Changes in Complexity

The complexity dimension, naturally, ranges from very simple to very complex. When the decision type had low complexity most participants saw their decision-making as essentially being recognition of something similar from the past or being part of a defined process. On the other hand, as the complexity increased there were implications within the approval process. Two comments reveal the two primary differences:

- *If complexity increases we use the same process but it is part of a different budget process – shifts from production to exploration. (V)*
- *As complexity increases there will be the need for more people to get involved in the decision and there will be more questions leading to a difficult approval process. (W)*

The first comment describes a total shift from one budgetary process to another. This may be specific to the corporate rules for the organisation that this participant worked for but there were indications of changing budgetary approval processes as complexity increased from other

participants as well. The second comment, by comparison, invokes an approval process that requires “going further up the ladder.” This clearly means getting more people to review and further review the decision ahead of it receiving its final endorsement.

Hence when faced with a decision that may involve more complexity the decision-making process should allow for a more complex approval process, that is, the more unsure the decision-maker is of gaining the right outcome the more they want to share accountability with others higher up the ladder (blame apportionment/buck shifting/“it wasn’t just me”).

In summary, as the complexity dimension changes, the hierarchical approval process is altered according to the “delegation of authority” within the organisation. Within the core or individual decision-making process, each of the phases (framing, modelling, sensitivity and learning) is impacted. Framing moves from a simple recognition heuristic, to major reviews. It can also move from one individual being involved, to many giving their opinions within the framing process. The modelling phase sees a move from simple predefined assessment, to extremely complex and integrated assessment using a multitude of tools. At the simplest of decisions no sensitivity is undertaken, to the most complex requiring scenario analysis as well as sensitivity analysis. And finally, feedback loops do not exist at the simplest levels, to all feedback loops needing attention at the most complex levels.

9.4.2 Changes in Constraints

Probing how the decision-making process will change given changes in constraints, such as time, capital and technology, led to discussions with the interviewees focused on the availability of resources. As one participant succinctly says:

- *Constraints impact resources. (Y)*

Whilst other comments are:

- *If the time constraint increases then we need to pull more resources (Y)*
- *If constraints are increased it accelerates the need for data and resources. (Z)*

Most participants clearly felt the need to have access to more resources if they were facing any increase in constraints. It is, therefore, advantageous for the decision maker to see that if the characterisation of the decision type indicates that there are going to be multiple constraints they must make the extra resources available. If this is not possible, the decision will need to be altered in such a way as to keep the constraints at a minimal level. One of the key ways to make the resources available is through technology. As one interviewee observed:

- *Technology is used to increase resources. (AA)*

This observation matches the findings of Simpson et al. (2000) and Jonkman et al. (2000). Both of whose studies found that, as decisions became more difficult, best practice required the use of more technology in the form of tools, which are used primarily within the modelling phase of the decision-making process. These studies, however, did not categorise decisions as has been done here utilising the decision taxonomy. The interviews clearly show that it is the modelling phase of the process that is mostly impacted with changing numbers and levels of constraints.

Another way of seeing the change is expressed by one participant as:

- *If constraints are dropped the decision changes because there are less arms on the decision tree. (W)*

Clearly this participant uses decision trees within the modelling phase and as constraints decrease the trees become easier to handle. The opposite

is assumed to be true as well with the more constraints involved in a decision, the more arms required on the tree, thus making the core decision-making process more difficult and the need to invoke technology to manage the difficulties involved more urgent.

In review, the modelling phase of the individual decision-making process is most impacted by changes in the level and number of constraints. This is where the “fit-for-purpose” and “modifying constraints elements of the “real world” model are more clearly used. The framing stage is also impacted because the decision-maker will need to take into account the need to allocate extra resources as the constraints increase. As the primary constraints are time and capital, it is also necessary to increase the level of debiasing that is within the system as cognitive biases tend to be more evident in more constrained decisions. The sensitivity and feedback stages of the individual decision-making process as well as the hierarchical approval process do not appear to be impacted by changes in constraints.

9.4.3 Changes in Ambiguity

The ambiguity dimension of the taxonomy relates to the number of objectives needed to make the decision. As the number of objectives increases, ambiguity increases because it is difficult for the decision maker to weight (or even find ways to weight) the relative importance of each objective. The participants recognised this and two methods were recommended to assist in managing it. Firstly, the level of trust, invoked during the hierarchical approval process, of either the person making the decision, or the decision-making process itself, needs to increase.

- *If ambiguity increases the same process is used but the level of trust also needs to increase. No one is asked did you do this or that. It is assumed that you*

have and that is monitored via the gate process.

(AA)

The “gate process” discussed by this participant relates to the point within the overall decision-making process where it passes from the core decision-making process into the hierarchical approval process.

The second reflects the need for predefined objectives being the control for the weighting – more specifically, that the highest priority needs to continually stand out above the other objectives during the decision-making process. It is possible that, as each value function is assessed, priorities may change and therefore conflict. As one interviewee observes:

- *As ambiguity increases we run the risk of getting too blind to our original objectives – we need to keep a “clear line of sight.” (AE)*

The “clear line of sight” referred to here is the need to keep continually focused on what has been assessed as the primary objective.

In précis; the hierarchical approval process is the most impacted by increasing levels of ambiguity. At the least ambiguous level, corporate directives state which objectives are to be used as the value functions – usually some form of NPV or EMV ranking – and, if these are used, approval is almost automatic. By comparison, at the most ambiguous end of the spectrum, high levels of trust are placed in either the individual or team making the recommendation or in the corporate process used to make the decision and recommendation. Within the individual decision-making process, the framing stage is the most impacted by variations in ambiguity as it is here that the objectives need to be clearly specified and weighed. Weighting of the different objectives ahead of actual analysis or modelling will allow the needed “clear line of sight” which can prevent ambiguity overwhelming the decision process. On the other hand, it may be dangerous to weight first. If the objectives don’t clearly discriminate

between alternatives, decision makers may be tempted to change the objectives. As ambiguity increases, modelling and sensitivity are also impacted because there is the need to make sure that “all the angles are covered.” Learning or feedback loops are part of the process whether or not the ambiguity changes.

9.4.4 Changes in the Structure of the Environment of Information

If a decision being made has, available to the decision maker, large amounts of data, but each piece of that data does not actually assist in improving the decision – in colloquial terms, it is just more of the same – then that decision should be made with the least amount of that data in order to be efficient. If, on the other hand each piece of data adds to the ability to make a better decision then data should continue to be included so long as that stricture holds. Slovic’s (1982) research has supported this idea, showing that adding more information does not necessarily lead to better decision making (although almost always leading to increased confidence in the decision by the decision maker). The real problem thus lies in understanding which type of environment the decision is being made within. One participant saw the methodology required to make this determination as Value of Information:

- *As information type and structure change the need for Value of Information analysis becomes more important. (AD)*

Although the use of this methodology is increasing rapidly it is not yet in the main stream of the oil and gas industry (Begg et al., 2002). A recommendation, distilled from the interviews, is that quick and simple models of Value of Information be used, up front in the framing stages of the individual decision-making process, to determine the type of dependency within the decision-making environment and then further information can be garnered as and if required.

Reviewing the various behavioural decision-making models formulated in this section it can be seen that each is a derivative of the overall “real world” decision-making model established in Chapter 6. The simplest of the models is the model for matchbox-type decisions, whilst the most complex is the complex block-type decision-making model; which is, in essence, the “real world” model. Parts of the “real world” decision-making model are added as each of the dimensions of the decision-making taxonomy is altered.

4 of the 8 decision types reviewed in the case studies used a single unique process for the tailoring. In addition, when tailoring is seen in terms of parts of the decision-making process that can be included and or left out to create a unique process based on the taxonomy of the decision, then, behaviourally at least, the hypothesis has been confirmed for the primary decision types discussed in the case studies.

9.5 DO COMPANIES ACTUALLY MAKE DECISIONS THE WAY THEY SAY THEY DO?

Chapter 5 documents the model that is created from what oil and gas companies say they do to make decisions. However, reviewing how the individuals in the oil and gas companies undertook to make both hypothetical and real decisions, as discussed in the case studies reveals differences in what they say they do and what they actually do to make decisions. The key difference is the number of times that the framing stage of the decision-making process is left out. Even when it is included, very rarely did the individual making the decision deeply question the construct of the frame to make sure that it truly reflected the company’s aims and objectives.

There may be several reasons for doing this but it is asserted that the primary reason is because most people making decisions in the oil and gas industry are technical professionals. They are highly skilled in certain technical disciplines

and actually choose these professions because they love to use those skills. The part of the decision-making process that most aligns with their skills is the modelling phase. Therefore they “jump right in” and undertake those parts of the decision-making process that they do well – the modelling, thus leaving out the framing stage. Yeilding argues similarly that with the birth of “Nintendo Geology,” professionals are more focused on the workstations they are using than in the thinking that should occur in operating the workstations (Durham, 2006).

A final change that may be pursued involves having decision makers stop and step back prior to jumping into the modelling stage of the process. The emphasis could be directed to taking time to carefully frame the decision prior to engaging in any modelling or assessing. If the reward system, previously discussed (section 8.6) were introduced for following process this final change may automatically be resolved.

9.6 FURTHER PRESCRIPTIONS FOR GOOD DECISION-MAKING

Several prescriptions have been enunciated and critiqued in the foregoing discussion, and are now recommended as further prescriptions for good decision-making. As in section 8.5, they are highlighted as priority ticked dot points. In this instance all prescriptions are considered highest priority because of their impact on the other prescriptions.

- ✓✓✓ That decision makers take the time to type their decisions first, and then assess their experience in such decisions, prior to deciding on what tools are used for the decision.

- ✓✓✓ That decision makers be encouraged to stop and step back when they are first confronted with a decision. This stopping should be aimed at taking time to frame the decision correctly prior to embarking on solving it.

- ✓✓✓ That when dealing with decision types that have increasing complexity closer attention be paid to all stages of the decision-making process, that is, the Framing, Modelling, Assessing, Feedback Loops and Approval stages.

- ✓✓✓ That when dealing with decision types that have increasing complexity closer attention be paid to the Framing and Assessing stages of the decision-making process.

- ✓✓✓ That when dealing with decision types that have increasing ambiguity closer attention be paid to the Framing and Approval stages of the decision-making process.

- ✓✓✓ That when dealing with decision types where the Environment of Information structure becomes less dependent closer attention be paid to the Framing stage of the decision-making process.

9.6 CONCLUSIONS

In conclusion, several observations can be made about the linking of the decision-making process with decision type. Firstly, it can be seen that all decisions are not the same and it is proposed that a single decision-making process, for all decision types, will not lead to optimality in each case. It has been demonstrated that in the “real world” people tailor their decision-making process to the type of decision they are making. Sometimes they will use a single unique process for the decision type, for example, axe-, shears-, funnel- and matchbox-types. For other types, differing decision-making processes will be used. Finally, for very difficult decisions, decision makers will either try to simplify the decision to a “go” / “no go” situation or they will use the full “real world” decision-making model derived in Chapter 5.

Secondly, consistent with findings across a variety of domains, cognitive biases are seen to exist within the decision-making process. These biases are recognised in the modelling phase of the process. In addition they are also noted in the overall decision-making process. The best example of this is where decision-makers leave out the framing phase in order to simplify the decision. This bias appears to come from applying the availability heuristic.

It can be seen that any change in the various dimensions of the decision-making taxonomy has impact on the framing stage of the decision-making process. This is also the stage that is most often left out by decision makers. It is therefore concluded that some of the suboptimal outcomes of decisions made under uncertainty in the oil and gas industry relate to leaving this stage out. It is, therefore, strongly recommended that the framing stage be included in the decision-making process.

A fourth observation is that the tailoring of the decision-making process for optimality may actually consist of commencing with the full “real world” decision-making process, established in Chapter 5, as the model for when all dimensions of the taxonomy are at their most intricate (the right hand side of the template), and then removing parts of the process depending on the differences in the various dimensions of the decision-making taxonomy.

All these conclusions are based on observations of decision making as practiced in the real world. In order for theories to be developed around them, further work will be required in the laboratory to test the proposed connection, in terms of optimality, between decision type and decision process.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 INTRODUCTION

This chapter is designed to summarise the conclusions of the research in the form of answering the research questions that were posed in the earlier chapters. These answers show that this research has produced results that make valuable contributions to the decision-making under uncertainty literature, the oil and gas industry literature, as well as practical guides for oil industry professionals.

The key elements of the research are, in summary:

- Constructing a theoretical decision-making model from current literature;
- Distilling of a “real world” oil and gas decision-making model from semi structured interviews of oil industry professionals;
- Building a taxonomy of upstream oil and gas decisions, from mathematical cognitive psychology, which facilitates the determination of various decision-making types;
- Uncovering the trust heuristic, by which hierarchical organisations approve decisions;
- Showing that the processes used to make decisions change according to the decision type;
- Showing that oil and gas companies do not always make decisions according to the processes that they say they use;
- Defining what “good” decision-making consists of; and
- Uncovering a series of prescriptions, relating to both decision process and decision type, to improve decision-making in the upstream oil and gas industry.

10.2 ANSWERING THE RESEARCH QUESTIONS

The research focuses on uncovering answers to six primary research questions distilled from the gaps in the current literature (section 2.5). Looking at each research question individually, the following conclusions are made.

First: Which processes should upstream oil and gas companies use for decision-making under uncertainty?

The theoretical decision-making model is developed via the focussed literature review presented in Chapter 3. The final theoretical model, depicted in Figure 3.10, consists of:

- An individual decision-making process that uses the multiobjective decision-making model which contains the following four stages:
 1. Framing,
 2. Modelling,
 3. Assessing, and
 4. Feedback.
- A successful team decision-making process (or approval process) that focuses on:
 1. Team Informity,
 2. Staff Validity, and
 3. Hierarchical sensitivity.
- Contextualising individual projects within a portfolio process.
- Three feedback loops – one for each of the following phases:
 1. Implementation,
 2. Approval, and
 3. Decision.

It also concludes that the key to improving decision-making outcomes lies in adhering to a defined decision-making process. Separating the decision from the outcome makes it possible to focus on the decision-making process. That said, outcomes with time horizons that allow for observations of “long run” probabilities – the best indicator of whether the process is good – should be considered. The tension between process and outcome is real and the theory indicates that the best hope for a good outcome is to give primary importance to process within a portfolio context.

Second: Which processes do upstream oil and gas companies say they use in their decision-making under uncertainty?

The “real world” decision-making model documented in Chapter 5 addresses and answers this research question. The model, shown in Figure 5.5, is distilled from data and information gained in qualitative, semi-structured interviews. The model is pulled together from “bits and pieces” of data and information, that is, it is not fully observed at any one place. The model consists of five major stages in a nested structure which is very similar to the theoretical decision-making model:

1. Framing,
2. Modelling,
3. Assessing,
4. Approval, and
5. Feedback Loops

Stages 1, 2, 3 are part of an individual, or core, decision-making process. The decision made within these stages – the people who make this decision are termed decision makers – is then passed to stage 4 for approval – the people who make the decision at this stage are termed decision takers. After the decision is implemented and outcomes are known, stage 5 looks at learning from the outcomes at each level of the nested structure to help improve future decision-making. This stage, however, is not regularly undertaken. Although being similar to the theoretical decision-making model at the macro level, it is different at the micro level.

Several important areas that influence the stages of the decision-making process are also uncovered. These include:

- Modifying constraints;
- Biases;
- “Fit-for-Purpose” tools; and
- Peer/Mentor Reviews

The research also found that very few decision-making processes are documented in the upstream oil and gas industry. It is also observed that decisions which deal with major emergencies, however, are very clearly documented by most companies. This leads to the conclusion that companies are able to document decision-making processes and that they should do so for other types of decisions.

Another critical consideration deals with the need for a balanced hierarchy of decisions. That is, the need for information to flow in both directions of the nested structure – technical information upwards from the decision makers and strategic information downwards from the decision takers. This facilitates decisions being made at the lowest point where the resources needed to implement the decision are available and enables individuals to clearly understand the company's aims and objectives. As a result decisions are made on behalf of the company, not the individual employees.

Third: Which criteria are essential for decision-making under uncertainty to be defined as “good”?

The industry and theoretical literature is divided on what “good” means. Efforts to improve decision-making usually use phrases like “better decision-making” but lack some objective benchmark. This research proposes that the benchmark for “good” decision-making should be optimisation. This objective lies between theoretical maximisation, the stated objective of normative decision-making, and satisficing, the observed objective of behavioural decision-making, and is best achieved via prescriptive decision-making.

Based on the comparison of the “real world” and theoretical decision-making models, several prescriptions for change are recommended to facilitate companies moving from their currently sub-optimal to optimal decision-making.

To facilitate practical use by the industry, these prescriptions are summarised in check box style in Table 10.1 at the end of this section. It is recommended that, when faced with making decisions, decision makers and decision takers go through each prescription ahead of going through the decision-making process.

Fourth: What is a useful structure or classification scheme for decision-making under uncertainty that defines the various types of decisions made in the upstream oil and gas industry?

Chapters 6 and 7 document the building of an oil and gas decision-making taxonomy together with a template that facilitates the typing of decisions made under uncertainty. This taxonomy provides a “framework” in the decision-making space within which to place the processes of decision-making. The taxonomy builds on established ideas in the human decision-making literature, but is itself novel, and involves four different components:

- complexity;
- task constraints;
- ambiguity; and
- environment information structure.

Each dimension of the taxonomy is a continuum, hence the constructed template allows for an infinite number of decision types. Sixteen primary decision types occur when only the end points of the dimensions of the decision-making taxonomy are used in the characterisation. These primary decision types are listed and examples of each, from the upstream oil and gas industry, are given. The way to type a decision is also explained and documented.

Fifth: Do upstream oil and gas companies actually do what they say they do in making decisions under uncertainty?

Chapter 5 documents the model that is created from what oil and gas companies say they do to make decisions. During the interviews, that collected this data, the oil and gas company professionals also undertook to make both hypothetical and real decisions. These are discussed as individual case studies, documented in Chapter 9, and reveal differences in what they say they do and what they actually do to make decisions. The key difference is the number of times that the framing stage of the decision-making process is left out. Even when it is included, very rarely did the individual making the decision deeply question the construct of the frame to make sure that it truly reflected the company's aims and objectives.

A change, then, that should be implemented involves having decision makers stop and step back prior to jumping into the modelling stage of the process. The emphasis could be directed to taking time to carefully frame the decision prior to engaging in any modelling or assessing. If the reward system for following process, previously discussed, were introduced this change may automatically be resolved.

Peer and/or mentor reviews are also rarely undertaken and should be included as part of regular decision-making practice.

Finally it is observed that the use of portfolio analysis to determine the mix of projects that should be perused in order to reduce risk, in such an uncertain environment as the upstream oil and gas industry, is undertaken by very few companies – in fact no interviewee mentioned portfolio thinking, methodology or analysis. Companies should strive to make portfolio thinking and methodologies part of their main stream decision-making.

Sixth: Do the decision-making processes change depending on the type of decision being made?

Case study analysis, documented in Chapter 9, shows that decision-making

processes in the upstream oil and gas industry do change depending on the type of decision being made. Hence, all decisions are not the same. Using a single decision-making process, for all decision types, will not lead to optimality in each case. In some instances the decision-making process is unique to the decision type, whilst in other instances elements of the decision-making process are modified depending on the characteristics of the dimensions of the decision-making taxonomy. Consistent with findings across a variety of domains, cognitive biases are seen to exist within the decision-making process. They are especially pronounced in the modelling phase of the process but they are also noted in the overall decision-making process. Table 10.1 also lists this series of further prescriptions for good decision-making distilled from the case study analysis.

Table 10.1 – Prescriptions for Good Decision-Making

<input type="checkbox"/>	Have I stopped and made sure that I have framed my decision – defined my decision context – prior to making it?
<input type="checkbox"/>	Have the decision takers predefined the aim and objectives? What are they?
<input type="checkbox"/>	Have I taken the time to Type my decision first and then determine which process to follow?
<input type="checkbox"/>	In my typing exercise did I note that as Complexity increases I should pay closer attention to the Framing, Modelling, Assessing, Feedback Loops and Hierarchical Approval stages?
<input type="checkbox"/>	In my typing exercise did I note that as Constraints increase I should pay closer attention to the Framing and Assessing stages?
<input type="checkbox"/>	In my typing exercise did I note that as Ambiguity increases I should pay closer attention to the Framing and Hierarchical Approval stages?
<input type="checkbox"/>	How are we going to Reward Process and Celebrate Outcome?
<input type="checkbox"/>	How will reality or plausibility checks be included in my analysis?
<input type="checkbox"/>	Which peers and/or mentors will I include and when will I schedule my reviews? Have I created a climate that is “helpful?”
<input type="checkbox"/>	How is the approval process going to be documented?
<input type="checkbox"/>	Have I integrated with the company’s portfolio of projects to determine how this decision impacts the whole?
<input type="checkbox"/>	Have I received training in bias recognition and how will I use it?
<input type="checkbox"/>	How am I going to include Value of Information as part of the decision-making process?
<input type="checkbox"/>	How am I going to find a way for the team to weight approval?

10.3 FURTHER RESEARCH

Of course any research that is as broad as the current study is (in contributing to the theoretical debate, developing a decision-making taxonomy, and detailing prescriptions for changes in the way oil and gas companies make their decisions) will have many avenues of work that could have been followed, being placed on hold to allow finalisation of the central aims. These various avenues are now documented to facilitate future research projects. The first series of recommendations deals with the theme of decision process.

Firstly, many of the conclusions made in this work are based on observations, via semi-structured interviews and case study analysis, of decision-making as practiced in the “real world” of the upstream oil and gas industry. This is positive in that it addresses the argument that most research into decision-making relies on laboratory experiments using college students (Plous, 1993). Clearly, much of this research has been practice-motivated – undertaken in the “real world” with the subjects being actual industry professionals. The present research has shown that people tailor their decision processes depending on decision type. What has not been clearly demonstrated, however, is whether this leads to optimal decision-making. One area, therefore, that could be expanded relates to theory-motivated confirmation of the observed connection, in terms of optimality, between decision type and decision process, using traditional psychology laboratory experiments.

Further work is also needed to help understand the impact of motivational biases on human decision-making. This research project considered the impact of cognitive biases and has shown that they certainly do influence decision-making in the oil and gas industry. Throughout the research, however, it was difficult separate the impact of the cognitive biases from those resulting from motivational biases. There is strong evidence that motivational biases are also present, and under conditions of uncertainty, still have a bearing. Most motivation bias

research is focussed on individuals, and undertaking research of this kind in the oil and gas industry is certainly recommended. It is also urged that such research investigate the impact of motivational biases on the hierarchical approval process documented in this research. Several comments from the semi-structured interviews give strong evidence that such biases do exist and further investigation should seek to quantify their influence. Also, can the reward/penalty style be used to remove these (once defined), and motivate good process.

Those interviewed as part of this research were a broad cross section of the Australian oil and gas industry. One sector of the worldwide industry, that is very minor in Australia, is the independent explorer – the person who invests their own money in the risky ventures rather than acting as an agent for a company. Another promising line of future research would be to carry out the same interviews with these independent operators to determine if the results are similar or different.

Finally, the practice-motivated research into decision type and decision process and the concept of optimality could be extended via a longitudinal study of real people making real decisions. As previously noted, many decisions in the upstream oil and gas industry have very long time horizons. In order to clearly understand all the elements of a decision outcome time would need to be involved – hence the longitudinal nature of the recommendation.

The next series of recommendations relate to the decision-making taxonomy documented in this research. The development of the decision-making taxonomy was done in such a way as to be as generic as possible. The first recommendation, therefore, would be to investigate how generic it is before testing its applicability to other, similarly uncertain, industries. As this is the first time such a taxonomy has been developed further research could also be directed towards determining how robust it is. This could be accomplished by

extending the research with more participants or with different decision scenarios. Finding a mechanism to objectify the various dimension scales may also assist. Perhaps even validating the taxonomy may be undertaken by having several decision scenarios typed by various people to see how consistent they are, that is, does the taxonomy facilitate ease of use? This may even be undertaken by using the feature based Bayesian hierarchical models.

One area that is nearly universally associated with good decision-making is experience, specifically the question of whether the experience of the decision maker has a positive influence on the decisions made. Within the framework of the taxonomy development it would, therefore, be advantageous to perhaps weight the similarity measures by the experience of the individual. Six individual results were averaged for each similarity measure in this research. This averaging may blur the experience factor so a new experiment may have to be determined to test this idea.

Finally, some interview comments raise an interesting area of investigation.

I didn't fully appreciate that . . . there are other ways of thinking about it, but the revelation to me in the last year or two is that not all scientists think scientifically. In fact, they have other ways of thinking and those other things predispose them to how to make their decisions and it often has nothing to do with the Monte Carlo simulation and risk analysis at all. . . What if ... I could evaluate psychologically all my decision-makers and say well , . . . where do you fit?
(G)

The personality of the leader has a big impact on how decisions are made. (AE)

Is there some link between the decision-makers' personality type and a predisposition to make decisions in a certain way? Or even expanding this question to look at whether there is some link between personality type and decision type.

10.4 CONCLUSION

This research project brings together literatures from both judgment and decision-making under uncertainty and the upstream oil and gas industry. It adds to the debate between how decisions *are* made under uncertainty (behavioural decision-making) and how they *should* be made (normative decision-making) by developing a series of prescriptions for optimal decision-making in the oil and gas industry (prescriptive decision-making). The proposed common theoretical framework for understanding human decision-making in the oil and gas industry has two central innovative components. The first is, as espoused by other researchers, that primary emphasis for determining whether a decision is optimal, should be given to studying the processes that lead to a decision, and not solely the outcome of the decision itself. Understanding these processes has come from both a “real life” as well as a theoretical perspective. The second innovation involves the development of a novel taxonomy for characterising different decision-making types and analysing the processes involved in making decisions of different types.

As with most decision-making research, this project set out to help improve decision-making. Specifically in this case, the upstream oil and gas industry. Normative theory defines decision-making where maximisation of utility is the aim. “Real world” decision-making in the oil and gas industry, however, is currently suboptimal – far below this theoretical maximum. The theoretical research has shown that the sub-optimality stems from the high levels of uncertainty as well as too high an emphasis on decision outcome as a measure of decision quality. Researching both normative and behavioural decision-making, in the “real world” and in theory, leads to understanding that both decision type and decision process are important to improve “real world” decision-making in the industry. Specifically, when decision-making processes are tailored to the type of decision, it is proposed optimised decision-making has a greater probability of occurring.

BIBLIOGRAPHY

AAPG, 2004, The Tale of the "Winner's Curse": AAPG Explorer, v. December 2004.

Alexander, E. M., and T. B. Cotton, 2005, Summary of the 2005 PIRSA Petroleum Industry Survey - Regulatory and Promotional Results, Adelaide, Primary Industries and Resources South Australia.

Al-Harthy, M. H., A. K. Khurana, S. Begg and R. B. Bratvold, 2006, Sequential and Systems Approaches for Evaluating Investment Decisions - Influence of Functional Dependencies and Interactions: APPEA Journal, v. 46, p. 511 - 523.

Allais, P. M., 1953, The Behavior of Rational Man in Risk Situations - a Critique of the Axioms and Postulates of the American School: *Econometrica*, v. 21, p. 503 - 546.

Allan, P. D., 2001, A Portfolio Management Approach to Assessing Acquisition and Divestiture Candidates: SPE 71425.

Archer, S. A., 1988, Qualitative Research and the Epistemological Problems of the Management Disciplines, *in* A. M. Pettigrew, ed., *Competitiveness and the Management Process*: Oxford, Blackwell.

Arkes, H. R., and K. R. Hammond, eds., 1986, *Judgment and Decision Making: An Interdisciplinary Reader*: Cambridge, Cambridge University Press.

Bailey, W., B. Couet, F. E. Lamb, G. S. Simpson, and P. R. Rose, 2000, Taking a Calculated Risk: *Oilfield Review*, v. 12, p. 20 - 35.

Ball, B. C., and S. L. Savage, 1999, Holistic Vs Hole-Istic E&P Strategies: SPE 57701.

Barker, G., 2001, Effective Management of Risk and Uncertainty in Field Development, Presentation given to FESWA.

Bateson, G., 1972, *Steps to an Ecology of Mind*: New York, Ballantine.

Bazerman, M. H., 2002, *Judgment in Managerial Decision Making*: New York, Wiley.

Beach, L. R., J. Christensen-Szalanski, and V. Barnes, 1987, Assessing Human Judgment: Has It Been Done, Can It Be Done, Should It Be Done?, *in* G. Wright, and P. Ayton, eds., *Judgmental Forecasting*: Chichester, Wiley.

Begg, S. H., 2004, Petroeng 4024 - Decision-Making under Uncertainty: Course Notes, Australian School of Petroleum, University of Adelaide.

Begg, S. H., R. Bratvold, and J. C. Campbell, 2001, Improving Investment Decisions Using a Stochastic Integrated Asset Model: SPE 71414.

- Begg, S. H., R. Bratvold, and J. C. Campbell, 2002, The Value of Flexibility in Managing Uncertainty in Oil and Gas Investments: SPE 77586.
- Begg, S. H., R. Bratvold, and J. C. Campbell, 2003, Shrinks or Quants: Who Will Improve Decision-Making: SPE 84238.
- Beliveau, D., 2003, Reserves Growth: Enigma, Expectation or Fact?: SPE 84144.
- Bell, D., H. Raiffa, and A. Tversky, 1988, Decision-Making: Descriptive, Normative and Prescriptive Interactions: New York, Cambridge University Press.
- Bernoulli, D., 1738, Specimen Theoriae Novae De Mensura Sortis: Commentarii Academiae Scientiarum Imperialis Petropolitanae, v. 5, p. 175-192.
- Boonstra, A., 2004, An Empirical Taxonomy of Is Decision-Making Processes, Groningen, University of Groningen, Research Institute SOM (Systems, Organisations and Management).
- Brashear, J. P., A. B. Becker, and D. D. Faulder, 2000, Where Have All the Profits Gone?: SPE 63056.
- Brashear, J. P., A. B. Becker, and S. A. Gabriel, 1999, Interdependencies among E&P Projects and Portfolio Risk Management: SPE 56574.
- Bratvold, R., S. H. Begg, and J. C. Campbell, 2002, Would You Know a Good Decision If You Saw One?: SPE 77509.
- Bratvold, R., S. H. Begg, and J. C. Campbell, 2003, Even Optimists Should Optimize: SPE 84329.
- Brehmer, B., and R. Hagafors, 1986, Use of Experts in Complex Decision-Making: A Paradigm for the Study of Staff Work: Organizational Behavior and Human Decision Processes, v. 38, p. 181 - 195.
- Brown, R., 2005, The Operation Was a Success but the Patient Died: Aider Priorities Influence Decision Aid Usefulness: Interfaces, v. 35, p. 511 - 521.
- Brunswick, E., 1940, Thing Constancy as Measured by Correlation Coefficients: Psychological Review, v. 47, p. 69 - 78.
- Brunswick, E., 1943, Organismic Achievement and Environmental Probabilities: Psychological Review, v. 50, p. 255 - 272.
- Brunswick, E., 1955, Representative Design and Probabilistic Theory in a Functional Psychology: Psychological Review, v. 62, p. 193 - 217.
- Brunswick, E., 1956, Perception and Representative Design of Experiments: Berkley, University of California Press.

- Bryman, A., 1988, *Quality and Quantity in Social Research*: London, Routledge.
- Buckingham, C. D., and A. Adams, 2000a, *Classifying Clinical Decision Making: A Unifying Approach*: *Journal of Advanced Nursing*, v. 32, p. 981-989.
- Buckingham, C. D., and A. Adams, 2000b, *Classifying Clinical Decision Making: Interpreting Nursing Intuition, Heuristics and Medical Diagnosis*: *Journal of Advanced Nursing*, v. 32, p. 990-998.
- Buehler, R., D. Griffin, and M. Ross, 2002, *Inside the Planning Fallacy: The Causes and Consequences of Optimistic Time Predictions*, in T. Gilovich, D. Griffin, and D. Kahneman, eds., *Heuristics and Biases: The Psychology of Intuitive Judgment*: Cambridge, Cambridge University Press.
- Camerer, C. F., G. Loewenstein, and M. Rabin, eds., 2004, *Advances in Behavioral Economics*: Princeton, Russell Sage Foundation.
- Campbell, J. M., Jr, J. M. Campbell, Sr, and R. A. Campbell, 2001, *Analysing and Managing Risky Investments*: Norman, John M. Campbell.
- Capen, E. C., 1976, *The Difficulty with Assessing Uncertainty*: SPE 5579.
- Capen, E. C., 1992, *Dealing with Exploration Uncertainties*, in R. Steinmetz, ed., *The Business of Petroleum Exploration*: Tulsa, AAPG.
- Capen, E. C., and R. V. Clapp, 1974, *The Ratio: A Possible Clash between Instinct and Science*: SPE 3974.
- Capen, E. C., R. V. Clapp, and W. M. Campbell, 1971, *Competitive Bidding in High Risk Situations*: SPE 2993.
- Capen, E. C., R. V. Clapp, and W. W. Phelps, 1976, *Growth Rate - a Rate-of-Return Measure of Investment Efficiency*: SPE 4613.
- Carroll, J. D., 1976, *Spatial, Non-Spatial and Hybrid Models for Scaling*: *Psychometrika*, v. 41, p. 439 - 463.
- Carroll, J. D., and P. Arabie, 1980, *Multidimensional Scaling*: *Annual Review of Psychology*, v. 31, p. 607 - 649.
- Chankong, V., and Y. Y. Haimes, 1983, *Multiobjective Decision Making: Theory and Methodology*: New York, North-Holland.
- Checkland, P., 1981, *Systems Thinking, Systems Practice*: Chichester, John Wiley & Sons.
- Checkland, P., and J. Scholes, 1999, *Soft Systems Methodology in Action*: Chichester, John Wiley and Sons.

Christensen-Szalanski, J. J. J., and J. B. Bushyhead, 1981, Physicians' Use of Probabilistic Information in a Real Clinical Setting: *Journal of Experimental Psychology: Human Perception and Learning*, v. 7, p. 928 - 935.

Citron, G. P., D. M. Cook, and P. R. Rose, 2002, Performance Tracking as a Portfolio Management Tool: *AAPG Bulletin*, v. 86.

Clemen, R. T., and T. Reilly, 2001, *Making Hard Decisions with Decisiontools*: Pacific Grove, Duxbury.

Connolly, T., 1986, Decision Theory, Reasonable Doubt, and the Utility of Erroneous Acquittals, *in* H. R. Arkes, and K. R. Hammond, eds., *Judgment and Decision Making: An Interdisciplinary Reader*: Cambridge, Cambridge University Press.

Cooksey, R. W., 2001, Pursuing an Integrated Decision Science: Does 'Naturalistic Decision Making' Help or Hinder?: *Journal of Behavioral Decision Making*, v. 14, p. 353-384.

Corner, J. L., and C. W. Kirkwood, 1991, Decision Analysis Applications in the Operations Research Literature, 1970 - 1989: *Operations Research*, v. 39, p. 206 - 219.

Costa, A. C., 2003, Understanding the Nature and the Antecedents of Trust within Work Teams, *in* B. Nooteboom, and F. Six, eds., *The Trust Process in Organizations*: Cheltenham, Edward Elgar.

Cottrill, A., 2003, Taking on a Cult of Mediocrity: *Upstream*, v. 23 May 2003.

Cozzolino, J. M., 1977, A New Method for Risk Analysis: *Sloan Management Review* v. 20, no. 3, p. 53-66.

Cozzolino, J. M., 1978, A New Method for Measurement and Control of Exploration Risk: *SPE* 6632.

Davis, J. H., 1973, Group Decision and Social Interaction: A Theory of Social Decision Schemes: *Psychology Review*, v. 80, p. 97 - 125.

Davis, J. H., 1992, Some Compelling Intuitions About Group Consensus Decisions, Theoretical and Empirical Research, and Interpersonal Aggregation Phenomena: Selected Examples: *Organizational Behavior and Human Decision Processes*, v. 52, p. 3 - 38.

den Hartog, D., 2003, Trusting Others in Organizations: Leaders, Management and Co-Workers, *in* B. Nooteboom, and F. Six, eds., *The Trust Process in Organizations*: Cheltenham, Edward Elgar.

Denzin, N. K., and Y. S. Lincoln, 2005, Introduction: The Discipline and Practice of Qualitative Research, *in* N. K. Denzin, and Y. S. Lincoln, eds., *The Sage Handbook of Qualitative Research: Thousand Oaks*, Sage Publications.

Dinnie, N. C., A. J. P. Fletcher, and J. H. Finch, 2002, Strategic Decision Making in the Upstream Oil and Gas Industry: Exploring Intuition and Analysis: SPE 77910.

DuBois, J. R., and J. I. Howell, 2000, The Decision Makers Dilemma: Oil and Gas Executive, v. 3.

Durham, L. S., 2004, Wall Street Has Its Own Rules and, Oil Stocks Have Their Own Personality, *The Explorer*.

Durham, L. S., 2006, Digits Can Distract from the Rocks, *The Explorer*.

Edwards, W., 1954, The Theory of Decision Making: *Psychological Bulletin*, v. 51, p. 380-417.

Ellsberg, D., 1961, Risk, Ambiguity and the Savage Axioms: *Quarterly Journal of Economics*, v. 75, p. 643 - 669.

Evans, D. A., and V. L. Patel, 1989, *Cognitive Science in Medicine: Biomedical Modelling*: Cambridge, MIT Press.

Fischhoff, B., P. Slovic, and S. Lichtenstein, 1978, Fault Trees: Sensitivity of Estimated Failure Probabilities to Problem Representation: *Journal of Experimental Psychology*, v. 107, p. 330 - 334.

Galli, A. G., M. Armstrong, and B. Jehl, 1999, Comparison of Three Methods for Evaluating Oil Projects: *Journal of Petroleum Technology*, v. October, p. 44 - 50.

Gigerenzer, G., 1991, How to Make Cognitive Illusions Disappear: Beyond "Heuristics and Biases": *European Review of Social Psychology*, v. 2, p. 83 - 115.

Gigerenzer, G., and U. Hoffrage, 1995, How to Improve Bayesian Reasoning without Instruction: Frequency Formats: *Psychological Review*, v. 102, p. 684 - 704.

Gigerenzer, G., and P. M. Todd, 1999, Fast and Fugal Heuristics: The Adaptive Toolbox, *in* G. Gigerenzer, P. M. Todd, and A. Group, eds., *Simple Heuristics That Make Us Smart*: New York, Oxford University Press.

Gigerenzer, G., P. M. Todd, and A. B. C. Group, eds., 1999, *Simple Heuristics That Make Us Smart*: New York, Oxford University Press.

Glovich, T., D. Griffin, and D. Kahneman, 2002, *Heuristics and Biases: The Psychology of Intuitive Judgment*: Cambridge, Cambridge University Press.

Goicichea, A., D. R. Hansen, and L. Duckstein, 1982, *Multiobjective Decision Analysis with Engineering and Business Applications*: New York, John Wiley & Sons.

Goldstone, R. L., 1999, Similarity, *in* R. A. Wilson, and F. C. Keil, eds., *Mit Encyclopedia of the Cognitive Sciences*: Cambridge, MA, MIT Press, p. 763 - 765.

Goode, P., 2002, Connecting with the Reservoir: *APPEA Journal*, v. 42, p. 50 - 55.

Goodwin, P., and G. Wright, 2001, *Decision Analysis for Management Judgment*: Chichester, Wiley.

Grayson, C. J., 1960, *Decisions under Uncertainty: Drilling Decisions by Oil and Gas Operators*: Cambridge, Division of Research - Harvard Business School.

Grayson, C. J., 1962a, Bayesian Analysis - a New Approach to Statistical Decision-Making: *SPE* 266.

Grayson, C. J., 1962b, The Calculus of Common Sense: *SPE* 309.

Hammond, J. S., R. L. Keeney, and H. Raiffa, 2002, *Smart Choices*: New York, Broadway Books.

Hastie, R., 2001, Problems for Judgment and Decision Making: *Annual Review of Psychology*, v. 52, p. 653 - 683.

Hightower, L., and A. David, 1991, Portfolio Modelling: A Technique for Sophisticated Oil and Gas Investors: *SPE* 22016.

Hollenbeck, J. R., D. R. Ilgen, J. A. LePine, and J. A. Colquitt, 1998, Extending the Multilevel Theory of Team Decision Making: Effects of Feedback and Experience in Hierarchical Teams: *Academy of Management Journal*, v. 41, p. 269 - 282.

Hollenbeck, J. R., D. R. Ilgen, D. J. Segoe, J. Hedlund, D. A. Major, and J. Phillips, 1995, Multilevel Theory of Team Decision Making: Decision Performance in Teams Incorporating Distributed Expertise: *Journal of Applied Psychology*, v. 80, p. 292 - 316.

Howard, R. A., 1988, Decision Analysis: Practice and Promise: *Management Science*, v. 34, p. 679 - 695.

- Howell, J. I., and J. R. DuBois, 2003, Monitoring and Managing Business Performance from a Portfolio Perspective: SPE 84333.
- Howell, J. I., and P. A. Tyler, 2001, Using Portfolio Analysis to Develop Corporate Strategy: SPE 68576.
- Humphrey, S. E., J. R. Hollenbeck, C. J. Meyer, and D. R. Ilgen, 2002, Hierarchical Team Decision Making: Research in Personnel and Human Resources Management, v. 21, p. 175 - 213.
- Jackson, M. C., 2003, Systems Thinking, Creative Holism for Managers: Chichester, John Wiley & Sons.
- Johns, D. R., S. G. Squire, and M. J. Ryan, 1998, Measuring Exploration Performance and Improving Exploration Predictions - with Examples from Santos' Exploration Program 1993 - 1996: APPEA Journal, v. 38, p. 559 - 569.
- Jonkman, R. M., C. F. M. Bos, J. N. Breunese, D. T. K. Morgan, J. A. Spencer, and E. Sondena, 2000, Best Practices and Methods in Hydrocarbon Resource Estimation, Production and Emission Forecasting, Uncertainty Evaluation and Decision Making: SPE 65144.
- Kahneman, D., P. Slovic, and A. Tversky, eds., 1982, Judgment under Uncertainty: Heuristics and Biases: New York, Oxford University Press.
- Kahneman, D., and A. Tversky, 1972, Subjective Probability: A Judgment of Representativeness: Cognitive Psychology, v. 3, p. 430 - 454.
- Kahneman, D., and A. Tversky, 1979, Prospect Theory: An Analysis of Decision under Risk: Econometrica, v. 47, p. 263 - 291.
- Kahneman, D., and A. Tversky, eds., 2000, Choices, Values and Frames: New York, Russell Sage - Cambridge University Press.
- Keefer, D. L., C. W. Kirkwood, and J. L. Corner, 2004, Perspective on Decision Analysis Application, 1990 - 2001: Decision Analysis, v. 1, p. 4 - 22.
- Keeney, R. L., 1988, Building Models of Values: European Journal of Operational Research, v. 37, p. 149 - 157.
- Keeney, R. L., and H. Raiffa, 1976, Decisions with Multiple Objectives: Preferences and Value Tradeoffs: New York, John Wiley and Sons.
- Kirk, J., and M. L. Miller, 1986, Reliability and Validity in Qualitative Research: London, Sage Publications.
- Klein, G. A., 1998, Sources of Power: How People Make Decisions: Cambridge, MIT Press.

- Klein, G. A., and K. E. Weick, 2000, *Decisions: Making the Right Ones; Learning from the Wrong Ones: Across the Board*, v. 37, p. 16 - 22.
- Lamb, F. E., G. S. Simpson, and J. H. Finch, 1999, *Methods for Evaluating the Worth of Reserves in the Upstream Oil and Gas Industry: Geopolitics of Energy*, v. 22, p. 2 - 7.
- Lee, M. D., 1999, *Algorithms for Representing Similarity Data*, Salisbury, South Australia, DSTO Electronics and Surveillance Research Laboratory, p. 1 - 58.
- LePine, J. A., J. R. Hollenbeck, D. R. Ilgen, and J. Hedlund, 1997, *Effects of Individual Differences on the Performance of Hierarchical Decision-Making Teams: Much More Than G: Journal of Applied Psychology*, v. 82, p. 803 - 811.
- Lichtenstein, S., and P. Slovic, 1971, *Reversals of Preference between Bids and Choices in Gambling Decisions: Journal of Experimental Psychology*, v. 89, p. 46 - 55.
- Luce, R. D., 1959, *Individual Choice Behavior: A Theoretical Analysis*: New York, Wiley.
- Macmillan, F., 2000, *Risk, Uncertainty and Investment Decision-Making in the Upstream Oil and Gas Industry*: PhD thesis, University of Aberdeen, Aberdeen.
- Malhotra, V., M. D. Lee, and A. Khurana, 2004, *Decisions and Uncertainty Management: Expertise Matters*: SPE 88511.
- Markowitz, H., 1952, *Portfolio Selection: The Journal of Finance*, v. 7, p. 77 - 91.
- McNamee, P., and J. Celona, 1987, *Decision Analysis for the Professional - with Supertree*: Redwood City, Scientific Press.
- Megill, R. E., 1971, *An Introduction to Exploration Economics*: Tulsa, Petroleum Publishing Company.
- Megill, R. E., 1988, *An Introduction to Petroleum Economics*: Tulsa, PennWell.
- Megill, R. E., 1992a, *Estimating Prospect Sizes*, in R. Steinmetz, ed., *The Business of Petroleum Exploration*: Tulsa, AAPG.
- Megill, R. E., 1992b, *Exploration Economics*, in R. Steinmetz, ed., *The Business of Petroleum Exploration*: Tulsa, AAPG.
- Megill, R. E., 1995, *The History of the Evolution in Concepts in Risk Analysis*: AAPG Bulletin, v. 79, p. 89a.
- Miles, M. B., and A. M. Huberman, 1994, *Qualitative Data Analysis*: London, Sage.

Mintzberg, H., D. Raisinghani, and A. Theoret, 1976, The Structure of "Unstructured" Decision Processes: *Administrative Science Quarterly*, v. 21, p. 246 - 275.

Morgan, M. G., and M. Henrion, 1990, *Uncertainty*: New York, Cambridge University Press.

Murphy, A. H., and R. L. Winkler, 1977, Reliability of Subjective Probability Forecasts of Precipitation and Temperature: *Applied Statistics*, v. 26, p. 41-47.

Murphy, A. H., and R. L. Winkler, 1984, Probability Forecasting in Meteorology: *Journal of the American Statistical Association*, v. 79, p. 489 - 500.

Naughton, N. C., 2003, *Strategic Decision-Making in the Upstream Oil and Gas Industry: Exploring Intuition, Analysis and Their Interaction*, University of Aberdeen, Aberdeen.

Newendorp, P. D., 1975, *Decision Analysis for Petroleum Exploration*: Tulsa, PPC Books.

Newendorp, P. D., and J. M. Campbell, 1971, Expected Value: A Logic for Decision Making: SPE 3327.

Newendorp, P. D., and J. Schuyler, 2000, *Decision Analysis for Petroleum Exploration*: Aurora, Planning Press.

Nooteboom, B., 2003, The Trust Process, *in* B. Nooteboom, and F. Six, eds., *The Trust Process in Organizations*: Cheltenham, Edward Elgar.

Nutt, P. C., 2001, A Taxonomy of Strategic Decisions and Tactics for Uncovering Alternatives: *European Journal of Operational Research*, v. 132, p. 505 - 527.

Nutt, P. C., 2002, *Why Decisions Fail*: San Francisco, Berrett-Koehler Publishers.

Oppenheim, A. N., 1992, *Questionnaire Design, Interviewing and Attitude Measurement*: London, Continuum.

Pieters, D. A., 2004, *The Influence of Framing on Oil and Gas Decision Making*: Marietta, Lionheart Publishing.

Plous, S., 1993, *The Psychology of Judgment and Decision Making*: New York, McGraw-Hill.

Quattrone, G. A., 1982, Overattribution and Unit Formation: When Behavior Engulfs the Person: *Journal of Personality and Social Psychology*, v. 42, p. 593 - 607.

Rose, P. R., 1985, Dealing with Risk and Uncertainty in Exploration: How Well Do We Predict? How Can We Do Better?: AAPG Bulletin, v. 69, p. 2046.

Rose, P. R., 1987, Dealing with Risk and Uncertainty in Exploration: How Can We Improve?: AAPG Bulletin, v. 71, p. 1 - 16.

Rose, P. R., 1992a, Chance of Success and Its Use in Petroleum Exploration, *in* R. Steinmetz, ed., The Business of Petroleum Exploration: Tulsa, AAPG.

Rose, P. R., 1992b, Risk Behavior in Petroleum Exploration, *in* R. Steinmetz, ed., The Business of Petroleum Exploration: Tulsa, AAPG.

Rose, P. R., 1994, Implementing Risk Analysis in Exploration Organizations: What Works? What Doesn't?: AAPG Bulletin, v. 78, p. 245 - 246.

Rose, P. R., 1995, Getting from Geological Chance Factors to Chance of Economic Success: What Are We Risking?: AAPG Bulletin, v. 79, p. 83.

Rose, P. R., 1996a, Risk Analysis in Exploration Plays: AAPG Bulletin, v. 80, p. 1331-1332.

Rose, P. R., 1996b, Risk Analysis of Prospects Versus Plays: The Play's the Thing: AAPG Bulletin, v. 80, p. 1530.

Rose, P. R., 1997, Prospectors, Managers, Lognormality and Uncertainty: AAPG Bulletin, v. 81, p. 1408.

Rose, P. R., 1998a, Taking the Risk out of Petroleum Exploration - the Adoption of Systematic Risk Analysis by International Corporations During the 1990s: APPEA Journal, v. 2, p. 56 - 61.

Rose, P. R., 1998b, What They Never Told You About Oil and Gas Economics: AAPG Bulletin, v. 82.

Rose, P. R., 2000, The Explorationist's Dilemma: The "Prospector Myth" Vs. Systematic Management of Prospect Portfolios: AAPG Bulletin, v. 84, p. 1691.

Rose, P. R., 2001a, The Relation of Corporate Organizational and Cultural Patterns to Exploration Performance: AAPG Bulletin, v. 85.

Rose, P. R., 2001b, Risk Analysis and Management of Petroleum Exploration Ventures: AAPG Methods in Exploration Series, v. 12: Tulsa, American Association of Petroleum Geologists.

Rose, P. R., 2004, Delivering on our E&P Promises: The Leading Edge, Vol. 23, p. 165 -168.

Rose, P. R., G. P. Citron, and M. A. McLane, 2002, Current Status of E&P Portfolio Management as a Corporate "Best Practice" - Obstacles, Solutions and Consequences: AAPG Bulletin, v. 86.

Rose, P. R., G. P. Citron, and M. A. McLane, 2003, The Link between Chronic E&P under-Performance and the "Prospector Myth": AAPG Bulletin, v. 87.

Rudduck, N., A. Khurana, M. Congreve, and J. Lourens, 2006, Multiobjective Decision Making: A Critical Analysis of the Applicability of Renewable Energy Technologies: SPE 101770.

Russo, J. E., and P. J. H. Schoemaker, 1989, Decision Traps: Ten Barriers to Brilliant Decision-Making and How to Overcome Them: New York, Simon & Schuster.

Russo, J. E., and P. J. H. Schoemaker, 2002, Winning Decisions: New York, Currency.

Savage, L. J., 1954, The Foundation of Statistics: New York, Wiley.

Schuyler, J., 1999, Decision Analysis Collection: Aurora, Planning Press.

Schuyler, J., 2005, Balanced Scorecard Linked to Shareholder Value: Making the Numbers Count: SPE 94539.

Schuyler, J. R., 1997, Best Practices in Project Evaluation and Influence on Company Performance: Journal of Petroleum Technology, v. 49, p. 818-825.

Shepard, R. N., 1964, Attention and the Metric Structure of the Stimulus Space: Journal of Mathematical Psychology, v. 1, p. 54 - 87.

Shepard, R. N., 1974, Representation of Structure in Similarity Data: Problems and Prospects: Psychometrika, v. 39, p. 373 - 422.

Shepard, R. N., 1980, Multidimensional Scaling, Tree-Fitting, and Clustering: Science, v. 210, p. 390 - 398.

Simon, H. A., 1956, Rational Choice and the Structure of the Environment: Psychological Review, v. 63, p. 129 - 138.

Simon, H. A., 1990, Invariants in Human Behaviour: Annual Review of Psychology, v. 41, p. 1-19.

Simpson, G. S., F. E. Lamb, J. H. Finch, and N. C. Dinnie, 2000, The Application of Probabilistic and Quantitative Methods to Asset Management Decision Making: SPE 59455.

Skinner, D. C., 1999, *Introduction to Decision Analysis*: Gainesville, Probabilistic Publishing.

Slovic, P., 1982, *Toward Understanding and Improving Decisions*, in W. C. Howell, and E. A. Fleishman, eds., *Human Performance and Productivity: Vol 2, Information Processing and Decision Making*: Hillsdale, Erlbaum.

Slovic, P., 1993, *Perceived Risk, Trust, and Democracy: Risk Analysis*, v. 13, p. 675 - 682.

Smith, C. S., 1999, *Divisional Strategy: Value Creation and Relatedness within the Multidivisional Firm*: PhD thesis, Warwick Business School, Warwick.

Sneider, R., 1999, *Multidisciplinary Teams in Exploration and Production - Their Value and Future - Part 1 - Concepts, Definition and Team Successes: The Leading Edge*, v. 18, p. 1366 - 1370.

Sneider, R., 2000, *Multidisciplinary Teams in Exploration and Production - Their Value and Future - Part 2 - Financially Successful and Unsuccessful Teams: The Leading Edge*, v. 19, p. 28 - 31.

Sneider, R., 2000, *Multidisciplinary Teams in Exploration and Production - Their Value and Future - Part 3 - Building Successful Teams, Team Recognition and Rewards, and MDTs in the Future: The Leading Edge*, v. 19, p. 136 - 137.

Snow, C. C., and J. B. Thomas, 1994, *Field Research Methods in Strategic Management: Contributions to Theory Building and Testing: Journal of Management Studies*, v. 31, p. 457 - 480.

Soelberg, P. O., 1967, *Unprogrammed Decision Making: Industrial Management Review*, v. 8, p. 19 - 29.

Stanfield, R. B., 2000, *The Art of Focussed Conversation: 100 Ways to Access Group Wisdom in the Workplace*: Toronto, Canadian Institute of Cultural Affairs.

Steiner, I. D., 1974, *Whatever Happened to the Group in Social Psychology?: Journal of Experimental Social Psychology*, v. 10, p. 94 - 108.

Steiner, I. D., 1983, *Whatever Happened to the Touted Revival of the Group?, in H. H. Blumberg, A. P. Hare, V. Kent, and D. M.F., eds., Small Groups and Social Interaction*: Chichester, Wiley.

Stirling, W. C., 2003, *Satisficing Games and Decision Making*: Cambridge, Cambridge University Press.

Suslick, S. B., R. Furtado, and F. Nepomuceno, 2001, Integrating Technological and Financial Uncertainty for Offshore Oil Exploration: An Application of Multiobjective Decision Analysis: SPE 68579.

Szidarovszky, F., M. E. Gershon, and L. Duckstein, 1986, Techniques for Multiobjective Decision Making in Systems Management: Amsterdam, Elsevier.

Tenenbaum, J. B., 1996, Learning the Structure of Similarity, *in* D. S. Touretzky, M. C. Mozer, and M. E. Hasselmo, eds., *Advances in Neural Information Processing Systems*: Cambridge, MA, MIT Press, p. 3 - 9.

Tetlock, P. E., 2002, Theory-Driven Reasoning About Plausible Pasts and Probable Futures in World Politics, *in* T. Gilovich, D. Griffin, and D. Kahneman, eds., *Heuristics and Biases: The Psychology of Intuitive Judgement*: Cambridge, Cambridge University Press.

Thaler, R. H., 1992, *The Winner's Curse: Paradoxes and Anomalies of Economic Life*: New York, Free Press.

Tomassini, L., I. Solomon, M. B. Romney, and J. L. Krogstad, 1982, Calibration of Auditors' Probabilistic Judgements: Some Empirical Evidence: *Organizational Behavior and Human Performance*, v. 30, p. 391 - 406.

Tversky, A., 1969, Intransitivity of Preferences: *Psychological Review*, v. 76, p. 31 - 48.

Tversky, A., 1977, Features of Similarity: *Psychological Review*, v. 84, p. 327 - 352.

Tversky, A., and D. Kahneman, 1974, Judgment under Uncertainty: Heuristics and Biases: *Science*, v. 185, p. 1124 - 1130.

Tversky, A., and D. Kahneman, 1982, Judgments of and by Representativeness, *in* D. Kahneman, P. Slovic, and A. Tversky, eds., *Judgment under Uncertainty: Heuristics and Biases*: Cambridge, Cambridge University Press.

Tversky, A., and D. Kahneman, 1983, Extensional Versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment: *Psychology Review*, v. 90, p. 293 - 315.

UKOOA, 1999, *A Framework for Risk Related Decision Support*, London, United Kingdom Offshore Operators Association.

Ullman, D. G., 1995, A Taxonomy for Classifying Engineering Decision Problems and Support Systems: *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, v. 9, p. 427-438.

Verbeemen, T., G. Storms, and T. Verguts, 2004, Similarity and Taxonomy in Categorization: COGSCI 2004.

Vickers, D., 1970, *Freedom in a Rocking Boat*: London, Allen Lane.

von Neumann, J., and O. Morgenstern, 1947, *Theory of Games and Economic Behavior*: Princeton, Princeton University Press.

von Winterfeldt, D., and W. Edwards, 1986, *Decision Analysis and Behavioral Research*: Cambridge, Cambridge University Press.

Wason, P. C., 1960, On the Failure to Eliminate Hypotheses in a Conceptual Task: *Quarterly Journal of Experimental Psychology*, v. 12, p. 129 - 140.

Watson, P., 1998, A Process for Estimating Geological Risk of Petroleum Exploration Prospects: *APPEA Journal*, v. 38, p. 577 - 583.

Welsh, M. B., 2005a, *Matlab Data Analysis Algorithms*, Adelaide, Unpublished.

Welsh, M. B., 2005b, *Matlab Data Collection Algorithms*, Adelaide, Unpublished.

Welsh, M. B., S. H. Begg, and R. Bratvold, 2006, Correcting Common Errors in Probabilistic Evaluations: Efficacy of Debiasing: SPE 102188.

Welsh, M. B., S. H. Begg, R. Bratvold, and M. D. Lee, 2004, Problems with the Elicitation of Uncertainty: SPE 90338.

Welsh, M. B., R. Bratvold, and S. H. Begg, 2005, *Cognitive Biases in the Petroleum Industry: Impact and Remediation*: SPE 96423.

Whyte, W. F., 1984, *Learning from the Field: A Guide from Experience*: Beverley Hills, Sage.

Yin, R. K., 1989, *Case Study Research: Design and Methods*: Beverley Hills, Sage.

Yin, R. K., 2004, *The Case Study Anthology*: Thousand Oaks, Sage Publications.

Appendices

1. Papers Published during Research
2. Outline of Semi-Structured Interview
3. Request to Participate in Semi-Structured Interviews
4. Transcripts of the Digitally Recorded Semi-Structured Interviews
5. Summary Notes of the non Digitally Recorded Semi-Structured Interviews
6. Decision Scenarios
7. Submission for approval of the University of Adelaide's Human Research Ethics Committee
8. Participant Request
9. Information Sheet
10. Consent Form
- 11a. MATLAB Data Collection Algorithms
- 11b. MATLAB Data Analysis Algorithms
12. Decision Process and Decision Type

APPENDIX 1

Papers Published During Research

Mackie, S.I., Welsh, M.B. & Lee, M.D. (2006) An Oil and Gas Decision-Making Taxonomy.
Society of Petroleum Engineers (U.S.) eLibrary Database

NOTE: This publication is included on pages A1.2-A1.10 in the print copy of the thesis held in the University of Adelaide Library.

It is also available online to authorised users at:

<http://dx.doi.org/10.2118/100699-MS>

Once paper is located, click "Add to Cart" and then "Checkout".
Click the "Member/Subscriber Checkout" button and then enter name and email address

Mackie, S.I., Begg, S.H., Smith, C.S., & Welsh, M.E. (2007) Decision Type: A key to realizing the potential of decision-making under uncertainty. *AAPEA Journal*, 22 (1), p 307 – 317.

NOTE: This publication is included on pages A1.11-A1.21 in the print copy of the thesis held in the University of Adelaide Library.

APPENDIX 2

Outline of Semi-Structured Interview

**INTERVIEW
TO DETERMINE
HOW DECISIONS ARE MADE**

Introduction

- Steve Mackie, PhD student, contacting you to assist in determining how decisions are made in upstream oil and gas companies
- I am striving to interview those involved in decision-making to review various aspects of decision-making
- This will be the first interview and it is designed to be qualitative in nature. A possible second, follow-up, interview will be more quantitative
- The purpose of the discussion is research only. Results are to be published as part of PhD and in industry journals but will be totally anonymous. All answers will be treated as confidential. Information disclosed in the interview will be kept securely at the university
- Interview should last about 60 minutes
- Do you mind if the interview is recorded?

Roles and Responsibilities

1. What is your job title? (Make note of company, position, experience, training, etc)

2. What does decision-making mean to you?

Now define a decision as:

**The conscious, irrevocable choice to allocate resources
to achieve a desired objective**

3. What decisions do you have input to?

4. What decisions are you responsible for making?

5. How would you determine if you are the decision-maker or simply having input to a decision?

6. Describe how decisions are made in your organisation?

7. How do you define what a “good” decision is?

8. How does your company define what a “good” decision is?

Decision Types

9. What are some of the different **types** of decisions that you have made?

10. Why do you consider these to be different types?

11. Here are some decision situations. I would like to look at them one by one and have you verbalise how you would go about making the decision.

12. Now can we take a decision that you have made lately – one that really sticks in your mind – and do the same thing? Can you walk me through the steps you took in order to make the decision?

13. Here is a template that allows decisions to be typed (Explain the four dimensions). How would you classify the decision you have just described, based on this template?

Decision-Making Processes and Tools

14. Does a **formal or informal decision-making process** exist in your organisation?

Formal Informal Don't know

a) Can you give an explanation of it and some examples?

15. Does your organisation use any specific processes in decision-making?

Yes No Don't know

a) If yes, what is the process?

b) Is the process the same no matter what type of decision is being made? In other words, does it change depending on the type of decision being made?

16. Does your organisation use specific **tools** in decision-making?

Yes No Don't know

a) If so, what tools do you use?

b) What stage/level in the decision-making process are they used?

c) How effective are they in this position?

d) Are they used with just a certain type of decision?

17. Is any internal or external software used to aid decision-making in your organisation?

Yes

No

Don't know

If so,

a) Which software package/s is/are used and when?

b) How is/are the results of the software tool/s integrated into decision-making?

c) Do you think that this/these tool/s have increased the ability to make “good” decisions in your organisation?

Yes

No

18. Do you think software tools, in general, assist decision-making?

Yes

No

19. Are decisions in your company primarily based on the output from the software packages?

Yes

No

Don't know

If not what occurs to the output prior to the decision being made?

Learning Feedback

20. Does your company have a formal learning feedback process where the **actual implementation** of decisions is compared to the original decision's recommended implementation?

Yes

No

Don't know

a) If so how would you describe its success?

b) How often is it used per type of decision?

21. Does your company have a formal learning feedback process where the **outcomes** of decisions (results to date) are compared to the original predictions?

Yes

No

Don't know

a) If so how would you describe its success?

b) How often is it used per type of decision?

Comparison and Future

22. How effective do you think your company's decision-making processes and procedures are in comparison to your main competitors?

Increasing effectiveness and efficiency



0 1 2 3 4 5

23. Are any changes likely in the foreseeable future to your current practice?

Yes

No

Don't know

If so, can you share further details?

Thank you for the time taken to conduct the interview. Do you have any further comments?

Comments:

APPENDIX 3

Request to Participate in Semi-Structured Interviews

To: "XXXXX, Xxxxx" <xxxxx@xxxxx.xxx.xx>
Subject: Research Interviews
Sent: Friday, 11 August 2006 11:51 AM
From: Steve Mackie [<mailto:steven.mackie@adelaide.edu.au>]

XXXXX

As you know for the last year or so I have been undertaking a PhD at the Australian School of Petroleum with the University of Adelaide. I am working within the portfolio area and specifically researching how oil and gas companies make decisions under uncertainty. My aim of course is to help improve that process. I am now at the stage where I would like to interview several CEOs and senior managers to look at finding answers to the basic question: "How do upstream oil and gas companies make decisions under uncertainty?"

I was hoping to interview yourself, XXXXX, XXXXX, XXXXX and XXXXX from XXXXX. The interviews would be recorded and transcribed to allow analysis but they will be highly confidential with all records kept according to the university's confidentiality requirements. I would also be happy to sign any confidentiality documents you may require as well to facilitate getting the data.

I have attached a draft of the outline of the interview so you can get a feel for the things I am looking to find out. Based on dry runs, I estimate that the interview would take about 1 hour of your time.

If its OK, I will give you a telephone call mid next week to follow-up and hopefully set up a time.

Looking forward to speaking with you.

Steve

--

Steve Mackie
Australian School of Petroleum
Adelaide University
North Terrace
Adelaide SA 5005
Australia
Phone: +61 8 8303 8048
Mobile: +61 411 092 721
Fax: +61 8 8303 8030
e-mail: steven.mackie@adelaide.edu.au

This email message is intended only for the addressee(s) and contains information which may be confidential and/or copyright. If you are not the intended recipient please do not read, save, forward, disclose, or copy the contents of this email. If this email has been sent to you in error, please notify the sender by reply email and delete this email and any copies or links to this email completely and immediately from your system. No representation is made that this email is free of viruses. Virus scanning is recommended and is the responsibility of the recipient.

APPENDIX 4

Transcripts of the Digitally Recorded Semi-Structured Interviews

***Interviewee: Participant A (A)**

***Interviewer: Steve Mackie (S)**

S: But that's not my view [inaudible]. You've heard that before. [inaudible] are a record of what we meant to say. Everyone edits them to make them that way. So the aim of this is really just to get things off the top of your head.

A: Okay.

S: And a little deeper but it's around the aim of decisions, decision making, the processes you go through and so to start with we just want to see what you mean by decisions versus what we mean and whether they're the same. So what do you think decision making is to you?

A: Okay. Every question that deserves an answer entails a decision.

S: Whether to answer or whether not to answer. Okay. Good.

A: And decision making is all about taking into account factors using your experience and judgement and I would suggest to you the more cannibal you are for your decisions the more rigorous one tends to be in the process for decision making. At least to the extent that you provide some foundation for your decision irrespective of whether or not you explained how you arrived at your decision.

S: That may even be in the form of justification.

A: Yes.

S: But accountability leads to better process.

A: Absolutely. You know transparency breeds covering [inaudible].

S: Okay then. The things that I like to include in decisions, three key words for me are that its irrevocable allocation of resources so the person who is actually make the decision is the person who allocates the resource, that's one of the things.

A: I don't know that the buck every stops at one place.

S: Okay.

A: Especially in a team or collaborative environment. You actually can only ever make decisions for the resources at your disposal. You can't make decisions for resources that aren't at your disposal and a lot of decisions entail somebody else's resources.

S: Correct. So is that really decision making or is that you passing on recommendations?

A: Well there are a few slogans or [inaudible] we operate open. One the only kind of a good surprise is no surprise and actually start with the end in mind and understand what you'll need and need early and actually join all the participants in the decision making process so that you're actually making the decisions in parallel rather than series because if it's anything that efficiency and effect is bred from it's actually being openly inclusive 360 degrees in all of the people and organisations that are going to be both required to implement and be effected otherwise you'll be just actually making, not making good time.

S: Right. It will be much less efficient.

A: Yeah. Work in parallel not in series. Make sure all the silos are communicating.

S: Okay. The other key word that I use is choice and you've talked about. So you've got to actually choose between two things if there's no choice.

A: Called priorities. First thing first and I don't disagree with the approach, the matrix approach that there's the urgent, the non-urgent, the important, the not so important and there's no question that people respect feedback even if it's thanks I got that, I'll get back to you. They even more appreciate here's my decision quickly, promptly. You build trust and forgiveness from being explicit and expeditious every step of the way.

S: Everything is very open as it can be.

A: There's another credo around here and this is mine and I've only developed this philosophy since I moved from a company environment in which there was always insufficient time to deal with an imperfect data set to reach what you knew would be an imperfect but you hoped on balance a correct decision and when I moved for corporate to government and found out at least I had a grace period to find my feet I realised that the saying that the only thing you need to know in life and business is innovation and marketing, that is build a better mousetrap and then make sure people know that you've got one. That build trust and reduce uncertainty was what government needs to run with as its credo.

With for instance in our area land access being the starting point from everything and trusted land access being the lag action which leads to further sustainable land access the build trust is all about doing as you say and also delivering to expectations. The reduce uncertainty is all about actually prioritising working out what are the most material things to work on, understanding what are the critical uncertainties and expected value term and use your pittance and constrained resources to actually only do those things that matter. So the first portion of a day almost always starts with what's on the plate, what am I going to chew on and what are my people going to chew and what are the things that I impede if I don't chew on first and how many of the subsequent projects kicked of implemented by others can I keep in tow and go moving ahead by just simply doing this or that and not actually have that end up working in series rather than parallel.

S: Okay. So you've got time?

A: Well I had time to think and actually I don't have that luxury anymore but I did for some months and the time to think got me to the point where I do know understand that there only really three important things. Build trust, reduce uncertainty and have fun.

S: There you go. I'll put those ones in. I like all the credos. So how in your mind would you separate the person who makes the decision from the person who inputs into the decision?

A: We'll I'd have to suggest to you that the only real difference is experience and training in most instances. There's authority or delegated authority but really the good idea will stand up through those echelons, it doesn't require ... a good idea doesn't require the right hand corner office to come up with it. So I'd suggest to you that it took years for me to understand how to work on just the material things and not be so detailed, so interested in myriad details irrespective of the materiality of it and I don't think anybody coming in through university into a profession instantaneously has [inaudible] to separate the interesting from the material which may also be interesting. So I guess what I would suggest is that more experienced people tend to cut to the chase sooner, they don't need to build from the ground up each and every decision, they have enough credibility checks to know what incremental analysis is required to reach a decision whereas inexperience would not actually necessarily know where to start and does need some mentoring.

S: Okay. So experience allows you to step in here higher up the decision process than here.

A: And I guess the other issue though in the build trust part of the business that doesn't mean that you won't actually be held accountable for tracing the logic of how you got there but that becomes relatively easy with a memory and a cognisance of why you actually started from that upper level.

S: Okay. Good. And finally as an intro good decision making. What makes a good decision?

A: Good decision. I'll actually define the best decision before I define a good decision. The best decision is one which is consistent with ones principles and the ambitions. I don't think a good decision necessarily has to be consistent with all of those things.

S: So there's only two that you've mentioned there, principles and ambitions.

A: Well I [inaudible] objectives when I say ambitions I mean objectives, I mean outcomes.

S: All of those.

A: Yeah. All of those things.

S: So that's the best one. Whereas a good one [inaudible].

A: A good one can actually not be founded on every shred of information only to time constraints. A good one could be not based on every shred of information you can possibly get because of cost constraints. So the best decisions are always based on everything you can get and fit your principles and meet your objectives. But a good decision is one made to time to budget and has the intended outcome. Because you don't actually know if you've made a good decision until you've had a chance to audit it.

S: What if you, I'll have to use the word good, what if make a decision and it leads to a bad outcome but that was because of the way it was implemented?

A: That's we call experience.

S: So it's not a bad decision?

A: No. If you're not falling you're not learning. By the way people have over-paid, people have underbid, both of those you could call those bad decisions but it's part of the learning curve in getting your [inaudible]. People who drill dry holes, it happens all the time. So there isn't by the way a chopping block for the head that makes a decision that doesn't reach its intended outcome. I would suggest to you that more often than not especially in the oil and gas business we are bound to be wrong in terms of locating wells, to find commercial quantities of petroleum that flow at an economic rate and what we basically have to do is be willing to learn. Though we get back to Topfner's philosophy that the only thing in life that you need to know how to do is change, which is learn.

S: Good. I like that. I'm going to use that one. The things that I'm really investigating are what we're calling decision types. Our hypothesis is that if you can match the process of making a decision to the type you'll end up with a better decision. So that's where we're coming from. So when you hear the word type of decision, what might you be thinking, where do you go?

A: I have to say that we had an earlier conversation so I will use the word taxonomy which I hadn't actually heard used recently except in the relationship to palaeontology and biology but it is true to say that higher of your taxonomy of decision making and actually speed, the quality process and a good example, just this morning we were talking about occupational health and safety risks and we were talking about organisational risks and where different processes had been provided for occupational, health and safety which deals with the risk of a particular activity of an individual as opposed to a different methodology proposed for decision made about what you should do to mitigate organisational risk which entailed groups of individuals working together in some way, shape or form and it was interesting.

Though you would have thought that the risk assessment process leading to what are the steps that can materially reduce the chance of an occurrence of crap happening would have been similar but coming from two different directions hoping for the same intent we found out that one of the processes which was offered for occupational health and safety because we're experienced in how we handle organisational risks we're able to pick it apart and realise why it wasn't working for us. It was a [inaudi-

ble] where we actually, somebody tried to turn nodes on decision trees into something which was going to be easy to deal with and in the process for people who are well aware of decision tree logic. It just [inaudible] and in fact we found out it was double dipping on calculating uncertainty and actually over risked things.

S: What's going on?

A: So a long story short what I'm getting to is that there are inherent dangers in approaching decision making in anything but a well understood way and so if you've characterised your decisions that's fine but on top of that the process can actually can invade and bias our decisions and one needs to be cautious about that. I may have gone on.

S: No, no. That's exactly where I'd like to come from. You've said it now so I wouldn't have prejudiced you beforehand. I firmly believe that the process you use to decide how ...

A: [inaudible].

S: You've still got it have you?

A: No. That was [inaudible].

S: Okay.

A: But basically it was we had a [inaudible].

S: [inaudible].

A: Yeah. And we had an expert occupational health and safety and he ran us through the [inaudible] and basically we took the idea of driving a four wheel drive vehicle down to Mt Gambier and knowing that you can go out to get statistics about what was the actual risk for the idea of ... the risk of driving to Mt Gambier and having an accident which resulted in serious injury or death and what we found was that the occupational health and safety case was not starting with the articulation of the question properly. It was actually having you guess at what the outcome would be. In other words they only want you to say what the risk of driving the car is. Well that led you down to the fact that well the risk of driving a car is that somebody is going to die and that's catastrophic. So we actually and because we undertake any catastrophic risks where we can't drive any more.

S: Because you didn't open it up early.

A: We didn't actually frame the question. Okay. I think that quintessentially is the most serious starting point of decision making is appropriately framing the question you're trying to answer or how XXXXX used to say make sure it's a question worth answering.

S: Well that's the next one. Is it worth spending the time on? So, yes in taxonomy, so you've heard us use that word. We've developed a taxonomy that is fairly

generic. We wanted to make it generic to all sorts of decision making, not just oil and gas and it has four main dimensions. The first of those is we call it complexity, but essentially it's the process and how much is involved in the process. So is it serious decision making, is it parallel decision making? Does it require something very simple or is it very complex?

A: This gets back to complex [inaudible], desired outcomes or objectives or goals or targets, whatever you want to call that at the end. The lag results from lead actions. When you've been down the path and you've gotten to the point where the outcome is there to be real even then you could go woo, god that was complex. All of the things that you had to bring along ancillary, especially if in fact people's feelings are part of the outcome that you desire to remain intact or for that matter stakeholder respect which is sort of like the same thing but I would suggest to you that if you've ... this gets back to dissection.

If you have a request from somebody to [inaudible] is to deconstruct it and to dissect it to understand exactly what is being asked, the request and refrain if for no other purpose so those who are going to implement the undertakings to provide a framework for the decision making, understand what's wanted and to actually lay out what is a sort of workflow that will need be undertaken in an intuitive way and I don't mean [inaudible] way. Before you actually get started I actually find that just white boarding things with the people, with a small group of people no more than one or three is a great way to dissect a request that requires a decision and I do find for whatever or other reason that [inaudible] is as good in architecture as any if things are exceedingly complex.

What I have learned actually in the last three years that when you don't know what you want which is probably one of the most complex issues. So for instance let's have a plan for energy. Okay. Well what do we want? Do we want safe, secure, price competitive, robust in emergency, attractive for investors and are energy supplies that are environmentally friendly, I forgot to say that. Okay. Well now we know what we want what can we do to facilitate, foster, direct, lead, and implement actions that lead to those outcomes? Well in taking the strength, weakness opportunity threat approach all of the opportunities that you list are things that one might consider to implement and what we've implemented, what we did here and we're doing, we run a greenhouse strategy and was something actually developed by our team.

On a one to four scale vertical and a one to four scale horizontal do-ability versus materiality and just take all of those opportunities which have a contra positive in terms of the threats and you've already gone, you're already starting to intuitively realise this and say well which ones are the ones that actually are doable and very material. Will this get started? What are the ones that are impossible and measly? Well don't even both. And it's sort of the cow star, the same as the Boston consulting group approach to quadrants and so I suppose I take more of an intuitive statistical approach based on [inaudible] tables using linguistic variables for quality, chance of happening, value of happening to risk rank or to prioritise. What's the first thing first?

S: And if you did that for each and every one of your objectives that would get ... we use the term ambiguous because some of those may overlap and you're looking at them separately.

A: Yeah.

S: So as well as being complex it could also be highly ambiguous.

A: Yeah. So for instance cheap, competitively priced doesn't necessarily mean low emissions. So you're going to have healthy tensions between some of your ambitions and so I think complexity is as much built from conflicting desired outcomes that if everybody wants exactly the same thing they're not going to be that complex but in fact you're trying to be something to everybody and so much more especially in a political world, a political word becomes eminently more complex than a straight commercial world where it's just a matter of NPV.

S: Good. So that's exactly it. The other two dimensions that we use are constraints, you've actually talked about that, time and money being two of the main ones and then we have a dimension called environment of information structure. That is the how do I get the information? Have I used this before?

A: And this gets back to Covey's sharpening the saw and I say that because the old story about oh we spent 90% of our time looking for data. You really do have to grow a garden where in your sphere of decision making ready, easy, access to information, input once for ever databases or the lifeblood of efficiency and if you go down the workflow of data generation to value adding to access to retrieval one really does only want to ever hold the piece of paper or the bite once. So in our sphere we've certainly tried to get the data acquisition process which is one not controlled by us, controlled by industry but for the benefit of industry to now be digital not analogue.

To now be digital within certain data schemes. So here's a gig in a box ready to rock and roll on the work station and [inaudible] information converted to make it readily accessible. So there's a fair amount of grooming background work which if it doesn't reduce uncertainty because eventually you could get that data and manage it and process it and get it back. It certainly does add time value to decision making because it takes less time and time is money.

S: Good. What I want to do is ask you to think of a decision that you've made recently. This is not one that you've had input into but one where you actually made the decision and I want to try and firstly type it by that taxonomy so have you decide how complex [inaudible].

A: Absolutely. There are two of them I can think of.

S: Okay.

A: And I'll give you two. First thing we now manage a sector which doesn't have a cash flow that the community wants to win the geothermal sector. The geothermal sector demonstrates resource is [inaudible] extensive with very few else. I mean its granite, it's hot, and it's expensive. So the same rules for the size of licences for geothermal to be practical are not the same rules for petroleum to be competitive and we realised that we needed to enlarge what people could retain and also use different criteria for proven plus probable limits to retain areas where they had drilled one well,

they hadn't done anything to demonstrate commerciality but they really did earn the right for a retention licence all over the place and once they had that, not having a cash flow we couldn't really use the square kilometre charge for petroleum for retention of production licences as being a realistic charge for three reasons.

One they weren't doing much, they weren't causing us a big expense for compliance. Two they couldn't afford it and three honestly government would be overcharging so it's really only two things. They didn't really create the cost which is a reason for a licence fee because they're not doing much and two they couldn't afford it. So we went ahead and said what's the most expensive PPL, quite arbitrary, what's the most expensive PPL. It happened to be \$120,000 a year. I said right, the most expensive GPL production licence or GRL is going to be \$120K. We have an arbitrary but balanced benchmark out of thin air. When then said of course when somebody is not undertaking work irrespective of their capabilities you're a low surveillance operator.

They pay 60 because it's half the price and you realise that and then we changed it from a 100 square kilometres to 1,000. So we'll now charge a maximum of \$120,000 per annum licence fees on GRLs and GPLs and when they're not any work at \$60,000 over something which is 10 times and if you'll have it a decision that we did on a whiteboard with a few people in the room and saying how do we do this, it's quite arbitrary, it was a good answer, it wasn't the only answer and it's been satisfactory, we've now got the first one through the door that stakeholders said okay we can tolerate \$60,000 a year.

S: Okay. So before making that decision ... that's a good one. So before making the decision did you worry about how complex it might be or how ambiguous?

A: We did a SWAT and we basically said well where are these guys, at what point do the punters can they not actually afford this. At what point do we actually taking money out of the mouths of research and progress that in fact ... it's not that we can't use it. We could do pre-competitive but [inaudible] they may be better at doing their pre-competitive studies and we're certainly not putting the time into it.

S: Were you under a time constraint?

A: No. We knew that the first of the GRLs were going to come up for surrender five years from 2001. Hey we're here. Okay. So we knew we needed it in 2007 and we actually at the Hot Rock conference for the last two years we sort of enunciated that, at the [inaudible] conference we enunciated that. It's part of the green paper for the changes to the Petroleum Act and we have discretion on fees myself as delegate for the Minister to actually give dispensation like this so we don't actually have to ask to implement in advance of actually modifying based on the intent. So [inaudible] and we've gone to all of the geothermal places. So we actually had an [inaudible] approach on [inaudible] relatively complete stakeholder engagement to close the loop.

S: Okay. Had it ever been done before elsewhere?

A: I've got no idea; we're running ahead of the bulldozers here.

S: Okay.

A: We didn't actually have anything to go on. If there is something to go on we didn't bother to try to uncover it.

S: That's good. By the taxonomy I would draw that decision as what we call block decision.

A: Okay.

S: That was highly complex, highly ambiguous because you're trying to accommodate everyone. Your time constraints are not all that great but you have never done this before.

A: We knew what the outcome was. We needed to have a fiscal resume that was both attractive and fair to government and the investor.

S: Now you've mentioned way back as you started that the guys seem to be happy with it.

A: Yeah. And they've already signed up.

S: Okay.

A: Without any ...

S: So do you take that as this was a good decision?

A: Well I guess what it breaks down to I'm sure there would have been a lot of other ways to approach it. I'm happy with the time it took to basically come to something which without us taking a vote on it appears to have at least a tacit acceptance e.g. silence and also the explicit acceptance e.g. we'll take it, first one through the gate. I fully expect that the least funded companies will bleat no matter what and so be it. I don't know that it will wash because at the end of it if somebody doesn't have something light \$60,000 a year minimum to forge ahead on a retention licence, I don't know that they have the financial capacity to say that we shouldn't have the land back up available for other people to bid on it. Contestability is an underlying ...

S: So just to reiterate the process. What I hear you say is you got a group together, so this was a group decision.

A: Actually I just erased it from my whiteboard.

S: You use the whiteboard, I've got that down and you use SWAT analysis. Did you do anything else as part of the process?

A: Well we actually gathered up benchmarks. We actually said right, what do we now charge for petroleum exploration licences? What do we now charge for petroleum retention licence or what do we now charge for petroleum production licences? What do we now charge for geothermal exploration licences and it was all the same. Okay. And right, we can't possibly charge for geothermal big areas but we charge ...

because they would have to paying \$4m and \$5m a year based on the per square kilometre and what people want to ... I mean [inaudible] would have had to pay us like \$3m a year just to sit on a limb for something that without a missions trading is not going to be commercial. There's a market failure and so we could actually ... we would have been in a position to in fact gazump the sector, lose all of the shareholders' money. I mean the actual ... when we looked at what the threat was, oh let's stick with this and let's actually bankrupt [inaudible].

S: And be their best friend.

A: We would have got a 10 and it wouldn't have stuck.

S: Okay. You've enunciated the process very well. Okay. Final one is on these different processes that process you use is that a formalized process or it's one you've developed or it's [inaudible].

A: I say there's not ... we do not have a corporate or a group process police. What we have are four functional units that day in, day out come together on projects as multi-disciplinary teams that form and un-form. Each one of our functional groups are global experts in their functional areas and also increasingly expert in the collateral areas from all of the experience I have in multi-disciplinary projects. Government actually has quite definitive objective based legislation and regulation within which to operate. We have got more than enough construct or context to constrain our operations, we don't need more. Flexibility is good.

S: And so would you use that same process say for example to make the decision of to whether award or not award retention lease for a petroleum licence?

A: Okay. I'm going to go right back to the very beginning. We have a strategic plan that we revisit once every 24 months formally. The strategic plan has seven main desired outcomes. One of the desired outcomes is to have an attractive fiscal regime; one of the desired outcomes is to have a trusted regulatory regime. Another one is to be trusted by all of our stakeholders. Another one is to enable our people to be able to do their jobs. There is a healthy tension between wanting to demonstrate that things are infinitely contestable and being an attractive investment regime that doesn't move goal posts. So with that we clearly have policies which are very broad which say ... and this is in the legislation ... an explorer who finds petroleum is entitled to a production licence up to twice the proven plus probable limits of the field.

So to your specific question anybody who finds petroleum pursuant to the petroleum is entitled to a production licence up to twice the area of the field. The only thing that you can then say for instance is and this is a [inaudible] to some extent. If you so choose to orient that area of the licence to include an area which hasn't been drilled or demonstrated to be production but maybe could be a prospect. That's fine but you can't fulfil your work program obligations in the PEL by drilling in that PPL because there are no work programs in a PPL. So we've approached things somewhat differently and left them some number of years ago and now it's where the onus is, actually the decision making is strictly a matter for the company in some ways and what bought that change from what I have perceived to have been a nickel and dime of PPL

areas to ... it really it doesn't matter the area that you want, you can have up to [inaudible] tell us where it is.

We may actually argue with you what [inaudible] area is but we won't actually argue with you what this [inaudible] what we actually understand that but a good example was there were seven failed PPLAs that when they were offered as exploration licences no-one bid and when all seven were merged together and offered as a single PEL no-one bid. They have languished on the shelf now and it will be probably eight to ten years with no-one getting any benefit from that. We've proved nothing about contestability. Had we actually said right we're going to create our own rule which says that whoever wins the surrounding block gets it? No-one would have argued and they would now ... some of them would have been drilled and there might have been discoveries and benefits may have flowed.

And something I tell the team consistently look down the track and try to work out in your [inaudible] what is some of the undesirable outcomes that might follow your decision and you do need to think about what the downsides are as well as actually simply trying to be [inaudible] this is the little objective I'm trying to make. Contestability, another good way. In the mineral sphere of things first in is best dressed on over the counter bidding and whoever stakes the claim that's the claim, you've got it. There was a point in time when some might have said oh well if somebody calls for an area to actually demonstrate we've been contestable let us go ahead and say right our rules are you've applied for this area over the counter, we will go ahead and put in notice obscure or note into the newspaper and say that unless anybody else says something this is [inaudible] in 30 days. Well do you really think that we added that much more to contestability in the next 30 days up until the point where all our pre-competitive information was out there trying to entice a bid and the only advance on why bids might be lodged is the IP you've actually stolen from the company that bid. Maybe too strong a term.

S: Yes. But I can see what you're saying.

A: Okay. And so there's a new philosophy here too about when somebody lodges an over the counter bid. We instantaneously instigate the offer acceptance process with a letter that says you're ripped and we don't put it onto the website until they say yeah, we've got the bona fides to do this so we get [inaudible] about the financial and technical capabilities because there's always going to be some time between the lodgement of an application and you being able to undertake the due diligence to say you're the guys because you've got the right capabilities pursuant to the Petroleum Act. And we've mitigated the risk to people's IP and in that way I believe made this a more attractive investment destination by changing our philosophy within the constraints of the Petroleum Act.

S: That's as an aside, as an explorer that's a great idea. Back to here. What I'm interested in is the process ...

A: That was a very complex ...

S: I'm making an assumption and I just want to get it clarified and that is where the Act is very specific about defining what actually has to occur, the process you use in ...

A: Is [inaudible].

S: But it is a different process than one where the decision is very complex, the Act hasn't even considered it.

A: And what it breaks down is that unintended consequences, there are no principles that come without unintended consequences and abundant caution, restraint, discretion are behaviour sets that must rule during the decision making process. That you don't actually seek outside council until you actually know your own ... until you actually have a position or you've come to the point where you feel like you can't arrive at a position, things are so ambiguous that you can't. So whenever we've got a complex situation be it like that the GEL or be it like we had two overlapping applications lodged and all of a sudden we had no idea what to do, we're like a deer in the headlights because we hadn't actually done anything which created effect and [inaudible] accepted process even though we had two and all we could do was say by the guys we can't tell you who it is but somebody else has applied for something overlapping and if you give us permission to tell that other company your name and went to the other one and said the same thing, you can talk to each other.

We reckon that's better than where we can foresee this ending up eg. in the courts then us actually either calling for bids right now. So we're going to give you the opportunity to partner before we have to tell you that per happen stance you basically both applied ineffectively for the same places for the same time, we can't pick between you without one of you feeling pretty awful. So we're just going to have to put it for bid but you guys have got a choice, you guys can partner, resubmit applications and come back to us. They're doing that and again that was a complex one where we didn't have an answer and we didn't actually have an answer nor could we come up with an answer that would satisfy all stakeholders without actually turning the decision almost over to somebody else.

S: Did you use the same process, the whiteboard and the [inaudible]?

A: Yeah, we did.

S: Yeah. Okay. In all of these do you have any software? Do you use any software?

A: No. That's [inaudible]. And in fact that causes the computer to take pictures.

S: [inaudible] the way it's set up it looks like it's linked in. Yes you capture images but that's about it.

A: Yeah. And then we document it and instantaneously an email and that goes in the files.

S: Okay. But there are no giant spreadsheets?

A: No, no.

S: Okay.

A: The only thing that we use spreadsheets for, we obviously have accounting software for royalties and stuff like that and that's just accounting. We have every ... and something I've instigated here, we have a metric for every ... this probably will surprise you ... we have a metric for everything under the sun, kilometre, seismic, wells drilled, number of wells it encountered, accumulations, number of wells on account of accumulations, [inaudible] to differentiate geological and ... technical from commercial success, number of native title details, what our fees are relative to other states. We've got a spreadsheet which attempts to our people versus our number of licences to show what our ratio of head count. And we now also ... I'll get back to this. We have taken our strategic plan and we have structured our monthly report under the same headers.

So everybody reporting on a monthly basis actually harks back to our strategic plan as the skeleton outline for what they're reporting under. So we can actually ... so all of our operations, all of our actions are actually hierarchy split that they're always working towards one or another desired outcome under our strategic plan. When the state strategic plan came in we took our group strategic plan and there were like 87 targets or whatever and we mapped and we said well this that we're targeting does a little bit of that and little bit of that, a little bit of this and so we had like you know 16 state targets that this [inaudible] was contributing to. Explorations licences contribute to [inaudible] contribute to Aboriginal welfare. And then we took our budget and we split our budget, both our people and our project budget and put it to ... attribute all of it to both our strategic plan and the state strategic plan.

And then we lumped those things in different ways and I can show you clock diagrams of TBL, triple bottom line, environment, social, economic and I can tell you that our organisation is 60% of that economic and about 20/20 on social and environment and that's for our people and/or projects. I can also tell you that 75% of our budget and people work on regulation and 25% of our budget is on marketing trying to promote investment. I can also tell you that our head count has remained rather static since 1998 or so even though the licences have done that. Even though we actually not just petroleum but we're geothermal now too. And we do that because of the objective Petroleum Act which is basically allows everybody to understand what needs to be achieved instead of actually having to trace how people get there.

So we've tried to be fairly holistic. I've tried to be fairly holistic in how we plan to do our work through the budgeting process, how we can demonstrate what our work is meant to benefit by mapping to various strategic plans and with the matrix we've got ... we can actually talk about what are the outcomes, what are the measurable outcomes for Aboriginal welfare, what are the measurable outcomes for investment, attraction and competition with our jurisdictions like us.

S: By keeping the database of matrix.

A: Yeah. We are 90% of the licences and the investment in geothermal licence in Australia. And I can say that because I know.

S: You've got the data. Okay. And to help me understand it a little bit better. Can you think of a decision that you have made that is just you, where you haven't included other people in it? Or can I say do you ever make them like that?

A: I can tell you that I actually come to conclusions about where I think things will land but I never draw that decision as the final decision without consulting with my team.

S: So always a group decision?

A: There might be rare times when timelines don't afford you the opportunity but it's my [inaudible] the watermelon when I say for instance XXXXX got up in parliament and here's the Hansard and they need by noon and here's the answer and I [inaudible] people, not asked people whether or not that it was okay, it was an obvious thing.

S: So where time constraint is [inaudible].

A: Where time constraints ... we have constraints and sometimes you have no choice. I will say this ... also where privacy is involved, in HR contracts you can't consult all that widely.

S: Okay. Yeah. So there are some things where your basic premise would be grouping decision making.

A: Absolutely.

S: But there are ...

A: But that may not be the perception of my team.

S: Oh yeah. I'm not going to check that with them. That's not the purpose of this.

A: But I will say this that organisationally I'm very attracted to and I am maintaining and I have resisted request to change that I believe that having functional experts look after the health and hygiene and development to functional experts who come together all of the time on multi-[inaudible] projects, that's the way to go. So you have a matrix organisation which ensures the capabilities are there but ensure that projects get done and done well through collaboration and cooperation.

S: And when you've got a [inaudible] organisation you have to do it as a group?

A: Yes.

S: Okay. Well the last part. So won't keep you too much longer. I'd like to look at feedback. So in other words having made the decision, we talked about this geo-

thermal one, the feedback you got came from the people. But do you actually have a set up or a process set up ...

A: Very formal. We have quite a formal engagement process, a consultation process so for instance statement of environmental objectives has to be the subject of public consultation for at least a month but the way we do it is we actually say right company, it's your SEO, it's not our SEO, and it's your SEO. You go ahead and list all of your activities that you think create a risk and you go ahead and list all of the steps that you're going to take to mitigate those risks being something more than [inaudible] and by the way you consult more widely but we suggest, strongly suggest that you at least communicate with these organisations and these people who we see as stakeholders and when you're done, you come back to us and then we will take a look at the approval of that following a minimum of one month engagement through out website and stuff like that and depending on how high profile it is we may convene sessions and broadcast widely that we're convening sessions.

S: I was thinking more after the decision. So you've [inaudible].

A: Well we try to actually, what's a good example of ... I'll try to pick up an example of where we made a decision and we subsequently changed a decision. There was a longstanding policy on the website which was really just putting a flag up the flag pole which said that part of XXXXX's compliance policy we would post any notices of perceived non-compliance with the Petroleum Act on our website because research had been done by the head of the School of Criminology in Melbourne and the development of the Petroleum Act that said the single most motivating factor amongst corporate is shame and the shaming principle of actually putting dirty laundry out in public came to a head in an instance where one letter from one company was posted on the website and had the potential for that company to lose tens, if not hundreds of millions of dollar in litigation.

Legal advice was then sought and the legal advice said you cannot be judged during an executioner, in terms of natural justice you can only put on your website that which is not jeopardising any private commercial interests and where if there is some potential for that with the consent of the relevant parties. So there was an example where and by the way the decisions to post things ... I was here, I got here when that was the policy. I didn't wish to rock the organisation down to its core fundamental beliefs but I was very pleased to see unfettered discretion and as a consequence we still have people rattling around in their cages saying oh no, we've got to hang them high but no, no, we can't because we'll have the Minister's arse in a sling. So that's probably the most apt example I have where there was in fact a policy that wasn't law, wasn't regulation, it was well founded, it was well intentioned as are another suite of roads to hell.

S: But because of a formal feedback group you were able to rectify it?

A: Yeah. That formal feedback loop I think was a letter to the Premier.

S: Okay. What about when you implement a decision, do you ever have a look at how it's implemented as opposed to the outcome because ...

A: Absolutely. In terms of ... the answer is absolutely yes. Okay. And the answer is to minimise work.

S: Okay.

A: Okay. There is no question that there are 1,000 ways to get to Rome, some of them fast and some of them slow, some of them are efficient, some of them are effective and you want efficiency and effect and so we always think about efficiency and effect before we set off on a process. A good example is just today, we had a process foisted upon us that we couldn't seem to get it to work so we got the process inventor here for occupational health and safety from WorkCover and we had them with their little [inaudible] sit here and understand our decision making process and have it turn out that even if the question was what is the risk of somebody driving to Mt Gambier of an accident that has serious injuries or death as a consequence and you would say well in terms of frequency we don't do it that often, we occasionally do it.

In terms of likelihood well according to the road statistics it's a very low and even us I mean we're not like drink drivers here because of all of the controls that we have in place about four wheel drive training and this, that and the other so it was going to be a very low chance for an infrequent activity but their [inaudible] asked you to draw the line between where those things lined up which was done here and what was the outcome. Well the outcome was you still could have a death and the trouble was the question framed what the probability of that was but they were [inaudible] the probability of having a death appear and it was like a switch. If you have a death you're up in here in red and by the way you can't be insured. So you should stop driving.

S: That's the answer. If you want to avoid death you don't drive.

A: And so that was a good example of where we actually had to bring in the process inventor to show him how it actually ... under ISO 9000 you can actually ... you can meet ISO 9000 quality standards for the construction of concrete life preservers.

S: Thank you. [inaudible].

A: No, no. They were constructed perfectly well. The fact that they don't work is a separate issue.

S: That is a real problem. Okay. The last question. You use the two words. Effectiveness and efficiency.

A: Yes.

S: This is the only number that I would like from the whole interview and that is your assessment of your processes, your decision making processes in terms of effectiveness and efficiency. So I'd say ... zero being very bad to five being the ants' pants.

A: I'd say that we are unable to demonstrate our decision making process except in a generic way, with a generic description and we do not record all of the steps, all

of the information in a cohesive way to remonstrate how we actually made the decision. So it can't possibly be a five. On balance it's better than average and amongst our peers it is the best. So I'd say a four.

S: That's a well reasoned answer. And that's it XXXXX. So I hope ... what we're going to do now is obviously I'm going to try and get 20 or so of these done and see what I'm looking for and that's why I ask certain questions is did you use a certain process for a certain type of decision even though you may have considered ... I may consider them the same type.

End of recording

***Interviewee B: Participant B (B)**

***Interviewer: Steve Mackie (S)**

S: Okay, so in, I guess the best way to start is how, what you would think of when you're told you need to make a decision. What's a decision to you?

B: Well a decision I reckon, is when you've basically got to allocate resources or assets to the, to achieve an objective. It's sort of; if you're not allocating resources and out to achieve a result then it's not a decision.

S: Okay.

B: It's easier almost to think of it in terms of what it isn't. So, you've got assets and you've got to use them to achieve something. So a decision's the process to do it.

S: How would you define it?

B: Okay, right.

S: Sounds like you wrote the book. So, yeah that's exactly, the things that we like to think of in decision making, and I don't have to go too much because you've thought about it obviously. Is that it's an allocation of resources and we say that it's irrevocable. A lot of people argue about that, but you know, you might make a decision and then change your mind, well that's okay but you've actually allocated resources and to stop allocating resources is an actual other decision.

B: Exactly, and you've already incurred costs.

S: That's it. We say that it needs to be conscious, so, one of the big things that we researched down at the school right now, is this experience concept you know, and is that a sub conscious decision making thing or is it actually consciously done and those sorts of things. And it's to achieve desired objectives. So, [inaudible] and it has to be a choice. If there's no choice then there's no [inaudible].

B: Exactly, [inaudible] a no brainer.

S: Okay, so having got that sort of definition, the next thing I'm trying to determine is what decisions you actually make and what ones you might have input into. I'm actually looking at your experience and your role right now.

B: Okay, in terms of what the, my role as a manager, there's decisions revolving around staff, careers, career development, what they work on, decisions made about how they're performing, feedback etc, so I am allocating their time as a resource to achieve objectives. So, that's the people management side of things. It's will I support this reclassification, would I recommend that this person apply for another job, etc, etc, so it's the people management part of the job. Then I [inaudible] objectives that the branch is trying to achieve relate to promotional activities. To do the promotion we undertake research, applied research so there's a decision about what research pro-

jects and directions we're going to follow and what resources we need to do then. The promotional stuff, which conferences we're going to invest in, where we are going to travel to, what products are we going to develop, how are we going to market them, and so on. How am I going to package them up, how am I going to talk to people at conferences, how are my staff going to deal with that side of things. And then the other element is we do, XXXXX is involved in regulations so there's regulatory decisions to be made relating to license grant, bid assessment and we also make decisions on variations of licenses, suspensions, expiries and things like that. We will make decisions and in some cases it will be a direct decision talking to the company. In other places we will package up options and XXXXX has the responsibility to make the ultimate decision but I like to do what I can to help.

S: To make it easier, yes.

B: Yeah. So there's a lot of that sort of stuff.

S: So you've identified at least three main areas and you've also identified that some things you totally control and some things are passed on. And you see the difference very clearly by the way you've described it.

B: Yeah, and some of that is driven by the legislation. So XXXXX has this regulatory responsibility to make that decision, I don't. He's got the delegated powers under the Petroleum Act.

S: So, the DOA, is ... is that what you call it here?

B: Well, it's delegated powers but it's the same sort of deal. So yeah, you have to be very clear on what you can actually decide and talk often in conversation with a company or via emails, there are decisions that I can make. In other cases, and it will be a recommendation of XXXXX who will have, who has the regulatory powers to make the decision.

S: Okay. What would be a good decision in your mind?

B: In which area?

S: Any area.

B: Well a good decision is one that leads to, I guess, and efficient allocation of resources to get a, achieve a, you know a significant objective well. You know what I mean, you can measure that you've gone through a process, it might in a case of regulation it might be a consistent process to achieve efficiently a critical outcome for the group. Something that furthers taking the big picture, you know the state's economy though company investment.

S: So something that achieves a critical outcome. Okay. Good. Well that's all just introduction to try and piece it all out. The thesis that I am putting forward and so everyone knows up front where I'm coming from, is, in order to make good decisions, which I haven't defined yet, one needs to [inaudible] decisions and to apply certain

processes to those types, so that the process you go through for this type of decision is different for the one you go through for this type of decision. Okay? So that's the thesis I'm going through. One size does not fit all. Not essentially.

B: Certainly not, particularly when you've got regulatory processes and so on.

S: Okay, so you have experienced that, [inaudible] in your current role?

B: Oh, yeah.

S: Okay, so what ... any ideas or examples for that?

B: Well for some things that we do, like bid assessment, we've got a very clearly mapped process that we go through to determine a decision on who's got the best bid, so that is very process [inaudible].

S: So a clearly defined process for a bid.

B: [Inaudible] companies are aware of the methodology and adhere to it and that, so that, the discretionally stuff will come at XXXXX's level where he, if we've got a close situation he will weigh up what is the best benefit for the state. But we'll try and get it to the point where hopefully it doesn't have to do that.

S: Okay.

B: Through a very clearly defined process. Other decisions like you know, do we go to a conference or how do I market, how do I promote this and what research do we do, are not as rigorous and defined.

S: Okay, and would that be ...if I said decision type, I don't want to put words in your mouth but that seems to be how you're dividing them up, by your roles, would that be ..?

B: Yeah, I think so. They're fit for, they're driven by the roles. With regulation there are clear principles and procedures that really map out exactly what you're doing and I guess that's weighted on the risks of the organisation in terms of a bad regulatory, or the impact of a bad regulatory decision or a good regulatory decision versus, you know, if I don't, you know if we decided we'll send three people to APPEA instead of two, you know what I mean, it's slightly, [inaudible] this profile's different I guess.

S: Yes, and that leads to different outcome.

B: Yeah, so that then, that can then drive how much investment you put into standardising or developing procedures for sessions I guess, so there's a sort of an economic efficiency thing running in it too. It just seems easier for me to frame it around ... I mean I can [inaudible] the regulatory roles but a better way would be probably be to [inaudible] significance of the decision, the risk level to the organisation and so on.

S: Okay ...

B: If it's a higher, I guess what I'm implying at the end of all this is if it's a high risk activity, decision for the organisation, then the organisation tends to invest more in making the decision making process more consistent and defined and clearer and if it's a lower risk activity you can have a bit of fuzziness I guess.

S: But the [inaudible] has really showing it is risk differences which is a [inaudible] because you, you know you have attended the presentation [inaudible] ...

B: I saw it yeah.

S: So this is the template we've come up with to separate out decisions and it actually, your risk actually fits in here. Complexity is one of dimensions and that is how complex is the process that you go through to make it, you know, is it which bus do I catch to [inaudible] multiple types of decisions. The constraints that are involved, so you know, I'd like to send three people to Apia but I've only got two, that makes it a slightly different sort of decision. We've called this ambiguity, in making your decision, this is where your risk element comes into it. There are certain measures. The one that everyone sees in industry is NPV [inaudible]. But that's only one, you know, now we've introduced social and environmental, this triple bottom line type idea.

B: And we've got political risk.

S: That's it, that's it.

B: A major [Inaudible] driver.

S: And as you get more and more of these required to make the decision it becomes more ambiguous because there's trade offs going on ...

B: Yeah, and a lot of, yeah, that does occur with some of the benefit for the state, the decisions that have to be made.

S: Yeah, so you relate to that. And then this one we've called the Environment of the Information Structure. That is, where's the data coming from, have I made this sort of decision before, is the process fairly well defined up to I've never done this before, I don't know where to find anything, and I wouldn't have a clue about how to go about it. And so, and by that we draw little pictures of what these decisions look like based on those templates. So what I actually want to do, is if possible, I've got a whole stack of random decision scenarios, if we want to use those, but if you think of one that you have made recently, we could then type that decision by this, and then I want to look at the process you went through in making the decision, so that I can tie type and process together. So ...

B: Right, well ... I mean how confidential are these?

S: These are a totally confidential so, when it's typed up, I will show you, if I'm going to use your individual one, I will show it to you before it gets published, but you're Client X in Company A, sort of thing right now as this is being typed up, so it ...

B: It's not a drama; I just thought I'd ask. So I don't directly make ... I was just thinking about the bid assessment that we just went through for the XXXXX block, but I didn't actually directly make, well the decision I made was to package up the, the two very close bids, was to basically package it up and XXXXX actually made the decision, so that wasn't me, so that's probably not, a good one.

S: So, did you make the decision that you couldn't make the decision?

B: Yes, actually. I basically got the team who were assessing the bid to try a few different things, to weight things differently, to run some scenarios. There still wasn't much of a split, so it was a case of saying to XXXXX well, here's the deal and he went and made [inaudible].

S: Do you mind going through that one?

B: Can do.

S: Because the fact that you've actually, prior coming to the conclusion, you recognised that certain things had to be done to make that conclusion. I think that would be worthwhile exploring.

B: Okay.

S: Yes?

B: Yes. No, that's cool.

S: Let's try and type it first and then go through the process you used. So how complex was that decision?

B: It would be getting up towards the high side.

S: The higher end?

B: In terms of there were a number of different variables, that had a ... there was a process to go through; there were enough variables to mean that there wasn't an easy split. We assess financial, technical, you know there's a number of things we assess and it was very hard to get a split.

S: Okay, so you have metrics each time you're making that and yeah, okay. Constraint? Were you under time constraint or dollar constraint or people resources constraint?

B: Well, there was an element of people resource because it does take time to do this and there were other priorities. Timing, I really wanted to wrap it up quickly so that the companies didn't [inaudible], XXXXX wasn't driving the timing, but I was. I wanted it done so people knew where they were.

S: Okay, so there were a few constraints? But [inaudible] ...

B: But they were sort of self imposed or I was imposing it on the team more than XXXXX was imposing it on me.

S: Okay, but that [inaudible].

B: [Inaudible] constraint.

S: Ambiguity ... these are the measures, so you've actually mentioned that as part of the complexity as well.

B: The ambiguity came about because of the parameters that we were assessing. We didn't get a score split that was sufficient to ... and there was some ambiguity in the information we were getting from companies like that, so ...

S: So it was fairly ambiguous. And the environment of information?

B: We've done it before but every situation's unique. And yeah, it's probably ... it's not like we've never done it before.

S: No, some were in the high end, some were in the middle, for task constraints and somewhere further up on ambiguity and somewhere in the middle here?

B: I'd say so, yeah.

S: Yes. So, just so I remember that's what we've drawn, so if high, middle, high, middle and down. Okay, so having typed it, can you describe the process you went through?

B: Okay.

S: Firstly was it formal or informal?

B: Formal.

S: It's a formal one?

B: It's a formal process. There's a clear scoring process that a team of people have to go through to score bids that we received for acreage releases. It's pretty well defined. The companies that were applying were given a copy so they know ... it's very transparent.

S: Yeah, it's very transparent. Okay. They know what you're going to be assessing them on?

B: That's correct and they ... you know, it's up to them if we've tried to shut down all the potential rorts that can occur, and it's amazing, people still don't get it, so that's just the way it is really. So there's a transparent process but it's a pretty rigid process. Okay? So what occurs in the business received by one team, I was on that particular team. Then there's a team that assess it. So the assessors don't know the identities of the companies, I did know the identities of the companies. So basically the assessment team went off and scored the work programs, following a rigorous process.

S: So there was a work program? Yeah?

B: And it was scored according on an NPV basis, so early work scores, better, etc, etc. The problem, complexity came about because it's a small area, it really is a one exploration well and then development type activity thing. So getting a split between the five bids we received for essentially what's a prospect, becomes difficult. So there's a number of decisions that then flow out. We had one company say well, we're going to do 50 square k's of 3D another company said we're doing 55, well what's better? Because one company said we've looked at it and we don't think the northern part's worth spending money on. So we had to start ... the assessment team were coming back to me to say well, what do we do about this, how do we score that. So it was a case of trying to reflect I guess [inaudible] thing called industry practice in those sort of situations to try and get a split. They have to determine the number of targets that the well's going to, going to intersect. We had people that wanted to re-enter the existing well versus people who wanted to drill a new well. So there were a number, while the scoring process was very simple, there were a number of ambiguities that the team had to deal with and when they couldn't deal with them, I'd be called upon to try and give an idea of how are we going to manage this consistently. And so there was a stream of however rigorous the project, you can never second guess what you're going to get. So there's [inaudible].

S: So how did you go through that decision?

B: Well that ... see I was in the situation where I did know who the companies were but I basically, you don't want to do anything to favour any particular company. It's got to be how it pans out. However much you say that, you're never sure subconsciously what's going on, but I had zero buy-in with either of them because it came down to two. It was a case of well, what's reasonable. Is the company that's actually put in some thought and said that this 3D will give a more efficient result better than somebody who's just doing a shotgun approach? And so you start having to make rather qualitative decisions, but in consultation with the team. So, in the case of the 3D I think we determined that we would basically ... I wanted to treat 3D as being a one off. If they had they had 3D they got that score, if they didn't, they didn't get that score, but I think we actually ended up factoring in ... did we end up factoring in the areas, I can't quite recall, but I felt that was producing, the company that put a bit of thought into it would be more efficient. So, so there's, there's a series of little things like that that had to be sorted in the bigger process right? So there's a lot of iteration.

S: And did that all occur in your head or, did you vocalise that in a group think type situation?

B: It was a bit of both. There was thinking but there was also ... XXXXX was sort of the contact point between the teams. XXXXX and I would talk through the logic with XXXXX as well, so we go through the steps together to say if we do this, that, da, da, da. So it [inaudible] consultation more than anything else, but you do have a bit of a think too. I'm big on consultation.

S: And then the final decision ... So you like [inaudible] ..?

B: That's one of my ...processes.

S: Would you only use that where they ... do you use that all the time for example? Or is that ..?

B: It varies.

S: It varies.

B: I think for the regulatory stuff some, where it's ... okay, thinking again instead of what the category, what work area I'm talking about, I find the more complex the decision, the more useful it is to consult and get ideas to a point ultimately where you will have to make a decision but I think getting the other ideas coming in assists this, [inaudible] the decision making process.

S: Okay.

B: So it varies.

S: In making all of these decisions, that you have had to make, were there any tools that you used?

B: Well, the only tool that the process, is the process that we've defined and we did have to honour that. There's a series of steps that you go through and there's a series of calculations and things that are done in those steps, so we had to, you always had to come back to will we assess this first, then we'll go onto that. For instance, when we couldn't get a split with the work program, I said to the team I want the licensing branch to now check the financial capacity and I'll check the technical capacity so, we were trying to stick to the flow that we've developed for this. But decisions have to be made, it's steps in that side.

S: Okay, so any sort of tools would have just been spreadsheets that just put numbers instead of [inaudible]?

B: There's a spreadsheet that gets built by the assessment team which we were looking at, that decides that scores. There's a step-wise process quite rigorous.

S: Okay. If the scores added up that one, you said that you had five bids or something, if one was 50 and the next one was 40 and 30, that's a stand out in the decision [inaudible]?

B: Yes, that's right. What we do, we've actually defined the process that if the bids are within one well equivalent, because scores all come down to one well equivalent, we thought [inaudible] one, we'd have to go to another process to try and get splits, so we had to make that decision to go to the next process and this is all before we went to XXXXX to see if we could get [inaudible]. And that's where we had to, I had to call that we needed to go back to the companies to get more information because there were some ambiguities in the way they presented the work program and try and tease that out and give that information back to the team to iterate through and see if that affected the scoring.

S: Okay, and that's fairly well defined in the process [inaudible]?

B: And it's in [inaudible] you document what you do to, so... the emails, the phone contacts all of that stuff is documented.

S: Sounds like a very good governance.

B: Well, it's part, I wouldn't say it was about protection but there's a defined process.

S: Oh, yeah, it needs to because you have to be transparent.

B: Yeah, it's a multi-million dollar decision and it's easy when things get close, there's been a few occasions in XXXXX and elsewhere where people have said well why didn't I win the block, and you say, well, because of this, this and this.

S: Sounds very much like hiring a person, you know, you've got, well anyway that's me putting my stuff on it.

B: No. But it [inaudible] rigorous, [inaudible] decision.

S: And so, just to reiterate in my own mind. There were points along the decision process where little decisions are made, build up and if it's obvious at those points, then everything's okay but, there is feedback occurring if it's not obvious.

B: Yes, that's it.

S: Okay, so therefore the tools are used at defined points along the decision making process.

B: yes.

S: Cool. Okay. The other part that we want to look at is, this feedback as I called it. I should actually have a template to show you what I mean. I draw it every time I interview a person. But we see, quickly draw this, that the outcome of a decision,

here's the decision we make, the decision leads, may lead to the outcome, but two other things influence the outcome. The first of those, is how it's implemented.

B: Right.

S: So, you may have a prescribed system, but if you don't implement that properly, the outcome is going to be different.

B: Certainly in the case of a bid assessment. You know I like, got the neatest handwriting, we'll give it to them.

S: [Inaudible] process. And the other one is chance itself. No matter how well you implement the decision the outcome may be governed by chance and one of the classics we use is do I take an umbrella to work and chance does come into that.

B: Yes.

S: So what I'm looking for is, was there formal or informal things that you may of just thought of doing, feedback on the implementation itself, so as you're making the decision, do you feedback how that's going to be ...do you look at how you implemented it, and say, so for example, this decision you've made about having to send the two recommendations to XXXXX, if in previous times when you've come up against this sort of thing, and you've implemented it a different way, did that lead you change the process/

B: Yeah, we do ... we had a similar situation in XXXXX and the bid assessments. And it was handled in a slightly different way. This time around XXXXX basically said upfront that when we, if we couldn't break the two companies he wanted to know who they were and he would make a decision based on his experience, etc, etc, etc of what was going to be the best benefit for the state. Whereas in the previous times we've got to this point, XXXXX basically he, he still didn't want to know the companies, he still wanted to try and break it before he knew who they were, so there was a slight different, a slightly different approach at the end point of the decision making.

S: Did that come about as reviewing the old process? Or is it just that you've got a new manager?

B: I think it was XXXXX's; XXXXX basically wanted to cut to the chase, [inaudible]. But when we, the process that we used to asses the bids last time, as we were going through it for XXXXX, we've realised there's some loops that we haven't closed that companies could [inaudible] or this could happen, or that could happen and so we changed the process. And based on what we've done this time round, we're going to further change it to really narrow it down for the next round of releasing XXXXX, so there's a continual improvement process going on, basically, every time we do it.

S: And so you do do that, [inaudible].

B: Oh, yes, it's part of how we work. We've had all the bloody [inaudible] to that and the causes of that, and we may not go exactly around the wheel that they have ... so there's a whole series of things that we're actually going to feed into.

S: What about the actual outcomes? Do you ever study the outcome for a bid assessment process, for example you've awarded some bids to XXXXX and they're coming up for their relinquishment so you can check their work program against what you [inaudible] with ...

B: [Inaudible] all the time.

S: Okay, so that is ... that sounds like a very formal process as well.

B: We do check against the outcomes. We, it's partly it's because we have to in terms of you know, are they on track to achieve all the big work. If they're not, then we have to go through, because there was a lot of over bidding, so basically we've actually reached the philosophical point where what we have to defend is the second bid. Right?

S: So you've made that as a conscious decision then?

B: Yes, we must defend the second bid. The company that won the block cannot score lower with their new, with their work program. Whatever chops and changes they go through. Originally, we were defending, if you said you were going to drill 20 wells, you're bloody well going to drill 20 wells. But, if the next bid was 10 wells, we're now saying, well, practically speaking, as long as they don't go below 10 wells, we've protected the integrity of the process. So, we're doing that, we're also like, when we go through the process of a company that wants to drop, a winner that wants to drop a work program, we're constantly going back to the original decision. In some cases we're saying well why did that company come second. What was the thing, and so we are checking and revisiting.

S: Okay, so that's a very formal process by the way you've described it.

B: Again, and yeah, in particularly in XXXXX it becomes quite critical now that we're getting towards the last months for some licenses, and we've then got to go to a new bidding round. People have to see that, you know, hand on heart, the second bidders have not been ...

S: Didn't miss out.

B: Have not been missed out. Exactly.

S: Okay, now just taking those two ideas. Feedback on implementation and feedback on outcome, if it were a different type of decision. So, we've talked about the bidding process, if we go back to those [inaudible] ...

B: Formal.

S: Yeah, so there's more informal ones like staff type questions. Is there a, do you go through a similar sort of process for them?

B: I'm just trying to think of about, a decision with a staff member. I'm not sure what would be a good [inaudible]...

S: [Inaudible] ...

B: Yeah, I guess [inaudible]. You go through work reviews, you know, I'll go into a work review with a, you have a dialogue but there are times where you have to decide well do I tell them they're not actually going as well as they think they are and I guess you revisit if you've made the decision to do it and you do it, then you revisit to see if behaviours are improving and things like that, so there are some output with a decision like that.

S: Okay.

B: With other things ...

S: What about promotion? You know, you've decided to go to APPEA but AAPGs coming up, do you revisit how you went about promoting at APPEA to see whether that impacts on your AAPG?

B: We do a bit, but I must admit, you know, the level of experience of [inaudible] promotions builds up to a point where ...

S: Okay, so you've done that several times in the past?

B: Yeah. I guess the way we go about it, you're always looking to do it better and you're always taking on board feedback from companies and things like that about what would improve things, but in the end it's pretty much a formula nowadays because we've got a pretty slick package.

S: It's been done so many times.

B: Yeah, exactly.

S: [Inaudible] find where I put my template ... Anyway, now that I cannot find it, what I hear you say is you've done it so many times now everything is starting to shift down to that bottom end, it's becoming a simpler decision, and so therefore you don't go through the process as much. Am I putting words in your mouth?

B: There's still a process that you have to go through but because the experience levels build up, I mean I never get complacent, so you never get complacent about how you do it better and all the rest of it, is that really the best product and all of that, but the actual process of organising the conference and going there and doing stuff is pretty much based on a lot of experience, so that does push it ... but like I say I'm always looking at what everybody else is doing and can we do things better with the

resources that we've got and so on and so forth. Like I say, the minute you start relaxing is when it ...

S: It falls over.

B: It goes bad.

S: And the last question and this is the only number I'm asking anyone. And this really is to try and have you think about the processes you go through. So, simply worded it is, in your organisations decision making processes how do you consider them with regard to effectiveness and efficiency? On a scale of 0 to 5, 5 being we're the best thing since sliced bread, and then to help you come up with that number I'm saying compare yourself to your competitors.

B: [Inaudible] industry [inaudible].

S: [Inaudible]. I can fill that in, but I'm really after what you think.

B: I mean if we look at the regulatory decisions, I think we are a four or a five.

S: Right, So [inaudible] up there.

B: [Inaudible] up there. In terms of promotion we're not, just looking at the outcome, you just want to know what the outcome is don't you?

S: Yes, it's the process [inaudible].

B: The quality of the process?

S: No, the process [inaudible].

B: Okay, the quality of the process, it's probably really a ... so for promotion I'd say it would be a three or a four.

S: And that's it.

B: Okay.

S: Thank you so much for that.

End of recording

***Interviewee: Participant C (C)**

***Interviewer: Steve Mackie (S)**

S: So the main aim is really just to have a look at decisions, decisions you've made, so looking at what you would think a decision is and then the process that you've used to make that decision and then to look at any tools that you might have had a look at in coming to that decision and then if there was any sort of feedback loop at the end of the decision process. So they're the keys we're going to cover. So your background and experience is primarily XXXXX?

C: Primarily XXXXX. Early days in XXXXX of all things. Okay. So have experience in XXXXX and a long distant past there.

S: Okay. Well how long have you been with the XXXXX now then?

C: XXXXX now, pretty well 30 years now.

S: Okay. [inaudible]. So to you with that experience, so this is trying to get a very broad picture thing, what do you think decision making is?

C: Well certainly in XXXXX it's an interesting question because it depends on the level of the decision. I can make certain decisions at a, shall we say a more technical ...

S: Level.

C: Which will have limited technical review from on high as opposed to say a more a policy making type decision such as whether to open a can of worms about land access, parks negotiation, that type of decision where the decision is more a political decision [inaudible] levels up.

S: Input to that.

C: We would have recommendations to that type of decision making within XXXXX as a whole.

S: Okay. Well the first thing we do is try to tease out that difference because a lot of people see the input as being decision. So what we've done is we've actually defined decisions as being this. A decision is conscious, it's irrevocable and it's a choice. So they're the three key words and it's meant to achieve a desired objective, the cognitive bias sometimes make that not happen but the way we try to get people to think of decisions is by saying that you've made a decision if you've allocated the resources.

C: Yeah. So that goes with the responsibility level.

S: That's it. Yeah. And so there are some decisions that you make, I take it by the way you've said that.

C: Yeah. Well that's right we might make a decision on the nature of data management that we do. For example, how do we store our magnetic data. We hold in here physically something like nearly \$1b worth of required data. Obviously as a XXXXX asset we don't want to lose that so the decision on how you actually manage that data from magnetic deterioration. Quite a large decision and one that will have very little review from on high [inaudible].

S: They expect you'll look after that?

C: That's right.

S: Yeah. So most of the decisions you make then in summary you would classify as this technical type decision rather than a policy type decision?

C: I would say in the main, yes it's going to be a geotechnical decision. The other one we might have would be along the lines of involving land and water access policy type discussions and the decision there would be whether we want to open up a box, we want to go and fight the fight or negotiate at all.

S: Okay.

C: Or whether we just leave it alone and say too bloody hard.

S: Not going to touch that and that is actually a decision. Okay. That's good that you've recognised it is a decision to decide not to do something.

C: And I guess the classic of that would be the [inaudible] XXXXX thing where we want to buy in here, there are resources up there, we know there are resources and it's bloody years worth of effort and we actually ended up with a political decision taken at the very highest levels but it was the decision that we needed to buy in as an agency.

S: Okay. So within your regime and this is from your perspective, how do you think decisions are made?

C: Interesting. I think by and large we really try to go back to our stakeholders, there's very little altruistic stuff in here. We're looking at first of all our prime stakeholders, our minister, then the XXXXX, the community general, industry, it is really to a large extent a balancing act between one alternative and another alternative and what is the optimum between the varying alternatives and that could apply to a bidding round for example where we do assessment of the bids that roll in.

S: And make recommendation then.

C: We assess the business, is this work program better than that work program. We've developed virtually a recipe type list for the optimisation of the discoveries, what is likely to make best discovery and best discovery rate will mean an accelerated

development, more royalties for the XXXXX earlier and obviously for the industry more money earlier.

S: Okay. Because royalty ... if the XXXXX is getting royalties the company is also getting income. So you're balancing both of them there. What about the concept of a good decision?

C: In terms of making them. I guess it's interesting that you can only make decisions on the knowledge base that you have at the time and most people say hindsight is a wonderful thing when you've got some more information that generally comes at a later time or which is otherwise not available to you. So good decision, yeah, tricky that. I would say you try and make the optimum you can on the day.

S: Based on the information you have?

C: Based on what you've got at the time and one would certainly hope that political influences don't influence you to a large extent. We do work under a parliamentary system so you're always cognisant of what would the green movement or the Liberal or the Labour or whatever, how would they see that? Is it likely to end up being a controversial matter but if you made a very rational [inaudible] and documented your thinking process behind that either decision or input people can actually see where you've come from and then if there's a controversy they can actually see well this in error because I've got this piece of information and that counteracts that.

S: Would you consider, well I take it that's your opinion of what a good decision is? Would you say that that is the same for XXXXX, so XXXXX would consider a good decision the same way?

C: In what XXXXX means. As you go up I guess the politics become more and more to play and we work into different and other agendas. I guess working from a reasonably straightforward industry.

S: Agenda. Right.

C: Agenda here. I'm not quite sure how to answer that in terms for XXXXX but I think there are different influences around which may muddy the waters.

S: That's a good observation. Okay. So now we move into these things called decision types and we've talked a little bit about that before we began. When I say decision type what are the things that run through your head?

C: Well I can think of probably two different styles. One is the hierarchy of decision making, the amount of influence your decision may have or the amount of resources that impacts upon and some may be whether to make a certain size of map, we make products here. Is that the right map to make or do we need that one or something else. So fairly low level stuff and then we go into, let's say we went to the magnetic data issue, the whole issue and that's a \$1b exercise. If you get it wrong and next year it's all wiped out there's a lot of people going to be pretty cranky.

S: Yes. Just go to XXXXX.

C: So that's one of a more technical nature and then there's different styles of, I sort of mentioned the land access, the more negotiating type decision making.

S: Okay. That's a good one. So you see types of decisions as one of the things you've talked about are these technical decisions and then political decisions but you've called those more negotiated decisions. I like that because it connotes what's actually going on, more people are involved, more differing opinions are involved.

C: Yeah. I think that's where we're moving into discussing a lot more stuff which happens in probably this house that maybe might happen in, let's say an explorer's hats where a lot of it is based around financial, making money for the shareholders type stuff. We've got to deal with a lot different nature of the beast, environmental, political, social.

S: You've introduced something very quickly. So this is this template. Now I don't believe you've seen this before. I presented it to a few of the guys here and a talk back came down to the university but this is this decision making taxonomy that we've come up with and we did it, well as objectively as possible but essentially we've shown that decisions no matter what they're type have these four things in common. So within a decision there's the level of complexity. That means just how many decisions actually flow on from it. It could also mean the amount of time you're going to have to spend doing it although that can slip into this constraint. It's the amount of resources you have available but then again that could be a constraint. So that's what we've called complexity. The next area is actually the constraints. So it could be just time, this must be done by Monday or it could be dollars. It must be done within a certain ...

C: Some sort of resource constraint.

S: And it could be lots of them. So it could be it must be done by Monday, must cost under \$50, must only take one person and as the number of constraints increases you have a different type of decision to one where there's just one constraint.

C: Where you've got decisions like that.

S: Yeah. The next one we've called ambiguity and this is where what you talked about comes into it. When you make a decision it's based on a whole series of trying to optimise different objectives and many of those objectives actually are financial as you talked about but then there are also social and environmental, there's triple bottom line type of idea but one of the other measures is our own personal, you know if I make this decision I'm going to be the guy that looks really good and I'll get the promotion sort of thing. So all of that comes into it and as you increase the number of those measure, if you want to call it that, becomes more and more ambiguous is the [inaudible] that so that back here you may be making your decision based purely on dollars but by here it's dollars plus is it a socially responsible one. Is the environment taken care of as well. So that's what we've called ambiguity. This final one is the environment of the information structure. That is sometimes we make decisions that

we've called them highly dependent and that is the information you need to make the decision is the same as a decision you made yesterday. So you actually don't have to gather it.

C: Okay. So you've really got a good knowledge base here, low knowledge base there.

S: Have to go search for information down here. And at SPE the conference coming up in a couple of weeks I'll be presenting how we came up with all of this. Suffice it to say we have this. So what I've done then is I've got a whole series of decisions and these are ... they're not the decisions but they're decision scenarios I call them and just to get the ideas going I'll just pull two at random and then show you how this is done for them. But what I want you to do is think about how you would go about ... not the decision you would make, but how you would go about making the decision. Does that make sense?

C: Okay.

S: So here's number three. Medium size petroleum company has invested six months in having a small team working on the prospect in an offshore area due for acreage release. The teams established a strong case for an active petroleum system identified several prospects. They believe other companies have gained this knowledge. They predict that bidding will be fierce for the central blocks of the release and that they may not have the financial resources to bid as much as they believe the blocks are worth. Do they go it alone and submit a bid that assumes they will farm out as soon as the blocks are awarded or do they commence negotiations with other explorers to reduce their interest ahead of the bid?

C: Okay. No, that's a fairly typical sort of scenario I would have thought.

S: That's right.

C: And probably one very close to our hearts in the XXXXX I would have thought. Just one word and you've got I think.

S: Yes. These do come from experience.

C: So the process. Well obviously there's constraints in there, there's a time constraint. Obviously you've got to put a bid in at a certain time when it's ready, you've obviously got competition constraints so you're aware that it's going to be fiercely bid. So then you've got to go back and say well what are my capacities and if you can't or don't expect to have enough capacity to drill your ten wells in the central blocks then obviously that's your major decision point. That loose bid for the outer blocks, your one well type bids or do you get in bed or try and get into bed in there. You're a medium sized exploration company so assumedly you have some reasonable knowledge of who's around and which way is up. You've probably got my some mates you've dealt with, some strategic alliances or allegiances or knowledge. Yeah. I think my first thing would be on the dog and bone and start ringing around saying lis-

ten XXXXX [inaudible] and again whether you class that as soliciting further information as part of your knowledge base.

S: The term that's used in the literature about what you're describing is the search for alternatives. So there's two alternatives written here. Number one you can make a decision to bid more than you've got the money for and then seek to farm it out which I think is what most people tend to do but then there is the other one of doing that ahead of time so that you can go to the XXXXX agency that you're bidding to and say we can guarantee this because we've got the resource to do it. Whereas if you'd been a medium size company and bid 15 wells your processes may actually say I don't know that they can do that.

C: Well they bloody well should and throw that out and that is one of our decision trees is to look at the capabilities of these type of bids and we've certainly seen the cornea type examples in the past, so experience comes in. So if you're not aware of that sort of thing you're not quite so circumspective looking at these options. So essentially you've got three different types of decision to make whether to come with a consortia, farm in later into someone else's bid or just go for the outside blocks.

S: That's right. So you've got the search occurring. What would then occur? What would lead you to make a decision?

C: Yeah. [inaudible] actually looking from the total other side. My suspect would be that you would start to develop linkages out there and come up with a pre-competitive bid with a consortia.

S: Okay.

C: That would be I think my prefer because then you've got slightly less risk not getting into the central blocks which you think are highly respective. Though obviously you've got to, you've got to make some decisions on the present values and that type of decision tree based on if you put \$10m and Fred puts in \$10m, you've got a \$20m bid and then you've got to look at well my size of prospect is ... well you've got two or three of them here, say one of them comes in and you work out your numbers and divide by 50%, I should be able to make X dollars for my company.

S: Okay. Good. What we've done is ... so looking at that decision we've sort of put it like this saying the complexity is it's fairly complex, you've got competing things going on. Constraints, the only real constraint was the time the bid had to be in and you've got a constraint on you dollars. So that's what it's talked about. Ambiguity. Yeah. There's a bit but it's not highly ambiguous.

C: I agree with that.

S: But you've not done it before. So you're going to have to go searching which is what you picked up. So when this access is high this is where you begin a search for information. So that sort of explains what's going on there. So having got those juices going what about a decision you've made recently. That was just one that I made up. Is there a real one you can think of?

C: Let's take something which has got a bit of size to it I suppose. We might go back to the tape management, data management, one which is close to home, decision I've made with my branch there. So we're looking at the risk there as being a potentially multi-million dollar loss of resources and assets.

S: How did you go about making the decision? So ignore that for a minute. Just talk us through what things you did? Number one you've recognised a decision needs to be made, then what do you do?

C: Firstly it's the recognition that it is a public asset.

S: Okay.

C: Second one is responsibility lies with first of all the department then with a group personally, as a professional. As a due professional you certainly wouldn't want to lose that type of data. So there some sort of ethic, moral type thing in there. Then the next step is how would we go about it, what's involved? What steps do we need to take to minimise the risk of loss of data and the key one for us would be transcription, we obviously need to take some sort of third party involvement, we can't possibly do it so we need money.

S: Money.

C: Where do we get money? We get money from the XXXXX. It's a matter of putting up bids and we've got a bit. We probably spend over \$1m on transcription data over the years. So a decision was we need to do this, we need to put up a substantive bid to XXXXX to actually get resources. Time constraints was a fairly small matter with the exception that obviously if we don't it in a certain time then there's a higher risk that things will fall off so there is a somewhat timeframe there but it's not urgent. So money and I guess people to actually undertake the job is resourcing to be done. The other decision is technically how do you take this data from this old nine track tapes and put them onto something new, something that's going to last in a more archival fashion. So it was very much a technical one there and a lot of searching globally to try and find what is the world doing with this basic data. Problem was that as time moves on there's new technologies. Okay. So there was a decision to be made between about two or three different technologies of what to put it on and our research shows that if you go for the leading edge technology you'll end up paying a huge amount of money and you're not guaranteed that this stuff is going to be around next year or the year after or what it's longevity is. So I made a decision that we would go for something which is fairly ubiquitous in the industry. In this case it was [inaudible] tape, reasonably modestly reliable and proven and we always recognised that we need to move from there to something else in the medium future.

S: And any decision you made know also took into account something that would also ...

C: It would be an ongoing matter anytime you put something on to magnetic tape and even now we hear stories of CDs are not all that cracked up as archival media as

originally people thought. So again there's still no perfect choice for archive [inaudible]. And I'm sure we don't want to go back there.

S: Okay. So you know what you want to make, the decision. You've given me what I call objectives. Your objectivity was to make sure it lasted a long time and was retrievable and there was a professional ethic involved as one of your objectives as well. So based on this sort of template would you have considered that a complex decision?

C: I would have put it down in the lower ranges here somewhere.

S: The lower ranges. What about task constraints? You said there was no real time constraint.

C: There was certainly a financial constraint. So again probably somewhere in this order here. Ambiguity ...

S: So on the utility measures.

C: Yeah. I would go probably a bit on the lower side of that.

S: Not been done before [inaudible].

C: This one here is probably on the higher side. I mentioned searching for all sorts of stuff.

S: So it looks like a boot? We would call that a boot type decision.

C: Alright. [inaudible] well for you.

S: Okay. Now having a look at that. Was that process that you went through, was that formally described here in the department or did you have to invent that?

C: The evaluation process was undertaken in a somewhat ... would say informal way. It's obviously a typical sort of search and find type of scenario. However it was written up as a cabinet submission, formally documented. There's market research with this decision making.

S: So it was the recommendation or ...

C: So it was the recommendation that this is the proposed way to go, give us the money to do.

S: Great. But they did not get a paper ahead of time saying this is the problem we've got and this is how we're going to tackle it. When I say how we're going to tackle it, not the answer, we're going to use [inaudible] tape because of all of this but we're going to go about it by searching it out, looking for how much it costs. Was there ever that sort of stage? More or less given as a fait accompli, please approve.

C: Just trying to think back now. This was done a few years back now. I think it was almost half and half type of an approach where we recognised the issue, we sort of thought well we're maybe not quite sure of exactly how we might end up but we recognised it was going to be at least \$500,000 exercise to this, whatever we do. The biggest exercise is actually getting stuff off, in this case, nine track tape.

S: And onto [inaudible].

C: And then dump it onto something else. That was the relatively small [inaudible] of the equation.

S: When it comes to any sort of decision with XXXXX, if you have to make a decision is there a book that you can go to or a handbook or whatever that says this is the process you go through?

C: The only one I can think of at the moment would be there is a code of ethics for the public service. There's a whole raft of that nature of guidelines and regulations and [inaudible] and that type of thing but in terms of decision making let's say within this resource sector here, really in the public sector not really, not in the way that I think you're asking a question like how do we make our maps for promotion, how do we do all our promotion and stuff, how we do our data management stuff. In terms of the assessment we've actually, XXXXX and all the people here have developed a recipe for we will go through this recipe when we do competitive bid assessments.

S: Yeah. So that is ...

C: So it is quite rigidly documented.

S: And that's what I mean by a formal decision making process. That's a good example.

C: And that's made open so people out there when you're bidding you know that these are the things that have been considered in your bid.

S: That is a classic formal decision making process. Everyone's aware of how the decision will be made ahead of the decision having to be made.

C: Yeah. Another one which I can relate to is developing of a what we call a compliance policy.

S: Okay.

C: And it's still in a development stage and again it's one of those that how do we make a decision on whether to prosecute you or to take action for non-compliance of [inaudible].

S: Okay. And so that's in process and it's in use?

C: And again that's probably not a bad useful one for us if you want to work it on us again because we have struggled over quite some years to get equity of decision making let's say in what we do in geophysics here, with what we do with a plant or a well non-compliance. Where's the equity in the level of our involvement prosecution levels.

S: It is a tough question. In all of that you've mentioned, let's take this bid assessment one because that's a firmed up process that's [inaudible]. I see the way you've described it, it seems to be a piece of paper with questions on it or something like that. Is that what it's like?

C: Yeah. It's almost like a calculator if you like, guaranteed well, that scores so many points in year 1, year 2, year 3, year 4. Non guaranteed well, less points. Seismic, percentage of a point type of thing. So it really is a calculator. So when I see year 1 you've bid 100 square kilometres of 3D, that was approximately 2.5 points or whatever.

S: Okay.

C: And then you add up the whole program, guaranteed, non-guaranteed and see what you come up with.

S: Good. There's a tool.

C: Yes.

S: That's excellent. And at what stage is that used, virtually the whole way through, the way you've described it. How effective has that been? Have you had any disputes about it?

C: We've had zero disputes. It has precipitated some, shall we say some awkwardness for us, the tricky bit is when we get a whole heap of wells, bid, win. There's two teams. One team opens the bid and one team does the assessment. The assessment team don't know who the bids are from, like your A, B and C thing. When we see there's 20 wells bid then we've got to go back to team A and say listen the preferred bid and have they got financial capabilities with that. Particularly when they put five wells in year one. Not quite sure this is technically or financially feasible.

S: Do you use software for it or is it just Excel?

C: Just a spreadsheet.

S: Yeah. All of that is the same. So we can skip all of that. So there's are the last set of questions, do we need to quit.

C: One minute.

S: Okay. Learning feedback. Is there a formal process of checking up. So you've been through all the bids, you've worked out what the high bid, you've awarded that

bid. Do you then come back a year later, five years later and check whether that was the best decision?

C: Good angle. I don't think we've formally done. We've really only got this thing going for the first round or the first set of rounds for the [inaudible] and we're only just coming up to renewals but the one thing we have been doing is an audit of have they made their commitments.

S: Okay. Yeah.

C: So there is an audit which has been done. The other piece of feedback on that area is if people put in for a variation of commitment we check against the second bidder. If they want to vary it below the second bidder we say no, you've got to maintain above that second bid otherwise you're compromised, against that second bidder.

S: Yeah. No, that's good. And then finally against this magnetic data one because you actually said that as you made that decision you knew there would be another decision down the track as well. So looking at the outcome now you've got everything on [inaudible] tape, has it been, was it achieved within the timeframe, within the cost structure? Was that ever looked at?

C: Well pretty well, yeah, we had a fixed budget. It was basically \$500,000 over about four years. So that was the size of cloth and we didn't get everything done but we got pretty well a lion's share done as opposed to GA.

S: So there is some comparing going on.

C: So there is a comparison. They had \$22m and they got 10% done. We had \$500,000 and we got 90% of our lot done.

S: And that does go on doesn't it?

C: It does go on and we compare ourselves. We went to XXXXX to see what they were doing and XXXXX and I came back and we're shaking our heads and said we're very happy doing what we're doing. And I think that's come home to roost with the XXXXXs that they're bloody hopeless.

S: I know. As an explorer I'd come here any day. Okay. That's all mate.

C: Okay.

S: That's it. That's certainly been a big help. I much appreciate your time in doing it.

C: Okay. Well I'll be very interested to see the results.

S: See how it all comes out.

C: It's a novel theory I must say.

S: As I said the answers are going to be ...

End of recording

***Interviewee: Participant D (D)**

***Interviewer: Steve Mackie (S)**

S: As we discussed it's really just looking at decisions, what ... what are they, who makes them, how you make them and how do we make them better, so they're the broad questions. So when you first hear the word decision, what's the first thing you think of? What do you think a decision is?

D: A decision for me is ... is an ... it's a process of analysing information to reach a ... a ... to deliver an outcome.

S: Okay, to deliver an outcome, that's ... that's pretty good. Most people say I don't know. The way we've defined it to ... is along the very similar things, so firstly ...

D: Oh, well there you go.

S: We've said it's got to be conscious, in other words it's got to be deliberate which is what you were saying here, it's an analysing thing. We've used the word irrevocable and you locate that with irrevocable allocation of resources so that in making a decision you actually need to do something that you can't then come back on, you can change your mind in the process but once you begin implementing, the decision's made if that makes sense and then the other part of it is choice, you've got to be able to have several alternatives. If you've only got one alternative there's no decision.

D: That's what I mean about processing information, part of the schematics of choice. So irrevocable that's interesting, a decision is a conscious irrevocable choice, so that assumes that you've made ... influenced the outcome.

S: Yeah, well not necessarily the outcome, we said ...

D: Yes, please do.

S: We see a decision make ...

D: I hope we don't eat into your tape.

S: No, no, that's fine. We see three things leading to outcome and one of those is the decision but the other is how to implement it and the other one is chance, so the matter you may make the best decision and we'll talk about that in a minute, implement it the best way possible and pause with rain and so the outcome is not what you thought about, so what we will talk about here is the process about all that kind of [inaudible] so that's why we define it in as an irrevocable thing, the decision's made once you begin to implement.

D: Oh, okay.

S: That's really what that's trying to get across. Now that's not to try and influence what you've said because the idea of processing information is really this, the one thing that we notice a lot of people forget about is to achieve a desired objective. Often times we'll make decisions that yes it was to achieve that objective, having made that decision it becomes difficult to implement so we make another decision which actually heads off to another objective and from [inaudible]

D: That's correct.

S: And the other thing, the reason we use this irrevocable allocation of resources is the question of who is the decision maker? So thinking about your position, what sorts of decisions do you make?

D: In a ... in a nutshell my decisions that I make which are probably the most ... the ones I make on a daily basis, provide ... are whether or not to provide advice or no, my decisions simply relate to providing advice up to the director to approve or not approve a ... a particular regulated activity and also not only regulate activity but relation to compliance issues when we speak to ...

S: So they're regulations.

D: Regulations and compliance are the key areas and what actions we need to take.

S: Okay, so which of the ... the decisions do you think you make and which ones do you think you have input into?

D: Decisions that I make and input into? It's interesting because we work like a team I expect my guys underneath to do all the analysis and all the investigation and then I look at the information and make a balance on what is in front of me in terms of yes this makes sense or no that doesn't make sense and then make a decision so I would actually ... okay in terms of the regulatory and the compliance I would say I have the key input, input rather than being the sole decision maker, I think when it comes to the allocation of resources and the way that I manage the branch I have sole decision making, so there's two types of decision making I make, I have to ... if I can go back to that, there's a governance question with respect to the management of the branch which is to do with where do we spend our time in terms ... which again relates to compliance and where do we spend our time and I make the final decision on that and also I instigate and also make the final decision. When in terms it comes to deciding on the technical aspects of compliance and approvals, my ... I think my role is predominantly inputting and keeping an eye on the bigger picture, that's my whole role.

S: The bigger picture.

D: Yeah, my role is a bigger picture but that's the biggest influence for me is all of the political ramifications of this, you know there's ones that are routine, oh there's no political ramifications, we're just going to [inaudible] just thanks for letting me know XXXXX, over to you XXXXX to just sign the paper, to sign the letter. Other

ones do we let this particular income operate in Australia? That's when the bigger picture comes into it.

S: Okay, excellent, does XXXXX have a process to help you make these decisions?

D: This is going to be an easy question to answer, no.

S: Okay, good. Well it's not good but it's a good direct answer.

D: Can I ... when you say process what do you mean? Because the ... the act ... the spirit, the principals and intent of the act is what governs ... I'll correct that, governs my decision-making.

S: Okay, so the act has some prescriptive element to it.

D: It has ... what I always say, what's the intent? The intent of the act is always what's the big picture behind my ... what is the intent of the act? And this is the multi-million dollar question that I continuously ask and I just haven't got the black and white answer to say well this is what we should expect from [inaudible] so therefore the decision is easy. It's ... there's a grey area there.

S: Okay, no that's excellent.

D: But in terms of XXXXX as an institution saying XXXXX, this is the way you need to decide things, no, the answer is no.

S: Okay, and what about a good decision?

D: What is a good decision?

S: Yeah.

D: One that is informed, that balances the costs and the benefits and there's enough information to be able to exercise that judgement, you've got to be able ... a good decision is one that has exercised judgement based on the available information.

S: Okay, how does your ... how does XXXXX define it?

D: Define a good decision? I don't know, I really don't know. Which is a good ... interesting point, that's a good point XXXXX I think need to debate internally.

S: Types of decisions now, when ... when you hear the word types of decisions, what do you ... what's the first thing you think of, what ... what are the different types?

D: Types of decisions? Straightforward black and white type decisions like my son little XXXXX, you don't cross the road when there are cars there and I'm not holding your hand, that's a black and white decision, there is no ... there's no ques-

tion and then I think then there's the ... the majority management type decisions or executive type decisions which ... which can be grey and are very much influenced by the bigger picture of things and that's where they become very difficult and sometimes I find very frustrating to actually sometimes make because I'm always having to balance.

S: Yeah, totally.

D: And then make judgements, the decision that you need to make judgements before you make ... whether it's professional judgement or whether it's informed judgement, or professional judgement or whether it's value judgement and I think that's an important thing in any decision you've got the components of professional and value judgements you've got to make.

S: No, that's good, that's good. I've got ... in here what I've brought ... a couple of things but I've firstly in defining the decision making template that you've seen the presentation on, we used a whole series of decision scenarios to come up with that, I've got them here and what I'd like to do, I'm just going to draw one out at random and have you not answer the decision but just run through the process you might take to make that decision, is that okay?

D: Yeah, sure.

S: So not the answer ...

D: So you're just picking them randomly?

S: Yes, yes, that's right.

D: So Dave will have got a different set to me?

S: Yes, he did. Yeah and so I've just got to make note of which one.

D: Number 10.

S: Number 10? Okay.

D: Okay you want me to answer that question, should they notify the marketing, if so how, or do you want me to ..?

S: To go through the process of how you would make the decision of whether you should notify them.

D: Okay. Okay we've made a large discovery, we've gone back in, reappraised the field, we've found gee this isn't as big as what we thought it was. Okay what sort of decision needs to ... process needs to be taken and how? Oh god that's an interesting one, so can you repeat then the issue that you want ..?

S: So what I want you to look at if I remember that one, it's you've made this discovery.

D: That's right, we've gone in ...

S: Yeah, you're trying to get it on stream as quickly as possible because that's the economic way to make money. In doing so you've missed that it could be smaller, it is actually smaller, you are now being told that it is smaller.

D: And you've already informed the market that it's ...

S: [inaudible] as it is, there are also ... yeah and the platform design is far too large so it's an offshore field you thought was 100,000,000 barrels, you got ...

D: Yeah, I understand that but the process you want me to comment on is on the decision of what needs to be followed in whether or not to market [inaudible]?

S: Market [inaudible] yeah.

D: Well as ... as ... do I speak as an executive or as a company?

S: Yeah, yeah.

D: Well as an executive, obviously the first question you want to ... you need ... you need the demonstration. You need ... you need to have ...

S: Is the info valid?

D: Is the info valid? You need to get that, is the info valid? The next process is to say well what's the pro's and con's of asking ... telling the market ... telling the market or not telling the market ...

S: [inaudible] would you get involved in that or would you do that yourself?

D: No no, you need to get ... you need to get basically your legal ... your legal team involved, I ... I ... I would imagine that you know, especially if it's an Australian [inaudible] thing I think you first need to ascertain the validity of the revised decision, I think once you've got to that point, I think the way the law is, you just wouldn't survive in the longer term by brushing it under the carpet so you're going to have to go to the ASX or the stock market and make an announcement, I mean that's our validity and once it's vilified and the board is satisfied yes these guys are right and then after that you start kicking the [inaudible] in a nutshell I suppose.

S: No, that's good, right so you've actually been through a process which is good, some people when they ... even though you tell them I don't want to know how ... what you decide, I want to know the process by which you would decide, the very first thing you get is what they've decided and then a process of justifying it which is interesting.

D: Yeah, that's right.

S: Okay, what about one you've made lately? Can you think of ... you know over the last 18 months ...

D: Yes.

S: A decision you've made?

D: Yeah. And any reference to any ... it's going to be confidential?

S: Yes, absolutely.

D: I'm still making that decision.

S: Okay.

D: There is a particular drilling rig that's currently operating in XXXXX, it's seeking to operate in XXXXX, we've sought for the last ... over the last 12 months for that rig to demonstrate to us that the rig is fit for purpose from both a physical conditional point of view, from an equipment point of view and from a management/maintenance point of view. As yet we haven't received anything that's satisfied to our satisfaction, we're getting to the point we're going to have to make a decision if the company decide to use these rigs, this rig to drill in XXXXX and in a very environmentally sensitive spot may I add, and this is the one that I've been priming up XXXXX to up the line to say we may have to make an unsavoury decision which may have ASX ramification. So at the moment we're giving opportunity to demonstrate and we're continuously ... continuously doing that. There are factors concerned which I think are not ... out of my control, there are things out of my control.

S: Okay, so there are some elements ...

D: There are some elements out of my control and if they don't happen I'm going to have to make a ... a decision in the negative which [inaudible]

S: Okay, and you understand the consequences obviously?

D: Yeah, the consequences can potentially ... I don't actually fully understand the consequences. They could be political even though the licensee's on site and say look if these guys can't demonstrate we won't use them, dah, dah, dah but you always get the uncomfortable feeling that you know, there will be some political slur, political mud thrown around, you know letting these new guys on the block keep the market [inaudible] bigger contractors and that's not the case so they're the pros and cons.

S: With that sort of decision ... so here's this template that we've shown you before, if I just run through these dimensions, complexity is essentially the amount of information that has to be processed so you know if there's not a lot it's not really complex like you've said XXXXX was it?

D: Yeah that's right.

S: Yeah, crossing the road, up to you know we've got all sorts of things we've got to calculate and work through. [inaudible] constraints is in each time you have to make a decision there's lots of constraints on it, you know, I have to make the decision by tomorrow whereas I'd really like to have a week to do it so that's a time constraint or I'd really like to use this drilling rig but it costs \$1,000,000 a day and I've only got \$500,000 so there are constraints in there and this dimension increases the number of constraints that are in your decision. Ambiguity is the ... the way you make the decision is based on objectives and you have to weight the different objectives and the more objectives you get, sometimes they conflict and so therefore you bring ambiguity into it. So this is the number of essentially in decision making terms, the number of utility functions that are going to be used to make the decision and then the environment information structure is have I made this decision before? Is it very dependent on the way I [inaudible] last time or I've never made this before and so I've got to go from it that way.

D: Yes, okay.

S: So looking at this decision of the drilling rig, where do you think on each of these dimensions it might sit?

D: Okay, now in terms of complexity, again like you said, complexity is relation to the number of things that have to be weighed up in terms of ... it's definitely not like it's not a simple black and white decision, I would definitely say it fits more in the medium to high.

S: Okay, so it's somewhere in there.

D: Medium to high.

S: Any constraints on it?

D: Yes, there's definitely constraints because these guys need to ... they've suspended their licence but they want to come out of suspension of the licence so when they do come out of suspension they may need a decision to be made, I mean we've been trying to make this decision, so there is a time constraint.

S: So there's time.

D: Yeah, increase.

S: You mentioned to me in the way you discussed it there's a political constraint as well.

D: That's right, the political constraint in terms of how ... you've got to be careful you don't put your minister in a ... in an awkward position so ...

S: Okay, so it's ...

D: I wouldn't say it's right up here but I would say it's somewhere in the middle.

S: So same sort of area. Ambiguity, these are the things you're going to use to judge whether you've made the decision properly so ...

D: I would say it's close to the low/medium because it's quite simple, they just simply have to demonstrate to me that all their stuff is certified, verified, fit for purpose, systems are there, so it's not ... it's not very ambiguous.

S: Okay, so it's down the lower end. And then the environment of the information, have you made that decision before?

D: Yes only on the low [inaudible]

S: If I drew ... we draw pictures of this so you've got high, medium/high, low/high. Looks like that, does that make sense?

D: Yeah, that's exactly ...

S: You've gone from medium high to about the same.

D: About the same.

S: And then [inaudible].

D: And then over here to the right, Yeah definitely.

S: Okay, now the reason I do that is ongoing right now in the psychology labs we're running experiments on all the different permutations of this sort of template to come up with the best processes to use ... well when I say best pro ... the most optimal processes to use and what I'm going to do is when we go back and look at what you've said is some of the things you've done to make the decision, are they the pro ... is that the process that matches that type of decision?

D: Oh, that will be interesting to see.

S: Yeah so that's the sort of thing we're reporting back at the end so that when I say everything's going to be confidential, it'll only be this type of decision right?

D: No, that's fine, that's fine.

S: Not the actual elements.

D: And then just to compare that with a regulator versus that of an operator.

S: Correct and that's why I'm trying to get government as well. Okay now you've mentioned that there's no formal process to help you make this decision, do you think there's an informal one?

D: I think there definitely is, there definitely is because ultimately my master is XXXXX and I've ... three, four masters of varying degrees and the decision making goes through that chain of command and I think that sort of filters and ... and ... and when I'm making those decisions I make [inaudible] I'm always thinking of the mindsets and areas of responsibility of those four.

S: Okay.

D: So I think in a way I've got ... I've got the sort of constraints set out in a sort of informal way.

S: Yeah, no that's good. In making the decision, are there any tools available for you?

D: Yes, tools that we've created under our act.

S: Okay so ...

D: Such as what we call a set of criteria called operator assessment factors.

S: List of criteria.

D: So list of criteria which assesses capability of operators, the ... in significance of environmental impact of a particular activity, so those criteria all set up to help exercise judgement.

S: And it's out there in the public.

D: Yes.

S: So the public can see ...

D: Yes, it's part of the regulation and we publish particularly on the environmental impact assessment when something's low, medium or high impact that's all on our registers so people can see, so [inaudible] the decision might not be right but the process we followed is out there for scrutiny.

S: That's a good thing about this department. Okay are there any ... a stage at which those tools are invoked? In other words if I was dealing with the decision that it was all down in this end, would I be invoking those tools or do I only invoke them here or do invoke them right across the board?

D: That's a good point and sometimes that can lead to complacency. Ideally we have to do it for every new operator that comes in or ... there's this thing called low supervision and high supervision, once you're ... if you're high supervision, every [inaudible] has to go through that process so it gets to the stage where they become ... even though it's high dependence and we've made that decision before, we still go through the tick-boxing exercise but the danger of that is it becomes high dependence

structure where you've known you've made that decision before and you can sometimes maybe miss something but I would say that for the majority of cases now we're operating with some of these guys of the high dependent ...

D: Okay good, do you use any software in doing this?

S: Yeah, we use basically we do it all on the spreadsheet, excel spreadsheet and the [inaudible].

D: And the criteria ... Yeah that's right, with guidance from ... and we use a matrix which we've set up, this is for when we're determining whether an activity's going to be low or high or medium impact, so we've got ...

S: Okay, so that matrix has a score value to it?

D: Yes, its' got score values.

S: Okay, so it's a number generated ...

D: It's a number generated thing so you've got to read the criteria and make a judgement whether it affects [inaudible].

S: Yeah, no that's a standard decision making process, okay when ... when it comes to actually making the decision, if that matrix gives you ... I don't know what numbers it comes up with, if a ten is good and a five is bad, if it comes up with a five do you say right don't do it, or do you then say oh yeah I really need ...

D: Just to talk in actual terms is one to five and one of the key criteria where we question the decision making is ... or where our decision matrix is [inaudible] we question information because we don't have enough to make informed decisions on what we call predictability criteria, predictability criteria says you know if ... there's a lot of certain information they provide in the report it gets a one, if there's hardly any certainty it's five, so if you're in the two, two to three range we'll either go back to them for more information or we will trigger the level of impact to the medium impact which requires us to do more consultation, so we've got a fail-safe in there which says if we're scoring a two or three and we're ... we're at the medium for most of the risks we need to do more consultation so we [inaudible] before we make the final decision of whether ... ultimate decision is whether to approve or not and we're basing it on these matrix of one to five.

S: Yes, and it sounds to me like you are ... one of the things we've found is people may use software to help them make a decision but we see many ... maybe for example in your area you'll come up with the decision yes we should allow them to go ahead, you'll pass that onto the director and the director will then question that. We're trying to determine whether people just believe the software and how it's been done or whether they bring something else to there.

D: We put up a minute to the director saying look, on the basis of all this information, this is ready to approve, we've already done our consultation. We will ... we

would not be in a position to put up anything to the minister if we're still at the uncertain stage, we will go back and get them to consult more or get more information, so we will never go to the minister with impact which means there might be a lot of uncertainty because it's a bit pointless saying look approve this even though there's a lot of high uncertainty so ...

S: No, that's good, the last part is this outcome concept that you talked about earlier and that is a lot of companies are nowadays having some form of feedback from the outcome back to the decision or the outcome, the implementation back to the decision, they're the two areas we want to look at. So in the types of decisions you make, do you have any formal or informal process whereby you actually look at how you've implemented the decision once it's been made?

D: No, I mean unfortunately the ... the answer to that isn't ... I would love to have it but we ... we don't.

S: Okay, so like to but don't right now. Okay what about for outcome? So you can see the difference I'm trying to draw between implementation and outcome, so have you ever gone ... looked at your outcomes and compared them back to what your original decision was?

D: Part of the review of the criteria we're using like in the assessment factors which we're now putting up a green paper and part of the review is on that actual assessment factors for operator capability because we've realised [inaudible] things. In terms of the outcome some things have actually slipped through the ... the hoop, not because of the decision but because of the lack of the right information that we've requested so yes.

S: Okay, so you're doing that.

D: Yeah, and I would say that was part of ...

S: That's a very formal way of doing it okay?

D: Yeah, yeah.

S: And you're in the process of that so you can say whether it's successful or not?

D: Well at the moment the green part that we've put up the criteria and we're satisfied with that and we're waiting on the ... on the green paper to go out for public consultation, but having said that I've also got another decision where we've developed a set of criteria for assessing rehab, rehabilitation [inaudible] and we've had it in place for five years and I've just now got the environmental consultants going back out on the field to test their assumptions for the criteria they proposed back five years ago so they're about to hit the ground this week actually and they're going to be going back to some of the old sites that they used to say well look if you achieve this, this and this that will deliver ultimate ... ultimate recovery to appropriate level. Now it's

been five years have gone past, they can now go back and revisit their assumptions so yes we do have that.

S: Excellent, excellent, now is that used for all types of decisions or just for certain types of decisions?

D: No, just only used for certain types and ones that we decide are critical.

S: Okay, so yeah.

D: The critical ones are of course getting incapable or incompetent operators out there doing operations which is safe and environmentally dangerous or damaging and also having a ... setting up ... setting the wrong standards in terms of what the environmental performance should be so anything that related to that are critical okay?

S: Good, last one and this is just your opinion so don't ... never gets back to the director. In your opinion do you think ... what do you think of [inaudible] decision making processes compared to your competitors? And so by that I'd mean other ...

D: Agencies.

S: Agencies rather than operators. I've got a scale of zero through five with five being the most effective or efficient down to nothing.

D: I think ... I will ... it's interesting, when comparing ourselves and this is an absolute, this is relative.

S: Yes, that's right.

D: I would put us in the four, from both the regulatory, from the licence issuing and assessment process, I would say we'd be struggling to give ourselves anything less than four so I'd definitely say a four, but that's relatively speaking, I'm not saying anything 100% perfect.

S: No, just relative to other agencies.

D: Yes and because I'm involved with all the national working groups and even internally in government interstate, intrastate, it's appalling how some of the policies are developed. The decision making to develop some policies is just so reactive and not sit back to go through a principal process. Just going through a process right now with the new legislation that's going to overlap with ours and it's a process that follows nothing short of appalling but ... and so yeah I have no doubt ... I had a meeting for two hours on Friday with another agency so you'll really hit a ... a high point now, it's four without a doubt.

S: Compared to others that's good. Well that's it, that's all I'm after XXXXX so that was easy.

D: Oh easy, I thought you were going to be four and a half.

End of recording

***Interviewee: Participant E (E)**

***Interviewer: Steve Mackie (S)**

S: So the key thing is to find out firstly what you mean by decision-making. When someone says you're making a decision, what do you think that means?

E: I believe it means analysing all pertinent facts and coming to a conclusion based on facts presented.

S: Analysing and facts coming to conclusions?

E: Yes.

S: The three things that we see as part of a decision are firstly as you've said, it's a choice and the end. So at the beginning you get data or whatever word you wish to use, analyse it as you've said and then make a choice. That choice is based on objectives, that you've got to do this, or this, or this, and you'll perhaps rate them or perhaps you won't but there will be some objectives there. And the way we say ... and we say that it needs to be conscious. Some things are unconsciously done and so we've got a guy, I don't know if you've talked to XXXXX.

E: I don't believe so.

S: Okay, he's researching the subconscious type of decisions which we tend to call expertise, but the other end of it is the question of who makes the decision. Have you thought about that?

E: Well everybody that works here makes decisions [inaudible] a process. My role here, I am not the final [inaudible], I am [inaudible] of the process and make recommendations [inaudible] ultimate decisions [inaudible] decision maker.

S: Okay.

E: Irrespective of the process there is a number of decisions that has to be [inaudible].

S: Okay, so the decisions you make may form part of a bigger decision where you've made [inaudible].

E: [Inaudible] my staff would obviously have to make a series of analysis and conclusions and decisions, recommendations.

S: Based on what they're doing.

E: Based on what [inaudible] the chain for the ultimate [inaudible].

S: Okay, so what sort of things would you decide that, not the ones you pass on, but what would be some of the things that are in your control?

E: [Inaudible] I see my role as being “an expert on [inaudible] in respect to [inaudible] administration” essentially I have to be accountable for the process and recommendations that are legally sound for the people who make the ultimate decisions.

S: Have you ever found they go against what you have recommended?

E: It has happened.

S: Yes, okay so it's not a rubber stamp type system?

E: No, it is not a rubber stamp type system. What may influence the ultimate decision is [inaudible] policy decisions which are [inaudible] legislation. So it is not always fait accompli.

S: So your recommendations are based on the act [inaudible].

E: I certainly make my recommendations, I would hope are legally sound, but the ultimate decision would be based on my recommendations plus overall policy, is it in the interests of the state, the object [inaudible].

S: And that's where someone's [inaudible]. Okay, and then the concept of a good decision, what do you think a good decision is?

E: That's an interesting one. Ultimately I believe we are all working here for public benefit. They see that as our number one guiding light in a [inaudible] distressed if [inaudible] arbiter made a decision which I did not believe was in the public interest.

S: So a good decision then is one that leads to public benefit or something that is what it the public wants?

E: That's how I see my role here. And what's good for industry, what's good for the public in general, what's good for Aboriginal people, what's good for a whole plethora of people must come into consideration [inaudible].

S: It's balancing the trade offs going on and all of that.

E: Yes. But, whilst I've been involved in I guess considering those things based on what I understand is now overall policy, is ultimately that decision [inaudible].

S: Okay, good. Do you make any decisions with regard to staff at all? In other words hiring, firing, leave, or is that a process driven thing?

E: Certainly mostly of those. The firing one is something that is not ...

S: Something that doesn't happen?

E: [Inaudible] within the public service sphere. So, certainly hiring staff, managing staff including [inaudible] any leave, and training management, performance appraisals, that is my responsibility.

S: Okay, so we may think about those things as well as [inaudible]. Okay, that was to try and lead into this concept of type. When I originally said that we're proposing that different types of decisions should be made different ways, what was the thing that came to your head, how would you separate type?

E: I don't know. It's an interesting one. This, my whole training has been based on [inaudible] and I guess legal backing towards ultimate decision-making, a concept that I don't really like to think about greatly. But being how that may match in with higher objective policy type of issues, [inaudible] does not [inaudible]. So, I've been exposed to every kind of policy matters, where ...

S: Strategies may come into play.

E: Strategies may come into play.

S: Yes. That's ... most people think of decision types in that sort of fashion. You know there are some types that are made by the Premier in your area through to which bus to I catch to work, for the guy who works on the floor. Yes. Okay. In, so you would, I'm putting words in your mouth in a different way, how may different types of decisions do you think you would make?

E: Oh, well my, I guess I've got [inaudible] aspects role. One is the involving [inaudible] administration [inaudible] I am a manager of people, I have within the management decisions [inaudible]. Also provide general admin support to the group which means that any admin person who works for me who isn't bound by Petroleum act or anything like that, is purely a [inaudible] function, so there's at least four categories that I would be exposed to daily where there would be some decision making required.

S: Okay, and you call those roles, that what most people would use as the word, so, do you, in those roles, the way you make decisions is it the same for each role, or have you thought about how you actually do it?

E: I don't believe that [inaudible] require onset.

S: Can we take one example then and try and tease it out a bit? Take the royalty one. Decisions made on royalties. Okay, can you think of a decision that is in that role that you've made in the recent past that we could talk about?

E: We get royalty returns on a regular basis from company [inaudible] summary documents. We are required to [inaudible] those reports. There are some fairly inventing and creative people out there who are obviously looking after their company's bottom line. It's an interesting [inaudible] for the client. Basically, I don't believe, if they're all doing a [inaudible] accounting exercise, also understanding business to understand is that expense relative to this activity that physically happened. They basi-

cally need to have some background knowledge on physical process of getting oil or gas to the market. So ...

S: So, the [inaudible] has in royalties you know, yes, you'll pay a royalty but it's specified whereabouts on the stream it's paid and what deductions are required, and the decision you would regularly make is, are these deductions valid according to the [inaudible].

E: The actual description of the type of expense. How's that fit for [inaudible]?

S: This is possibly the first time you've seen this. This is a taxonomy that we've developed to [inaudible], we've tried to make it very generic and at SPE I am going to be running though how we developed it but right now, suffice to say it's being done academically. We found that there were four major dimensions in decisions, that once you begin to tease them out along these dimensions you can see different types evolving. The first of those dimensions we've called complexity and by that we mean the number of different processes that are required to actually make a decision. Task constraints is all the different constraints that can back it up and we've simply said that as the number increases, it will change the type of decision. So the first constraint that most people think of is time, it's got to be done by Friday sort of thing or money, it must be done within a certain budget, so if we get two of those, then it's moving up this. The next dimension we've called ambiguity. This is the measure of these objectives so you, sometimes we turn them into numbers and sometimes we don't, we just used words to describe them. But for example, if all you're making a decision on is based on economics then your ambiguity would be low, but if you're now trying to also satisfy environment, plus heritage, you're going to have three different types of measures, then they're going to trade off against each other and so it will become more ambiguous about how you actually do that. And the final one is what we've called the environment information structure. That is where the information you're going to use to make the decision is it highly dependant, in other words we make this decision day in, day out and we've always got the information, versus this is the only time we've ever made this decision and we don't know where to find anything. Now given that sort of taxonomy can we try and tease out one of these royalty type decisions that you've made to see where it might fit on those dimension? So, firstly think of one that you've had to do recently, so it's easier to think about. How complex was it? You know, how many types of processes did you have to go through?

E: Well, I mean, when you've been working in a place for a long time, complexity takes a different meaning.

S: If you're used to it ...

E: If you're the new chum on the block and learning from scratch well then obviously it's a different ball game.

S: That's it. So this is specific to you, that's why at the start we talked about your experience, you've been doing this for a long time.

E: Yeah. I mean, like I indicated in that royalty issue, you really need to have ...

S: [Inaudible].

E: And that can only come over time.

S: So, to you specifically, I'm seeing complexity is at the lower end because time has moved it down this way.

E: I think that is probably a realistic statement. For most events you always get this, [inaudible] had to deal with and [inaudible] royalty payments that are [inaudible] on the book and new issues associated [inaudible] haven't had to come across.

S: So, each individually case may sit in a different place on their ...

E: I think the long-term pales to the new [inaudible]. Certainly we'd be bouncing [inaudible] in some cases. I mean ...

S: Okay, should we take on in the mid here. One of these new chums and ...cause what I want to do is try and define the decision and then look at the process you actually use to come to the decision you made. They're the two things I'm trying to tie together is type and process. So, rather than sort of blurring [inaudible] right across, can you think of a specific one, so a specific company who's recently just put royalty through and we'll run that through.

E: Without trying to implicate anybody, [inaudible]...

S: Choose anyone then.

E: It makes it very difficult. [Inaudible] specifically, obviously we can't, we have [inaudible].

S: No, you can't mention names you deal with day in, day out.

E: [Inaudible] deal with day in, day out and I mean, it is a constant networking arrangement.

S: Okay, so part of the process, I'll jump back to that in a minute, but there's a networking going on as part of the process.

E: I mean, one of the major issues that impacted on my business [inaudible]. Okay the complexities involved, I mean that's really, we've had to really put our minds to [inaudible] a major issue.

S: Yes, it certainly would be.

E: And it impacts on ...

S: Who can claim what?

E: Not only [inaudible], it impacts on a multitude so there needs to be a thread throughout so it affects everybody.

S: It's got to be consistent across the board.

E: It's got to be consistent [inaudible]. So you've had to ... I mean that sort of stuff is ...

S: Very complex.

E: So, that is an issue that is common to almost all of our royalty payers.

S: When it comes to constraint, do you have to process it within a certain period of time? Is there a time constraint on you?

E: Not written time constraint. Personally I guess politics and pressures from [inaudible] obviously come into play.

S: Yeah. But is that fairly constant? In other, [inaudible].

E: Yeah, we are constantly [inaudible], you said you were going to get that [inaudible] what happened.

S: Okay, so it's [inaudible].

E: So, it's at least [inaudible].

S: Okay.

E: And obviously add [inaudible] from management at any time, [inaudible] royalty cheque was two million dollars [inaudible] and we thought what's going on.

S: What about people? I shouldn't have asked it like that, but I was going to say have you got enough people, but the people resources, is that a constraint, or is it not a constraint?

E: It can be at times depending on the priorities you have going at one particular time. Murphy's Law will indicate ...

S: That's always the way.

E: That's always the way, but I mean, this [inaudible] relative fortunate that management recognises that we need people to do [inaudible] relatively successful and obtain the resources but it's not normally a timely manner within the government. So, you're never going to catch up.

S: Okay. And the decision you make is governed by the act as to what's in them and what's out of deductions on [inaudible]. So in terms of measuring ...

E: Well, it is in a broad sense, the act is very broad, so there are areas that are open to interpreter numerous times where we've been in a [inaudible].

S: So, is the driver solely dollars or do you also have an environment driver or a social responsibility driver or any other driver to make the decision?

E: I think as regards royalty goes the decision is primarily [inaudible] drivers dimension [inaudible] cold hard dollars and cents and it's a business decision. He's obviously trying to maximise their return, we're trying to make sure that the public is getting what's it's due.

S: That's right. They own the resources, yeah. Okay. And you make these types of decisions sort of day in, day out, this is the role, so, yeah, the information is there, you're used to making them, you see them up at this end they're dependant on each other, they're the same sort of thing each time?

E: Yeah, well essentially there must be common principles [inaudible] [inaudible].

S: Because of consistency it absolutely has to be that way.

E: So, dealing with a multitude of people who offer different agendas, they have to be the [inaudible] process.

S: Okay. So let's talk about that process. The thing you mentioned firstly was networking that goes on. What other things are involved in the process of making that decision?

E: Well, as general networking, there's also we have the ability to get a bit more active as regards eking specific information that [inaudible] and at times we've had to go in and [inaudible] expenses [inaudible] to that particular [inaudible].

S: Okay, so almost an audited type thing.

E: We do have a [inaudible] more [inaudible] and we do use [inaudible] specific issues that [inaudible].

S: So, is this process fairly well defined? Is it formal, is it in the act, you know, you've got to do this, this, this, this, this, and this, or is it something you've developed or ..?

E: We've developed guidelines.

S: Okay, so there are guidelines.

E: And guidelines are guidelines.

S: Yeah, [inaudible] shift and change.

E: The act is fairly simple in this is [inaudible] and we've based on the role of development in this state and previous [inaudible] issue guidelines towards [inaudible] this is how we interpret. Well the act means [inaudible] a practical way. The guidelines go for about six pages. Fairly specific things.

S: Okay, so there's a lot of detail in there. And of course consistency. You obviously work your way through that.

E: And everybody is subject to those guidelines. We would often cross check against [inaudible].

S: In doing this, I would assume but I'll check it, that you have some tools that you also use. By that I mean you might have a spreadsheet that you've developed that works things out for you, or you may have some other [inaudible]. For example, the best example I use here is XXXXX and his whiteboard, you know, that's a tool he uses, so that's just some examples. Do you have specific tools that you use to help with this decision?

E: Yeah, we have got various databases where we monitor [inaudible]. Also rely on other expertise. [Inaudible] so I mean, we don't need specific [inaudible] knowledge for example, or we don't know exactly what's going on in that field, if there's things [inaudible] or there's a different ratio of [inaudible] products, you would ask for [inaudible] specific expertise within to give us some advice.

S: And the way you work out whether that, so you have some form of check that goes through that's checking for you know, [inaudible] ratio for the last seven months has been x, y and z whereas now it's all of a sudden this, then you go to an expertise.

E: Yes.

S: Okay. That's a good tool so there's a [inaudible] benchmark check.

E: So we don't know everything and we rely on people [inaudible] skills to assist whenever necessary.

S: So the spreadsheets that you use to actually do it all, they've been developed in house?

E: Yes.

S: And just in Excel sort of thing, you don't [inaudible].

E: Well, essentially Excel.

S: Do you use any other product at all?

E: Well, we've got the [Inaudible] database where we also [inaudible].

S: But that's an internally developed [inaudible].

- E: That's an internally developed database.
- S: And that's run on Access or do you know what database it's on?
- E: [Inaudible]. I mean [inaudible].
- S: Yeah, but no, it's ...
- E: It's a specific for our [inaudible].
- S: It's been internally developed so ...
- E: It's been internally developed [inaudible].
- S: Okay.
- E: So that is, I guess that era of [inaudible].
- S: [Inaudible].
- E: I mean our [inaudible] mainly [inaudible] bits from individual [inaudible] productions [inaudible].
- S: Okay, so it's a huge ...
- E: A huge database.
- S: And you take a portion of that.
- E: [Inaudible] or infiltrate a portion, an [inaudible] portion [inaudible].
- S: Okay, now this process that you use for this type of decision, the royalty type of decision, and the tools that you use for that, is that specific to royalty or would you use the same process and tools for say your tenement role?
- E: I think that would be specifically ... tenement role is reliant on [inaudible] regulation and policy, whereas there are a number of [inaudible] tenement administrations [inaudible] a different way of analysing where things might [inaudible].
- S: And you use a different set of tools to actually determine that?
- E: Oh, yeah, I would think so. I mean tools [inaudible] in the head rather than a [inaudible] database or a huge financial spreadsheet, mind boggling to most [inaudible].
- S: Okay, that's good, so that's explained it very well for me. Because yours is a very defined one so it works out well. So the last two things I wanted to check were, if I were to draw it, and we see three main [inaudible]. This is the outcome of a decision

and here is the decision, we make it and it leads to the outcome, but there are also two other things that have influence on the outcome. First of those is the way it's implemented, so you may decide to do x, y and z and say it needs to be implemented this way, but it doesn't get implemented that way, so therefore the outcome is not what you expected. The other one is our old friend chance. You know fate or whatever word you wish to put in, will change you know, if we've made this decision and implemented it the way we've wanted to implement it, it might rain and so you'll get wet if you didn't bring a broly sort of thing. Now one of the things that we're looking at is how people actually benchmark the outcome back to the decision and whether they benchmark the implementation back to the decision. So do you have any sort of formal feedback that says how do you know that in making this decision I desired to get to the outcome to implement it this way, do you ever go back and check that that's how it was implemented?

E: I believe in a lot of cases yes. One of our general decisions warranted that there be a pros and cons before a recommendation went out. [Inaudible] trigger another series of actions. I'm not sure whether that's exactly what you're sort of referring to.

S: So, what you've said is, in making a recommendation you've recommended x, the director general has come back and said yes, go ahead with that and in going ahead with it, you then work out how to implement what you've decided. The question I'm asking is have you implemented it, for example guidelines. As I understood it, you said you'd developed those guidelines so that was a process you put in place to implement the decision. Do you ever go back and check that that's the best thing to do?

E: [Inaudible] has issued the wrong [inaudible] perhaps or we are in effect [inaudible] a firm but hey [inaudible] not perfect. I don't know how many [inaudible] you put in there, there'll always be somebody who [inaudible].

S: So, it's more or less like steering a ship. As little things change you make little changes.

E: Yeah. [Inaudible] are the same as any of our [inaudible] we put our subject to. If they're not set in concrete [inaudible] time. But there has been reason for us to change, because something came out of left field that we've never thought of before.

S: No, that's good. So, that, what that says to me is [Inaudible] is not the best word but it is an anomaly based review occurs.

E: Yes.

S: So, as you seek changes that are not quite the way it always has been that's been where you'll be getting through. At least there's a trigger mechanism going on.

E: Well, I don't think there's necessarily a conscious thing of reviews specifically. But there's certainly [inaudible] pop up from time to time that forces us to re-think and until somebody tells us [inaudible] ...

S: Ain't going to fix it.

E: [Inaudible] the resources to sit down and think constantly about things.

S: Especially if they're working.

E: Yeah.

S: And the last page is really just a number. And what I'm trying to get is a feel for how effective and efficient you think your processes are for the decisions you make. Compared to, so that this is compared to your competitors and let you choose your competitors. The reason I'm asking like that is I'm trying to get a feel for what people actually think is what, is how good they're doing.

E: As far as I'm concerned there is no other jurisdictions certainly on shore, of an exploration that would be better processed as regards regulation of [inaudible].

S: Okay, on a scale of one to five, you'd give yourself a five.

E: Yes.

S: Yes.

E: That's not to say that ...

S: Can't be improved.

E: It can't be improved, yeah. We have [inaudible] based on comments from [inaudible] people nationally and internationally and not impressed.

S: You guys have ...and the thing they like about the process that you actually haven't mentioned, although you have talked about the way it was networked, is the transparency of the process. They feed that back regularly.

E: Well that's ... we've tried to put as much information out there for digestion as [inaudible], work in the long run because the answers will be there, if they wish to look without having to sort of talk to us.

S: Are there any plans into the future to change the way anything is done in the area that you are looking at?

E: I don't think there's major changes in the way we administer [inaudible].

S: No, [inaudible] policy.

E: We are under some pressure to [inaudible].

S: Okay. And that's outside pressure or inside pressure?

E: Both.

S: Okay, so there's tension going on.

E: Yes, there is a lot of tension going on with all these new chums on the block. All of them associated [inaudible].

S: Third party tolling.

E: Third party tolling issues and [inaudible] that's raising the awareness [inaudible] being contemplated in that aspect.

S: Okay. [Inaudible] good. Especially if you've got a good system and you still see change that says that you're proactive in what you're doing. [Inaudible].

E: [Inaudible] process is [inaudible] constantly under review. I mean I just changed another process yesterday. And sometimes you can't see the wood for the trees, but when you're fronted with [inaudible].

S: That's it. And the thing I'm looking at is whether, because I've noticed a lot of people do do similar to what you've done and I'm putting my interpretation now on what you've said, I could be totally wrong but I see that, I use this idea of a ship with a rudder you know and as the winds change, it changes the way it moves and it's this continuous change to improve. One of the things I've noticed is people doing that may actually have the best process for a certain type of decision back here. But as they keep changing it for this type of decision, although the types of decisions they're moving towards may be very different. They leave this process alone and move towards another one so they're using the one process to do all sorts of decisions whereas it may have been better to keep that process for these sorts of decisions and modify it for these sorts. That's what I'm trying to analyse.

E: Yeah, so nothing is set in concrete here.

S: Oh, yeah.

E: And we're learning something every day. And we're getting confronted with new challenges every day. [Inaudible] all these new players on the block.

S: Well that finishes my hour with you so I won't take any more of your time. So I much appreciate you giving it though. It's very much appreciated.

E: That's alright. [Inaudible].

S: We will keep you informed ...

End of recording

***Interviewee: Participant F (F)**

***Interviewer: Steve Mackie (S)**

S: So really to start it off, it's really a discussion on what you think decision-making is. So firstly, we'll get an idea of what you mean by decision-making and then look at that decision. So what is a decision to you?

F: Oh, actually I think we make very few decisions. It wouldn't be my thing because I think ... in terms of major life decisions I'd say I've ever made two or three because mainly when you weigh up the pros and cons of a certain thing, there's an obvious solution and you're not actually out too much on a limb. That's the major life ones. Within the company environment ... okay, is sometimes where the data's a bit fuzzy but never the less the decision is usually very, very obvious coming out of when you've got all the data down in a certain way. A decision comes out very obviously on that. There are times when you have to make a very, very big decision which might be in the case of business country entry, in the case of lifestyle to get married or to study geology or something of that magnitude and things where you really are going out on a limb with enough data and you may ... and those become a bit emotive. How do I feel about the person I'm going to marry? How do I feel about the country I'm proposing to make a country entry to and how will it develop in the next twenty years? And they're not based on a lot of fact. But if it's a decision to do with purely shall I invest in this opportunity or not? You can make a very good analysis given what you know at the present to make that decision.

S: Okay.

F: So, I find most decisions ... actually when you put all the data together, you can come out with a very objective yes, no type of decision.

S: Okay, and it normally falls out based on the ..?

F: [Inaudible] you don't always get it right 'cause sometimes your input data's wrong and you know that ... you know that's a possibility right from the start but you can always defend yourself. The knowledge I had at the time ... this was the way forward.

S: Okay.

F: So you don't always get it right but that's you know ... it's ... there's not much pressure in making a decision if you've done your analysis and you've looked at all the pros and cons. It's only occasionally when there's so much fuzziness that you're having to do it from ...

S: The gut.

F: Yeah, yeah.

S: Okay. The ... the other area we're looking at is because one of the things we use in the definition of decisions is the allocation of resources. So the person who makes the decision is the person who allocates the resource. If I'm not allocating resources, then I'm giving input to the decision but I'm not actually making it. So, would that fit with the way you're talking about decision-making?

F: I ... I guess so. I mean allocating the resource, on a technical side I'll allocate technical people to do the analysis to come up with the relationships and I'll go through that to make sure it's the right decision. So in fact, I've allocated the resource and then gone and made my decision and the ultimate decision is usually made by the VP or the CEO of the company.

S: He's using you as a resource.

F: He's using me as a resource to have filtered the raw technical work, I guess. So ...

S: So there will be some decisions that you pass on ..?

F: A lot of my decisions would be my ... because of my recommendation and I'll pass that on. I think that's pretty much as a middle manager, where you're destined to live.

S: What about ... would there be any decisions that you have ultimate call on?

F: Yes, there would be. I sent some boys off to a data room this week in a foreign country and I didn't clear that with anybody. That was just ... yeah, you need to look at that data room and that's my decision. We want to look at that area so yeah.

S: So there are? And that's good. And so the final one is, in the introduction, is what's a good decision?

F: I guess in reality a good decision is one that results in a favourable outcome. Now that's a bit flippant 'cause it might be a favourable outcome, but for the wrong reasons. But still, you've made an effectively good decision and you will as an individual, twist it to say well, yes it was my call to get into that block or that country. And even if your call was based on data that wasn't what actually made the thing work, you will still say you made a good decision. So ...

S: It's outcome focused?

F: It's outcome focused really. It's also ... comes back to bite you 'cause you can have made the right decision for the right reasons but the outcome doesn't come out either for a reason that was unknown at the time of the decision and people will view that as a bad decision. But ... so you ... so you point to what you're getting at.

S: And that's one of the areas we're trying to tease out. Is, is a good decision one that results in a good outcome? Or is a good decision one that has been achieved

through using a good process? And my thesis is that it's the process one and you're going to need lots of decisions in order to determine the roll of the dice.

F: Even the process ... you're right. The process is the right answer but the reality of a situation is that as human beings, we are very much you know, we'll fall back on yeah, that was my decision even though you've twisted it to make sure you get the maximum value out of it. I think everybody will do that and ultimately they would be able to defend that because they'll be able to say that although I made the decision and it mightn't be wrong, my gut feel was that we should be in XXXXX or whatever it was.

S: That's why I was prejudicing it?

F: Yeah. We've achieved that and now look at all the other good things that have happened because of that decision.

S: And if you made the wrong ... if the outcome's wrong, you'd no longer be with the company.

F: That's right, yeah.

S: Okay. So as I said, the decision was on decision types. When you first hear that sort of phrase, what do you think of?

F: Don't know. I would have thought it would be magnitude of importance, perhaps?

S: Okay.

F: That would be what I would have thought.

S: No, that's good. The other one that I noticed just if I go back to what you talked about. You talked about life decisions versus company decision. Do you ... would you see them as different types, 'cause you even described a different process? One was more emotive, one was more fact based.

F: I think I'm paid for ... at the company to make fact-based decisions and so I take that on board. I wouldn't propose that XXXXX marries another company for example, whereas I was able to make that decision myself and it was a good decision. But I ... so there's certain decisions you can make in your personal life that you're prepared to take the consequences of but I am not going to make those size of decisions for the company. I will make an objective based decision for the company.

S: And so you see the ... the level of decision-making is important as well? So that where you are on that chain of command, is that what I'm hearing?

F: I guess ... I guess so ... I ... it's ... I'm not quite so sure about that because we'll make very strong technical recommendation to do a piece of work and then it's not going to get looked at technically again as it goes up the decision chain, so the deci-

sion's effectively been made at that level. It'd only be turned over if there's a deeper strategic imperative for the higher level not to do that bit of business so ...

S: So how have the ... what objectives are weighted with what level? So technical is the highest weighting in the decision-making, they'll go with what you've recommended?

F: Yeah.

S: But if something else says, you may get overturned?

F: That's right.

S: Yeah, okay. No, that's fine. So let's look at this big decision. Can you ... in ... in our taxonomy that we're ... this is really what the SPE presentation next week is, is how we came up with this but I won't go through how we came up with it, but we found that there were four main dimensions to decisions. The first we've called complexity and that it's similar to what you've called magnitude of importance. It's really the number of processes you go through to make the decision from very low ... which bus do I catch to work this morning? To very high. I've got to do lots and lots of calculations to come up with a weighting and then I'll add those together sort of thing, so that's the complexity. Task constraints. The classic constraints are time and money and we've found that if you have lots of these constraints the type of decision you're going to make is very different to if there were very few of those constraints. The third is termed ambiguity. These are the objectives. So as we've just talked about, you may have a technical objective and you get a number that represents that but then there may also be a social objective or an environmental objective or a political objective, all of which have to be weighted in some fashion and because there's going to be trade-offs occurring, that becomes more and more ambiguous the more of these objectives there are. And then finally an area we've called information structure. So this is the information used to make the decision and the process, if you want to call it that. So, I've got all the information I need to make the decision, it's readily at hand plus I've made this sort of decision lots of times before through to I don't know where the data is, I've never done this before. That sort of thing so on this sort of taxonomy could we type that big decision you made?

F: Yeah.

S: So how complex do you think it would have been?

F: In terms of block bidding decisions it would have been somewhere just to the right of the centre. Just slightly higher than that.

S: Just high of middle. Task constraints? Were you under ... you know did you have resource constraints? You didn't have enough people or data constraints?

F: We had time constraints. There was a big deadline and the right number of people working on it and it was a joint bid with another couple of companies and they did a lot of the technical work as well which ...

S: So that had been worked out [inaudible]?

F: Yeah, we'd independently been to a data room. There were data constraints. If we don't get a certain part of the data from the data we can take home with us, our team mapped the thing up and it was all very good and very similar to what had been mapped by our partner who had more data and more experience in the area so I felt that we were you know, on board with that. Our volumetrics were slightly conservative to our partner but that didn't make any difference at the end of the day. So that was good.

S: Task constraints sound like they were at the lower end.

F: Yeah, I think so. I think this was a properly resourced new ventures evaluation.

S: Okay. What about ambiguity? You know, was it purely driven on NPV or did you have to bring in political risk and weigh those things as well.

F: This one was pretty much purely driven on NPV but we had an interesting thing in that the board of our company decided they really wanted this thing as well.

S: Some other measure [inaudible]?

F: So, yeah, there was a strategic imperative but we still constrained it within the MPV envelope and so that was there. The other ambiguity was that our partner there wanted to bid one less well perhaps than we did but we were able to persuade them into going the same level as us, in fact the agreement ... written the agreement they had to come with us or not but they were happy to. Technically the agreed that we needed that number of wells and we did.

S: So it sounds like the ambiguity was fairly low as well?

F: I think it was probably fairly low, yeah.

S: And then the information that you had at hand ... lots of it and you'd done this before or this was the first time?

F: Yeah, lots of them. We'd done it before. It's a fairly standard new ventures evaluation.

S: So if I were to draw a picture of that, we'd have it high in complexity ... mid to high. But task constraints, ambiguity and environment structure are all fairly low. So it would look something like that? I ... I call that a pennant decision.

F: Okay.

S: 'Cause it's [inaudible] style. Okay. Now what I'm looking at now is the process you actually use to make that decision. So, first question here is whether it's for-

mal or informal. Is it a documented process that you use or is this something you've come up with and it was a defined process in your head but it's not formal?

F: It's a formal process in that it was written in the joint study bidding agreement that we would have meetings at certain dates and put stuff on the table, okay? So we went up and met with our people in another country and did that. We reviewed it ... peer reviewed it internally in the company and then we presented it to XXXXX and then we presented it to the board for final approval.

S: XXXXX.

F: XXXXX, yeah, yeah.

S: Okay, marks.

F: Yeah, marks about that. So XXXXX and then board and it's a very standard process for us to do that. Yeah, so just went through their very normal process. In terms of working it up it was a very typical process in that there was a geologist and geophysicist who did the work, came with a volumetric ... we involved our planning economics group. They came up with you know, an evaluation. The way the bid worked, you were bidding on a work program and on government take in a PSC environment so you had two levers in which to pull okay?

S: And that's fairly defined in the way you're ..?

F: It's very, very ... it was very, very defined and we had our standard oil price forecasts and we have our understanding of gas market in that country and you know, it was all a case of ... yeah.

S: So if you were going through a bid process in any of the countries that you're looking at this would be the same process?

F: This would be the same process, yes.

S: Is this the same sort of process you would use for example, I'm just pulling stuff out of a hat, when you are looking at your staff to determine whether they should be promoted or not?

F: Yeah.

S: Yeah?

F: Yeah.

S: So it ... it fits across lots of different areas, this sort of process?

F: This ... yeah, it would go XXXXX and the board quite in the same way but I would ... actually I mean the promotion thing would be annual performance review, you know, ranking them, rating them, and just discussing with them what they need to

be in the next job category up. They will have had that discussion with them in the year or previous year and if they've picked up on the elements they've said they needed to improve to get them to the next upgrade and demonstrated that, then it's a paperwork thing. I write a ... on a particular form, send it to a particular group and it gets considered and then normalised against other requirements. So there's a ... it's very much ...

S: So it's a very formal process again?

F: Yeah. Probably the staff promotion thing can have a bit more of an emotive thing into it 'cause you'd go to a staff member who feels he should be or he should be in a different job grade than they are and you're not letting that happen, that is a bit more emotive than a bid round. But even so, the bid round should we give this many wells or that many wells?

S: Yeah, it can especially if you've got a partner in there.

F: It can be quite emotive too.

S: In the process, lets go back to that bid round. In the process that you used there, did you use any specific tools to come up with the answers that you make your decisions?

F: Software tools.

S: Software is part of it but other tools might be a framework so this ... the way you've ... I'm putting an answer on what you've said you've said now, but because it's written down as a written agreement, that to me is a tool that you've used.

F: Okay. So the contract ... a work contract basically which is called a joint study bidding agreement which ties the parties down to meet and to bid at a certain level as defined. So [inaudible] ...

S: So you have a contract, then you have software, which is ..?

F: Your software which are various geophysical and geological packages which go from seismic interpretation, based on modelling, migration path modelling ... that sort of stuff.

S: Okay, so all of the standard technical software?

F: And then the economic stuff. We have our own in-house programs which mimic the taxation regime of those countries and which we model government take on to see ... so we can balance it to make it a NPV neutral [inaudible] project.

S: NPV neutral?

F: Basically.

S: So when you went through all of that, you'd have come up with a [inaudible] value for the block or something like that?

F: Yes, yeah.

S: How did you then decide what work program and what government take are required? Was that ... did you use a tool to the ... you know, an Excel spreadsheet or some matrix or was it something in your head?

F: No. There's two parts to it. The first part we focused on in this decision because of the structure you're bidding on both work program and government take and it's different in every jurisdiction but because both those were biddable this time, we looked at the range prospects we had and said it's a 5,000 km². What would it take to test this block properly? And based on the number ... the variety of different prospects we recognised that were valid, we came up with a number of wells that we thought you had to bid and prior to drilling those wells where we had a 2D grid of seismic, we realised we were going to need a 3D to define some of those things that had been better. So we came up with an area of 3D seismic. Interestingly, the three other companies that bid came up with an almost exactly the same bid. They came up with the same number of wells and they came up with the ...

S: Same 3D?

F: Almost the same 3D although what I did, I added 10% to what would be a fairly round number to make it something slightly bigger and it would have given us the edge technically which was just you know, insignificant in the total number of dollars ... it probably added \$1m to the overall bid package. But it ... it gave us perhaps a little edge and so that was probably a little irrational thing of the edge just to make it not a round number.

S: To give you a comfort feel?

F: Yeah, so there was ... that.

S: Okay, so that the integration of the pro- ... the technical output and the final decision actually was occurring as a reasoned logic, I guess you could say.

F: Yeah. So there was reasoned logic for the work program and then once we built that in we had estimates of cost for wells and seismic in the area. We then went and used our spreadsheet which we've got for the ... and to manipulate the government take to get it down, given the risk of these prospects to what we considered was a EMV neutral ... EMV discounted it. The discount we use in that country ... neutral result and that was what we based our bid on and so built into that is our prediction of an oil price scenario. Our prediction of you know, the type of costs for doing business there.

S: Okay. Do you think these software packages you used are crucial to the decision-making or beneficial, or you just feel good about them?

F: I think the ... I think they're crucial. I don't think we could've come up ... because the government takes splits and vary introduction [inaudible] in quite a complex way, you've really need to have it tied down quite well to understand what you're bidding. And in this particular case we came second and the company that came first bid something that we can't see how you can make money out of and whether they had a [inaudible] had a much higher oil price forecast than us ... But even then they ... they've bid fairly [inaudible] terms. I suspect they're probably going to lose money and I know the companies that won. I know the people there and I suspect that they didn't have the rigour that we did and so although we might have made a right decision, we didn't get the block. I took a bit of a hit from it from certain sectors of the company ... so, yeah.

S: That's brave to talk about it. Okay, so that's ... it's a similar process and you would've called this a good decision because you feel comfortable that where your bid was, was the neutral position and you had ..?

F: And I think the fact that we were the second highest bid, from what we know in that's only hearsay 'cause the jurisdiction doesn't really release information that readily. But we gather from our intelligence that we were ... and that the highest bid made the pay a very high signature bonus which wasn't part of the bit which was a bit odd and also ... and the signature bonus was 15 times higher than ... the signature bonus had been in that basin before and also offered a government take that was we believe, 20 or 30% more to the government than we were offering, you know. So it makes you think that there was something non-rational perhaps, about their bid. We couldn't have gone into that territory and still been positive on ... you know it wouldn't have been responsible use of our shareholders' funds. We'll know in 10 years' time whether that was [inaudible].

S: And that's one of the problems with the oil industry 'cause that's what I'm now getting to is this learning feedback.

F: Yeah.

S: So having gone through this process now, you've explained how you've got some intelligence that helps you understand why the decision ... why your decision actually didn't win which was what the outcome you wanted?

F: Yeah.

S: We've actually divided this learning feedback into two. One we call the implementation and the other the actual outcome. So there are three things that influence an outcome. One's the decision, one's how you implement that decision and the other is chance itself and you can't control chance. That's random, so let's look at how we implement and then how the outcome came up.

F: Okay.

S: So, did you go through any sort of formal learning feedback on the implementation? So in other words, the way we sent the guys to the data room, the way we put

the contract together, the way we met and got on with our partners, the way we made the bid. And although we didn't get it, we still feel that it was a good decision.

F: The answer's no in this case. I think that's no in this case. I think in a lot of other processes if it was [inaudible] the well, we would have a formal process for feedback. But in ... in a bid that you've done your best and you've come second, we haven't got a strong formal feedback process on that.

S: Okay.

F: And I think there were learnings that were taken on but because the team is relatively small, those learnings were immediately applied to the next one and we build up our knowledge and database.

S: So it's an informal process?

F: Yes, that's probably it [inaudible].

S: Because of the size?

F: Because of the size and the nature of it, but in a lot of our operation [inaudible] decisions we probably would've had a formal ... particularly for wells or drilling engineering projects, we would've yeah.

S: Yes. In other people I've interviewed at your company, that comes out very strongly.

F: Yeah, I don't want to let the side down [inaudible] these formal look backs like we would on those ones.

S: Again, I go back to my thesis. My thesis is that the process drives whether it's a good or a bad decision, and some decisions based on ... for example you didn't have a task constraint of people because you have a small size. So is it that that type of decision does not need a formal feedback loop?

F: Yes, that's right yes.

S: It's already got an informal one that's working fine. So that's what I'm saying. So that you shouldn't have to do exactly the same thing for all the different sorts. Okay then the final part of the interview is to try and gauge how you feel about what you've said. So it's a feeling ... so it's a number that I'm after and that is, talking about the decisions that you've made and looking at the process, not the actual outcome but the process itself. How would you rank your company's efficiency and effectiveness of that process with regard to your competitors?

F: I'd say we've got some very good processes. I'd say sometimes they get overridden for sometimes good strategic reasons, sometimes possibly good strategic reasons but we're not in on the strategy so we don't always understand ...

S: ... know the reasons?

F: ... the reasons. So I think that would be the politically correct answer.

S: Okay, so on a scale of zero to five, I'm hearing somewhere around three?

F: Three to four. You know, I think we've got ... let's say, I mean if you took a little start up company that was just rolling the dice in XXXXX you know, I'd give them zero to one ... would be my sort of thing 'cause they're not doing the technical work and they're just hoping like hell that they throw double six or two dice as effectively. Whereas I think we're way up there in terms of we've got good analytical skills and ... and we've got good commercial skills. So I'd probably say we're ... we're probably on four, might be more accurate. Yeah, I'd say we were ... we have got those skills. I think you know, sometimes [inaudible] that come up aren't always the ones that we take ... would be ... that does happen. So that would be why we can't possible get five. We've certainly got all the mechanisms in place to make the right technical recommendations on things. The case I gave you was one where we were properly resourced and we had a proper partnership relationship in very early, it was still a rush in terms of time but it was enough time to do the work. Not all of our evaluations end up like that for a variety of circumstances ... staffing or countries having very short time fuses on data ... data rooms [inaudible] stuff so ... But I think overall our processes, having looked at a lot of other ways other companies do business and some of the blocks other companies are taking, I think ... I'm quite confident we've got fairly strong processes in place.

S: Good ... good. Now to finish it all off, I have in developing this taxonomy; I actually put together 20 different decision scenarios.

F: Okay.

S: And you know, it was done in a scientific way is the best summary I guess, to come up with the taxonomy. But what I'd be interested in is if I showed one of these to you at random and what I'm after is not the decision you would make, but the process you'd go through to make the decision. Does that make sense?

F: Okay, yeah.

S: Okay so randomly it's number 11. If you just want to read through that and then just ...

F: Okay.

S: Now what sort of process would you go through if you needed to make this decision?

F: Okay. The first thing that they would do ... I would do, would be to get the relevant people together which would be to try and get the geologist who's done it, the geophysicist who's been involved and the various drilling people and probably the

mud person as well involved and probably run two streams in parallel. One, trying to understand what has happened and two, coming up with options for remedial action.

S: Okay, so it's a group think type of thing, getting all the people together?

F: A group think, but then letting people come up with their contribution to it and the more operational group of people would be charged with potential action plans and you'd probably choose which of those action plans is the most applicable once you've seen the various technical scenarios for what we might be doing with it and you'd hope that somebody would say well, yes we've hit some cavernous rocks [inaudible] in a fault and ... or whatever and so you try and match the correct solution to the correct scenario.

S: Okay, and so how would you actually choose that? So, in the decision we've defined that it's actually the choice so you've said when everything's laid down, most times the decision is obvious. Is that what you'd expect to occur here?

F: You'd certainly hope it would but it would be a fairly clear way out of the morass. I think you'd be in this particular case ... you'd be relying on people's experience. But as you say in this particular basin, you haven't had the experience of a lost circulation zone, so ... but you'd be relying on you know, the accommodation of their global experience perhaps as to what you do when you lose circulation in a particular zone. That ... that would be part of it but within the team structure you ... you very much have a team leader who would probably be a drilling engineer responsible for that well, I assume.

S: Okay, so you'd appoint someone to head up the [inaudible]?

F: There would already be someone appointed who's got the responsibility for delivering that project. That person would be charged with making the call. Now, his call you would hope, would be made by looking at the different pieces of data to try and understand best of what's happening and then to try and draw a process ... okay step one, step two, step three, step four and then to get it implemented.

S: Okay, good. Thank you for that. Just so you know what I'm doing with that, we've ... we've typed each of these decisions and we type it like that. Here it's high on constraints because you know, you're drilling right now and it's got to get done. Ambiguity is still high because you've got different drivers for those two different teams, you know the technical teams want it to be a certain way. But the drillers may have wanted something different. So there's ambiguity in it. But they have been drilling in the basin quite a bit so maybe that's going to help. Maybe it should be over here. As you can see we don't always get types right. But because of that type, you've now given us an off the cuff process. I'm sure if I gave you several days, you'd come up with a different ... not different but a more refined process and so that's all we're after, is to get as many of these in ... into the system.

F: Okay.

S: And that's it XXXXX.

F: It's easy.

S: So I very much appreciate your giving me the time.

End of recording

***Interviewee: Participant G (G)**

***Interviewer: Steve Mackie (S)**

S: So they're the things I want to talk about. And really the aim is just to try ... as we go through it, one of the things I'm going to be asking for is an example of a decision you've made because the thesis we're working ... well, I'm working from, is that in order to optimise decision-making, you need to match the processes to the type of decision. In other words, you can't use the same processes to make all sorts of different decisions. So ... and I'll go through a template that I've developed on how to type out decisions. So I'll want to try and type a decision that you have and then see the process, talk through the process you used to make the decision.

G: Right.

S: That's where we want to go, but [inaudible, overtalking].

G: Well I haven't made decisions ... I'm not sure ... in terms of operational decisions, I haven't made them for years.

S: Okay.

G: So I'll have to recall one of them years ago or ... contemplate it in terms of recent things.

S: Yeah. So we'll get to that one. So, to lead into it, what ... when people talk about decision-making, what do you think it is?

G: [inaudible] in my mind is ... the basis on which people made their decisions in the first place, my experience is clouded by observations of either what I do or what other people do in this company and also what's come out of various psych testing and so every now and then, some psychologist will come around and give you some survey and you find out not how you make decisions, but are you extroverted, introverted, all these sorts of things. And it sort of dawned on me that the step one is I didn't appreciate that I'm at one extreme where I make decisions on the facts. I'm an analytical type person so, give me the facts, lay them out dispassionately, evaluate them, make sure that you've got the facts right and apply the principles, scientific principles with [inaudible] all the rest of it. Then I've learned that at the other end of the spectrum there are people who make their decisions even in the exploration production business based on beliefs. And I didn't fully appreciate that that's what they did until recently and so I thought that everyone thought in the exploration and production business that they all effectively had the scientific approach to business and I found out that is absolutely not the case. XXXXX is some one who I understand is beliefs-driven and the example for that is the ... when he first turned up in the office, I was responsible for making decisions if you like and for exploration in XXXXX. We gave him an overview of the prospectivity of the basin and we said, this is what we've found, this is what the creaming curve looks like, or discoveries ... the actual creaming curve, this is the theoretical optimum and we're not far off that for ... when we look in detail at the last five years worth of drilling and we look at the different things

we've been trying to find, different types of traps to get off the creaming curve to find new opportunities, bold stepouts, stratigraphic. The only things that worked were the anticlines and they're getting smaller and smaller and smaller. So the creaming curve is flattened out. So unless we do something quite different, we can't expect the past to be any better than ... the future to be any better than the past unless you do something different. And what are we doing different? So we talked about stratigraphic traps and high-end geophysics and things. So that was the analytical approach. Within six months, I was no longer in that job. I was doing other more exciting things in data management based on his view that it wasn't being worked hard enough. These words come out, it's not being worked hard enough, or, I've never worked in a basin which just had one major play and that was it, or there must be more potential, which is a beliefs-driven statement. There was nothing in what had been displayed which indicated that there was a rationale for there being more potential. Well we talked about that. The comments came back which were all beliefs-driven, which was more the ... you can't be doing a good job, not interested in looking at the facts, I don't want to have a discussion over the technical issues, I'll make my decision based on what I believe. There have been other instances of various other meetings where there's a perception ... belief perception has a lot more potential say for XXXXX and I'll come along and I'll be invited to attend a meeting where they're discussing some of the issues. I'm invited specifically by XXXXX to provide some paradigm-shifting views and some other alternatives. That's what they wanted, to flesh issues out. So I'll explain what I see the opportunities to be and what you might do to get some significant success. That relates to things like high resolution stratigraphic mapping of reservoirs and seals and stratigraphic configurations and a whole bunch of other things. So there's more data you can get out of seismic than people ever imagined. There's a lot of value in there but so few people know how to do it. Having said that, the feedback from other colleagues there was no, this is simply rubbish, it's only good for ... it doesn't work in our basin. I thought this is wonderful. Here's the analytical view saying I think there's potential upside, there's a lot of risk attached to it, but it's worth doing. Other people said no. Their experience was it doesn't work, it doesn't work in XXXXX, it doesn't work here. That's the end of it. And I thought XXXXX would be keen to get a difference of opinion to work from. But the answer was no. He wasn't interested. He just wasn't interested in the upside I'd given him. He'd already aligned himself I think mentally with another party who he had confidence in. So his decisions were based around belief. Even before you get to the actual technical merits of the decision itself.

S: Who he's trusted and what advice he was getting.

G: That's right, Yeah. So I think the ... 80% of all these things come from that predisposition to where you've come from and your past history.

S: These are some of the things that led me to where I'm at, that's to investigate this and one thing that I want to actually do when this part's finished is tie ... because I believe there's now a very close tie between the decision types that I've worked up and the personality types belonging to Myer-Briggs.

G: Yes, yes. And that was my ... I didn't fully appreciate that that was the case and maybe there are other ways of thinking about it, but the revelation to me in the

last year or two is that not all scientists think scientifically. In fact, they have other ways of thinking and those other things predispose them to how to make their decisions and it often has nothing to do with the Monte Carlo simulation and risk analysis at all.

S: That's what we're actually looking at – biases ... so, we've broken it into cognitive, how the mind works, and motivational. And I'm looking specifically at cognitive and motivational is the next one we'll do. So there are lots of spin-off projects coming out of it. But in cognitive, psychologists have found over the last twenty-five years that the way we make decisions is very clouded by the heuristics we actually use. So these rules of thumb that we have to shorten the thinking process actually bias the answers we come up with. And that's what we're looking at here in this so that we're trying to ... instead of just going about decision-making in the normal way and then trying to de-bias it down the track which is the feedback loops and all of that sort of thing, we're looking at whether you can actually change the process. So in other words, if it's this type of decision, the process you should follow is this sort of thing. One thing I'm learning is very few people have a process.

G: I suspect that's the case. There are notional processes but what actually occurs probably is quite different. The brain fade at some stage we're going to go this direction or that direction ...

S: Rather than spend your time justifying that choice.

G: Exactly. Little time is actually ever spent on the decision itself. It appears some time in a time sequence of things but never ... clearly the light goes on or off. But I would have thought in the decision-making process I would ... if I know what I know now, I would rather there was a ... I could evaluate psychologically all my decision-makers and say well, what sort of ... not box you fall into, 'cause that's a continuum, but kind of where do you fit, how do you ... how are you more likely to make decisions and have that as an understanding of the group that yes you are more beliefs-driven and you are more like this. Okay, we understand where you're coming from. Let's now, when the decision is made, be consciously aware of that we do it in different ways and when the facts are laid out, we can challenge it or challenge someone's belief system rather than ... they can challenge my ...

S: Analytical observations.

G: [inaudible] ... on the basis theory that hopefully group think is better than the individual. That's not always the case, I don't think. There are too many biases in that as well.

S: It's interesting. I did an experiment ... I've just published a paper that's totally outside of all this, while teaching. I experimented. I like experimenting while I'm doing stuff and I gave a mid term exam and gave them the opportunity to do it as groups or as individuals and I was lucky in that half the class chose to do it as groups and the other half as individuals, so I got a good statistical background. And I then presented to them their results based on their choices and those who chose to do groups got 15% higher grades than those who chose to do it as individuals. But the person who got the

highest grade chose to do it as an individual. So what group think does, in this case, was shift everyone to a mean of all of the individuals. So it shuts down the high end and brings up the low end and everyone who's in the low end really likes it but you've got to determine which way is the best. Do I make this decision as an individual or do I make it as a group. And I found in industry, especially the oil industry, most decisions are made in groups. So you hear people talk of, well I'll get my team around and we'll talk about it and that sort of think about it, and that sort of thing. And you get more average performance that way.

G: I guess the question is you want unbiased assessments, is the most important thing. That's why my impression is you've ... the group think is good to actually capture the ... is to capture the assessment of an opportunity as distinct from should I invest in it or not? I think they're quite separate. You've separated those two things because otherwise there is motivational bias, I think. And we don't adequately do that. We actually ... often these things are blended together. I think you're better off to say your job is to ... the job of the geoscientist is to identify all the opportunities in an area and to do an assessment of the resource range and the risk attached to it in an unbiased manner. That's what you're paid to do. I want everything, I want it unbiased and tell me what I need to do to find more of these of things or to eliminate the risk or reduce the risk or quantify it better. I think it's important to do that so there's an inventory of investment decisions to be made and to separate the decisions from that. We don't do that in this organisation. I don't think many do. Those who do the assessments are the ones who decide whether to invest in it. So there is motivational bias. Don't have an organisational philosophy without learning from your decisions, you'll never appreciate how the bias you have been and how far you're taking your company into ruin until it's too late, or you ... I think in the event of success, you're fooled into thinking you've done something right. And I've just bought a book which I'm going to read on my holidays which was called Fooled By Randomness. I haven't read it yet but I think the thesis will be along the lines that when things are random, there will still be clustering of results. It doesn't mean that because they're clustered that they're actually mean [inaudible]. So you have a sense that clustering means something when in fact it's not, it's still random. And I think that we can be fooled ... you are fooled by some of your successes into thinking you've got it right. And the examples there would be you watch the football tipsters on the TV and you have the tea lady in the office or the lady who reads the news makes her tips. Often her ... they lead the tipping pool in the office ahead of the actual expert. So it really says there's a lot more randomness out there than what we care to believe and we actually don't want to know that. We like to believe in ...

S: It's one of the things that we have as a question in an exam. You know, tossing a coin, heads and tails, you know, which is the more likely. And all of them have got three heads and three tails, but the people go for the ones that are really ... look like they're very random. No-one chooses head, head, head, tail, tail, tail. But the chance of that occurring is just as much as the others.

G: Is it? Hmm. Anyway. I'm not sure if it's on topic.

S: No, no, it is. Well, it's helping me. [laughs] So the final part of the intro is a question of a good decision. Have you ever thought about what you would think

needed to be done or be part of, or whatever words you want to use, to be a good decision?

G: I guess a good decision would ... I guess in the exploration, it depends on whereabouts you are and whatever business you're in and what part of the segment you're in. In exploration, to me, a good decision would be one whereby consequences of the decision are well thought out apart from not just the actual project itself but it's implications on the business beyond just the decision by itself.

S: About the implications of it all.

G: Drillers prospect, it has impact not on itself, but on the adjacent ten prospects or on the play, or it's always looking to the future. This'll be where my [inaudible] always trying to find growth and find new opportunities. So I want to know where the next twenty discoveries are going to come from, not just the next prospect. So I want to know if I do this activity or drill this well, what does it mean beyond just [inaudible]. So to my mind, a good decision is one where it's clear what the implications are beyond not just for the project, but beyond that.

S: Good. So that's all introduction. So let's get down to types. When you first heard me talk about decision types, what sort of went through your head? How would you type decision-making? There's no right answer here.

G: I've never really thought about it. It could be analytical decision-making or it can be beliefs-driven.

S: So there's a psychology bent to it.

G: I'd say there's a psychology bent to it. You have decisions which are plenty short term versus long term value-driven. The value can be short term, long term, big tick whatever that really means.

S: Yes. Big tick versus tactical, you hear that one all the time.

G: I think there'll be ... decisions are also made on a variety of different metrics, commercial metrics. Is it NPV cash positive I mean, those things.

S: How do you determine which choice you make?

G: Metric for that. I think decisions are also made for a lot more psychological reasons than personal impact reasons. 'Cause this ...

S: Motivational.

G: Motivational has impacted me and my career to be seen to be doing something, versus making solid decisions for the greater good of anyone else.

S: Why do you see all those things as different types?

G: Probably just experience of a range of different decisions which have probably expressed ... which seem to fit into those categories. Over my experience, that would be it. I don't know they are. I suspect that with all things, it looks simple until you're given the details and everything's a continuum of psychology on one side and ...

S: The way you process it.

G: ... process on the other side, whether it's commercial at one end or belief-driven at the other end, if you like.

S: Well, that is actually ... [laughs] this is being presented at SPE next week, but this is an experiment I ran last year, that I went through interviewing a group of people, given them decision-scenarios and asking them to compare the scenarios and work out their likelihood of being similar or not similar. And out of that we found that the way people intuitively grouped decisions or typed them, included four main dimensions and these are the ones we've called them. Complexity [inaudible], how complex is the process? You know, is this just a one off? I just make this decision, I go catch the bus or I don't catch the bus, down this end up to I've got to make about fifteen different decisions to make up this whole decision process. The other one is these constraints you've talked about, so, how many constraints actually changes the type of decision. So, if I've got to get it done by Friday, that's going to be a constraint. But if I've got to get it done by Friday within half a million dollars, that becomes a different type of decision. Ambiguity, is really these drivers. How are we going to ... the metrics, you called them. So is it just NPV or have I got a social responsibility here or have I got a personal driver on top of all of this? And as you add more and more of these metrics to it, it becomes more ambiguous as to which one of those you're going to use and how you're going to weight them. So that makes it a different type of decision. And the fourth dimension we've called the environment of information. So that is, have I made this sort of decision over and over and over again, so therefore I know the process, I know by experience what to do.

G: [inaudible, overtalking]

S: Yeah, if you want to call it that. It sits down this end up to, I've never done this before, I don't know where to find the information, I don't know how to find the information, up there at this end. And each thing, you can draw pictures of what these decisions might look like. You know, they're not really too com ... but it's a continuum as you described it, so there's not boxes but they sit somewhere in there, up until some decisions are extremely complex, have lots of constraints, very ambiguous and I've never done it before, down to I do it every day, it's only dollars that matter, time is the thing and, you know, so it's that sort of ... and each of them change. You mentioned that you haven't made a decision, I don't doubt that, but ... [laughs].

G: Maybe I do it intuitively without [inaudible, overtalking].

S: So let me use one of ... do you mind if I use one of these scenarios and just have you talk through how you would go about making this decision rather than what your decision would be. So, the process you would use.

G: So what's this question about? What does the drilling department do? Oh, it's quite simple. They just drill ahead and ignore everyone else and in my experience, they just ... their motivational bias is so great that they will come up with all sorts of reasons to do exactly what they want to do. They'll find the reasons.

S: Okay. But they will justify the decision to just keep drilling ...

G: Yes.

S: ... because of the motivational bias.

G: Yes, yes. And it'll be ... it should not be the case.

S: So if you were an exploration manager and the drilling manager reported to you rather than [inaudible, overtalking] ...

G: It's quite simple, quite simple.

S: ... how would you go about making the decision?

G: Oh, the decision is quite simple. There are only two reasons for drilling wells. One is to evaluate the rocks for exploration and the other alternative is to actually have a good producing well and when you're in the exploration phase, if you haven't got an evaluation you've got nothing. So they will do whatever they're told to do to get a ... as best evaluation as possible and then the trade off will be well, just what are the options to get the best evaluation. Okay, I'll run another ... I'll spend some more time, but just give me the engineering options that will take me over the zone of interest so I can get the evaluation that I want and then I'll determine whether or not I'm prepared to pay that with the options that will be best for me.

S: So step one is gathering information?

G: Number one, set the objective. The objective is crystal clear. The objective is you must evaluate ... I want this evaluated. It's not ... I'm not interested in getting there [inaudible] if we're getting it done in the quickest time. That's not the metric. The metric we all face is the evaluation. Get them aligned on that. If they don't get aligned, you just tell them. That's what ... so, with that, gather the facts. What are the alternative scenarios for this. And then I would also then gather the experienced people who have been through this before or have other experiences like an [inaudible] or a ... and see, from their experience base, what seems reasonable with these different options and I'll try and pick an optimum solution biased towards getting the evaluation right rather than ... I'll trade off some rig time for that, but if I'm paying a million dollars a day for a rig, it's ...

S: It's a big trade.

G: It's a big trade off.

S: So there's a fair bit of ambiguity here because even though you've got ... money's not the sole driver.

G: No.

S: You've got to get the information.

G: Because the value, as I said before, the value is not just in that one well. It's in ... the implications of that for the next twenty wells. That's where the value is. And I think the issue is the decision isn't based upon just that one project. It's on the implications of that project. And they can be difficult to quantify sometimes, like the value of an IT project. It's ... you can't work the ROI easily and if you do, you know it's rubbish. But you know if you don't have the equipment and the software, you're not in the game so I think it's one of those things you have to perceive the value of ... the decision is really an operational decision but it has implications in the longer term. And that drives the way things ...

S: Good. If I flip that over, this is how I've classified it, if you want to call it that. But it is fairly complex because you've got to make a series of decisions along the way. The task constraint is not all that great. You do have a time constraint which is a dollar constraint, blended together, but that's about the only constraint you've got in the project. The other is this, it's highly ambiguous because you're fighting against, as you pointed out, motivational bias as well as everything else. But, you may have, and this changes, but you may have XXXXX say oh yeah, we've done this before.

G: I'll seek to find. I'll seek to find people who can reduce that uncertainty for me. So that's what I'll ... I'll seek out these things and I'll seek out to reduce the ambiguity and I'll seek out to get the experts if I can.

S: That's good. So what you've described is a process and you've enunciated it better than anyone else I've interviewed. [laughs] But I appreciate ... without any cards on the table.

G: So if anyone's looking for a job, you can phone me on this number. [laughs]

S: The [inaudible, laughing] about this will be sent to, to type out. [laughs] Okay. So in that process, 'cause that's an analytical process and you've described that's how you make your decisions, does XXXXX have a defined or formal decision-making process?

G: No.

S: Okay.

G: In that I would have to think long and hard to find one.

S: It's not specified anywhere?

G: It may well be specified in documents which were constructed in the past under different general managers or different executive managers, but they are historical documents that probably describe what many people do but they are not revalidated by the current executive saying we affirm that we want to use this methodology to make decisions. So we do have processes, we do risk analysis. That's a hang over from what we started out ten or twelve years ago under a strong direction. The current organisation uses these words but doesn't appear to believe them intrinsically that they drive ... show me decisions based upon these things.

S: Yes. The good example I think you used earlier and putting words to it, is portfolio analysis which has been described as the way this company does things, actually separates the person who develops the opportunity from a person who makes the decision. But you said it's not occurring.

G: We don't do that. It's not occurring.

S: No. Although you say it's portfolio analysis, it's really just words. You're not actually doing it.

G: It's just words. Yeah, and we do ... we're supposed to have post mortems after every project. But that's still seen as an administrative event rather than a learning event. There isn't a ... there aren't discussions around those issues. Most discussions that I come across these days, even from my fellow colleagues, is very much around operational decisions and that matches the style of XXXXX who are very operational ... their background is very operational decision-making. So they'll talk about running the 9 5/8" casing and all hitting the gizmo into the whatever and it's all very techo and there's very little discussion about what's the implication of this well on the next prospect, and that the best thing? So their background is operations, not exploration.

S: Strategy's missing.

G: Just a note that when we did the psychology tests of people, I turned out to be on the absolute extreme of the explorers in terms of ...

S: Analytical.

G: ... analytical and how I think and explore. Most of my colleagues are very much into the rational mode of thinking so I don't know that I'm necessarily representative of my colleagues in how people think.

S: No, that's why I'm trying to get as many samples as possible. There's going to be quite a few people. So we'll see different answers, okay. So no formal process that you're aware of. You'd have to go searching for it. What about an information process? 'Cause you use a process yourself, but how has that built up?

G: I think there are a number of different dimensions to the processes we have. Each individual manager like XXXXX or XXXXX will evaluate opportunities and they will get together within their own team and work the issues backwards and for-

wards like an accordion until they reach a view and I think that they will do a very good job of getting their best assessment with group think, which is good, driven by the quality of their leadership, their team leadership. They do actually seek external input, so we do have peer reviews. Sometimes they appear to change assessments but often it's just a show and tell. It would seem to me very ad hoc as to whether you get involved early on in that process or your ... if you come in late at the end and the decisions have been made or when technical considerations have been fixed and it's very difficult for people to change their mind, it's pretty much the longer it goes on, the more people defend their existing positions. So we do have their reviews as well. We do try to flesh out inconsistencies. People in this organisation will know who the experts are in many areas to seek experienced advice. So if you do want to shoe seismic, we do have world experts with XXXXX, we have XXXXX and his group for well site operations and we have them in a few other areas. XXXXX for [inaudible]. So we do have internal experts that you can go to. We have ... there's a company, a group of geoscience experts under XXXXX for structural geology and sequence stratigraphy, so we've got internal experts that can come in and look at issues.

S: And they can be called on?

G: Yeah.

S: Okay. And you've mentioned you do have a process of getting the prospects together and putting them together and [inaudible, overtalking].

G: Yes. Prospects are identified. They do go into our prospects and lease inventory. There is some approach ... there is an attempt to have your review ... certainly reviewed before their decision is made to drill. But the ... going up to the decision process, but once the well's been drilled, that's almost ... the results are ignored and you move onto the next one.

S: Okay. I'll come to feedback in a minute.

G: Yeah. Absolutely.

S: Tools?

G: Yes. So we have prospects and leads inventories. We have a simple one which is XXXXX, we have the more complex realistic one which is XXXXX increasingly used, greater value if you're looking at the dependencies between different inputs, whereas XXXXX doesn't. The economic analysis which can be simple or complex, a wide range of those tools. [inaudible] has the XXXXX for [inaudible, overtalking] roll-ups.

S: [inaudible, overtalking] for roll-ups.

G: Portfolio roll-ups.

S: Okay. But there are certainly tools to assess.

G: There are tools around. The issue is not tools. The issue is how they're being used and ...

S: Yeah. Well, that's why this question's in there. Because the next part of the question is, if the tools are there and the tool says the number is ten, is that what management does?

G: Interesting question. [inaudible] fourteen? I think in the current environment we're opportunity constrained, the prospect is there and it looks like it can make you some money, they'll go on do it. We're not heavily into the ... we don't have that many opportunities that we can realistically ... and we compare one with the other and the seriatim.

S: Very interesting, 'cause they go back to this template. You've just said that one of your constraints is actually opportunities.

G: Yes. It's an opportunity constraint. You will accept the poorer opportunity because there is nothing else.

S: And therefore the way you'll make that decision is very different than if you weren't opportunity constrained.

G: I think it changes. The lack of opportunities influences your motivational bias, I would say. The assessments might still be there and it says this is not a very good prospect, but the other arm will come out and say well, we're going to do it any case, we've got nothing else. The issue then becomes, does the actual technical evaluation get modified, anticipating that motivational bias or not, and you'll only ever know that if you do a post mortem. And I suspect the absence of post mortems is a desired thing. But if you don't know how bad you are, then you can keep going.

S: So, looking at feedback, one of the things that I'm trying to have a look at is in an outcome from a decision, there are actually three inputs. The first of those is the decision. But there are two others that we oftentimes ... we know about, but we ignore. The first is the way it's implemented. So you may make a really good decision and choose to implement by doing x, y and z. But then when it comes to implementing it, it doesn't get done that way, so therefore the outcome's not what you have desired. And then of course you've got the chance. So no matter how good your decision and how well you implement, it may rain and your suit will get wet if you didn't bring your brolly. So I'm looking at feedback from making this decision. I can't control this, that's random. So, do I get feedback on the implementation and do I get feedback on the actual outcome? If I did feedback here ...

G: Well, the feedback between a decision and implementation is generally experienced by the operational management. So we have [inaudible, microphone interference] operations and well site operations. They'll tell you every morning and every afternoon what's going on about the implementation of the decision, if it's a drilling decision. But if the decision is more nebulous, farm-in, farm-out decision, it seems to be we're very comfortable in the operational mode. But when it comes to more cerebral, vague, value-based prospectivity assessment-based issues, then we do less of a

linkage between the decision and the implementation, it seemed to me, and I think that's why we're a beliefs-driven and operationally focused organisation which reflects the current management.

S: Okay. And then for outcomes? This is these formal reviews, as you call them. Does that do all of these types of things? In other words, do you do the drilling as well as the farm-in, farm-out?

G: I think the drilling is done, so I think there's a drilling post mortem done. Once again that's only done because of the strength of character of the management of the drilling group and having key people in the drilling group who understand the importance of that. If they left, I think it would collapse.

S: Right.

G: Operational geology, the learnings of every day and just incorporate it into how they ... what they do. And so they progress, they learn rapidly so many times, they do theoretical ... they do post mortems because it's occurring every day. They learn every day in what they're doing. That'd be the same for the geophysics, I mean, they learn every time they run a survey. I don't think they do a formal write-up but they're a small group which have been doing the same thing for many years. So I think in your guide there, they're constantly doing the same thing with the same group of people. Where it falls down is we don't do post mortems on wells to the extent that we should. A ... learn as rapidly as we should, in my view. That is even more important because we have a higher turn over of staff. There's a loss of knowledge, the loss of experience is horrific.

S: Yeah, so there's operate loss.

G: I think we don't measure that loss. Just hidden in the ... this is the nature of our business type response, as distinct from we could do this better. This doesn't seem to be the mindset. [inaudible] of mine, I think we waste too much money but you'll only ever know that if you do the work.

S: Okay. In recognising your time, sir, I don't want to spend too much although I'd love to 'cause I think [inaudible, papers rustling].

G: Oh, that's all right.

S: [laughs] But the only number I'm going to ask for, and this is really just to try and get a feel for how to quantify what you're responses have been, and that is, as it comes to the company itself, how effective and efficient do you think the decision-making processes and the way decision-making is done, I guess, is the better way, on a scale of one to five?

G: Two.

S: And the reason you've put it down there?

G: The reason ... there is a lack of direction on the decision-making process. Leaves everyone to do their own thing. It means that there is ... the process isn't visible. It's not demanded. Or it means it's not valued. Doesn't anticipate need for thinking about issues of bias and learning.

S: Plenty of room to improve?

G: Oh, lots. But it will only improve ... improve's the wrong word because that's ... it's a personal view about what I think improvement is.

S: Yes, okay.

G: I personally think that decisions are better made analytically rather than belief's-driven because I'm an analytical thinker rather than belief-driven person. So towards my personal bias of making decisions, I think there's a long way to move.

S: Whereas you'd feel that if I interviewed some of the beliefs-driven people within the corporation, they would see their processes more up at the five end?

G: They might see it, yeah, I'd say three to four. I think that's where they would put it. So, that's how they see the nature of the business. Risk management business ... as a risk management business, every decision we make is under uncertainty. That business, the only way you're successful is if you actually understand the risks you're taking, understand the resource ranges and the outcomes. You've understood that through collective wisdom which means ... so it all comes back to the business decision, I think. The decision-making is really based around continuous learning. But I think we do that.

S: Well that's it. So you could have [inaudible].

G: Can I get my money now? [laughs]

S: [laughs] Your motivational bias? [laughs] I'll turn it off now.

End of recording

***Interviewee: Participant H (H)**

***Interviewer: Steve Mackie (S)**

H: Okay, and how long will it take approximately?

S: As long as you want but about half an hour ...

H: Okay, that's fine.

S: ... is all I'm ...

H: Okay.

S: So really ...

H: Am I able to eat at the same time?

S: Yes. I'm glad that I even got you so that's good. All I was targeting at ... at your company were people who've been exposed to major decisions. By that I mean, you know, the decisions to do this project rather than this one, so that was it.

H: Strategic decisions as well?

S: Yeah. Yeah. Although, at the top of the strategic pile of decisions in my mind are visionary type things, you know and to this country and I don't know that what I'm looking at may apply there. I'm just tossing it around. The basic premise I'm coming from is that in order to make the best decision possible, you need to tailor the processes to the type of decision. So you know, the same sort of processes don't [inaudible].

H: [Inaudible] yeah.

S: Well that's where I'm coming from. It's never been actually stated before in decision-making so that's why I'm trying to get how people actually do it. So you've made lots of decisions there at XXXXX and in previous lives, you've been involved in decision-making for a long time. So what do you actually think it is? What is decision-making?

H: Well decision-making is the process of ... well deciding. The process of forming a view and once you've formed the view, agreeing a way forward for that project or that strategy or whatever it is. It's actually the point where you have a lot of information, a lot of analysis, a lot of logic [inaudible – loud background noise] and then you disseminate all that stuff, all that information and all those trade-offs and what have you, and then you say okay, there's a few alternatives and we're picking one alternative to go down, whatever that alternative is and then we commit to an alternative, you know is the commitment [inaudible].

S: So the [inaudible] is where the decision is actually made.

H: Yes, but it's the ... the [inaudible] of a decision are a lot of elements. There's the data, the lodging, the analysis. It fits the [inaudible] of the alternatives and then there's the ... okay, this is the one we want to do, we consider the [inaudible] alternative is the one we want to do and then committing to do it.

S: Okay, good. So are there some decisions obviously you've made, are there other decisions where you simply have input into them?

H: Yes.

S: Are they different sorts or types of decisions?

H: I think the decision ... you're involvement in the decisions really affect your [inaudible] and your position in the organisation and I've been in roles from providing a bit of information to roles of deciding to roles of being disempowered as well. So I think ... thank you very much ... and it just changes you know, depending on the situation.

S: Okay, okay. So it's a role-based thing within the organisation?

H: Well it's role-based but it's also an organisational thing, how the organisation's set up and I have a view about decision-making that I think there's sort of ... there's some principles there and decisions should be taken where the knowledge is greatest really and knowledge in [inaudible] but also understand that.

S: Okay.

H: But I don't think a lot of organisations believe in that. They believe in hierarchical and there's knowledge of a discipline [inaudible].

S: I can't make comments. I don't want to lead you.

H: No, no, no.

S: But I agree with what you've just said. I've seen that.

H: It's principle. I mean I'm saying any organisation, I'm just saying that Australia's ...

S: Yeah, okay. So there's ... when I first talk of types of decisions, what's the first thing that sort of pops into your head? How would you begin breaking decisions up?

H: Well, there's ... in any business or in mine?

S: Well, both. Is that a break-up first? Are business type decisions different from life type decisions?

H: I mean at the end of the day, they're all about life. I mean taken in the bigger picture. You know, your business is normally just a part of your life so I would ... I always say that [inaudible] life decisions, who you marry, where you live, how many children you've got, your religion [inaudible]. Yeah, you probably don't have perfect information to do them but a lot of it's related to emotions as well ...

S: Okay.

H: ... and culture. So there's that side of it and then the other side of it is the business one, which is really it's only a very small part of [inaudible] life, it should be a small part of your life but it tends to [inaudible] people think about and [inaudible] and then when you're in business decisions and you've got [inaudible], there's people ones, there's [inaudible] decisions, all sorts of things like that and [inaudible] the whole way through really.

S: And you would see that it's difficult getting lunch in as well, so just don't rush it. I was going to say I haven't ...

H: You want some?

S: No, no, no. I haven't seen a pizza that small before. That's well done.

H: They're good here.

S: When you come to make a decision, do you have a formal process that is this decision now so we're talking at work. Is there a formal process you go through?

H: I think there's a combination of ... there's some process in there and there's some adhocery as well, a combination.

S: Okay.

H: And it's quite hard to put your finger on some of it but you know, it's a mixture of both. There's an attempting at some process but I don't think it's a perfect process.

S: Okay. So in the adhocery, so when you're faced with having to make a decision where perhaps you don't have all the information, do you have a process you would personally go through?

H: Well, it depends on the decision. I mean there's certain analyses and techniques that are required to be done, certain quality assurances that should be done before you make a decision. The processes that are meant to be reviewed are [inaudible] process, risk analysis and [inaudible] some sort of assessment comparing of other projects as well, because in some ways, [inaudible]. There's definitely a set of forms you expect to see.

S: Okay. So these are sort of like tick-off boxes? Has this been done, has this been done?

H: Yeah.

S: Okay.

H: And also ... excuse me ... who's had a look at it. You know, who's ... who does the proposal come from and the credibility of that person, the experience of people, who's actually reviewed it with them. If somebody I believe is very experienced has got a really good track record, got a really good judgment, then you would [inaudible] this ...

S: Scrutiny to.

H: Then somebody who you really don't know.

S: Okay. Quite a few ...

H: A lot of it's to do with preferred.

S: Yeah, quite a few of the people that I've interviewed, especially the ones higher up within the hierarchy ...

H: Yeah.

S: ... and the one word that keeps coming up all the time in the way they talk about making a decision is trust ...

H: Yeah.

S: ... you know, do I trust the people or the person? What sort of relationship have I had with them, which is the softer side of the decision-making.

H: That's correct.

S: Yeah. We don't have a ...

H: If we have to have that ...

S: Yeah.

H: Well, I mean I personally [inaudible] as well but [inaudible].

S: Okay.

H: I mean I believe in the good people, good tools, good processes, good [inaudible], the whole lot but it helps a hell of a lot of the way if you know some people. You know, you understand their [inaudible], their judgment even.

S: Okay. So the other two areas that I'm looking at is a good decision. What would you classify as a good decision?

H: Well, a good decision is one which has gone through a proper process, so it's really about framing the decision properly. You know, what is the decision, what are the [inaudible], you may not know. Sometimes people [inaudible] about what the decision is. So what are the givens, what are you actually deciding at that point, what [inaudible] and then they can [inaudible] if the right information, firstly the right people, the right information, right data and the right [inaudible], and the analyses and identify the [inaudible] the alternatives and that's all about you know, depending on the situation but getting the brainstorming to get it open and then analyse ... and then having a bit of a liaison with the decision-makers so you get a bit of steerage. So you need a team, a project team, you need a decision-maker, you need some sort of alignment, these alternatives are reasonable or not. Analyse those, a little bit of trade-off with strengths and weaknesses of each of them and come up with [inaudible]. I think those are the things and then the outcome ... and then you have ... the outcome is [inaudible] really a definite outcome as long as you explain what the outcome could be and you know, a decision you take may have a big reward but it also may have a big risk on it and as long as that speculative uncertainty is explained to the decision-maker and it's reasonable, if it's tested properly, reasonable that's a good decision. You know, the outcome may be anywhere on that spectrum. It may be [inaudible], that's okay but at least you've informed the people who are making it, that's what it is. The people who are making the decision have to have a pretty good understanding of ... they need to have an understanding of what the [inaudible] problems could be of the company or what they can afford to lose, and so they need to take it into account the [inaudible] of the decision with what the [inaudible] is and it's clearly a bad decision if you have a reasonable chance of losing a whole [inaudible]. So it all depends on the interplay.

S: Yeah, the interplay between the possible outcome and the risks involved in getting that, and even from the implementation of it.

H: And the ability of the company to absorb the outside outcome.

S: Okay. Good. Well of the people I've interviewed to date, you're one who talks of the process being a good decision. The others talked of outcome as the driver for a good decision.

H: No, that's the problem because you know, nothing has to [inaudible] and it's actually about the input at the beginning. It's actually about how you made the decision, I think is the important thing.

S: Good. Well I agree with you so ...

H: Okay.

S: ... so that's real good. Okay, and the last side ... there were two more things. The last one is the feedback. You know, how do you know that you're learning from each of these decisions? So you could get feedback on the outcome itself, so you

know check what actually occurs or you could also get feedback on the implementation process, because that could actually affect the outcome as well. In the decisions you make, do you have any formal or informal feedback occurring?

H: Well, I mean there's [inaudible] because you know ... I mean you don't ... you're probably not [inaudible] and then on a smaller ones, there's sort of an actual versus [inaudible] type of analysis done and people do it with that, but this is sort of a routine.

S: Okay, and that's on every decision?

H: Well, I wouldn't say every but a lot.

S: Okay, but it's not restricted to bad ones, you know bad outcomes? Good outcomes are analysed as well?

H: It's done [inaudible]. I mean it's not done ... I don't think it's done on sort of say recruitment [inaudible] or whether that person should be in that role or [inaudible] but [inaudible].

S: Okay, work [inaudible] as well?

H: Yeah, but it's not [inaudible]. I mean it's always hard to get these things totally embedded but you know, I think there's awareness that they want [inaudible] should be done.

S: Okay. Well the last part of the interview was to talk to you about a decision that you've made so ...

H: Coming to XXXXX.

S: Do you want to talk about that one? Good or bad? What I want to do is now that you've talked around the whole area is just have you talk through the decision you made and I'm not really interested in the outcome unless that had an impact on continuous learning, but just the process you went through. So if you want to talk about coming to XXXXX, yeah that ... any sort of decision you want to talk about.

H: So what do you want out of ...

S: Just the process you went through.

H: Oh, okay. Okay, well I can tell you. I don't know about coming to XXXXX. I mean it wasn't a perfect situation. So the process was ... and I think it was part of the reality of decision-making is we're never in an idealistic world. You're never ... the decision in a whole way is presented in a logical way, and I mean basically what happened in that situation was that I decided to come here because I needed a job and the reasons that I needed a job was because the old company had been taken over. I knew somebody in the company who I like and the role sounded reasonable, working in the country which is a good country and a city which is a good city but also the trade-off

that I actually viewed. The company had a [inaudible] reputation and I thought well with XXXXX, there's a reasonable chance that things will improve and I thought it's not a bad time to get into a new organisation when you need a job anyway. Family's the most important thing to be in the right [inaudible] and an organisation which should be able to improve in terms of its ...

S: Okay.

H: ... performance and in terms of its culture.

S: Yeah. So you didn't have perfect information ...

H: No.

S: ... in all of those.

H: And there weren't that many alternatives really because at that time, [inaudible].

S: Okay.

H: And it was not ... it was sort of a ... it was a bit opportunistic and vain, where one thing comes along, and I could've taken ... in some ways, it was a bit [inaudible]. In hindsight, I probably should've said may be six months ...

S: Okay.

H: ... and got a few more alternatives but the reason that I rushed into it is pressure on the side here to get the delivery done and I suppose getting a little secure at the time that I had to get a job for the family, so those were sort of the drivers really.

S: Yeah. So there were ... I don't know if hurdle is the right word but there were certain levels within some of the objectives that you have but once you've crossed those, you are comfortable to move.

H: Well, I wasn't comfortable ...

S: Okay.

H: ... because the way I did is that I left the family in XXXXX and we thought we'll try it out for a bit and I commuted back and forth for six months and we went through the same decision process at the end of the year and that was a very imperfect decision and the reason for that was it was again a really ... the organisation was ruffled and an unreasonable requirement to make a decision in a short period of time by the [inaudible].

S: Yeah. So when time is constricted, it actually becomes a different sort of decision.

H: It does. It does, yeah.

S: Yeah.

H: And there was a trade-off built into that so we also had a negotiation saying well, if it didn't work out then you'll send us to go home. That was the trade-off so ...

S: So you [inaudible]?

H: We covered it, you know but it was ... I suppose in hindsight, I think probably ... probably we were a little bit rash.

S: Okay.

H: We probably should've ... probably if it happened again, I'd probably take a bit more time and look at the alternatives a little bit [inaudible]. I don't think it was a good decision because the other thing that I have all the alternatives probably mapped out and I had one other one mapped out but it wasn't ... it was basically consulting and being away from home a lot more. So it wasn't the perfect decision ...

S: Yeah.

H: ... in terms of process.

S: Thank you for sharing that because it's always difficult when it's talking about personal things.

H: That's true.

S: That's right, yeah.

H: Everybody knows these things that you know, career decisions are all imperfect, you know.

S: That's right. We never have perfect information. Well that's actually all I'm after.

H: That's good. Well, I hope that's helped.

S: Oh it certainly has, yeah.

H: I mean I think it's a very important thing what you're doing and my opinion is that companies that do it right and really right, sometimes they win. I mean the ones in ... a lot of people are not even aware of it.

S: That's correct.

H: Yeah.

S: I don't know if you've ever read Graeme Simpson's stuff.

H: No.

S: He's now with RPS but he was with the University of Aberdeen and he had a PhD student working on you know, if you use these decision-making tools, are you a better company and ...

H: There's no question that you are but if it's tools you can get. I mean there's ... you know, there's all sorts of different [inaudible] but it's also about actually having people being aware ... consciously aware of some of the components of the decision and they need education, and to be quite honest, I'd really love to train these guys up.

S: Most people when you ask them to talk about a decision and how the process they use, it's actually the decision is made like that ...

H: It's intuitive.

S: ... yeah, and then everything else they talk about is actually justification ...

H: Yeah, I know. [Inaudible]

S: ... of that decision.

H: Yeah, and that's completely the wrong way around. I mean I learnt of this through the SD Group ...

S: Oh, okay.

H: ... and we had a lot of courses in Stamford built around that and went through the whole process and we actually had a decision ... I've been bloody trying to find the toolkit for some of the techniques around the decision, you know the course fields and there's diagrams and blah, blah, blah, all that. You know what it is.

S: Yes, yeah. I'd love to see a book on that.

H: We had one but I bloody lost it.

S: And it came from Stamford?

H: No, we put it together.

S: You put it together.

H: Yeah, the company put it together and we had a proper process.

S: So which company was that?

H: SDG.

S: SDG?

H: It's Strategic Decisions Group.

S: Yes, I was going to say.

H: It's XXXXX. Do you know him?

S: Yeah, I've heard of him. Yeah, so you were part of that group?

H: No, I was part of the group but we went through the program.

S: You had it with them.

H: We developed a software package with them. It's called Daily Management System but it actually became ... it morphed into international PEEP. We actually got that going with [inaudible].

S: Yes.

H: But the whole ... you're right, the whole feedback was very important but I just don't think ... I think to get the discipline and [inaudible] at the very top and it has to be an organisation which is somewhat [inaudible]. You know, it's ...

S: Oh yes, because of time constraints, I've noticed many companies even though they may talk about this framing the decision you talked about at the start, very rarely gets done because of time and that's really ...

H: Everyone does it [inaudible].

S: Yes.

H: May be we didn't do a lot in a big way. I mean for the big strategic decisions, yeah it's [inaudible] well. You know, the major thrusts, you should do it.

S: Yes, at the strategic points of the triangle.

H: Yeah, that's right. You know, do you go downstream or not?

S: Yes.

H: You know, those things.

S: That's right. Yeah.

H: I think it requires a discipline but it also requires a humbleness because you actually have to listen to other people and take on board all this thinking and that culture difference, you know.

S: So culture is important I trust and other people? Okay, I'm going to turn it off now.

End of recording

***Interviewee: Participant I (I)**

***Interviewer: Steve Mackie (S)**

S: To start the whole thing off, it's really just to get a feel for what you think decision-making is. So what does it mean to you when you say someone's decision-making?

I: Just in the broadest context is when you have series of options that you need to choose from, the decision-making is which one or none of those options do you actually progress through, but that's very broad. It does depend very much on whatever you're talking about because there are strategic decisions that differ greatly from tactical decisions and a tactical decision is would you want to perforate the particular zone, the very specific minutia of ... well, I've got a massive drilling program here that I want to execute, should I wait, should I be executing the drilling program, should I be purchasing a company, should I be changing the direction that XXXXX takes in terms of how we actually grow as a company? I think fundamentally it gets down to having to make a choice of a number of alternatives.

S: That's in fact ... that's the definition we use, so that's exactly it. So we ... the three things that make up a decision for us are it's got to be conscious and that's why this subconscious/conscious thing comes into it. So the other thing it's ... the decision-maker is the person who actually irrevocably allocates resources.

I: An interesting choice of words, irrevocably because decisions ... you may see a certain number of signposts particularly for larger decisions, more strategic decisions that move you down a particular path and you make a decision to head down strategy A. As you progress down that strategy, the signposts may change that say hey, I've got a particular problem here and I need to step back and reassess the decision I made six months ago or 12 months ago. So depending upon the context of the decision, I don't know whether it is necessarily irrevocable. [Inaudible] perforations, absolutely.

S: Yeah.

I: Company strategy, you must reassess the decision you make in light of changing external conditions.

S: Good, and so that leads us to the very last set of questions which deal with these feedbacks loops. As you make a decision, do you get feedback on how you implement it or what the outcome is, you've got signposts, you make the decision and everything else but irrevocable, we mean one of the resources you're assigning is time, both the decision to move down strategy A stops time being used on doing strategy B. It changed that down the track and that's why we're using it that way because I fully understand where you're coming from because it's one of the concerns I have is where ... where is the decision made? The decision, the whole thing that includes the feedbacks went of choice, [inaudible].

I: But it does depend when ... to jump there. It depends upon, I think you might've said in the introduction, the type of decision being made because you ... when XXXXX made the decision to go and move down an acquisition strategy for XXXXX, we went down a particular path and the decision was actually consummated when the sale price was agreed with ... with XXXXX. Now things could've changed up until that point.

S: Correct.

I: Equally, we could elect to reverse that decision and sell the XXXXX asset now but that's almost accept the decision process after ... you go back to your perforation decision again, once I've made the decision to perforate a certain interval, job done.

S: That's right. I might come back later on and perforate another interval or re-perforate.

I: But that's a subsequent decision.

S: Correct, and that's the question that we're actually coming up against and so you've raised and I'm trying not to prejudice how you're answering but one of the assumptions I've made is that it is a function of type. What about a good decision then? If that is choice that you've decided is your decision, what's a good ...

I: I'm going to get another laminated bit of paper ...

S: No.

I: ... put in front of me surely.

S: No, you're not. This time it's open.

I: If ... yeah, it depends very much on your perspective at the time and the context of that decision. Taking a perforating example again, a good decision to perforate in that particular slot ... in that particular zone is if I get my expected oil production or gas production, I don't get any water. Bad decision in that context would be perforating the zone and I get water. Okay, it's fairly black and white and it's fairly unambiguous of people as well because just about every stakeholder in that very tactical decision about perforating sand will know whether it was a good decision or bad decision because of the instant feedback they get. They get to a higher level and you get a more strategic decision about again, a corporate acquisition and you use the XXXXX example where people who made that decision, who perhaps have all the facts, will have certain perimeters in their mind in terms of deciding is this a good acquisition. It may well be the ability to increase growth, it may well be the ability to be fairly acquisitive to the XXXXX share price, it may well be the ability to ... to take technology from that particular area and apply to other parts of the business, it may well be to get a strategic foot ... foothold in an emerging part of the business and you may get some of those KPIs delivered immediately or they may not actually manifest themselves until two, three, 10 years down the path. Other parts of the organisation, who perhaps

aren't ... aren't unaware of some of those other strategic issues might say that the people make the decision to go and acquire XXXXX, I can't make any sense of it, that's a really bad decision. I didn't see any share price increase in XXXXX, therefore it must have eroded. Though a good decision I think does depend upon the stakeholders who are involved, it does depend upon the type of a decision and it also does depend upon whether or not that when you set your decision to ... when you set your course of action to make a decision, did you define for yourself what success looks like? If you did define for yourself what success looks like and you can on-balance after a period of time, which may be anywhere between a year, and a day and 10 years arguably so to on-balance, I got what I said I was going to get then I think you can consider that to be a good decision.

S: Okay. Okay. So ...

I: A bit ramble really wasn't it?

S: Oh no, no, no. If I were to summarise it based on what I've been doing, your good decision is based on the outcome being what you predicted or add decision and whether the outcome was ...

I: Simplistically, yes but ... and ... and for smaller decisions, I think it can be quite ... the smaller tactical decisions, again the perforating example ...

S: Yeah.

I: ... it is as black and white as that. In the exploration world, the decision to drill a well, it may've been a very reluctant decision to go and drill. I thought one of those wells that on-balance, you know it's our work but I've got to try and do it to try and get my 2P reserve or I was going to take reserves off the books. You know, a rock and a hard place here, I'll give it a shot. When I actually drill a well, serendipity gives me exposure to a brand new play type that I haven't even considered so success looked nothing like what success looked like going into it but I would consider it to be a good decision because I happen to actually luck into ...

S: Okay.

I: ... something other than what I had originally thought I was going to get so I think it can't be as black and white as you said. I think there has to be ... there's a continuation ... the continuation, what does the external environment give me and in that context, was it a good decision?

S: Yeah. One way of looking at it is if this is the outcome, things that go into that outcome is the actual decision you make, the way you implement it because you know, you may choose to perforate a zone but you ... you know, stuff up the job essentially and then there, as you said, serendipity or chance comes into it. So those three things all influence the outcome and the question is what makes this bit good?

I: But it's also the external environment as well ...

S: Yeah, good.

I: ... because a decision to go and implement an oil play or to go and acquire a company that had good oil assets, if you had made that decision three years ago or four years ago then right now, the external environment would have been turning a very mediocre decision into the best strategic decision your company could've made at the time, and a lot of small American companies have done that. Their share price, their total shareholder return has increased remarkably because they made acquisitions three years ago and they have written the share price over. XXXXX's last well in XXXXX found the XXXXX field. External environments have changed and it is an extraordinarily value-creating project and will continue to be and they've created for themselves a substantial strategic foothold in XXXXX. So by almost any measure, you can say that XXXXX has been a remarkable success and much of that success was actually driven by the external environment.

S: Thank you. Types, decision types? Now you've mentioned tactical and strategic, and is that what you mean by types or anything else come into your mind or?

I: A great type example, you know you make a decision everyday which ... you know, which way are you going to go to work? Do I walk ... so tact ... strategic decisions to me is trying to set the ... you can ... you can potentially distil it down into those two decision types.

S: Okay.

I: Strategic being setting the broader context of your vision of success so being able to paint for yourself what does success look like? How do I position myself to actually go and manifest that vision into reality? Tactical decisions are all about almost day-to-day operational decisions to physically manage that vision, to make it successful. So the allocation of resources, the management of personnel, the way we implement a little chart for [inaudible] to go and execute it so it's almost about doing the doings, strategics about seeing the broader context of visaging ... visioning, sorry ... the visioning to position us in a certain location.

S: If I looked at those different types, do you see the way that you ... you personally visions being different in those two areas?

I: An example just the other day, we were looking at XXXXX area. One of the guys in the team ... actually, an interesting process. We were looking at whether we should connect XXXXX up to XXXXX. There's an opportunity to drill some further exploration wells surrounding XXXXX and there's a further opportunity to connect up potential success to actually commercialise and have a central hub in XXXXX. Part ... the guys were working this, discussing this, and this [inaudible] was looking at XXXXX but they decided to actually have a look at the broader exploration and play around it. What they did is they focused purely on the exploration plays around it and came up with a very good business case that in their views was strategic about it didn't help us at all just to look at XXXXX. We actually looked ... needed to look at the more broad ... broader strategic concept of just drilling exploration wells, but they went down a very tactical path about acquiring a rig for slots in 2007 or 2008 because

the right part ... it's a rough path to go down but what, in my view, they neglected to do was step back further and think well, if I'm going to do ... not do, if I'm going to undertake some activity around here which is very tactical, what do I actually want that hub to be? Is there a market there for it? When does that market become viable? When should I actually position myself to ... to allocate resources to design a gathering system? Should I be pre-ordering materials? So the way we went through that discussion was if it had just been a tactical decision about locking in slots on that rig for late '07, early '08, it's different in the broader context. So I did make that decision differently because there was more strategic outcome that I wanted as opposed to more tactical outcome that they wanted. But interestingly, different people's ... a person's strategy may be at different levels tactics but depending on where you are in the organisation, what may be tact ... tactics for me ...

S: Yeah.

I: ... that ... for like a higher level may in fact be a strategic for someone lower down in the organisation, if I can use those terms ...

S: Yeah.

I: ... in terms of what's actually happening. So strategy and tactics blur depending on where you are in an organisation and what your line of sight or thought process goes out X years in the future.

S: Oh that's good because that was the question I was going to ask. Do you see that as ambition within [inaudible] or [inaudible] or?

I: I think ... I think it has [inaudible]... a part of the reason for that is that when you're an engineer or a geologist just working the company, you don't have potentially the experience, potentially the time because you're so focused on an operation, the tactic, potentially the breadth of the knowledge, potentially the breadth of knowledge of what's going on now and having different people feeding in different ideas at a higher level and as you move through the organisation, your ... in my view is your planning horizon, I think if you're doing your job properly, extends so if you're an engineer, your planning horizon might be a day to six months. If you're team leader, your planning horizon might be ... it might still be a day but it should go out to a year or 18 months. If you're a manager, your planning horizon might be a couple of weeks to a couple of years. If you're a senior manager, it might be a couple of weeks to five years and if you're the CEO, it should be you know ...

S: A life.

I: .. 10, 15 years down the track in terms of like what we're doing today is going to make us successful in the future. So as you ... as your planning horizon moves out, you generally move further up the organisation and you also therefore ... not therefore ... but you also then tend to be able to create that space to have that thought process, you need to be able to extract yourself away from the day to day tactical decisions.

S: In the taxonomy that we developed for decision-making, so this is what it actually is, we came up with four dimensions that broke decisions down. The first one is complexity which is the amount of processing that goes into making the decision, a little bit to an enormous amount. The other one is task constraints, that is how many things actually mean that the decision is not bounded ... I mean is bounded and bounded so if I've got to get it done this week as opposed to weeks and for under half a million, really I should be trying to aim for [inaudible] constraints. Ambiguity is the actual measure of, I won't call it success, but reach ... how we know what our objectives are. How many objectives there are, just a utility objective, dollars is what matters, the return, NPV, or whatever or is there a social dimension involved in this one or is there an environmental dimension. The more of these objectives that come into play, the more ambiguous the decision is because you're playing them off against each other and the final dimension is what we've called ... whether it's a dependant structure or an independent structure, that is have I made that sort of decision before and therefore I can implement an old known workable process, or is this the first time this has ever been done? All of those tease out all sorts of different types of decisions. So for example, if we take your XXXXX example ...

I: Yeah.

S: ... the way I hear what you're saying, the guys originally saw it as fairly complex and they expanded it even more so rather than just hooking up XXXXX, they looked for other things, so they made it complex. The ... and that's okay, I'm not saying that's bad ...

I: That's fine.

S: Task constraints, they broadened those constraints so that they added extra things in there so it moves it along that dimension. The ambiguity, from what you've said, remained fairly much the same. The decision was a return ... so a dollar return type thing but what they also came up with is that it was less and less dependant. It wasn't just hooking up a field, which they'd done before, but looking into other things. So if I were to draw that sort of decision, it would sort of be out here, out here, back and then out sort of thing?

I: But they didn't take it far enough. They ... they have constrained themselves in terms of task constraints. They have put remarkably ... they had put a constraint on themselves that their materiality or decision truly rested on the ability for the organisation to make a decision to secure rig slots in late '07 to drill those wells.

S: Yeah.

I: They haven't taken it further.

S: Yes, there were more constraints in the decision that you've turned it into from what they had.

I: That's right.

S: Yeah.

I: But that ... I saw them going ... as having gone from ... gone half way. They had expanded their thinking appropriately but they hadn't expanded it far enough.

S: Yeah, good. And the reason I'm asking you those things is 'cause what I'm trying to do is get an example from each person I interview of a decision so you've used this example. We can sort of type it in ... in broad context and these people working in the psych lab can tell us what process we should go through in coming to that sort of decision. You talk about the process you actually used in making your decision.

I: I guess firstly I ... I'm a bit unfair on the guys is that I had the broader strategic context ...

S: Okay.

I: ... of what the corporation strategy was. Yes, we had communicated to people what the strategy was in the company in a broader context. I had more granularity behind that that they didn't have so I was able to, because of that greater context, stretch their decision-making process. So firstly it was I understood the broader context. Secondly, it was the ... in that broader strategic context, the ability to understand the value in having another hub that we could be the logical operator of and thirdly, it was down to well, if I tick those particular boxes then get down to is this the right resource qualities so now getting out of numerics, the tactics of does this resource stack up numerically from an EMV perspective, from a market perspective? Do I actually satisfy my desire to get a particular foothold in that broader strategic context? So it started off is it in the right context and it ended up ... it will end up eventually what do the metrics tell me about this and how does this particular choice I have ... because there are obviously other choices ... how does this particular choice stack up against like other strategic alternatives to supplying into a market?

S: The objective is supplying gas to a specific market, here are different objectives and I'm going to wager those.

I: It's not even a specific market. It's a market. It's a series of market scenarios. So ...

S: Okay. So you've even got scenario planning?

I: So it's ... and that's right, and there are also different options to execute this decision as well. So depending upon what market scenario you believe has a higher probability or higher liking, like the outcome, it then changes your tactical decision to extract the hydrocarbons in the reservoirs because there are a number of different ways you can extract a volume in a different profile or a different timeframe. So that's why it then gets down to melding the hard business KPIs of EMVs, a rate of return, capital investment efficiency. How does that compare against my other strategic options which could in fact, in a scenario could in fact be if I develop this, it may then obviate the need for me to develop XXXXX. If I do that and the [inaudible] of the

XXXXXX development then do my resources to exploit XXXXXX go to other parts of the world, and therefore to get them back causes XXXXXX to be uneconomic in a future time horizon. It's trying to pull all those things together in a strategic context of we believe that we can ... we believe that XXXXXX is forced to have high prices, therefore if that is to be true, whether we have a long market or a short market, there is benefit in us having a foot on resource and [inaudible], and that's where the strategic context gets back to supplying the market scenario at a priced scenario.

S: I wonder ... well, that's a good ... is that a formal process in XXXXXX or is that a personal process?

I: Absolutely. It's formal, it's documented and I can show it to you if you wish.

S: No, that's good. So ...

I: It's a really good question to ask and I guess it comes down to the nub of what you're trying to get at in that strategic ... I guess that it's not ... it is not? XXXXXX, absolutely has discussions about what is the strategy for corporation, what are the various alternatives that we have to grow the company? But in terms of is there a formal process discussed strategy? Yes, there is and it's contextualised against what does our portfolio model tell us? So basing all the input from like everyone within the organisation that says our asset portfolio looks like this and that ... this actually translates into a production profile and free cash flow profile, growth profile, Opex, Capex. So well, this is what the company will look like in 2015 or 2012 or 2010 based on hard data. Do we want XXXXXX looking like that and then there's a strategic discussion about do we want that or not and if we don't, then what are strategic alternatives to grow or to change the output from ... that's at a very high level documented in the ... and in fact, a booklet that's being prepared now called How Does ... How XXXXXX Works and it talks about the role of XXXXXX to contextualise that strategic ... strategic decision.

S: That is ...

I: That's at the very high level but is it a documented process? No. You then get down to trying to implement the tactics of that and we have a process called XXXXXX, which whilst not operating as effectively as it should, the theory behind XXXXXX is that there's a series of decision gates. At those decision gates, appropriate people in the organisation are called upon to make decisions so feel the praise or concept selection, final investment decision etcetera, etcetera so there is a formal process to actually get it through the corporation that ... an example of a decision that I made is under that high level strategic decision-making process that provides the optionality to XXXXXX to make the strategic decisions. So that XXXXXX decision will not be made by me in isolation. It will be made as a strategic collective within XXXXXX but I'll provide that recommendation to that group and ultimately, for that high level strategic decision, XXXXXX will have that but from a very broad perspective, yes there's a decision framework, documented how XXXXXX works, documented of XXXXXX, documented in the DOA but the physical process, thought processes, absolutely not. They are not documented at all.

S: Thought processes? Three ... I'm talking about these types so that's ... I'm just reflecting back and so on, it's yes/no. So for strategic, there is a framework as you've called it but for tactical thought processes are allowed but there are decision gates as you ... where decisions must ...

I: Generally ... generally speaking that's correct. Is it working perfectly? No, it's not.

S: Yeah.

I: No. Well ...

S: Is my car?

I: It's not even working to our satisfaction yet so the theory is there, the concept is there, our ability to operationalise that is where we are struggling at the moment.

S: In those ... in those little boxes, you've made the decision, this is how you'd like to do it ...

I: Correct, and that looks, that will ... and that will take time because there's a culture change throughout the organisation. Absolutely, right.

S: Okay. The final part of it, so that's processes, is to look at whether there's any tools that you use in helping these processes. So when you mentioned decision gates, I have an image of a picture that says this is the process you go through, so I would call that a tool.

I: In that perspective, yes. I mean I can ... that's actually part of my computer. The high-level flowchart that describes that process, so if that's a tool, then yes we have a tool. We have other tools to make those decisions, economics tools, reservoir and geological simulation tools to actually allow us to assimilate data. We have market and modelling tools, we have a portfolio of tools, which allows us to wrap up what the company looks like. There are a series of tools that allow us to assimilate the data in a form that turns data into information against which strategic decisions can be discussed and like strategic options can be discussed and ultimately ...

S: With these tools and many of them are computer based, by the way you've described them, amount to numbers. When the number says this is what we should do, is that what's done?

I: Good question again, I don't have an answer for that. My immediate reaction is generally yes ...

S: Okay.

I: ... but I've got a burning desire to say but and the but is that the computer models, the data analysis, the hard data analysis, there was a lot of intelligent, competent people providing insight into what these numbers show, can't necessarily ... they

don't accurately reflect the benefit of making a decision in a strategic context. So a decision to drill a well, generally speaking you can make on what the numbers look like but we actually spoke before about sometimes, you actually make a strategic decision to drill a well because you just don't ... you want to test whether it's [inaudible], even though economics may be marginal. In a broader strategic context, and I'll try and put it in that context for you, that if we as a company decide that we have core areas that we wanted to grow into. If we decided that a core area is an area that has the potential to be a billion dollar NVP business in 15 years time, and if we decide for arguments sake XXXXX is one of those core areas we wanted to grow into, then when we come to do an exploration farming appraisal, raw numbers may say that farming opportunities ... raw numbers may say that us bidding thousand kilometres of 2D lines, two wells gives us EMV neutral. We're not going to do that based on those decisions. However, if ... if we genuinely believe the upside from that, if it gives us strategic optionality to grow into the area, if the capital exposure to actually acquire that acreage is relatively small and it's not going to make the ... break the company then we as a corporation should be bidding to win that acreage. So we may actually have a number that says based on all of our mathematics and signs, we should bid a number of three. The market will likely require a number of four to win it and if we really want to win it, then we actually want to bid 4.5 to make sure that that is something ... an asset that we get our hands on because we believe in the upside more than the others do. Though in that scenario, that's when I say it isn't always ...

S: Yeah.

I: ... made based on the hard data because it doesn't provide a strategic insight that ... context because ... however, that hard fact of a number is always taken into consideration because to move away from that, now moving into our risk management decision that says well, it's okay to make a decision different to that but be very well aware of the risks that we are exposed to in doing that. So I don't want to negate in any way, shape or form that hard signs and I think that XXXXX in the past has perhaps been guilty of the technical community gilding the lily based on pressure from their management. So the management says it can't be that bad surely, so the technical community will push the upside. Now the technical community isn't ... doesn't have that pressure to gild the lily so management can make a better decision in the hard light of day, the number is X and that's the best opinion the technical community can actually give us, okay. That's great, that's fantastic, we now know how much risk we're being exposed to, to move away from that call.

S: Okay. You've shifted from part of your decision is how much trust do I put into the numbers coming in to now I can trust those numbers, weight them. Okay. So the final part of it is this feedback that we talked about earlier on and I'm looking at feedback at the implementation itself so when you make a decision. For example, [inaudible], you would've had an implementation program. Do you go through any form of formal or informal review of how you implemented the decision?

I: Yes, we do. We ... it's actually, even though it's a requirement under the DOA that decisions in excess of \$X million XXXXX share, must actually have a formal look back. Perhaps I'll give you a project example, XXXXX.

S: Yeah.

I: We have not yet but we will be undertaking a formal look back on how ... you know, how our project formed. ... under part of DOA, as part of our process, theoretically should've been done already. Again, we haven't had the operational discipline to do it but we will go and look back and how that approach had formed, what our learnings in that project and was it a good decision. We're doing a similar one in XXXXX, which hasn't been as good but we're actually going to do a look back on that before the project completed to try and understand what went wrong such that we can stop the second phase of XXXXX suffering the same fate as the first phase, which hasn't blown out the cost per se but has blown out in time.

S: In time.

I: More strategic decisions in terms of a purchase of a company like XXXXX, absolutely. There are ... there are reviews to the Board in terms of how we actually ... what we said we were going to get out of this, what we've actually got out of it, how our production's performed compared to what we thought was going to eventuate and reserves, how are we actually tracking on our ability to convert the P10, P50 into an implementation plan to make those a 2P.

S: Now you've covered the next one because I've separated implementation and outcome but you've mentioned both, you have it for both. So just as a personal judgment from zero to five, five being we're the best there is, zero we have a lot to change, where would you place XXXXX in respect to its ... how you choose your competitors and in decision-making processes I guess, not looking at your share price.

I: Yeah, and that's very tough. You're going to talk to people, to our competitors, whoever they may be and they will believe they are making good strategic decisions.

S: It's not the decision, it's the ...

I: Process.

S: ... actual process that you're going through.

I: Three and a half to four.

S: Oh, that's great. Just to get a feel ... by that, and that's the only number that comes up in this entire survey and the aim of that is just to get a feel for how people actually think their process is going, really what's it to do.

I: Three and a half. Seven out of 10 is probably ...

S: Okay, that's great. Anything else you wish to discuss or ask? You know, it's all been one way right now.

I: No, no that's fine. I found the process very positive and you're a very good interviewer from that perspective. Even if I was talking crap, you said that's a really good insightful comment XXXXX, well done. You go away and scrub it later on. No, I thought it was very good. I think the way you conduct yourself is very non-threatening. It's all very positive and all the body language is excellent.

S: Thank you.

End of recording

***Interviewee: Participant J (J)**

***Interviewer: Steve Mackie (S)**

S: The voice record will be not used, only the typed record.

J: Great, yeah.

S: And it is confidential.

J: Okay. And the first thing I could say is, I mean, anything ... I've only been with XXXXX for a very short time, whatever it is, so, anything I'm about to say is really based on ...

S: Past experience.

J: Past experience.

S: And that's what I'm after. I'm after people who've made decisions, who've seen some work out successfully and even some that weren't successful. And I'm asking people to talk about a decision that might have worked, or if you want to talk about one that didn't work, you know, you thought you made a really good decision but it was a disaster outcome, and talk about the process you go through. Not necessarily what the outcome was unless you wish to, but I'm after ... I'm really looking at process and the other part of what I'm looking at is the type of decisions. So you saw that presentation where I made that template of type, so when I go away from my interview, I'll look at the decision you talk about and type it, and then [inaudible, over-talking].

J: Well, I'll give you one good example and I'll talk you all the way through it and it's not really in geoscience, it's more in technical computing.

S: No, that's good.

J: But then you'll have enough background. And so, it's kind of got different layers of complexity, but we were in XXXXX, a few years ago when a decision was made that we were going to move our operations group to XXXXX and at the time XXXXX really had no ... we had a small office in XXXXX, but it was government relations and accounting. We had no G, G & E presence, so we were going to move about 75 geoscientists, engineers, to XXXXX and we needed to set up a technical

computing environment for them. We looked at what was out there and we decided that we were going to go with XXXXX. So that part of it, I think, we read what was ... read the current press and went down and spoke to people and the things we were comparing it to was just buying a bunch of Unix equipment like we would do, so that was one of the options. The other option was just going to an all PC environment and just getting like XXXXX and some of the PC databases and so really moving away from, at that time and still today, it was XXXXX. And so I think on that basis, we were ... we did our homework, we read the press, we spoke to the people, we made the decision and it was definitely the right decision. But then we had a decision to make, were we going to do it ourselves or outsource it? And we decided that in XXXXX, perhaps if we had been in XXXXX or the in XXXXX, that we could have gotten people or consultants and we could have done it ourselves. But we felt that in XXXXX, we just were completely ... we didn't have the experience and so we made the decision that we were going to outsource it. And once again I think that was the right decision. So, made the decision to go with XXXXX. I think we went through a pretty good process.

S: And made that decision.

J: Made that decision and that worked out. Then we decided to outsource it and I think that was the right decision and I think we did a fairly good pro's and con's and I think we did a SWAT analysis and it's almost four and a half years ago. But we did go through the analysis and decided to outsource it and then, I think that was the right decision. What was interesting next was we basically said well we're using [inaudible] now, we'll talk to XXXXX about XXXXX and of course they wanted to do it and at that point we were like okay, we'll go with XXXXX, the price seems reasonable. And there was very little ...

S: Picking out of other alternatives?

J: Because I don't think we felt there were other alternatives so we felt, like ...

S: Just had to go.

J: We just had to go, and it worked out really well and XXXXX did a great job. But in hindsight, they could have done a horrible job, too. And it just basically came down that the people they assigned were good people and if they had assigned ... it had nothing to do with the technology or anything else. They could have assigned lousy people and it could have been a disaster. And you know, so I don't know if we got tired near the end, you know that in hindsight that might have been part of it where you're going through a complex ...

S: Step by step [inaudible, overtalking].

J: ... and I think, you know, you're very diligent the first couple of steps and then maybe at the end you just want to see it finished. And I've seen that sort of behaviour in exploration as well. You would hope in facilities you wouldn't see that. So that was an example of where it really worked out well, but I think it could have been a disaster as well.

S: So people play a big role is really your conclusion.

J: In that decision, I think people played a huge role. I mean I'll talk to you I think ... yeah, I would say ...

S: Very big role. So, can I just use that a minute and step back through and ask some questions? So the first one, the decision shifting people. You've got to set up a new IT regime, you decide on a certain process that you're going to go through and you've gone through that process and you said, "I think" we made the right decision. Is there anything that you base that on?

J: No, I think it was more than that. I mean, when we looked at XXXXX and we looked at costs, clearly the XXXXX had some clear advantages that we felt the PC solution just was not going to meet our technical needs. We knew the Unix environment would, but it was going to be really high cost. So, it was based on some hard facts that XXXXX really ...

S: Met the real requirement.

J: ... met the real requirement.

S: Was there anytime down the track, say you've implemented and three years later you look back to see whether what you said it was going to cost [inaudible, over-talking]?

J: It did, yeah, it did. Well because we went into a fixed contract with XXXXX, we knew exactly what our running costs was and there was nothing hidden. So that was all really ...

S: So the way it was implemented actually complemented the type of decision?

J: Right. And so that was really good. But then when it actually just came right down to execution, that's where I think it was ... and I think you might see that in a ... I mean my boss, XXXXX, we've been having a lot of talks about organisational structure and he's now said this several times, you know, you can have the worst organisational structure and if you have really great people ...

S: It will still work.

J: ... it will still work. You can take the best organisational structure, but if you have the wrong people in it, then it won't work. So end of the day, and like in our business a lot of it does come to our business, trying to think through a process ...

S: Well, you've described the process fairly well, because what you've gone through ... let me reflect back and you tell me whether I've got it right or not, and that is you sound like you did it as a group 'cause you used the word "we", so you've got a great group-thinking going on. You've also used a defined process because you looked at cost, you looked at the implications of the type of environment that it would

be in, you know, new office, we can start from scratch, all of those ... so you've been through that. You even mentioned SWAT analysis type thing which is a process tool, and you make a recommendation at the end. It's accepted and then you implement it. One of our credos that we keep going by is that the process is more important than the outcome if you want good decision making or in the long run because outcome is governed not just by the process of decision making, but also by the implementation and then also by chance. And you've talked about all of those. You implemented it by setting in a fixed cost contract and so you are able to monitor the implementation and that handled your chance. But you do say that the chance was we could have failed because of people, we didn't think about controlling people.

J: We thought about it and we spoke to XXXXX about the people they were going to put in. One thing I guess maybe we did do is we did have ... do some long, tedious, and I guess this is important, do some long, tedious negotiating with XXXXX. We did put into the contract some fairly severe financial penalties if the system didn't work as they were ...

S: Looking after it totally, yeah.

J: Right. And so they really had some skin in the game as well. So perhaps there wasn't ... I mean, I think we did recognise people as a risk and we did try to mitigate it and at the end of the day things worked out well, but it could have just ... it still could have been a disaster.

S: No. So you put in a risk management process to handle it, but it could have still failed.

L I just thought of another example where I made a decision that didn't work out well and that was at one point with my career at XXXXX. They approached me about being seconded to XXXXX. Today it's just run by XXXXX but when that project was first getting off the ground, there was about ten companies involved and it was a consortium. It was a mess. But they approached me about going to XXXXX and the way that process worked was that the consortium was post jobs and then companies were able to nominate people for the jobs. And so XXXXX nominated myself and this other individual and we both went over there and ... so both him and I went over there and they decided ... and it was really just for one ...

S: Short term thing?

J: It was supposed to be a couple of years. And they decided they would take us both because they thought we both had different mixes that complemented. And the thing just didn't smell good to me, you know, because there's only one person who's got to be in charge and then all of a sudden it was this ...

S: Two of you and you got to share it.

J: Two, and the more that I got ... I didn't really know this other person. I think it would ... even though he was with XXXXX, he was coming from another side of the business. I think it would have been different if I would have known him, but I

didn't really know this person and I started ... but I went ahead because it was like, well, this might be a good opp ... and it did work out, kind of, but it was pretty painful. And so I guess where I'm going with all this, it's sometimes funny you know, your head is giving you every warning sign in the book and you know you're getting those warning signs.

S: Override them. [laughs]

J: But you override them, and you override 'em for the psychology of human nature, you know, because it's the path of least resistance.

S: There are also ... I call them rewards, when you're making a decision, you're making it based on a set of objectives and different alternatives, but you make a value judgement and you may weight your alternatives or weight your objectives, whatever you're doing, you're doing that as you make that decision. But sometimes we make cognitive decisions, short term ones because our brain can't calculate fifteen things in a row and so our weighting functions for some things are much higher than we actually think they are and that's what drives us into these decisions. I know you were talking about *Blink* and *Tipping Point*.

J: Right.

S: And they ... that's his premise. His premise is that you pick up very rapidly what's going on. We actually have a student who's just about to hand up his thesis down there at the school who's been looking at expertise as a control of intuition, which is really what *Blink* is saying, that when I'm exposed to this many times, I get a feel for what's going on. Like you said, you know, you felt that something was going wrong, there were warning signs there. But have you read the other follow-up book?

J: No.

S: Called *Think*. And it's got the same sort of cover, so it looks the same, and he's saying that these ideas of these quick fix thinking things that aren't thinking, is the destroying of American culture. He even gets very strong saying that it's destroying critical thinking.

J: And this is called *Think*?

S: Yeah.

J: But you know it's interesting. I mean, another decision that we just made, we being me and the family, was this whole thing to come to XXXXX and what happened was XXXXX acquired XXXXX and I thought at first I was kind of excited about it. I thought, you know, okay, big company, good company, good opportunities. But pretty quickly, and I won't go into it, it just wasn't my cup of tea and it wasn't the cup of tea for a huge percentage of XXXXX folks. But I knew some people at XXXXX, people who I have a lot of respect for, so I kind of contacted XXXXX and they got me in touch with some people and everyone I spoke to at XXXXX, and this was kind of in the preliminary ... I wouldn't even call it ...

S: No, this is part of the search that's going on.

J: But everyone I spoke to at XXXXX, I just said, mm, these are the type of people I want to work with. Everybody was coming across as really enthusiastic, wanting to do a good job, and ...

S: Little politics compared to the bigger one.

J: And the book *Think*, you know, because it just ... oh, *Blink*, excuse me, you've got me confused now, you know, it was a really gut thing. So I started to talking to other companies as well, but my heart just wasn't really in ...

S: There was something in your mind that had clicked with the information you'd received.

J: Right. And so, you know, perhaps it was this whole thing about moving to XXXXX and it was going to be something new and exciting but not really because ... it could have been ... I mean, you could do a whole paper just on this. It could have been that a really good friend of mine who I just have utmost respect for, was kind of a broker to get me even though he doesn't work for XXXXX, he knows quite a few people who do and he really ... and so he was [laughs] a gnat in my ear telling me what an idiot I would be not to pursue this. But it all sounded good and I all went with it and the jury is still out.

S: Yes. The feedback loop's going to be a long one.

J: But I think the feedback loop is going to be more on what XXXXX does over the next couple of ... I mean, XXXXX ... and I think that's part of it and I think that was part of my decision making was that as long as the oil industry stayed healthy, even if XXXXX just fizzles out ...

S: Somewhere else to go.

J: There would always be somewhere else to go. But it certainly would be an interesting ride along. It's funny, you know, here was a pretty life-changing event that I felt that I made a decision just like that.

S: There were no spreadsheets involved?

J: No, nothing.

S: All happened in the head and the heart.

J: And it really was ... I mean, even the salary bit of it, you know, 'cause it's complicated with XXXXX taxes and ...

J: But even that, it was like the salary, you know, it was the back of the envelope, like okay, well I'll convert that to dollars and I'll take the tax out and it was like yeah, I guess ...

S: That'll do, we can live on that.

J: We can live on that. But really considering ... I guess what was interesting Steve, is that perhaps a different individual would have really pushed three or four opportunities and then ...

S: Juggled them.

J: And then juggled and did all that, and I just didn't. Just from day one ...

S: I use ... one of the things you've tweaked ... one of the things I use as an [inaudible] of different types of decisions and that is the decision to drill a well as opposed to the decision to get married. Do you use the same process to do it? And no-one does.

J: Yeah, right.

S: And we do that, you know. I don't know of anyone who does a multi-objective decision analysis of who to marry. It just doesn't happen.

J: Well perhaps people should, considering ...

S: The divorce rate.

J: The divorce rate, or ... I mean that's pretty interesting and I don't consider myself just someone who's going to make wild decisions, seat of the pants, I mean, I like ... I guess we all like to think we are logical, process-driven people. Here was a huge ...

S: Life changing decision.

J: Life changing decision that I really made in a blink.

S: Yeah.

J: And so I don't know if I've given you enough information that you're going to be ...

S: I'm going to be able to pull that together 'cause what I'll do is go back and type those two decisions, and the first one is a very complex one 'cause it had on-rolling decisions after it. The second one is not as complex, but it has a lot of ambiguity in it, and so we'll look at that and we'll look at the process you've used because I'm a firm believer in not using the same process each time. Maybe if you used a multi-objective framework and you chop bits out of it, you can say that that's part of

how ... that's one of the things I'll be looking at. So no, much appreciated. You've shared some good ideas there.

J: But I've been ... like I said, I've been in the oil industry. A big chunk of that, even though I've been in computing, I've been on ... not in IT groups, in exploration, development, production, on the side of things, had the chance to be in rooms a lot where decisions are being made about drill locations, do you drill deeper, do you abandon drill and God, it comes down to people.

S: Oh yes. Especially when you're in a room and group decision making is going on.

J: And I wonder if other industries like finance ... I don't ... I think financial ... well, I would hope Wall Street, there's a bit more analysis than if data is shown them that they've already wasted a million bucks and that they could spend another million with a one out of a hundred chance, that they would walk. In the oil industry, I'm not always sure they would.

S: There's a lot of prior ownership that's very difficult to get ... can I just ask you one more thing? You may not have had the experience, but in all of this IT background that you've had, have you been involved with any decision making software?

J: The only decision making software I was involved with, and this is a pretty funny story, you might even know of this person and know of this software, but when I was at XXXXX in XXXXX, there was a very bright young engineering fresh graduate named XXXXX.

S: Yes.

J: Do you know?

S: Yes. He's published a lot on portfolio.

J: And really a nice guy. His family was involved in the oil and gas business and XXXXX came to XXXXX and just started writing portfolio analysis software. You know, I guess, good on him, 'cause his management really never busted his chops that he really was supposed to be doing something else. And it wasn't really my place, but I was involved in IT and so he needed assistance and it's pretty funny in that XXXXX basically spent his ...

S: And then he ...

J: Got some people, managers at XXXXX interested and so then he actually got some funding to do this. But then ... then one of the downturns in the industry ..., and he talked XXXXX management into letting him go with all of his software and he turned around and sold it to XXXXX and it became ... I forgot ...

S: Their decisions package is what they call it, yeah. So that's where that's at, okay.

J: So I just kind of ...

S: No that's a good history. I like that. I didn't know that part of the history.

J: I find it ...

S: So his stuff ended up with XXXXX?

J: Yeah. And he made a bunch of money and I think he's ... I don't know where he is now.

S: He hasn't published for a long time.

J: I mean, he was a really bright, bright guy, no question. But I haven't seen now ... the only other time ... even though portfolio analysis software has been out there at XXXXX, I haven't really seen it.

S: Not many people use all that [inaudible].

J: Now, the only other time I've seen it was my last boss, who's published some stuff and why ... XXXXXX was the exploration manager who then got, when XXXXX acquired XXXXX, got a huge promotion to be the exploration manager for XXXXX but couldn't stand it and now is the exploration manager at XXXXX, but XXXXX was a big believer in just ... he just used Excel spreadsheet with an add on that did Monte Carlo analysis and so he was a big believer in this whole exploration, you know, drill ... the more wells you drill ...

S: The more you find.

J: The more you find. And so that was his big push. Now I'm not really sure if that is really portfolio analysis.

S: Not analysis, but it works.

J: Right. Because he really was ... I mean, he just had one area and so ...

S: Yes, he's not dealing with a portfolio, it's just more of the same each time.

J: Yeah. And so his [inaudible] was just drill up.

S: And Monte Carlo add-ons in Excel work brilliantly well. They're my bread and butter.

J: So that's my pretty limited ...

S: No, that's fine.

J: Portfolio analysis ... which is kind of surprising ...

S: Seeing you've been in IT and big [inaudible, overtalking] for a while.

J: For a long time. And I don't know what XXXXX uses.... really sure how much they do and I know XXXXX who works for me is ... has this one project and he really tries to take the different pieces of that and to kind of do some data integration and be able to make some portfolio decisions based on different things, but we're not there today.

S: No, it's interesting how people talk about portfolios. And they do it in their head, but they don't use a lot of software to do it.

J: I'll tell you there's been times in my life where I've played around in the stock market and have finally come to the realisation that I just don't have the time and so I now phone a finance guy from XXXXX, retired, and became a financial planner, and I just gave him all my stuff and I'm hoping he ...

S: That's right, and a lot of people make that decision too.

J: And ...

S: No, that's terrific, XXXXX, that is actually all I need.

J: Okay. I hope I was helpful.

S: I'll let you put some more fires out.

J: I've got one left. It's interesting ...

End of recording

***Interviewee: Participant K (K)**

***Interviewer: Steve Mackie (S)**

S: I won't take too much of your time seeing you're co-ordinating it all but the background obviously is decisions and decision types. Our thesis is that the type of decision that you make needs to be linked with the process that you use, so you can't use a process to do everything. I think most of us see that intuitively but what I'm trying to get at is an idea of what processes people currently use. So that's really all I'm at. So I'm after things that you may do personally, whether you do them consciously or sub-consciously we'll try and figure that out.

K: Okay.

S: And then some things that XXXXX may impose on you, if that's not the right word, but it means that sort of thing. So to start with, how long have you been in this position?

K: About a year now, coming up a year. So it's Petroleum Engineering Manager for about a year. Prior to that I've held various sort of petroleum engineering leadership positions over the last few years before this in our production unit. There's the [inaudible] for that and then before that I was overseas and did some stuff in the XXXXX and in XXXXX and a few areas like that. So I've got a career as a petroleum engineer I guess.

S: Okay. And this role then oversees [inaudible] function.

K: It's the lead functional role for petroleum engineering. Yeah. So I have responsibility for the petroleum engineering function in discipline within the area and so if people like an Asset Leader, he has a few petroleum engineers in his team that I allocate I guess to his team and so I guess the role is one of resourcing, technical standards, sign off on work and those sorts of things.

S: Okay. So when he talked of he'd like to come back and tick off the box as [inaudible] functional [inaudible].

K: Yeah. So I give him a tick in one of the boxes.

S: Okay. So that's how it all fits together. Okay. Do you enjoy that sort of role?

K: It's good. It's new to me because previously I've been in the line if you like and been the one presenting work. So it's new to me and the organisations evolving where the line positions had probably more power in the past to an organisation now where the functional positions have sort of the gate holders almost. So it's evolved and the good part about it is I get to see the breadth of the business. So that's the ... I quite enjoy that, it's good.

S: I had a similar role in geo science and that's what I enjoyed seeing all the projects.

K: That's good.

S: Okay. So would I be correct in saying that you make decisions of two kinds in my mind, not just one kind. You make decisions for people that are working within PE function?

K: Yes.

S: And you then input into decisions that are at asset levels?

K: That's exactly right. So I make decisions on technical work within the petroleum engineering discipline and then things like [inaudible] production profiles, reserve estimates, well count, well positions, well designs, all that go into the business evaluation if you like and then that gets wrap up to our petroleum leadership team as the ultimate decision makers on go, no go. So my main decision area is technical aspects of developments.

S: And you mentioned earlier that you put people in [inaudible] the asset teams?

K: Yeah. I'm responsible for the career development, the people aspects of the functional team, recruiting, training, career development, allocation of people to various businesses and recruiting and all those sorts of aspects of the people side of it. So make decisions on yeah, people and I guess technical issues.

S: Okay. That's good because in other organisations that I've interviewed the people issues tend to be handled at the asset level and everyone complains that you don't get to be used enough and the wrong people are there and ...

K: Yeah. We're trying to break that down. That's one of the reasons we're going to the more functional based organisation but petroleum engineering we've got quite a good rapport amongst the section leaders we call them in our businesses and myself. So it's a good relationship. So that's the idea getting the right people on the right jobs at the right time. So that's part of my role as well.

S: So input is at asset but actual decision is people and technical. Okay. Can you describe how a technical decision is made within your group? Just walk me through what you normally do.

K: So the work process is that the people in the line, people in the businesses or the fields, the working fields work up a proposal an infill drilling location or a development plan or such, so they work that through the process. We'll have what we call an early stage peer assist where we'll bring in ... I'll come in and we'll bring in a couple of advisor types, more senior technical people, review their work program effectively. Say yeah, that looks okay and you need to look at these sorts of things. So they execute the program then at the end of the program we'll get together and the level of reviews are a function of the capital investment. So for the large investments we'll have a formal peer review process that takes about a week and I lead some, some are delegated to others. So we'll go through the technical aspects of the work

presented by the team reviewed by external people, go through that work and make a decision yes or no whether the works are mature enough and if the proposal makes sense,[inaudible] write a report, issue it and it goes out, so our report then gets integrated with a facilities engineering report, an economics report to make the overall decision to go forward. So fairly formal I guess. I was going to say, fairly formal but it is fit for purpose. So that's for a major project. We put out production profiles every month, forecasts and so forth. So I'll review that primarily just with the individual and say yeah, that looks cool, get on with it.

S: And what sort of criteria do you use to say that looks cool?

K: Interesting, yeah. It's a good ... I guess it's an experience based decision, I've done the roles myself so I know what sort of work should be done.

S: Okay. And so you're questioning to find out whether that has occurred.

K: Yeah. What have they done, what tools have they used? We've got a standard set of applications and so forth for forecasting. Look at contrasts versus previous work and see if there's any major busts, anything strange. I guess they're sort of benchmark, not formally but in my mind benchmark against what I've seen previously in that sort of stuff and yeah, tick it off in that manner. So probably more ... I don't have a checklist or anything. I just [inaudible]

S: Something in the back of your ...

K: Something in the back of my mind that says that looks about right to me.

S: And that's basically the smaller ones?

K: Yeah.

S: That's right. I liked the comment you made earlier that in other projects you have, I think you called it early stage peer assist.

K: We call peer assist.

S: So you've brought people in, help people out. Is that determined at what stage or ...

K: Pretty much lead by the section leader in the team when he's comfortable to go. So we have, as the project goes through a tollgate. So I guess the main petroleum engineering part of project definitions in what we call pre-feasibility phase in which we write the sub-surface development plan effectively. Here's the reserves, here's the range of reserves, here's the development well locations, here's the well design and so forth. So we generally as a rule right early in that stage, so once that team gets formed and we pull a team together and we'll say okay we need to get together with you guys, get familiar with the data. Have a bit of a look at, a couple of months in so let's call a peer assist. Primarily they give us a bit of a briefing and the main aim is here's our proposed work program and in a year's time we will deliver you base maps, upside

maps, all the rest of it, dah, dah, dah. We plan to do it in this manner. We're not going to do these three things or whatever and we say okay, that looks good to us or you've missed something here, any input from a third [inaudible] party. So it sort of smooths the way I think for the final decision point is pretty, what I've learnt anyhow through the years is that getting to the final decision point after an extended period of work often years and then people saying no, no, you've missed something fundamental, you should have done some seismic inversion studies right back here and use that to control your mapping of reservoir properties and they go oh I didn't think about that and so we try to do is have an early one and a mid phase one we do at times and then a final review.

S: Okay. It's a good one. And the final broad question has to do with what is a good decision. Is there anything in your mind that makes something a good decision or is there a formal definition of what a good decision is?

K: Tough question. What is a good decision? You almost look at them retrospectively. I think a decision that accounts for the greater good of the business is a good decision. So in all our roles even though we have a technical focus or whatever you need to take account the rest of the organisation, the rest of the business outcome. So it can't be closeted and blanketed. It needs to account for things that are happening around you.

S: Okay.

K: Needs to take account of risk, the risk aware decisions. So sometimes decision making is not perfect, you've got limited information but there's a need to get on and do business here, you can study it to death. In our industry it certainly is a huge thing. So it's accounting for uncertainty and risk and I guess looking back at a decision it's got to deliver what it had promised to deliver. So what are good words for that I'm not sure but delivery against some predefined targets if you like. At the time you think you're making the right decision [inaudible] it's good to look back.

S: Well in terms that I'm using I've just broken that up into two. The first two I would term process. So you're deciding whether a decision is good or not by the process you've actually gone through. Whereas the last one is the outcome. So what it actually delivers.

K: Deliver what you've promised.

S: And I like it because it fits my pattern but the process one is the one that I'm focusing on because in my mind too many people I've interviewed and [inaudible] was the same so it might be a XXXXX thing. You guys are the first ones who are talking process first and then a little bit of outcome because you've got to have the outcome. The patient died but the operation was a success doesn't handle it. So you've got to have outcome but the process is important to lead to that outcome and so the fact that you've got both is I think good. Now is that formalised within XXXXX or is that just something that you do?

K: No, the process I think, petroleum engineering do it probably the best. It's evolved and we have guidelines on ...

S: So you do have guidelines?

K: Guidelines and standards on review. So it is formalised. Yeah. So it's something that I've been part of developing but for example where we have sort of deliverables for a standard set of deliverables for each phase of a project and so it's formal, we checklist it almost during review, not quite that bad. The more engineering base ones would walk into here and say top structure, velocity model, dah, dah, dah, right through [inaudible], sand control study and go through but you can run it like that if you wish and then others are a bit more flexible with their interpretation of the guidelines and standards.

S: That's what I'm doing here. I've got guidelines but [inaudible].

K: So it is a formal process I think, yeah, documented.

S: Okay. Good. Well let me shift to type now because I haven't defined it at all. So just to introduce it would you consider that you make decisions of different types?

K: Yeah. I think I do.

S: How would you break them up then?

K: I think there's the hard bigger like capital allocation decisions. So a decision to proceed with an investment would be one sort of area which is probably the most formal and rigorous of the decisions.

S: Okay.

K: To softer decisions around people, like people based decisions, like allocation of people, career development and so it's nothing that really follows a formal process but a decision that's more people based and then there's the day to day decisions like the rapid decisions that ...

S: The operational ...

K: Sort of the operational, someone comes to see you and say I need some money to do this or does that profile look alright. So they're sort of day to day less formal and I guess that falls back to the sort of experience based method of approval I suppose. Major capitals are people based ones and then those middle ground day to day ones.

S: What makes you sort of break it up like that? That's logical. I agree with that but what makes you break them up like that?

K: Just perhaps it's the way I think, I don't know. I think it's the way I view things.

S: It fits your cognitive pattern.

K: Of how I think, how I know that's a big decision. That needs this process. This one I can do on my own and this one needs a bit different skill set to managing the people than the others are doing.

S: And in those do you think you would use different processes or do you use the same sort of phasing of processing that you do?

K: I'm quite a methodical ...

S: So you're a methodical person.

K: ... style person so I'll try and so I will, I think generally I like to see the work, the base assumptions, the work process you followed, what comes out of, have a look at that versus other benchmarks and then move on to the next one.

S: That sounds good. Well I've got a bag of tricks here. I don't know if you read this question but in putting together one of the first things that you have to do when you're dealing with type and process is you've got to be able to type decisions and you break them out like that but if I asked someone else they may break them out a totally different way and I've come up against that now for about a year and a half. So I went to the psychologists and asked whether they had a methodology to actually work out a taxonomy and there is such a thing in cognitive psychology. So I put together a whole series of decision scenarios and from that we were able to determine things that underlie people's decisions.

K: Okay.

S: I can let you know that yours fit into that perfectly. What I want to do is just test that. So here's a decision. This is scenario two. What I'm after is, have a read through it and obviously there's a decision that needs to be made. I'm not after the decision. I'm after how you would go about making this decision. So if this is what happens to you how does it happen?

K: Okay.

S: I've deliberately chosen one that I think is outside what you would normally do.

K: Yeah. I'd be very process driven by this process.

S: How would you go about determining what process to go through?

K: I guess they've got two possible scenarios, they float now and leave out that acreage or do they wait for the new acreage to be granted before floating but I guess what I'd do is I'd try and value my organisation under both scenarios.

S: Okay. Value under scenarios. That's good.

K: And then that would drive the risk either way on those. You know you can do it through some sort of decision tree or so forth, make a decision in which gives the better value outcome.

S: Okay. And so you would follow [inaudible] rules and that is highest NPV you'd go.

K: What I'd go with in that scenario. The hard part you know there's a risk element to it I guess isn't there as well.

S: That's right. There's going to be a ...

K: [inaudible] analysis is not perfect and part of it will be as how people view you without that acreage I suppose.

S: Can I ask some leading questions?

K: Yeah.

S: Would you get others involved?

K: Oh yes, definitely because this is the decision that goes across various functional areas I guess, if you like. So yes you'd have your geoscience people, your exploration based people. You'd have to have people because of the native title adds a complexity to it, so some people that could advise you on that unlikely outcomes and the like and then the commercial analysis to wrap it up into the NPVs and probably someone with sort of ... for me anyhow not being in this side of the business, someone with an [inaudible] market background would be useful too.

S: So you would people pull in who had expertise outside your expertise?

K: Yeah.

S: Okay. We'll just flip that over. What I've done here is this is the taxonomy that we've come up with. We found in trying to draw out the things that were generic behind all decisions they consisted of these four dimensions, complexity, how complex a decision which is in fact what you use to break out your decision types. So that was part of it. The other one is task constraints. So we found that if you're dealing with a very complex or even a simple type decision if you've got more constraints on it then it becomes a different decision. So that's why constraints. Ambiguity. You actually just mentioned as you talked through this and that was the value functions you're going to judge this by and so the more of those you've got to bring in the more ambiguous it is and then the environment and information structure. That is how do I get my information. This sort of thing I've done day in, day out. When it came to your day to day profiles you have a good feel for those but the first time you did that it would have been you've not done that before.

K: Go right back to square one.

S: So we've typed this out as ... and I'm sure that can change and all of this is subjective but to get a good feel for the areas and if I can vocalise back what you've discussed is because it's a fairly complex decision you have gone to some form of formal process driven decision. The constraints weren't there and this is an interesting one. In here the question is we're not quite sure how long it's going to take and so there is a big time constraint in there and do you value that. You mentioned that you would do that by some form of subjective risk and so that's that one. You did mention the ambiguity and you definitely mentioned whether you'd done it before or not. So I'm just trying to point out that ... I'm trying to tell myself yes, we've got all the right things. So no, that's good. Would you mind doing that for a sort of a decision that you've made recently. Could you sort of give me a bit of background on one that you feel comfortable talking about?

K: [inaudible]. We're developing an oil field at the moment. So there was a decision about a year ago to make that investment decision to spend our share of \$US400m on that development.

S: Big decision.

K: Big decision. So the way we ... and my part of that was the sign off on the subsurface work. It's a heavy oil in 800 metres of water. Heavy oil more difficult to develop than most things that have been done in the area. Water injection, gas injection. So a complex field development. So you're stepping through that but we were very formal in the process. The work program was executed over sort of a period of 2003 to late last year.

S: Were you under a time constraint at all?

K: Not a formal one, not a licence requirement but a corporate imposed early first oil, get it going, get this going. So there's not a constraint but a pressure if you like in terms of ...

S: I like that word.

K: ... getting things done.

S: Fast. And how did you make the decision at the end that it was ready to go?

K: Okay. So it was following our review process so we did a lot of work, technical work on the day we appraised the field, determined we'd finish appraisal, got a very solid data set together, analysed that data set, put that into models, did our forecast mode, reviewed that thoroughly on two or three occasions. Brought in external review as well to ensure that we were on the right track and wrapped that all up and then said yeah, this development and the range of scenarios scoped out and that development captured the uncertainty going forward and then we tested and then we wrap it up into the commercial outcome and tested the investment decision over a range of possible subsurface outcomes and robust under those, therefore proceed.

- S: Okay. As you described it, a very formal process. And has it started yet?
- K: They're drilling now, the first two wells.
- S: So it got through the gates?
- K: It got through the gate, it got past XXXXX. and yes, so we've drilled ... we're on the second well now.
- S: In making that decision did you put in ... these are terms I use, feedback loops. Did you implement any sort of we're going to look at this in one year's time and see whether it's going the way we thought it was going to go or ...
- K: Sure. Yeah. We had a couple of ... almost recycles too through work where we were ... the cost environment and the market was going up. Our corporate oil price forecast was not, even though the oil prices out there. So we had a couple of episodes where we had to go back and optimise and test our bases of design to go through and say yeah, this still makes sense. We should be testing this, this and this. So definitely a sort of how we're going, checks and balances. Do we need to go back and rework an area? Have we got enough data? What else is out there? Can you help us make the decision, analogues and the like.
- S: Very formal set up. Okay. Now we've discussed all these before. You mentioned that you use some tools to help you with your decision making. Are they mainly software tools or ...
- K: Not so. In a decision tree [inaudible] and so forth.
- S: The frameworks as well as ...
- K: We don't have a lot of formal software. Probably something we could get better at. So we use decision trees [inaudible].
- S: And they're just run inside Excel spreadsheets?
- K: Excel spreadsheets. We do a lot of range uncertainty analysis so I do a lot of tornado diagrams and so forth.
- S: And that's just again done in Excel.
- K: Excel primarily.
- S: Any add ons to Excel?
- K: Crystal Ball is probably the primary tool in there and then that. We do full probabilistic economics.
- S: Okay.

K: Very formal process. Our investment process has a couple of areas. It goes through your base investment and then it tests it at a low mid high price and then a low mid high investment scenario so you may take a high Capex low reserve outcome and test that at your low price. So we do like deterministic [inaudible], about nine of those and then for the major variables in the project. So if it's reserves and capital costs and facility up time or something, take those out and then put a range analysis into Crystal Ball [inaudible], run that through and do the NPV outcomes in a distribution and look at the probability of NPV positive outcomes and that's used. There's no formal limits but it's certainly used if your negative NPV on any more than sort of 10% to 15% of the cases [inaudible] the project won't go.

S: Okay. So you have a formal gate?

K: Yes.

S: That says it must fit [inaudible].

K: [inaudible] has an ultimate say in that but it's unwritten [inaudible].

S: So that's an informal one.

K: Yeah. It is informal. It's not documented anywhere but everyone knows you go to project with a rate of return less than 10% or cases on distribution on NPVs anymore than sort of 10% to 15% of those negative you won't go. You'll be told to go back and recycle and try and change that [inaudible], take the big hitters and try and reduce the reserve range or whatever.

S: Or change the opportunity costs and all that. Okay. That's good. So we've handled all those. So just finally then to finish off. These feedback loops you mentioned during the time you're making a decision. If you've got internal feedback. What about now that you've made the decision to implement the project and one of the things that we've found is that outcome, so the decision outcome is governed by the decision, definitely but also by how it's implemented and also chance and so we are recommending feedback loops on implementation as well as the total outcomes which helps us understand chance.

K: Well certainly we have [inaudible] post implementation review. Formal process, appointment an independent team.

S: So that's right at ...

K: Right at the [inaudible] a year or two after you've finished execution, go back in your business submissions, you set targets on initial rates and all the rest of it and you do a XXXXX. At a lower level, for example in the development phase [inaudible] we do now on each well we set a series of we call a well quality index. We set targets for a well. So it's got to land in the target area, set a box for the drillers.

S: And what happens if it's outside that? Say the driller places the well outside his range and the reservoir is outside what you thought it would be, what do you ...

K: We'll feed that back through and if we have time, quite often you don't have a lot of time because you're onto the next well before you know it but we'll feed that back and optimise the current well. We do a lot of contingency planning if you like. So around the drilling campaign we'll have a contingency plan on a well by well basis. So prior to drilling the well we'll say here's the uncertain areas, we're not so sure we're going to get 20 metres of reservoir here. If we only get five what do we do. If we fail to get logs what are we going to do. We want core, if you don't get core are we going to sidetrack the core. So we set up front, so we set a set of criteria on each of those parameters so when we get to that point in the well ...

S: You can just move forward.

K: ... move forward and so that's a document that subsurface people[inaudible] sign off with drilling.

S: And what do you actually call that. You used a ...

K: Contingency plan.

S: Contingency plan.

K: So we have that document upfront and then we have a set of measures on the well so we can say well we failed on these, perhaps we should look at ... [inaudible] didn't work on this well, we really need it, what are we going to do? Get the peers [inaudible] in, whatever we're going to do to try and react to change the forward process. So yeah, we do a fair bit of that.

S: In an absolute worst case scenario, I don't know how many wells on [inaudible] but for say for example you're going to drill eight wells as your development plan and you've drilled three of them and all three are way outside the range, low, does that stop the project?

K: It's a good question. The trouble, if they're right outside really low I'd say yeah, it may. The trouble is you've invested a lot of the capital to that point ...

S: That's correct.

K: ... in this large offshore developments so you've bought your facility and you've got all the trees and flow lines and [inaudible] equipment and it's all procured.

S: And it's all out there.

K: And not reusable a lot of it.

S: And it is a risk based decision.

K: So you'd look at it. You'd look forward and say okay, if we continue on this path and we only get 20% of the reserve that we'd promised, it doesn't make sense to continue. We had an example like that in XXXXX, [inaudible] where it came in [inaudible] results were difficult. It came in at sort of the P90 reserve level or below. A decision was made to proceed. It's a nice thing to look forward, as long as there was enough revenue to cover operating costs the decision was to proceed and past things get forgotten.

S: Sink the costs.

K: 30,000 barrels a day and everyone's happy with that at the moment. I think we probably would stop things mid track if we had to.

S: Okay.

K: I've not been around one of those but ...

S: They're very few and far between especially if you've gone through a process similar to what you've described.

K: Even through process you still get things that come out a bit strange. So it's not perfect.

S: One of the other examples we actually use in our teaching is where it actually comes out on the high side and you put a platform out there that's only got 16 slots in it and you really need [inaudible].

K: We have a history of that because one of the downsides of review and review and review is conservatism gets built in and everyone who [inaudible] attends the review feels that they've got to have an action. So all of a sudden you get conservatism on conservatism and you do have scenarios where you're at the ... I'd say a number of our fields have come out of the P10 reserve estimate and perhaps could have done a different facility selection but we're quite good at ... we work the assets through time as well. We have depletion plans and say if there is a business case for expanding the facility doing something different we generally do it.

S: I was involved in one of those and XXXXX.

K: Good decision though because it showed how we recognised some value here and implementation of technology. So that's quite a good example actually.

S: Because as things go you miss things.

K: Others say it's too hard, don't worry about the oil. I don't know what the oil body wants.

S: But it was worthwhile. Okay. Well the last one and this is the only number in the whole circle. It is a qualitative discussion rather than quantitative but this is try and get a feel about how you feel about your company's decision processes. So think-

ing about the process that the XXXXX has and comparing that to whoever you think your competitors are, so I won't guide you there, how good do you think it is? By good I mean effective and efficient.

K: I think it's effective. I think it's rigorous, is onerous and therefore most things that come through are pretty good decisions. I think we're now slower than our competitors. In fact I'm fairly certain that we are slower than our competitors.

S: Is that a bad thing?

K: It's an interesting question. If you ask people at a working level within the project, they hate it because you're the one who has to go and see a partner and say no, we're not ready, we haven't approve this, haven't gone through our process yet. So that's from a working perspective. That's not a great world to be in. From a management position where you've got a broad portfolio of opportunities and delaying a project a couple of moneys and putting a partner's nose out of joint isn't too much of a concern for you, it's a good process. So I think it depends on which ...

S: Where you are in the ladder.

K: ... where you sit in the ladder.

S: The other one you mentioned maybe the rigour on rigour on rigour may actually lead to conservatism.

K: Yeah, [inaudible] conservative.

S: But overall if Five is perfect and O is absolute rubbish were do you think you would [inaudible].

K: Four.

S: Okay. And I would validate that. Based on what you've discussed that sounds good. Okay. That's the end of all of this. Is there anything that you think we should know about in making a decision that we haven't talked about?

K: No. I found it quite interesting actually because I never sort of sat down and tried to differentiate decisions, consciously and so I think it's a good process. No.

S: Okay. Well much appreciated. That's terrific.

End of recording

***Interviewee: Participant L (L)**

***Interviewer: Steve Mackie (S)**

S: So just a ... to background, that it's important for us to understand what you mean by a decision, and so part of that is who you are, so you've been in this sort of role for a while.

L: Well my role for the past three years has been as an asset manager, so effectively managing a multi-function team, and prior to that a lot of my experience has been commercial, but I think there's a lot of similarities between the ... the way that you operate in a general management role and a commercial role. Is what's crystal there is actually coordinating all the ... the different functional perspectives whether it's GSI, it's engineering, marketing, tax, whichever. So that's really my background, general management and commercial management is really how I'd put it but way back when Moses was a boy, I was once an engineer, so that's who I am.

S: Okay, still remember the word.

L: Okay, yeah.

S: No, that's good. So you ... would I be correct in saying that you would consider that you make a fair few decisions in your role?

L: Yeah, yeah.

S: Okay. What ... how would you classify the difference between making a decision and having an input to a decision?

L: I think having an input to the decision is where you actually define the reality and defining all the imperfections, that's having the input to ... the imperfections and the opportunities. I think the decision maker actually takes all of that information and comes to the conclusion as to whether the opportunities outweigh the imperfections and potential risks that have been laid before them, so one is just describing a problem, the other one is whether you want to do something about it.

S: Right, okay, and in that role, what's ... I know you can't generalise the percentages, but what sort of amount would be decision making that you make, as opposed to ones that you have input to?

L: I think ... think over the past three years in particular I would've said 75% to 80% of what I do is decision making, and the rest of it is input to others above me, making decisions with my input.

S: Yeah, that's good, that's exactly the sort of person we're after so ... so on that, is there a certain type of decision that you make?

L: That's an interesting question, types of decisions, I would describe them as business decisions, and that may actually sound like a bit of a copout, but it is those

decisions which actually encompass all the different functional perspectives, [inaudible] it's understanding what would you assign as risks, what the project execution and the market risks, well you know, those are terms as business decisions. If I was an exploration manager or perhaps a chief geologist let's say where you've got someone with very, very clear functional remit, the decisions that you make are ... is does this work? Is this a technically robust proposition? Yes or no, and that's much more focused decision, and it relies very much on technical arguments, once I make, rely on a whole bunch of arguments.

S: And they're ... could I be correct in saying that very fuzzy, they're hard to get your hand around and ...

L: Often times yes, yes, and particular when you actually start introducing market dimensions and then more so around gas, you know gas over a period of decades, and you start introducing things like what do you believe the economic outlook for North ... North Asia is? How do you see the emergence of the North American gas market influencing you know, LNG in the region, you know, those sorts of questions are very fuzzy.

S: Yeah, so you write out I use a pyramid and at the top of the pyramid is the strategy type decision so ...

L: Exactly yeah, yeah.

S: Okay, good, the reason for that is that's the background to help me try and talk about what sort of decisions, 'cause where ... where I'm coming from a perspective of decision type, needing to be matched to decision process, so I'll get you to process by asking you what you think a good decision is.

L: A good decision. A good decision is one that encompasses the broadest range of perspectives, yeah, you know, what I really enjoy you know, about delivering a decision is knowing that I've actually had my technical, financial and marketing people get across this and actually have the ... the ... the petroleum engineers say hang on guys, I've got an issue here around reserve risks and the marketer's saying well don't ... don't bother me, I've got a 20 year gas contract that's there to be signed, you know, and it's actually having those challenges there, you know, making sure that there ... there's you know, a bit of ...

S: Lead to what's happening as well as thinking?

L: Exactly, yeah.

S: Okay.

L: So ... so it's the robust and challenging conversations which I ... I believe deliver you know, quality conversa ... quality decisions, and quality conversation ... decisions, don't necessarily mean that you've got all the answers to all of the questions, a quality decision is one where you go in with your eyes open, and you say al-

right, I do understand the opportunities here, but I do understand the risks, and I understand if those risks eventuate, what the consequences are.

S: Okay, good, in my terminology, I would say that that is process, in that a lot of people make decisions on when it ... whether a decision is good or not by the actual outcome and we're ... we've found over the years that that doesn't really work, and we've tried to separate it by showing that sometimes good outcomes can occur by bad process, you would have good luck on your side, we'll call it that, so yes, you've described a process driven one which is going to help us in you know, so ...

L: You know, I'm just ... I'm just giving an example here, if you actually drill a well and you get success or you get a failure, I think it's a ... it's a good decision if you have contemplated somewhere in the spectrum of scenarios that you ... you know

S: Might've had the failure.

L: Thought through, but we might actually have that success or we might have that failure, if you actually follow it inside the envelope, I don't think it's been a quality decision, something has come out a left field, and we ask the question well there's a reason why we could've come out on the left field or could I have foreseen that with some more rigour in the conversation in the run up to making the decision, so you can have an absolutely stellar outcome which is great and the shareholders love you and there's nothing wrong with that, if that a quality decision, you know, it's just good luck.

S: Okay.

L: Yeah.

S: That's exactly down the path that we're trying to follow.

L: Yeah.

S: The reason that we believe that is in the long run, so probabilistically, as you make more and more decisions, if you're using a good process, you're going to get a better long-term outcome overall of the decisions you make, as well as maximising the opportunity of a better decision each time you make one, so that's ... that's where we're coming from. Okay, well with all of those background, I've brought some scenarios of decisions to ... to show you, and if you're comfortable, we'll run through a couple of those because what I've done is I made these up, these come from past experience of lots of people that I've spoken to, they're fairly simple, but all they want ... all I'm wanting to do is not look at the decision that would be made, but how you would actually go about making the decision, does that make sense?

L: Yeah.

S: And they're chosen randomly, so I just have them stacked in here, but I'll pull one out. Okay, number 15, we've got a few. I want you to read through that and just ... it ... it may come totally out of a different area from where you've been operating.

L: The [inaudible]. Okay, well there's a series of actions in here so you know, you have the series of actions in here. I think one if you realise that you've actually got a problem and you've got a managing director telling them well [inaudible] something that is not founded on all the facts, first thing you do is advise the managing director you may not have had all the appropriate information to hand in making that announcement, so there's the first thing, that's just ...

S: And it's an emergency thing to handle.

L: Stop ... stop the escalation of a potential problem, you know, the next thing you actually do is you actually go right back to the heart of the problem, so you ask your geophysicist you know, just outline exactly what you did here, so you understand the nature of the problem, so with that said, you then go into the scenario planning, well what are the consequences for that, how does this fundamentally change decisions which have flowed on from that, what scenario [inaudible] here, so do I have a material bust? I'll just read through this, this means a dynamic [inaudible] will be incorrect, are they incorrect by the material or incorrect, I don't know and that's why I'm actually doing the scenario planning here with the guys, let's just think through what the knock-on effect is, there's an op ... opportunity there as much as a risk and this is where I actually come back to one of the statements I made previously, are you actually fitting within the range that you previously perceived? Does this new information fit with one of the scenarios that you previously planned for? So if they ask that, it's yes, you know, you know, we thought there was you know, uncertainty around this, this particular technical matter, and fine you know, carry on as you were, if there's new information and it's a fundamental bust that's going to take you outside the envelope of scenarios that you were contemplating, that's when you're going to say right, we've got a whole new piece of information that needs to be relayed to the market, so ...

S: Okay, good that's how you do it.

L: Yeah.

S: Is there a process that XXXXX says to use? Like you know, do you have a book that you can go to and it says this is how you do this?

L: Is there a book? Yes, I think there is, I think there is, and what I'm reflecting on at the moment is one of our projects which has a material cost over on, one which we hadn't envisaged when the range ... when we took it to the board initially, we actually have a process in place that says as soon as you become aware of this, there is a time period within which you've got to put forward at very high level, preliminary advice but nonetheless advice that says I have an issue here, I have a strong belief that there's going to be material deviation to what I showed to the board, and that escalates its way up through the company and people recognise it for what it is, it's first advice of something that's materially changing, you hadn't previously envisaged. And then there's a follow up process that goes through a lot of this, and it says alright, now I actually do want to see the full 10 page submission and this will actually go to the board, and they will at least get briefed in detail on this and then there's another proc-

ess behind that that says I want a full blown forward summation that says excuse me, can I have another \$50,000, so yeah there's ... there are processes in place for something like a major cost over a ... there are also processes which ensure things like our oil reserves are robust, all our obligations around the SEC and demand that we have, scrutiny in our booked reserves, and those processes bosh out the ...

S: Snuff out problems.

L: You know, the [inaudible] is just having a bad day, so you know, you hope that you've actually covered the first time, but if you didn't and you just discovered it, the SEC process should actually flush that.

S: Okay, okay so you ... you have that series of processes on board, that's ...

L: Yeah.

S: Okay, good. Have you ... when you're going through those processes, so take for example the one you just used, a major cost over a ... when you're going through that process, as you said the initial part was a warning if I could call it that, then the second part is actually doing the work, getting it ready and then submitting, do you find yourself personally wishing that that were different? Now this is why everything is absolutely confidential here.

L: That the process was different?

S: Yeah.

L: Or that the ...

S: That the process was different, that you know, we can handle this a different way.

L: No.

S: And why do we have to go through this process?

L: No, I actually ... I actually value the opportunity to actually say guys, I don't have all the information, but I do have enough information to tell you that there's something fundamentally changed, I do appreciate the expectation of these people, well the level of expectation that all that they are going to get is two pages, and if they see some economics about the cost impact, they recognise it's a big turnaround 48 hours or ... or whatever the period of time is, they know it's ... it's an early indication number, they will expect the refinement of that number in the second or the third submission, it's a bit like safety, if we have a major incident, a significant incident, you know, within 24 hours I need to report that, and that goes right up to the chief executive and XXXXX knows about it, he doesn't expect the root cause analysis, he expects that over time, he expects that to be thorough and he expects that to be you know, diligent, but not in 24 hours, so I think ... I think they are good processes, I'll be honest.

S: Yeah, no, that's ... the reason I ask that question is because one of the biases we're trying to get a feel for is ... is personal bias, so that often times when it comes to risk or uncertainty, our personal feeling of risk, if I can put it that way or risk tolerance is very different to that of the corporation, and how does that overprint on the way we implement process?

L: Yeah, and I ... and I ... and I think what you're ... I understand the sort of scenario that you're ... you're working towards here, and I've actually been through one project where personal, emotional investment in the project ran beyond good commercial judgement, and it was actually at the very heart of why we actually have peer review processes, you know, this is a project we did in XXXXX, it took \$160,000,000 write down and I walked into that deal at the beginning of the development, and you could see from day one that there was a problem, and the problem would never have been there if we'd had peer review if you just say I've been working on this for ... for ... for a year, I just want XXXXX to come in, because XXXXX's done the same kind of jobs as I have, and he knows a dog when he sees one. So come on then XXXXX, just tell me what do you think of this? And if it's you know, someone actually said you can fool your boss but you can't fool your peers, there's a ... there's a grain of truth in that.

S: Yes.

L: And if someone comes in and says alright, you know, I've got every bit as much experience as you but I've got fresh eyes and I've got no emotional baggage around this project, that is a value of a peer review, and if someone's giving you an honest opinion that you may have actually overlooked a fantastic opportunity, or you may have actually overlooked a fatal flaw, you know, if you've got that built into your decision making process, that is another sort of you know, being able to arrive at robust decisions so ...

S: Excellent, and you have that obviously in your processes or you call on that?

L: We have ... we have process in place, whether we actually implement it to best effect, I [inaudible].

S: I think most companies would say the same thing.

L: Yeah, yeah. You know, is a ... as a champion for two major broad submissions last year, I was peer ... supposedly peer reviews, but I looked at the guy who was supposed to be my peer and I thought well when's the last time you woke up at three o'clock in the morning wondering how you're going to move your project forward? You know, when's the last time you had accountability for a billion dollar [inaudible] asset? You know, you don't, you're ... you're a smart, hardworking corporate guy, but you've never worked on one project in your life, so you need to have someone that you look at and view as your peer and have common respect for each other, so ...

S: Yes, that's a very good point, that's a very good point.

- L: Yeah, so the procedure's right, the imple ... implementation is not.
- S: When you raised that, then you jumped to ... towards the back, I asked you questions about feedback loops as ...
- L: Yeah.
- S: It's obviously not part of the decision but it helps improve other decisions down the track.
- L: Yeah.
- S: And there are two types of feedback loops, one actually looks at the outcome, and was the outcome within the ranges we said it would be, and obviously you have that, but the other one is the actual implementation, so do you have any sort of process to feed back on implementation?
- L: Feed back on implementation, so you're ... just to clarify that then, I've made a decision to execute a project, are you talking about periodical reviews to assess this decision ...
- S: Is this being implemented the way we wanted it implemented?
- L: We do actually, yeah, I'm just thinking through our corporate processes, you do actually have routine reviews through the course of a project, so ... so the corporation isn't wholly aligned upon the project director or the asset manager.
- S: If I come back to this example, for example, if we used this and it's being implemented, this may have been picked up earlier, and so that's the reason we're looking at that and I think most people would agree, if you can pick them up earlier, then you can begin to steer the ship a bit better.
- L: Exactly, yeah, yeah.
- S: Okay, well that sounds like the processes you said then. And I ask a very broad question that probably has no right answer, in XXXXX's processes, do you know how they got there? Was it organically driven, you know over years we've made mistakes and so we've got to try and solve those by putting process in place, or is it some right fellow comes in as a new CEO and implements these processes? Do you know which way it came about?
- L: I think it's organic, it's organic based on you know the ... the project that of course it was [inaudible] on and that write down happened in '95 or '96.
- S: [inaudible].
- L: Yeah, we have a new CEO coming, XXXXX, and XXXXX said alright, from what I've heard, if we'd actually had this peer review process, this would've been a whole lot better, and if we'd had milestone reviews on the [inaudible] board, this

would've been a whole lot better, and that was really the ... the initiation of how all these processes came into being. Now it took a long time for them to evolve to the stage they're at today, and they're actually still evolving, but they're evolving because we're still making mistakes, but the good news is we're actually learning from those mistakes, so you're actually seeing that ... that cross [inaudible] version.

S: Yes it's going through those ... the feedback loop as well.

L: Yeah, yeah but the conception of it, really label that ... that first ... the major screw up at ... that petroleum had, there's been others since, you know, this started off as a petroleum process, and it grew because we get deals like XXXXX which was billions of dollars, and that's when the broader corporate community said hang on, these guys have actually started to create ... create a process that we want to have so

S: Okay, that sounds good.

L: Yeah.

S: Yeah. Okay so there's a fair bit of buy in, if you look down the other way now, so with some of these decisions we've talked about of sort of you going up, now let's look at the ones where you ... it stops at you and things are coming up, would you have a process that you actually think through as you're in the process of making a decision?

L: I'm just trying to think of examples here, yeah, there's ... there's almost like a check ... you know, a checklist in my head, and I think what's at the heart of it is the functional piece, you know, what does engineer think, what does the geoscientist think, what do the finance guys think? Do I have the budget for this? You know, is this included in our production forecast, you know? Even can we market this stuff you know, if we actually get it out the ground, if we do is it going to be a distress sale or is it something we can latch onto the back of an existing contract? I'm actually going through more organisation and trying ... I want to get a sense how these guys thought about it, have they talked to each other? You know? And you know, yeah they try and talk to each other but sometimes because I'm standing back and I'm not in the thick of the hand to hand battle, I can actually throw in some of these challenges and [inaudible] well no we didn't think about that, let me just take it away. So my ... my checklist in my head is a functional one, and I'm looking for the linkages to these bits talk to each other.

S: Okay.

L: And then there's ... the process I've gone through that, alright, I understand it all, I understand where the linkages are, let me just step back, how does it actually fit into my broader business? Because there's obviously the strategic bit that you need to think about, you know? Is this [inaudible] my strategy? Is this something that I said was important to me in the first place?

S: Or is this just something I want to spend time on?

L: Yeah, yeah.

S: Okay, in ... in that sense, I ... I don't know what the new organisation will look like at XXXXX, but I hear that it's going to be more functional than asset, how do you see ... you know, you're now a functional manager, do you see the processes being different seeing you've only got one function or do you break it out into the different, say you're an engineering manager, you know, into petroleum reservoir, facilities, whatever?

L: Yeah, as I said at the outset, my background is largely commercial, and the role I'm going into is as our regional commercial lead, so I've actually got the fortunate circumstance whereby I can go back to doing what I've always done, 'cause the deal needs to reflect the risks and opportunities of all the other guys, so to some degree, I'm still carrying that checklist in my head.

S: Okay.

L: But my decision making, my decision making ... it's decision making as opposed to actually developing a deal.

S: Yes, that's how I ... yes, definitely it's that, the way the decisions are being made, not how I'm going to structure this outcome.

L: Yeah, I'm just reflecting, no I'm still happy saying that I'm running through the same checklist in my head, because somebody says why have you written this into your commercial deal? And I will say it's because I've spoken to the reservoir engineers and they have told me this could be 10,000,000 barrels or it could be a billion barrels, so I want a productive sharing contract that accommodates me for those doggy outcomes, and I want to be positioned to realise full value if this is a world scale project, so ...

S: Yeah, so no, that sort of process, the way you're saying it ... the process to me looks like it's the same no matter where you're actually sitting.

L: Yeah.

S: Okay, that's good. So that's process, now because you have processes, do you have tools that help you with those processes?

L: We have tools, whether they're much help or not, it's another question.

S: Okay, okay.

L: Yes we do have tools, we've got things like our ... our enterprise [inaudible] risk management and it's ... it's a useful tool for assessing the probability of a risk being realised, it allows you to value the exposure that you have in monetary terms and health and safety terms etc, we do have tools like that, what else do we have? Standardisation of economic models, all that kind of good stuff, so we've got stuff I can pull off the shelf to help me make a decision, some of them actually, yeah they do

help, some of them are just implemented because someone told you this risk registered in this way, yeah.

S: Yes, and you think going to the board requires this [inaudible]?

L: Exactly yeah, yeah. So ... so that's the bits that don't help.

S: Although they were put there supposedly to help, but yeah.

L: Yeah, yeah, you know the problem with ... with a company like XXXXX is they try to go for a one size fits all solution, and the fact of the matter is you've actually got ... even with the petroleum, a tremendously broad range of business opportunities, gas is different to oil, oil is opportunistic, gas requires ... gas is more strategic for want of a ... a word to differentiate, well can you ... can you apply the same tools to ... to both of those pieces of businesses? Not all the time, and you broaden that out to oil or uranium, they've got the same sorts of issues as well, you know, some of those are greenfield developments of legacy assets that fit with a major greenfields development of an [inaudible] you know, sort of defence that one size fits all, it's like oh, and doing 100% of this stuff and frankly only 60% of it is really relevant to my opportunity.

S: I'm smiling a lot because you've actually used a phrase that I use very often.

L: Yeah.

S: My ... my catchphrase is one size does not fit all.

L: Yeah, yeah.

S: Yeah, but it is ... it is difficult when you're dealing with a large corporation because the person that you're reporting to wants you know, he ... he's going to be looking at oil and gas and iron ore and some other mineral and he wants it somehow standardized, yeah.

L: Yeah, I can understand that, it's interesting, I took a major off road development to the board last year and XXXXX, the executive phoned me up and said XXXXX wants to see you, you know, in a couple of week's time, block out four hours in your diary, I said terrific, how long is that for? He said XXXXX wants to talk to you for the full four hours, so four hours of the CEO which was fantastic, great opportunity, but I could see XXXXX actually going through my stat and submission, and you could see that he'd red pen stuff and I could see what he'd done, it was like not relevant, not relevant, not relevant, and then there's a big circle round the stuff that was, and that's where we had the four hours of conversation, and it was great watching strategy for gas, how does this fit into it you know? You know, tell me about your [inaudible] partners, you know, what's the strategic value in your partnership with XXXXX or with XXXXX, whoever, and you know, I could see what it was doing, it was like yeah, not relevant, not relevant, not relevant, and I'm sure with a big red circle around an XXXXX project because what I'd written there was very relevant to XXXXX so yeah, one size doesn't fit all but sometimes ...

S: That's good your manager knows how to handle that.

L: Exactly yeah, so ...

S: Good, okay, anything else that as you went through the questions that you think might help us in trying to understand how ... the purpose of these interviews is to try and understand how people actually do make decisions, there are trillions of books, that's the exaggeration, we've got lots of books written on how you should, but we're like trying to get at how people actually do think through it and what they're actually doing. Anything that you would profit to help us make our decision?

L: I'd probably ... I'd really just stow it down to two things, one is ... is functional peace, if somebody has an input to the decision, get them do a review of the bit that is specific to the opportunity, get the reservoir engineers in, get them to do their stuff, get everybody with a ... with a stake in this involved and get them talking to each other, because that's the first bit is getting that functional excellence and the cross-functional communication, that's an important bit, but the other bit is be brave enough to actually call someone in with a passionate view, fresh eyes, who has got every bit as much experience in this industry as you do, and will tell you whether you've fallen in love with a dog.

S: I like the phrase.

L: Yeah, someone actually said don't let your dogs become your pets, so now and again you need to have someone come in and shoo out the dog.

S: Oh okay, yeah.

L: But you know, [inaudible] it's not just is this a bad deal? It's have you actually undervalued this deal? Yeah.

S: That's right, and could it be bigger than I thought?

L: Yeah, yeah. So ...

S: Okay, good. No, I appreciate that, that ... that ... that's very much appreciated. Well that's it, that's all I was actually after, we've covered a ... we didn't follow the pattern that was there because you ... that's tweaked all of your thinking so yeah.

L: Yeah that's fine.

S: Yeah but it was really just having a look at how ... how you actually go through the process, let me show you what I'm going to do with what you've told me.

L: Sure.

S: So we've specifically with this one, we've put together a taxonomy of decisions, we've ... and it's taken us a year or so of cognitive psychology, I leave it to the

psychologist, but we've found the four key areas that make up a decision in people's minds and then we can type it and this we simply call a box decision, you know, highly complex, lots of constraints, lots of ambiguity and the way it's been made has not been done before, and what I'm looking for is as I'm talking to people, others that I pull out are different types of decisions and I'm going to be then comparing the process you've talked through as yours as to whether another process is talked through for a different type.

L: Okay.

S: And I've been able to interview about 15/16 of general manager/CEO level people and have got three or four of you guys today and tomorrow and the same at XXXXX next week, and from that I'll have about 30, which is enough statistically to begin to pull apart what's going on. So we will feedback to XXXXX our findings.

L: Yeah, I'd be really interested to ... to read your findings.

S: Yeah, and hopefully that'll help people, that's my aim. My aim was always ... the problem I found was the ... I called it personality and one day I'm going to actually look at how it fits into all of this but right now it's ... the cognitive psychology, we used to use a lot of portfolio work, and rolling up portfolios and getting from the board what their direction was and then saying right, well if that's the optimisation you want then here's the project mix you need, and then they'd say yeah, thank you very much for your two years' work, but we'll do this and it was trying to get out what's causing them to do that is where I'm at. So the one thing I can feed back that we know very strongly is the best decision makers are the ones who make lots of decisions, that's a very trite statement, but it ... and we're working on is it the best of all sorts of decisions or just the best of certain types of decisions?

L: Yeah, well it's interesting, you know I actually asked the question of what does decision making mean to you? And I thought about [inaudible] when I said decision making is a conscious choice to commit to a specific course of action, with an understanding of the consequences that each action represents, so to me that is consistent with what you're just saying, if you don't make decisions, someone else is running your life for you, you're along for the ride.

S: Well that's it, it's very close to the definition that we're using which is conscious choice of assigning the ... you hold the purse strings if I can ... that's ... the way we try to help people see who makes the decision is the one who says you can use this, they've got the purse strings.

L: Yeah, absolutely.

S: Well that's it XXXXX, I much appreciate your help on that, I really do.

End of recording

***Interviewee: Participant M (M)**

***Interviewer: Steve Mackie (S)**

S: Let me start by just asking, in general terms, what you think a decision is.

M: A decision? A decision is what you produce when you're presented with a number of options and you need to decide which option you want to take.

S: Okay. So, number of options, having to compare, coming up with going with one of them.

M: Yes.

S: Okay. In your current position, do you make those sorts of things?

M: I do, yeah.

S: What might be some of those sorts of decisions you would make?

M: Well, my primary role is around development planning, so the decision I make is based on the work of my technical team, bowl placements, perforation intervals, well types and those sort of things, I suppose.

S: So you're implementing XXXXX?

M: XXXXX, yeah.

S: XXXXX. And so you've got a development plan that's been worked out when they said go ahead with the project?

M: Yes.

S: And you're now implementing that plan and you make decisions along the way.

M: I mean, a lot of those decisions were made in that plan, so we've made a proposal, we've had that proposal, if you like, QCd internally, and we're also in the process of getting it approved by the government.

S: Okay. So you're involved in that original process as well?

M: Yes. And then there's the ... when drilling the wells, there's the day-to-day decisions to be made.

S: Okay, good. We're defining a decision maker as the person who actually holds the purse strings, the resource allocator, whereas a lot of the things we may be involved in, we would term input to decision. Do you have a general feel to what percentage of the decisions you would be making as opposed to having input to?

M: I would say most of my role is input to, because in the subsurface world, the only thing we really hold budget funds for is personnel. So decisions that I make are directing people to specific projects. But ultimately we'd be making recommendations for someone else to reach the ultimate decision on a capital allocation.

S: Okay. So the resource that you can control is people. Dollars will go somewhere else.

M: Yes.

S: And the final one, just to get a good feel for what we think you think decision making is, we ask the question, what do you think a good decision is?

M: A good decision is that ... I think is something that everybody's happy with.

S: So, stakeholder buy-in.

M: Yeah. That's it. That is based on a sound basis, so it's not just a gut feel of which way to go, that it actually ... you act on facts.

S: So it's logic driven?

M: Yeah. And I think also value driven, that you're trying to optimise not just value, but also HSE aspects as well.

S: Yes. So, value being not just dollars, but some ... yeah, the economists call it utility.

M: Utility, yes.

S: So just some utility. And it could be several of those come together.

M: Yes.

S: Okay. Good. Can I feedback something to you and see where that goes? Many people, for example, I got caught in a rain shower as I was coming into the office. The question that I had this morning was do I pack my brolly in my bag. They've predicted rain, but it looked nice. So, yeah, maybe they get it wrong, I'll put my brolly in the bag and I won't carry it with me, but I decided to carry it with me and I don't get wet. Is that a good decision or a bad one?

M: It's probably a good decision. I don't think you're going to get wet.

S: Okay. And we use that to talk ... try and draw out this concept of outcome versus the process that went on. Did I use all the information? And you've used a process definition of good. None of that ... now, I don't know, maybe if I kept pressing you, you'd go to outcome, but this fits the model that most good decision-makers follow and that is the process one. So I'll feed that back to you. And my process, I

think, was good because it wasn't too hard to carry the brolly. But if it was hard, I might have packed it. Okay. What we're looking at in our broader context is the concept of type of decision being governed by process. So in other words, if I've got this sort of decision, I need to use this sort of process. Now, that's a hypothesis right now. We've not proved that that's the case. But we're trying to get a feel for how people think about decisions. So if I mention the word decision type to you, do you think of decisions as being of different types or do you see them as decisions?

M: The only way I would rate them as types would be the size of the decision, the materiality of the decision. So I think that's ... if I was thinking about type, it would be materiality.

S: Okay. If I can throw some others in there to see if I can expand it. Is that the same when it comes to, for example, you said you make decisions about people. Is it the same there, that ...

M: Yeah. Where we're going to get the most bang for the buck. What's the best place to direct those resources to maximise the value.

S: The value this person brings. Okay, so it's a value materiality size driver. Okay. So therefore, just off the top of your head, do you have a process that you go through to make those sorts of decisions?

M: Let's look at it as something specific, like we're rating up a couple of fields. We've got work programmes doing all those fields and where will I allocate my most resources? Probably to the one that I think has got the highest value. Whether it's the highest reserve, or also something along with complexity. The more complex the problem, the more resources it's going to take. But mostly around value, where you think the most value's going to be gained.

S: Okay. Is that what XXXXX requires of you, or is that how you approach it personally?

M: No, I believe that's how XXXXX requires it of me.

S: Okay, and you seem comfortable that that fits with what you're doing and you don't have a problem with that?

M: No.

S: I understand that XXXXX is going through a reorganisation and that you've been around with the company for several years.

M: Yes.

S: Do you notice any change in the way decisions are made?

M: I think at the moment that decision processes ... one of my biggest criticisms of XXXXX is the way we actually go around making decisions. I think that we tend to not make decisions quick enough.

S: Okay. So time ...

M: Time is an aspect, because that generates frustration for the people who are generating the inputs, if you like, if they don't get the feedback, things tend to ramble on for a while, people get frustrated. What I'm finding at the moment, we used to have XXXXX and it used to be ... decisions used to get made by XXXXX in some sort of consensus. It's not very clear to me how they were made, but they were made. And now we're becoming very focused on a single person, our CEO. It seems to be nothing gets decided unless he gives the okay.

S: So this XXXXX was an executive committee type thing and had several people on it. Whereas now it's going to just one.

M: Yes. And I think that where you generate ... when something's been in place for a while, you generate a certain amount of comfort around it, you know how the system works and you know how to get a decision made. It's all new now. Everyone's always trying to figure out how to get the decision made. What's the right way to approach it which adds extra time to things.

S: Okay. And by saying that you need to figure it out, that says to me that there's no formal process. So the CEO hasn't said this is how I'm making the decisions and this is what you need to do.

M: Yes.

S: Okay. That then leads to frustration in the way you actually do it.

M: So we're still learning the system, if you like.

S: Yes. And that happens in most companies as change occurs. Very rarely the formal documentation normally comes just as the change begins for the next cycle.

M: Yeah. Well I think part of it's trust, it's that he's a new guy, he doesn't know any of us, he hasn't had any experience of any of us, and so his level of trust to the people that work for him isn't there yet.

S: Okay. And as that develops, you see that time may improve.

M: Hopefully.

S: Hope. I like the word. Okay. That's a good perspective. Let me feed something back to you. One of the things that I have found and I'll be calling it that, is a trust heuristic. Heuristics are rules of thumb that we use in our heads to do things quicker. And a lot of people make decisions based on simply trust. So like you said, he doesn't know everyone yet. But I don't know if you use it, but we'll use you as an

example. If you got guys coming to you with decisions to be made, if the recommendation is made by someone you trust, you very rarely will even check it, you'll just say yeah, go ahead.

M: No, that's true.

S: Whereas if you don't, you will get someone else to do it. So yeah, you're describing something like that happening as well. Okay, now, in my box of tricks here, I've got a whole series of decision scenarios. Now these ... when it came to decision type, we actually have devised a way ... well it's a taxonomy of decision making that we've devised using cognitive psychology to put it together and it draws on four main dimensions of a decision. You've actually talked about all four in the words you've used. So I'll show you that in a minute. But what I want to do is show you one that I'll draw out randomly and have you read through it and then just talk me through how you would go about making the decision, not what the answer is, and sometimes the answer would be simple. So try to avoid what the answer is, but what you would actually do. And if it is a very simple one, the answer might be I simply make a decision.

M: Okay.

S: This one is a short one. I don't know that it's simple. Number five. If you just read through that.

M: What would be your first move. Okay.

S: It's actually a scenario. What would you do? You've got word that the rig's on fire, two people have been killed, what do we do?

M: I suppose my first move would be to make sure that the company processes we have, incident management teams and emergency management teams, to make sure that the proper people are contacted and those teams are activated.

S: Okay. So the actual emergency process has ... you've got systems set up, implement the system.

M: Yes.

S: What else would be going on in your mind?

M: I'd want to try and understand what the situation is. I'd be thinking about if I heard two people's lives had been lost, how to deal with that. And again we have a system in place to deal with that, so I'd want to make sure that was getting dealt with. The status of the fire. Is it something we can control or is it burning out of control? What resources do we need to put towards addressing the situation?

S: How would you then start going about it? So here you've listed about four different things there. Obviously this is an emergency. What do you begin to do now? Say the phone call came through at 2:00 am in the morning.

M: Well yeah, we implement the teams. If I was on the XXXXX, I'm actually on our XXXXX, so we come to the office and the XXXXX is a strategic group that looks at the company's position in the incident and then the XXXXX is a group that's set up to actually coordinate activities. So they feed information to the XXXXX so the XXXXX can make strategic decisions, the XXXXX makes tactical decisions.

S: Okay. So the teams ... so XXXXX is, let me get that right, was strategic? Is that right?

M: That's right.

S: And XXXXX was tactic.

M: Yes. So the XXXXX for instance, if there's been deaths, obviously have to notify the police, the coroner, the coroner has to be notified. So that's an external activity. And they would look at things like whether there's a need to get helicopters out there, boats out there, all that sort of stuff. Where we'd be looking at ... on the XXXXX side, talking to joint venture partners, talking to government relations, and planning the next steps that the company should be taking.

S: So hand lotion, yeah.

M: As part of the XXXXX there's a relative response group that ... they would be the people who, once the people who have died have been pronounced dead by the coroner, they would hopefully go with the police to notify the next of kin.

S: Okay. So that sounds to me like it's a very formal process.

M: Yes.

S: Okay, then a very formal process. Is that process ... how do you know when that kicks in? What if, for example, two people didn't die, but a guy got his hand burnt? Is that the same process kicking in, or does something different happen?

M: I suppose we'd rely on who's the initial person informing us to ... we have a matrix of decision making ... a decision making matrix that at different levels, different teams get activated. So depending on the injury, with the XXXXX we'd get activated and then whether the potential loss to the company or number of fatalities or whatever, we're the XXXXX, we could activate it.

S: Okay. So it's more or less fit for purpose based on a matrix. That sounds very, very formal. Okay. Good. Have you ever confronted that?

M: Not in reality, but I have practiced it. We have done drills.

S: So there are drills as well?

M: They're usually once a year. You get involved in a drill where you have to work through a scenario and it's usually linked to ... we've got activity going on, like

for instance the XXXXX development drilling at the moment would have been a drill done for that, just to make sure that things are in place and then we go back and re-view what was done well and what was done poorly.

S: Okay. We might use that a bit as we go through here, 'cause you've got all the process in there. So this sounds to me like it's a very formal process.

M: Yes.

S: It's documented, you know the matrix. It's actually drilled. Is that same sort of process applied ... we've talked about this is a people situation. What if it were just dollars?

M: Yeah. The matrix dictates what teams can implement it or initiate it and it's all around either injury, dollars, effects on the environment or reputation impacts. And if ... the way it's set up is if you don't know, you assume it's the worse case and you initiate the teams.

S: The teams in that worse case.

M: And then they review, and if they think, they'll stand down. And so each person in the team has a specific role to fulfil.

S: And there are obviously tools that you would use in getting this done.

M: Yes. So we have a situation board, we'll have a contacts board. What else have we got in there? I'm just trying to think. Yeah, who's ... you have a strategic plan and the XXXXX work out what the plan has to be.

S: Who make up the teams? How is that decided?

M: It's usually just senior people within the organisation here who have specific skills. Some people are good at organising, some people are good at joint venture relations and things like that. So my role is a ... I'm a partner and planning ... it's a partner and planning role, so I look after the partners, so I talk to the partners if there's a need to keep them involved. But also keep a view on planning and help the XXXXX leader in continuing to strategically plan, going forward.

S: And how has that worked out? How did they know you're the man for that job?

M: They just asked me.

S: Okay.

M: I mean, in this role, I deal with partners, so I'm sort of an obvious choice for that.

S: I'm most impressed. Other people have shown that too. The answer is panic. So it comes across as a very controlled ... and yes, it's emotional because people are dying, but there is a controlled process that assists with decision making so that it's not off the cuff and response driven.

M: Yeah, it's interesting, when they actually had drills, it does get a bit ... 'cause typically the drills are very compressed, so you get a lot of information very quickly. So you have to respond all the time and where an actual incident will probably take a lot longer. So it's not as compressed and not as urgent. But they're certainly worth doing.

S: Yeah, it sounds like, I don't know, I'd call it fun, but it would be experience. Okay. Let's flip, then, totally from that sort of situation to say one now you're doing some development drilling obviously. I would guess that you've got a development plan that you've been asked to implement. Each of the wells is meant to target a specific zone, it's meant to be landed at a certain depth and have certain reservoir qualities and that sort of thing. If it is outside that zone, say it's come in high and say it's much better quality than the plan had, is there some sort of decision making process you go through with that?

M: Yeah. What we've done with the XXXXX development drilling, for instance, is we've got a basis for well design which basically lays out what we think the expectation is and that's what the drillers use to design the wells. And then what we put on the side of that is a contingency plan. So we've tried to prior to actually intersecting the reservoir, anticipate what the main contingencies could be. If for instance in XXXXX, it's a very thin reservoir, we've got to land horizontal wells and it's a very thin reservoir, if we miss the reservoir, what are we going to do? Are we going to pull back and try and side track or drill on and try to go up and all that sort of stuff. So we've tried to anticipate that prior to actually implementing the wells. That's the first thing we've done. So we try to get in a process so that everybody's clear on what we will do. If it was outside that, then I would say, depending on how different it was, we've got an ability here that we can stop drilling a particular well, we could suspend the well and we'd go off and probably go and do some work. And then based on that work, come up with a revised plan, getting on a level, I mean, a level of surprise.

S: So this is a feedback loop that's ongoing as the well is going down into target?

M: Yeah.

S: Good. Now, how did that come about? When you first started at XXXXX, did they have the same sort of process?

M: I wouldn't think so. I'm not sure, to tell you the truth. I think we've always done a certain level of contingency planning. And the reason that's come about is that basically the lessons that you learned from these campaigns is that if you don't do enough planning up front, you do get yourself in a twist. You can't make ... you haven't got enough time to make the right decisions. And so if you have a ... if you sit down with a group and basically what they talk about is drilling a well on paper, and look at all the different things that could impact you, what you think could impact,

you obviously can't get everything, but what you think. It then sets up the thought processes, if you like, of which routes we're going to go down, 'cause otherwise you really don't have that time to make those decisions.

S: You've made the decision in advance so when it happens, you know exactly what to do.

M: Yeah. So that you can ... you've put all the arguments behind you.

S: I like that. That works well. What sort of tools would you use to assist you in making these sorts of decisions? When we talked of the emergency, you have obviously whiteboards and that sort of thing going on. When it comes to the wells, do you have any software tools that help you or is it just a spreadsheet of saying what to do and what not to do?

M: Well, the contingency plan is just basically ... it's a document we use ... decision trees. And value of information. Which is just ...

S: So you have VoIs.

M: Similar sort of thing. It's just a decision tree twisted around. We'll have estimates of cut offs so when we've ... 'cause obviously time's money, especially on a drilling rig. So if something's going to take us x hours, then the decision would be that we wouldn't go down that path. So we'd have measure of, or value ... I'd say most of it's [inaudible] around decision trees.

S: Yeah. And obviously the input to those trees is a subjective input.

M: Yeah.

S: How many people would be involved in this sort of thing.

M: Each well has a well planning team, and the well planning team will have a leader, will have a geologist, geophysicist, resource engineer, production engineer, a drilling engineer, a couple of drilling engineers, an operations geologist. And then for Stybro because it's part of a bigger development, we have representatives from the project team, if specifically impacted. So like the operations team, 'cause they're going to inherit the well, and people who are building the sub-sea kit are involved so they are aware of the design decisions we are making and how it factors on them.

S: Okay. So with XXXXX itself, is this platform or FPSO?

M: FPSO.

S: FPSO. So that's not on site? You're drilling the wells ahead of time and then you'll link them in. So when it comes to the decision making, if say for example everyone's done a perfect job up 'til now, but we find the field is way bigger than we thought it was going to be, that our first five wells are really good wells, is there some process built in to getting a second FPSO to handle it?

M: Our process is ... around development, we develop to a scope and once we're in execution and particular with XXXXX which is an FPSO, deep water and all that sort of stuff, we really can't change the scope once implemented. But what we carry is an opportunity register which, if we identify opportunity as we go along, we put those into the opportunity register and then that would get worked as a side issue until it became a project of its own.

S: Okay. So development is to a scope and that's the approved scope that's gone through before. Everything else sits on it [inaudible].

M: And it has to be approved separately to the development.

S: Do you get external people involved at all in any of this? By that I don't necessarily just mean consultants because of lack of resources, but as other eyes, or anything like that?

M: Yeah. Again XXXXX is a good example. Each time we get to a critical decision point, we have a ... Stuart explained to you, a toll gate system where we go from concept to pre-feasibility where pre-feasibility is basically finalising the preferred concept. Feasibility is doing the final tweaking of that concept. And then we go into execution. Each one of those steps we have an external peer review. And to make sure that we are on track and we haven't missed anything. And that's generally ... mostly made up of people within the company but outside the asset team.

S: Different projects.

M: And in XXXXX, for example, we had people from our joint venture partner, which is XXXXX, come along to those peer reviews as well and provide their guidance there. And also as we're developing the field, XXXXX are providing us with information from XXXXX which is a development I just brought on line. That's how we get outside in.

S: So there is definitely an outside process.

M: We also use, where we think we lack the skills, we'll use specialist consultants.

S: Okay. That's all of the tools. Now, these feedback loops. You've talked about quite a few of them. One of the things we've found is when you ... an outcome of a decision is made up of the decision itself, but also how it's implemented and the chance, there's still chance going on which is the industry we're in. We've found that you need feedbacks at both levels. So, to cover chance, you need a feedback at the end of the entire implementation. So XXXXX was meant to deliver x number of barrels over so many years and did it? But the other one is this implementation process, because when you make a decision, part of your decision is to implement it in a certain way. Do you have any feedback on that implementation? It sounded like this well contingency was one of those.

M: Yeah. Our way of ... particularly ... I'll use the development drilling of XXXXX again, is each well we drill, we have what we call well quality index. So that the drillers and the well project team get together and they basically mark themselves on how they achieved ... did they achieve the well quality they set out to achieve? And for XXXXX for instance, for these development wells, there's been a hundred items on that well quality list, so they will measure themselves on each one of those. So that's one thing. That's the well quality. Then they'll also look at cost and time. Was there non-productive time? Could we improve the way we do things? Did we ... we look at how we did the sequence in which we did things, did that ... is that the optimal. And that will get fed back into the next well.

S: Into the next well. Oh, okay. So that it's in that feedback.

M: Yeah.

S: How do you see that as working? Do people buy into that, or do they see it as just an imposition?

M: No. People buy into it. And the reason that people buy into it is because it's part of their KPI.

S: Salary is based on it. Okay. And so that's how you've got them to buy in.

M: Yeah. And then at the end of a project, we'll do a post implementation review. Usually here after the projects first, and then very rarely look back past that.

S: Okay. So you wouldn't do one five years after, sort of thing?

M: No.

S: Well yeah, within a year, you get a good feel to whether production is what you thought it was going to be.

M: Yeah. I mean, XXXXX for instance has got KPIs on cost, on schedule, on deliver of the first off-take, how soon it can get to plateau rate, and how ... I think, how long it keeps plateau rate.

S: Okay. And so they're good parameters. So they're both yes.

M: I suppose we [inaudible] on the project side before we ever, as part of the project development, is that we integrate lessons learned from previous developments into our project scope.

S: Okay. So it's a part of that first gate that you're going through.

M: Yeah.

S: This is the only number that I'm after in this whole interview. On a zero to five, five being you're the best thing since sliced bread, zero, XXXXX has a lot to

learn, in terms of effectiveness and efficiencies, so both of that, time and value, how do you see the process that XXXXX has in its decision making?

M: Definitely not the best. Definitely not the worst. I'd probably say right in the middle, about a three.

S: About a three?

M: Yeah.

S: Okay. And if you had your ... if you could say to XXXXX, I want to do this, this and this, what sort of things would you change?

M: Probably the number of people involved in the decision.

S: The reason for number of people?

M: It's ... what we've suffered from, and this is ... part of it's this peer review process. Peer review, they have to write a report at the end of it and it goes part of ... it's a separate process which goes up through the XXXXX as opposed to the petroleum site, and any one of those people in the peer review, whether it's technical, commercial or anything like that, can basically hijack the project.

S: The whole process.

M: And my issue is that some people are more educated on the process than others, or understand the petroleum industry better than others. And that I'd have some sort of weighing in there that reflects probably the importance to the decision.

S: Weight the decision by importance. And that way it can get through or not. 'Cause you mentioned earlier, that time was an issue. You were concerned about that. And that's what this is leading to, is what you are saying.

M: Yeah.

S: Okay. But overall, you seem ... you know the processes very well. So I would say there is buy-in there. Do you find them helpful or a hindrance sometimes?

M: Both.

S: Okay, good.

M: Helpful, and sometimes a hindrance. I can provide you with examples of where I've just totally think someone's off on another planet, and times where I've actually learned something. And I think one of the areas I have learned is when we use XXXXX, have you heard about XXXXX?

S: Yes.

M: They come in and review our project and although sometimes we don't like their feedback and it's very generic and it's very industry benchmarking and all that sort of stuff, I've actually learned some things out of that, that I've taken with me to the next project.

S: One of the things that XXXXX are good at are the industry benchmarks which a lot of companies actually are unaware of. That's good. Okay. So what would you recommend that I should do in my decision making? I'm looking at type and process. Do you think I'm off on a tangent? Or do you think this is the way to go?

M: So when you say type, could you give me some clarity on what you mean by type?

S: Let me flip this over, then. On here, one of the things that we have put together is ... the question we had at the beginning was how are we going to work out type, 'cause you could say well these are people-type questions and these are dollar-type ones and all of that. But everyone would come up with something different and in all other taxonomies of decisions, that's generally what's occurred. People have just sort of said well, when I look around, these are the different types of decisions. We didn't want that, we wanted something generic. So we went to our psychology department at the university and they actually can do that, they can pull out the underlying dimensions of how people see things and we used a similarity process. So these scenarios, I've got a whole twenty of these, and we gave them to people and asked them how similar or different they were to each other. And based on that, without guiding them, so people were choosing similarities and differences based on their own perceptions, we were able to pull out these four areas. So the basic underlying dimension of a type is complexity, which you've talked about. You know, some are very simple questions up to very complex ones. Task constraints, you've talked about as well. And that's not just people, but dollars, time, all sorts of constraints go into that. Ambiguity, you have talked about, but you didn't use the same terms we use. It's when you make ... you've got all these objectives and you've got to decide which thing fits them, you're going to be weighting each of them. If you've got more than just one or two, we've found that actually gets ambiguous. I'm not sure whether the personal side is more important than the dollar side and how do I weight that. Well that's this ambiguity increasing. The other one is the actual environment in which the decision is made. By that it's have I ever made this decision before? So that if it's one that I make daily and I keep making it, it's fairly easy to make. Whereas if I've never done it before, it's a very different type of decision. So it's a subjective measure of each of those. So for example the decision you had on the front, we saw that as very complex, had lots of constraints against it, very ambiguous, you've got money going down the tube as well as lives, and then it's highly dependent in that we hoped that people have practiced this. So you guys actually implemented that where it comes to this sort of decision, we've learned how to do it. So that's what we mean by type. So you could have ... some people in the industry have exploration type, development type, production type. And it tends to be that way, you know. Our probabilistic is being used in exploration but not so much in development and hardly ever in production and the economists don't even touch it, sort of thing. Whereas we're arguing that it's the type of decision that governs the process that you should be looking at. And so what I've been interviewing you for is to get a feel for, and what I read is XXXXX's

processes for different types of decisions. And you've given quite a few examples. So what I'm going to do as a result of this is go away, look at some of the things you've talked about and type those up and say right, well XXXXX is using this sort of process and XXXXX reckons that's worked out fairly well. Because what I want to come up with at the end is when you're confronted with this type of decision, here's a process that others have seen that works.

M: Okay.

S: And so that's what I mean. And one of the things that I leave people on is, is this the same when it comes to your personal life? Now I don't want to ask any personal life questions, but do you see ... in other words, are you a different person at work than you are at home?

M: I don't think so.

S: So that when you're confronted with decisions about kids and family and the car and the house, you would go through similar processes?

M: Yeah. I'd say I'm a very value-driven person. And value in a broader sense, not the money sense. What's the best good.

S: Yes. Very good economic description. Okay. And the reason I ask you that right at the end is because that gives me a feel for whether we actually have to recommend ways to get people to buy in, because if you're not like this normally, it's going to be very difficult. For example, I've come across one company that I interviewed about four or five of the senior people like I'm doing here. They are experiencing change with new management, and some of the people are having great difficulty with the way the new manager is doing things and he's doing them the way he would make decisions in his home, but they think it should be different in the office. And that's creating tension. But I want to get that tension out so that the process that's recommended is a natural way of doing it because there are so many biases involved. But I was unaware that there's a whole industry in what's called behavioural economics. In the finance industry, they use it all the time, that we make decisions and based on all these cognitive biases that we're involved in. And I see myself doing it now that I'm aware of them. But getting things that overcome that are group work which is what you obviously use a lot of within the corporation, so that helps balance it out, external which you've brought in, so that helps balance that out as well, and making the best ... the one thing that's been said over and over about decision making is the best decision makers are the ones who make lots of them. The question is, do they have to be the same type of decision or can there be lots of different ... the other one is experience, you know, is it all within one experience stream or is it broad? And they're the things we're trying to tease out.

M: I suppose the other thing I've noticed in my career is that you might have a group talking about a decision, but you still need one person to make the decision.

S: Otherwise it just gets talked about. That's right.

M: And you can just vacillate.

S: And do you find that there's a certain type of person who actually does make a decision?

M: Yes.

S: Okay. That's great. That's all I'm after, XXXXX, unless there's anything else you want to share back for us? Because I'm after everyone's opinion.

M: No. I'm interested in finding out how it all ends up. That's for sure.

S: Oh, yes. You definitely will. We'll be coming back to each of the individual companies and feeding back exactly what we've found out. So yeah, you'll be invited to that because you've donated some good time. So that's where we're at. And it was all recorded. That's good. I don't have a contin ...

End of recording

***Interviewee: Participant N (N)**

***Interviewer: Steve Mackie (S)**

S: Is it working? Yes it is, okay can leave that go now. So what I'm trying to look at is that concept of decision type versus process. Now you've seen the presentation so you've got a bit of a feel but when you first hear the word decision type what do you begin thinking of?

N: I guess I think of whether it's to do with or the how big the decision is, whether it is spending money or whether it's more on say a work plan like a schedule sort of thing.

S: Okay so you see it as different types, is that what you're saying?

N: Yeah.

S: Okay and it's based on the size, is that?

N: It can be, I guess you know different decisions on whether you want to drill a well or whether you want to do an additional logging run in a well. It is the magnitude of the cost.

S: How would you define the decision maker? So who's the person who makes the decision?

N: Again it depends on the scale of the decision, for example the decisions in our team which is Sub-surface Development Team, is made by the engineer or the geologist on whether they should do this study or whether we need to drill an appraisal well. As a team leader, which is my position, I would review it and see whether I'm on board with that decision or not.

S: Okay and so the work you do in reviewing it and then making a decision, what percentage of your time would be in making that, no not time, of these decisions are you making decisions on what percentage are you passing on to some other decision?

N: I'd estimate it at probably about 50/50.

S: Okay so about 50% you're making the decision?

N: Depends on the complexity of the decision.

S: Okay.

N: I think if it's a decision where it only requires say myself or an engineer to make a fairly simple decision, then get on with it. Then we spend more time pushing that decision further on if it requires other parties have to support it, example like a drilling department or the subsea installation team .

S: Okay, and that brings more people in.

N: Yes, more points of view or people have to go away and do some work, that can take some time.

S: One of the questions I asked in my presentation is what makes a good decision?

N: Well that's an interesting one, I haven't thought too much about it, I guess to my mind a good decision is when you take people's views on board and make a well balanced decision. Perhaps everyone may not agree with the decision, but at least it's a decision based on input from those that need to be involved.

S: Okay. And is that?

N: And there is people that have their say - that shouldn't be involved. You'll always get those.

S: Okay, that's how you do it at the office, would you do the same at home?

N: No, I probably wouldn't. I get pushed around more at home.

S: Oh, you have a group of people that have input in you just don't have the final say.

N: Yes.

S: But the reason I'm asking that is the other guys I've interviewed here at XXXXX make it plainly obvious that the company has a very prescribed decision making process that you're all going through.

N: Yes, in terms of the projects there is a defined progression plan or process to go through both in bigger projects and also in drilling wells.

S: What about, what I haven't talked to them about is the day-to-day type of operations type decisions, is there a process defined for those or is that more or less left to you?

N: Well I'm not working in an operations role and therefore don't get involved in those type of day-to-day decisions. I guess the decisions that I do get involved with are like people's work plan or studies, you know what they should be working on, what their deadlines should be, focusing their day-to-day studies. If we are involved in a drilling program, I have been involved in the past of what wells we should drill and then decisions made on those operations.

S: Is there a prescribed process to go through with your work schedules for example?

N: In terms of defining the teams work schedule, there isn't a prescribed method , everyone does it differently.

S: Okay.

N: The process that I usually do is complete it individually at first and then discuss with each individual – modify, then get the team together to co-ordinate all the work.

S: Okay, so it's a personal one and then a consensus one.

N: Yes, There's a lot of things that I don't know, so I would ask an engineer what work needs to be done and when it needs finished, is it going to feed into you, how long is that going to take, they work all that out and then go around to the rest of the team and put it together and get it together as a group and make sure it's all integrated and take it up to the next level to make sure it's integrated into the bigger project plan.

S: Okay, so the integration word is used a lot with all the work I've been doing here.

N: But sometimes the actual milestones are defined by the project manager. I want all the work done by such and such. So it's a bit of a circular thing.

S: Yeah, that's good.

N: Sometimes you have to push back and say well look it's not going to be finished for three months later so bad luck.

S: I can do it in two weeks but you won't get the answer, three months, okay. Have in your roles within XXXXX obviously team leader now, background is engineering of some kind ?

N: Geology.

S: Geology, geoscience okay. Was are there any other experiences of decision-making that you've been involved in that would have been different. So you've done it a different way.

N: Besides team leader Other things that I've been involved in is in drilling operations, as a well project leader for a drilling campaign, it has a slightly different decision process.

S: What sort of process would you have gone through for that?

N: Well the way that we do it is we put together as a well project group a basis of design and that's all agreed by everybody and then as we go and progress through to drilling the well, if there's any changes to that basis of design which defines exactly the drilling plans, if any changes then the well project leader would confer with team

members who needs to get involved to make a decision, as an example to side track the well.

S: So they're sort of responsive type decisions?

N: Yes, if the people on that team agree that a change be done, if it's outside the basis of design then that then it gets progressed to get approval internal – managers and JV partners. It is well defined process, and it seems to work pretty well in our company.

S: And has all your career been at XXXXX?

N: Pretty much, I've had a couple of years with XXXXX as soon as I graduated but since then, I've been with XXXXX about ...

S: Good career? Okay so the reason I ask that is, is there a comparison, you know do others do it similarly or differently?

N: I think we've evolved with decision making over time.

S: Okay, so even within XXXXX it's different to from ...

N: from previous times. Oh certainly, certainly in terms of who makes decisions.

S: How's that evolution, what do you think is driving that, have you thought about that at all?

N: I think it's more to there has been a number of changes in terms of moving the responsibility of the decision up to higher levels.

S: Okay.

N: Yes.

S: Rather than coming down, which you hear a lot of people talk about, finding it's going the other way.

N: And different sort of reactions to external influences on oil price and cost of rigs. In my mind when we do a lot of analysis on exploration prospects there's more emotive decisions made, for instance, decision to sack a number of people and stop exploration in Western Australia.. That might be a good economical decision but it's certainly not one that a lot of internal people would support. Alternatively, one could just spend another \$10million drilling two more wells and then maybe things would turn around. So in the industry there's certainly a lot of emotional decisions rather than rational decisions.

S: Well that actually is one of the biases, I only showed a slide that listed all these biases but ...

N: I think that's the biggest one. The biggest one that I've seen.

S: Yeah.

N: In terms of you know like portfolio analysis and risk analysis where you should drill or not drill a well, in the past our company and other companies off shore have been driven by the fact that they've got a rig at a certain point in time so whether a prospect is good or not, they have to drill it and whether you've have budget or not has a big influence on whether a well's drilled.

S: That's exactly right. I've got a series of decision scenarios that I've collected over the years and what I'm asking people, the reason I'm bringing it in now is one of them is exactly that. Was you know you've got a rig coming you haven't finished your analysis on prospect do you drill? So I won't give you that one.

N: Or should we drill another appraisal while we've got a drilling slot and you know and it's cheap, so okay we'll drill one more well.

S: That's it, yes to rig driven. What I want to do with these, this is a box of tricks I call it, these are a whole series of difference scenarios and what I'm giving to each person is a different scenario, I don't want you to tell me what decision you make but rather sort of sit back for a minute and think about how you would make the decision.

N: In terms of how the decision is made in this company at this point in time?

S: I'm more interested in you, how you would do it, and then just talk me through how you would go about it. Does that make sense? So in making the decision how is the decision made and then how would that be implemented? So two phases, does that make sense?

N: Yes.

S: Okay so that my record knows which one I'm giving you, it's number seven.

N: So the question is how would we go about deciding which prospects to drill? And when and how should they rank?

S: Yes, so there's all kinds of things going to spin off that, so yeah you've been exploring for many years, you've got a whole big mix of different prospects there, tell me how you'd go about deciding which to drill and when and ...

N: Given that there's a number of prospects to drill it becomes a technical strategy. And sort of getting into the details of the sort of medium-term and long-term strategy and it might be which prospects are going to unlock other prospects, looking at dependencies.

S: Yeah, so you've got, first step you would take I'm just repeating this back so I can clearly understand, is either have a strategy or develop a strategy, having done that then?

N: If there has been, I assumed there hasn't been one defined.

S: So now that you've got one, let me ask the next question, how would you got about that first? Is that something you'd just come up with or what would you do?

N: Well in terms of my position if I was working in the exploration team it would be a discussion that you'd have with the technical people, the team leaders and the exploration manager. In of getting an agreement of what the strategy is, is mainly with the exploration manager, long-term view, get an understanding of what budget that we've got and that will be the key to understanding what the medium to long-term program could look like.

S: Okay, so now we've got a strategy, what do you now begin to do?

N: Assuming that strategy has comes with a budget and you look at some of the key play types that are going to unlock the success for probably the ones that are the easier ones first and the ones that could unlock future potential, and be a balance of high risk and low risk prospects.

S: Okay, is there any tools or processes that you would use or?

N: We usually use some sort of risking tool or some sort of portfolio management, you know based on risk and economics etc.

S: So you would have those available and find them?

N: Yes.

S: Okay good that's great, that's all I was after, so yeah I've tried although they're randomly pulled I've tried to pull them from areas that you're not doing day to day so that I'm not catching you saying oh yeah this is yesterday and this is how it goes.

N: Okay, I haven't got involved in any of that.

S: And the reason I'm doing that is I'm trying to get a feel for how people actually think about going about making decisions and no, that's good. Okay, now so we've talked about process and we've talked about different decision types and we've now used those a bit, in all of this decision making that goes on do you consider yourself firstly and then XXXXX secondly, good or bad at it?

N: I think as far as the decision process, I think is very good at low levels, But not very good at higher levels.

S: Okay, when you say higher levels you mean within the hierarchy or the size of the decision?

N: Both, more likely the level the higher decisions have to be made usually aren't made very quickly.

S: Okay so time is an issue, and why do you see that as a concern?

N: I guess it's just an opportunity loss and frustration I guess.

S: Okay so there's frustration on people's side and there could be an opportunity cost involved, if I did it today I could be making money tomorrow.

N: Yes or moving forward quicker, giving ourselves more time on executing the program, rather than rushing the planning because we are waiting to get the nod to move forward.

S: Okay good. And when there's frustration, is that because you're unsure as to why it's taking so long, you know in other words if the senior management were to say to you well look this is going to take me two years to work this one through because of this, this and this, do you think that that would overcome it or is it more deeply entrenched than that?

N: I don't understand why but I think part of it is the fact that people don't understand why it does take such a long time, could be valid reasons why they need to engage other people or whatever, but that's never fed back to you, at higher levels it becomes difficult to feed back why things are taking so long. But that's only part of it I think people in upper management - some individuals are good decision makers and some are very poor decision makers, and you know I've dealt with both and yes the poor decision makers are very frustrating.

S: And by poor you mean they won't make it?

N: They won't make a decision. I had a discussion the other day with one of my colleagues about this and I was saying that it's strange because some people on a personal level really struggle to make decisions on day to day things - the classic procrastinators, but they might be good at making decisions in business and you get some people that are the other way round. We have got people in our company that take forever or don't like making decisions until it's forced upon them.

S: I think most companies are the same there. And that was why I actually asked you the question about whether you'd do the same thing at home as you would do at work because I'm trying to draw out whether good decision makers are the one's who it's just natural you know I do it no matter what I'm involved in or is there someone here at work that as you call it forced to make the decision so therefore they make it.

N: I find it easy to make a decision when I'm not spending my own money. Very quick but when it comes to buying something I can take ages like a camera or something I can spend a month or two thinking about which camera to buy.

S: That maybe is what's going on in senior management.

N: But whether to spend a million dollars to side track a well I can make that decision quickly. To me the choices are simple - yes or no decisions.

S: Interesting isn't it. That's actually one of the reasons I got involved, my background is geoscience, so geophysicist geologist whatever you want to call me from way back, involved in portfolio and risk management for many years and the same sort of thing, the frustration at working up a portfolio and having management say oh well we'll think about that thank you very much, and then doing something different and it's the psychology of why that occurs that has got to be going down this path. And I think there are several things I can't cover in each project but I would love to have a look at personality whether that also there is, this is just solely looking at cognitive biases, so the ability of the brain to actually function but there are also motivational bias, the way you are rewarded with your salary may influence the way you make decisions that could be detrimental to the company you know.

N: I think it's quite big motivational or emotive biases in making decisions in our industry. One of the things in the exploration game is people most often are wrong, so that's one aspect of it. The other problem is that the way we do things, as an example a team of a geologist and geophysicist work a year on an area and define a series of prospects, now at the end of that year there's a lot of emotion attached to the fact that they would like to see their work finished and drill a well. So without emotion and they looked at these prospects in the cold light of day and think - no chance at all of discovery, 5% chance at best. But you know they're not going to say that, they want to see one of their prospects drilled, for closure on their work, so they might say 30% chance, or what does it need to be, how big does it need to be?

It was interesting that at the AAPG presentation by Total about how they have done on the risking and exploration. I was looking at a graph in their presentation, and I was interested to note that all their prospects - there was not one prospect under 100million barrels in size. And they all run along the line, I said that's interesting it must be a company threshold. - but honestly, very unrealistic. We saw from XXXXX that all their prospects in the XXXXX were over of 30% chance of success, all of them not one presented to us were below this - that way their hurdle.

S: Very good observation.

N: So there's a lot of emotion put in the technical work and you know people like to see their work pay off or tested I guess. They put a lot of work into it and they say well yes how big can I make this so it will be tested. I need closure.

S: One of the things at the University we have three areas, we've got geoscience, engineering and management so we cover all three and I'm working in the management. The thing that we try to teach the kids by third year, so we've given them time to start but by third year we're trying to teach them that the oil and gas industry is a business its not academic. You know if it isn't the size or the value that the company needs all of your hard work and effort as a scientist will not be rewarded [inaudible] will be and we're trying to get the students ready for that as they go out there. I don't think we ever will because I've experienced it.

N: You know it's hard for some people to work a year on a acreage to then say we shouldn't bid for this or we drill a well. Some people like to see their work come to something, they are optimists, opportunists.

S: That's right, have you ever found that?

N: It's rare. And but it's easy to go and look at other people's acreage and say it's terrible and no chance of finding anything.

S: Because one in 10 is the success.

N: And the other thing is it is always the fight for money, you've got a short budget and you say well if that team drills three wells then I means I get nothing so there's a bit of that going on.

S: Okay, well that's all I actually wanted to cover. So I've gone through it and you've given some good answers there that I can now have a look at and see how that all hangs together. I really appreciate your time.

N: Good luck.

S: And as feedback we will be coming back to you, I can't remember which one's stop on here.

End of recording

***Interviewee: Participant O (O)**

***Interviewer: Steve Mackie (S)**

S: So let's start with decision making, for you XXXXX, what do you think it is when you hear people talk about it? What images do you have?

O: At a fundamental level, it's being faced with circumstance, that requires an input, that, a circumstance where the status quo is not possible and there are a number of different alternatives and it's basically weighing up the pros and cons of the various alternatives, all the different factors, that vary from environmental factors and technical factors and the impact that it might have, the impact the various alternatives might have on your circumstance and just choosing one that you believe will then, may not necessarily be the one that in the first instance may be the most obvious, it may not be the one that gives you the best outcome, the very next step, but may be the one that gives you the best outcome to move you in a direction that you actually have laid out for yourself.

S: Not necessarily when that particular [inaudible] but it will go towards making the whole [inaudible].

O: Yeah, exactly.

S: Okay, and you ...

O: That was surprisingly painless.

S: You got through the first question.

O: [inaudible] thank you [inaudible]. Are we done yet?

S: So, what sort of decisions do you think you have, that you make as opposed to ones that you may have input into?

O: As a CEO, it's really interesting, the decisions that are the most impactful are the ones that are made without necessarily all the data. They're the ones that involve either creating or taking a vision, either creating a vision or taking a vision and outlining a strategy to achieve that vision, so there's limited data and there's limited feedback, they're probably the ones that are the most challenging and probably the ones that require the most input from me. Having said that, the decisions that, so if you want to call it the slow loop decision-making, or the stuff that's got long delays in feedback, long to maybe even no feedback, okay?

S: Yeah, yeah.

O: What I find I need particularly, this is just, this is one of my personality traits. What I find I need to do though is I need to come back into the fast loop or the tactical decision making where I can at least get myself grounded again and in some respects the only reason I do that is because I actually just test my, I test my decision making, I

test my judgment on the fast loop, the stuff where I do get feedback, and then get the confidence back to test the slow loop again, where you, you're just not getting feedback, or you're getting very, very scarce feedback at all.

S: So, I'll skip ahead a bit because you've led into something there, the idea that this fast loop, slow loop, tactical, strategy, whichever words you want to use, you get your judgement level up by doing, keeping undoing. The one thing that, the one positive thing out of all decision making research is the best decision makers are the ones who do lots of it.

O: Yes, that's interesting, yes.

S: And so, you're saying that same sort of thing, but from my [inaudible], I'm sort of saying, well this, the way you make decisions in the fast loop, should, I'm saying should, [inaudible] question whether that's right, should be different from the way you do it in the slow loop, so therefore are you getting that judgment benchmarked?

O: Yeah, it's, exactly, it's very hard to do, but in some respects, you challenge that view by, when you're in the slow, when you're in the slow loop, if you're talking about, let's just say growth, in an organizational sense, what you are imagining, what you are trying to do is you are trying to imagine in a slow loop, you're trying to imagine the absorption or acquisition or move to bring in fast loop assets into your [inaudible] portfolio, so what you're trying to do is you're trying to picture the dynamic of adding fast loop processes to your current fast loop group, so you, so in some respects, you've got to get, the judgment is different, the judgements you make are different but fundamentally they have to still be grounded in fast loop because ultimately when you've made, when you've brought this, when you've brought a decision forward, or made an acquisition or made an addition to your portfolio, it just becomes a fast loop process.

S: That's right.

O: So you've got to picture it.

S: Yes. And it's got to give you the return 'cause that's the, your objective in making that decision. Yeah, [inaudible] that return in.

O: Absolutely. What I'm finding too and this is sort of where, I am actually using many of the similar decision making tools, or if you want, don't want to call them tools, you might want to call them the cognitive biases, I'm using a lot of the biases, I'm using a lot of the same in the two loops, now what I mean by that, I place an extremely high value on the personal team dynamic, personal interaction, interpersonal interaction, personal human capacity, intellectual capacity, at the personal level, so it's intellectual capacity at the personal level, it's the team, it's the narrow focus team, we're talking about the internal team, the team dynamics in the internal team and then we're talking about the extended team, which is the people that you associate with, that you're in a business relationship with and then you move that forward to people that you intend to have a relationship with so although it may sound strange, there are, what influences my decision making is that if I'm moving into a circumstance where

technically everything is sound, but the kind of individuals that I might need to interact with, if they don't fit my view of the dynamic that I'm trying, in other words the dynamic that will actually get things done, I'll use that bias, I'll use that as a very heavy negative bias to not doing it, to not doing it.

S: Yeah, so even if the numbers tell you, this is the way to go, if there is some other thing, in your case, specifically personal relationship, then it won't go ahead.

O: Yeah, if I can't, if I can't create a level of trust, which will then, I'll be able to anchor and build on, in other words develop the numbers, you know, realize the numbers that are there, and in some respects it's actually the foundation, if the foundation's weak, then there's got to be a risk described to the analysis and then you just add that to the risks that you might put on a decision.

S: That's a good way of looking at it.

O: So that is very, that drives me a lot, that drives me a lot. In building this team that we've built, I've spent a lot of time, yes, intellectual capacity is important and there is a, the team here has a very high intellectual capacity overall, but coupled with that, equally important to that is the team dynamic, human interaction. What we'll find here is that in terms of the work environment that has developed here and the culture that's developed here, I don't think I've ever actually been in an environment that has actually been, ever been an environment that has had such a, that has developed such a harmonious culture, but not a harmonious, comfortable, well let's just sort of slide, it's well we have to achieve and we have to set ambitious goals for ourselves but it's bringing that team focus to the challenges that are there, I've never experienced anything quite like what we have here.

S: Well, that's good.

O: Which is making it a lot of fun.

S: Yeah, well that, [inaudible] the word, a lot of people are using that word too, [inaudible] it's got to be fun to work and the fun, it relates to the culture, [inaudible].

O: Exactly, and that's why then there's a lot of the, in terms of the cultural risk; that's probably one element that's very significant to me, let me just give you a specific example actually, the XXXXX, we thought up until recently, the XXXXX proposal, we thought that we could go it alone, now we came over some hurdles that were very difficult for us to cross. We had set up a very strong relationship with an organization that we trusted and [inaudible] trust, but what we found is that rather than set up a normal contractual framework, the original concept was too limiting and we had some financial constraints and some constraints around our ability to influence decision makers in government and other areas, and so what we then did, is we said, look we think fundamentally the project is a good idea but there are a number of other opportunities [inaudible] you know, you might call it scope creep but it was is that the other opportunities were becoming so compelling and then it became a project that was, you know, we were having to make changes to the scope of the project to overcome impediments that we were facing and then when we were developing the scope,

it just seemed quite natural to suggest, well hold on, this is a bigger business and so now what we're doing, we're actually, the company that we were associated with that we were going to have a strong relationship, but commercially based relationship with, we've decided to say, well how about you [inaudible] you really want to establish another vehicle and expand the scope of the business and do it from an ownership, a co-ownership structure, so these are things, and we wouldn't do it unless we had the absolute faith in the individuals across the chain of influence and technical capacity that we had so we said, let's marry that capacity because they're the skills that are required and the technical capacity that are required [inaudible] to make a success of the business and then marry those skills to the proposal and just tailor that proposal that way, so that's where there has been a marriage of capacity versus the ability to work together in an environment where there is the technical risk, the economic risk, the political risks and most importantly trust.

S: Yeah, so it's a very complex environment.

O: Well ...

S: Not really.

O: It's life.

S: Yes that's, [inaudible] that's true.

O: It's life, it's just, and if you say, yes it's a very complex environment, well yes so is crossing the road.

S: Yeah, okay. Okay, from the other end of it, this concept of what is good, I mentioned what's a good decision, one where the outcome is good or one where the process is good, so do you have in your mind how you judge that?

O: Yeah, that's really [inaudible]. Look, I fundamentally believe that a good decision is one where the process is good. Having said that, that's sort of, it's pissed me off that in a couple of areas where I've thought decisions were bad, I'll just give you a couple of examples. I thought the [inaudible] decision to invest in [inaudible] was a poor decision. I just saw massive risk, they had massive technical risk, they had an absolute massive bloody commercial commitment, things like oil price risk. The energy markets, had run too far. I didn't believe that was founded on anything. So in my view, there was too much that was problematic about it. Then I looked at the fact they've got a single, effectively a single asset, that execution risk, timing risk and all that kind of stuff, the [inaudible] exposure was huge.

Then at the very end of the process, well okay, they've got a single asset, they've got to make five million barrels a year, well now reserves replacement's an issue. Okay, let me look at the portfolio. You're going to make five million, where are they going to get the five to ten million they need in a year out of their portfolio to replace that, so I was just thinking fundamentally that that decision in itself was too big a step. Okay, well if you look at history now, the outcome of that decision is unquestionably, using an outcome framework, that decision was a first class decision.

I'm a believer in the process, now what my view of the process, is go back to one of XXXXX's fundamental beliefs from an exploration, evaluation perspective [inaudible] perspective and other things that he drove into [inaudible] almost from the very first day he arrived, he was looking for consistency, he was looking for consistency of evaluation in the process, looking to challenge the consistency by the [inaudible] that's very positive and he was looking to try and eliminate some of the biases okay. I believe in that, I really believe in that and that was one of the things that then convinced me the process was very solid, there was very tangible benefits, managing really known and unknowable risks, you just, as long as you manage to consistently [inaudible] at least you would have a consistent framework to evaluate like [inaudible].

I believe in that and I believe in good, in a good business sort of flow from that and I've, we've spent the last probably six months or so just working really hard on our portfolio, which is when I first joined three and a half years ago, our portfolio was very deterministically based.

Fundamentally people knew intuitively that, you know, certain areas were better than others, then they basically set about working them out and just delivering prospects but the prospects were not linked and certainly not economically evaluated so we've done a lot of work there. We recently completed a portfolio analysis, so I'm actually very comfortable that we've got a very, at least at a strong working level and I'm not saying it's perfect, but a strong working level, I'm very comfortable that we know what's possible out of our portfolio, because it's been, because we've been able to, we've got enough history now, we've been able to compare it to and we've got consistent framework we think we have an idea of what we would be able to achieve, out of the current portfolio.

That's one area of process, the other area of process is logistics. I am a fundamental believer that everything we do and I take this through life, everything we do in any environment is we manage logistics. Logistics is totally process oriented. So we've spent a lot of time modelling, in fact I started doing [inaudible] we were having a lot of trouble with the process and there was a lot of, in fact [inaudible] was a classic, [inaudible] was a wonderful fire fighting organization alright. Why is that? Is that because they know how to work in a crisis and work together, they've got talented individuals but when you remove the crisis, there is no strong process that underlies everything they do, so they're lost. What we've done is we've spent a lot of time on the process and the logistics of everything we do, right from mapping and getting all the approvals so that we minimize the amount of perturbation in our system because the perturbation causes angst and increases pressure, leads to potentially sub-optimal decision making because you're under pressure. When you're rushed it actually requires an inordinate amount of effort to then move beyond the bottleneck that has been created and so when I look at a decision, [inaudible] way we've come up with a decision, if we have got breakdowns in the chain at the tactical project delivery base, then it takes us more time and more effort to deliver that and we have less capacity to deliver.

In other words, we deliver less projects and they take more effort or more cost or whatever you, by whatever measure you want to deliver and here for an organization like ours, because we've outsourced a lot of our tactical staff, if that's not working properly then the time that we spend focusing on tactical or [inaudible] problems means that we're actually stealing time that we should be spending on ...

S: [inaudible].

O: [inaudible], yeah.

S: No, that's a good way of thinking, and so you, that's, I can see why you're process driven 'cause that's what logistics is, it's very [inaudible].

O: [inaudible] in logistics, and right through to the beginning, right through to the concept stage, in fact if you look at where XXXXX was coming from, from a portfolio stage, I have either gone naturally to where he's gone or gone in further and just, like if we've got a series, we start like normal people start, which is you know, we're going to make this much, we want reserves, replacement, okay, let's go and build the portfolio, okay, and so therefore we have to deliver this many prospects, etc, and so how are we going to deliver this many prospects in this time frame so we then go back, so from the outcome, we go back to the beginning, which means that we have to choose opportunities that literally have to be material or mapping has to start so we actually put the entire process around the [inaudible] scientific function so what we're doing is we're not saying that creativity is bad, 'cause that's generally non-process oriented, but what we're saying is that there is a time for creativity and if the creativity can't deliver you an acceptable outcome at this particular time, you either take what you've got if it's acceptable, or you ditch it and bring something else.

S: [inaudible] because time is part of the decision, yes. So looking at perhaps one decision, can you think of one that you'd be comfortable talking about just how, what process you went through. You just described a very good process there of getting prospects into a portfolio and I would assume and this assumption that I'm trying to find out is true, you do the same for even acquisition of other groups of people, that sort of thing?

O: Yes. All of our growth up until now has effectively been organic. The only commercial deals we've done up to now, have really involved obviously the commercial agreements [inaudible] had in place [inaudible] with bankers and stuff, that's not quite what we're talking about, has been people farming in, [inaudible] in terms of the process of acquisitions, we are setting that process up, the board has decided that we are going to be looking for acquisitions and we are trying now to put a process in place for that, that will address those very issues.

We're looking at some very high level screening tools so that we can, well what do we do. One of the first things that we did is we built an integrated activity based model of our business. I can describe this is the tactical and strategic because they run into each other.

When I came here the work flows weren't mapped out, they were in people's heads and what was happening was that it was just taking a lot of effort just to try and keep on top of things. In fact you could never tell ahead of time where the next surprise was going to be so what we then did is at the project delivery end is we started mapping out, we mapped out the work flows and the key milestones versus just what milestones happened and the ones that were causing the most pain.

We built a model and effectively the model was just something very simple. It was MS project based, a model of a generic project that had all the key elements. We built an entire program based on similar projects that interacted with similar resources.

We were then able to come out with a series of actions that had to work together to bring a series of resources in and out of various locations, I did that at XXXXX and I found it very successful. I brought that here to try and get the process around it so, and what I found at XXXXX and we've done a bit of it here, but XXXXX was a lot more complex, number of projects and the amount of interaction of the resources.

What the model allowed us to do over there and allows us to do here is if you link the outcomes to the inputs and by outcomes, I [inaudible] mean production. Production versus capital to get that production, you can then, when you have an upset, when you come up with a piece of feedback that is not what you expected and you then make the judgment to withdraw that element or that project from the process and say, now we can't proceed because the outcome won't be what we want, then what you're doing is you're putting a perturbation in the system and so what we were allowed to do, because we modelled it, and this was, as I said it was most effectively used at XXXXX, as soon as we put the perturbation in, when we were doing things by hand, as soon as we put a perturbation in, it was, all hell broke loose. The system was so complex it was almost impossible to intuit the decisions required to get back on track.

So what would happen is we'd drop deadlines like they were going out of fashion. That's how it was manifested, we couldn't meet any deadlines, not even the required ones and so what we then did is we basically remodelled the whole system and got a solution that obeyed the hierarchy of key elements, what we determined was important, at the time we determined that running a [inaudible] efficiently because it was such a big cash burner was most important to us and so it was an efficient use of resources, so we remodelled it with the perturbation, job right!

The system and the process was just fantastic and we just kept on going. Now, [inaudible] translate that here, so I've done the same thing here for very much the same reason.

What we then chose to do, as in a small company, cash flow is very important; we needed to understand our expenditures so we set about modelling cashflow. In modelling our circumstance and what we then found is we were able to get friendly with the bank so we were able to out our very innovative funding system in place that was related to our reserves and our production so what then happened, so what we could borrow was flexible. As the business changed then our capacity to fund changes. What then became obvious is that we needed to put in a more robust accounting sys-

tem, we needed to marry our financial [inaudible] to the accounting system so we knew that the starting point was right, then we could project forward

We are now able to model scenarios. In fact we've got a couple of scenarios now, we've got a low [inaudible] production case, married it with a bank facility so that we know that we've got cash that we require to put the biggest program in place so we actually put, so we run very much closer to the edge 'cause we've got a higher fidelity model so that influences the decisions that we make in terms of the size of program, if we want to extend ourselves to achieve some of our, reserve our goals or put all the money aside for other things like our XXXXX business because we've [inaudible] it all.

We now have a model that effectively models financial outcomes, I mean, by financial outcomes I'm talking full balance sheets, full cash flows, full set of financial [inaudible] full set of [inaudible], so we've done it a couple of times now, we've married [inaudible] the understanding we have at our business 'cause we know what our business is, we know the value of our business right to the asset level, we actually now know the value of our business from a portfolio level, right, so we know what our portfolio's capable of delivering, we're actually sharpening that up now to make sure that it's, that we can deliver, that we can put in place targets that are visible for people to work towards so we know what our business is going, we know what our business, we know what our portfolio's capable of because we've got a financial model, we now have, we've got a full set of financials that spit out as a result of it, what we can then do is we can take the balance sheet of another organization that we won't target, pop it, superimpose it into the model, superimpose the production forecast that we might [inaudible] and look at the financial outcome, for the [inaudible] organization, so we've just got that, we've just completed that capability.

S: So you've built that obviously yourselves?

O: Well funny you should say that, the reason we've built it 'cause we said it was important but we were pushing the bank, the bank said, well we [inaudible] lend you money because it's unsecured, yeah, but we need to model the business a bit, so the bank actually built the very first model that we put together, which then delivered [inaudible] and projected performance on [inaudible] and so we took that and we said, well gee this is a good thing and then we said, well now we want to increase the size of our facility 'cause we're a bigger company and said well this spreadsheet based model's not good enough so we actually then got an expert modelling crowd to come in under the bank's auspices, we built together a fully integrated funding and financial model that links with [inaudible] so we've got full end to end capability that was driven in virtue of the fact that we didn't want to go to the market for funding all the time, we wanted to maximize the use of internally generated funding so we could keep the [inaudible] instruction time and as a result of that [inaudible] we now have a full [inaudible] modelling capability that we've almost got, we've got to do more work on the portfolio 'cause we're going to use a few more of the rose tools than we are using but we will actually now be able to drag most of that stuff into at least a decent fidelity to give us some support to make decent decisions so modelling is a very important part.

S: ... and it's because when you've mentioned [inaudible], that is ground up, you've built that from the ground up, you're not inputting numbers half way.

O: Oh no ...

O: Well we are actually [inaudible] I mean it ...

S: Oh yeah, absolutely.

O: [inaudible] logistics right, so yeah that's an average, that's an average outcome, I think we've assumed here three discoveries a year out of our portfolio, an average size but it's been built from the ground up. So we haven't gone into things like efficient frontiers or, we're not there yet, we don't have that level of maturity on our portfolio but at least we have, we have a level of maturity where we are not making, we know we're not making bad decisions, we may not be making quite the best decisions, but we're not making, knowingly bad ones.

S: That's excellent. So and the way you've described it, I'm just trying to see whether most of your decisions then would be governed out of that process at your level, the decisions that you're making are governed [inaudible].

O: They will be [inaudible] because I have fidelity in the process so if I can't actually see a value outcome that will heavily influence me. If we have a line ball outcome, then I'll come in and rest on, I'll come in and pick up on the other issues, which are things like, I mean, well I have to work with people that [inaudible] me off, then we can get into ...

S: Yes, well that's the next question, having such a great model, if the model says the number is 64, do you make the difference [inaudible]?

O: [inaudible]. If the number is 64, and one number is 60 and another number is 70, to me there's actually no difference in those three numbers, it's 160 versus 60, yeah,

S: So that there is a judgment that you bring to bear on top of what's there.

O: Yeah, and I guess when you're talking about the capacity to automate some of these decisions, when I was in XXXXX we were working on a project where they would bring you a range of outcomes and so we're not there yet but in the back of my mind, it's saying, okay, well if you've got the number 64, the number 64 has a variance limit you know, [inaudible] okay, and the other alternatives in the same range of uncertainty, and if they are, the numbers are the same for all intensive, for all practical [inaudible].

S: Yeah, no that's exactly right, that's the other end of you know, doing decision making as you're playing around, I play a lot with Monte Carlos to see that same sort of thing.

O: I love the Monte Carlo approach from the perspective of, a lot of these judgements are to remove the bias, a lot of these judgements are best made with a statistical model that's been built up with more data than we'll ever see in our lifetime and I am happy to use those approaches [inaudible] ...

S: [inaudible] didn't have the range [inaudible].

O: No, we were there, we were there, it's just, well you know how probability works, you know, there's a 50% probability you'll get this outcome, either less or more, we just happened to get the one outcome that was [inaudible], we were certainly within the range of outcomes. And it's hard, you know, academically that's excellent [inaudible] five million dollars.

S: That's right. Try telling the board it was the best decision.

O: Oh no, to their credit, I mean, it was the best decision, with the best information we had at the time and we did, because there was so much uncertainty, we did do it probabilistically, we got a very you know, we went there with our eyes open and what we got is we got a you know, we got a result that, we got a [inaudible] result. And that is one of the problems, I was just talking with XXXXX yesterday about this concept of, you know, probabilistically if you use that, you will always get the best long-run answer, you know, you've got to put a while [inaudible] ...

S: You've got to put a number of events together and that's what statistics based on and that's why I'm a believer in just keeping the number of events going so I don't have a problem with it, it's just ...

O: But see, that's the other thing too, we're using the business [inaudible] fascinating to have been able to grow with this business, this business has grown significantly from when I joined it [inaudible] fortunate enough to be a part of it so we've been making decisions really on a little toy problem and some of these decisions now are moving away to being quite material and so then you do things like you look at what is at risk and the relatively, the risk of a poor outcome [inaudible] that unnamed circumstance, right, was not a company risking decision, right, so that was [inaudible] so then when the decisions and mistakes get higher, then if you look at the range of possible outcomes and this is what I've sort of got in my mind, if the range of possible outcomes, you know, let's just say 90% of the outcomes or wherever you choose to be reasonable [inaudible] 90% of the outcomes will see you still with an economic project, say an offshore project, which is a slow loop project. If 90% of the outcomes [inaudible] you deliver an economic outcome or at least a break even outcome, well then you're actually reasonably okay with a project like that [inaudible] so if you've got a mean, if you've got a project with the same means, same mean outcome, economic outcome, but where you know, all but 25% of the outcomes expose you badly, then you can, then you know you have to approach that with a different level of caution.

S: That's it, and that's the point so you know, we talk about the long run but if you use the process it also maximizes your probability on each individual event.

O: Yeah it does.

S: And that's sometimes misunderstood, you know, everyone says yes, probability works in the long-run, but this one event, I can't say whether it'll be this or that but you do maximize the process if you have used that probability system.

O: Yeah, I do believe that.

S: Okay, well I'm very conscious of your time so you've been through, what I was after was to get a feel of a type of decision and the one that I've picked up from you is this, you use this modelling a lot in the way you [inaudible] organically things together and in my typing, the one area we haven't talked about is this concept of type, although you've mentioned it several times, you've talked [inaudible] fast loop, slow loop, you've talked of tactic operational strategy, vision, I'd even put that above all of those, so you've mentioned that as types, is that how you see them or am I supposing that?

O: No, that's how I see it.

S: Okay.

O: That's how I see it, built on the fundamentals, of the individual, the team dynamics of the internal and the extended team. In my view, organisational effectiveness, at the end of the day, it's all about the people, right.

You've got a process and you expose people to that process and the people that are outside this organization, I treat the relationships that we have with people outside the organization almost as importantly as I treat the relationships that we [inaudible] internal [inaudible] this organization so very heavily influenced by the skills and the ability to work together, collaboratively to an outcome. [inaudible] said that superimpose that onto logistics chain. I'm a very strong believer right through the whole value chain, I mean, we're talking in life now, of the influence of logistics in our lives, logistics do lend themselves to modelling, to help in decision making.

S: Yeah, that's operational research, that's exactly the field, which has actually [inaudible] my interest at one time or another and I'd love to be able to do more of that and [inaudible] it's all about what [inaudible] doing with [inaudible] whether problems are just too big, to [inaudible] and then to work, once you've set the vision, [inaudible] see setting the vision is an interesting thing and this is where the decision, this is where the decision, we as a team and me as an individual, and this is a personality trait really, 'cause it's all about people at the end of the day, I'm actually not afraid to change my mind, when more data comes in so if there is a reason to change or, and the change can justify the upset to the system, I actually don't have a problem with that so it's the flexibility to be able to change and that's, again that's where things like modelling come in because you can understand or be a little bit more clear as to what might happen to you if you make that change.

O: Correct, and that focus ability gives you opportunity. If you're not flexible, you lose the opportunity.

S: And that then adds a lot to what we're doing, so you know, we're looking ...

O: We'd look at our portfolio, from our portfolio, we understand it more and just again, it's a bit of a decision thing, [inaudible] it's another decision we made, we looked at our portfolio, we looked at the gas aspect of our portfolio, the oil aspect of our portfolio, we made a call to push the oil side first. We said, okay let's take a big push, let's put a lot of money into our portfolio, let's determine if we can arrive at the next level of production, the next plateau, [inaudible] pretty much as a plateau, that's sort of the way we view it. We put a lot of money into the program that we [inaudible] last year, we didn't deliver the results, and as a consequence, we didn't grow, so we then put the more effort on the portfolio again, much, much more rigorously and we looked at the portfolio outcomes, we married in the results of our program

We said, hang on, this portfolio's not capable of delivering us the profile that we want and so we made a call and say, okay, well let's look at the size range that we've got and we looked at it, and okay, pretty small. So we said, no, we now have to add the next layer or the next size range of opportunity to grow to the next level that we want, and it's those kind of outcomes, so we've adjusted, we've adjusted our view of what is possible in our current holding and determined really about three years early to be honest because we could stay here and do this for the next three years.

S: And you keep improving your production and yeah, profits would go up, yeah.

O: But three years ahead of time, we know and that's where we talk about slow loop 'cause it's going to take us or we worked on it, our first opportunity, and I've been working on it for 12 months already, s by the time you get any production from the next opportunity, we've got three to 30 million [inaudible] opportunities at the next level and it'll take two or three years to do that and so you know with enough lead time, and again it's the logistics of adding another [inaudible] business that then drives you.

S: Yeah, that's exactly it.

O: And that's what we've been able to, that's the clarity we've been able to bring to the business by virtue of examining it a lot, modelling it where we needed to and then bringing the data out so that we could all sit around the table and make decision on [inaudible], talk about it, discuss it and develop a view, a vision, change it, and then get the strategy in place.

S: Good luck with it.

O: Well we're optimistic, as I said, the last four months wasn't brilliant, we still delivered a good financial result but at the end of the day, none of us around here are particularly pleased but all of us are motivated, and all of us are positive about the approach, the process that we've undergone, and we all believe that we'll deliver [inaudible].

S: And you will [inaudible] in the long run if you keep following that process.

O: Exactly, so no we're pretty happy.

S: Excellent, thank you, XXXXX.

O: Thank you, Steve.

S: No, you've given a lot more time than I expected so I appreciate it.

O: No, no problem at all, it was a pleasure. Hopefully it's going to ...

End of recording

***Interviewee: Participant P (P)**

***Interviewer: Steve Mackie (S)**

Recorder not working for initial part of the interview

P: [Phone call: 0:00 to 0:54]. [Inaudible].

S: They work. I've got 20 different scenarios in here ...

P: Right.

S: ... and I'm just going to show you one ...

P: Yeah.

S: ... and what I want is not your decision, even though that's what it asks for, but the process you would go through to make the decision.

P: Okay.

S: Okay? So ...

P: Presumably the ... the ... the misinterpretation is through the betterment ...

S: You hope.

P: ... in kind of respect, yes. [Inaudible - reading].

S: Deliberately vague.

P: [Inaudible – reading]. Well, yes you have to ... I would say first of all, fortunately the managing director as a start, not to keep ... to keep going on with the idea of throwing resources in the process. I guess you sit down with the geophysicist and that's not really the process is it?

S: Well, no that's a process. You sit down with him, try and figure out what the problem is ...

P: But that's not the problem ...

S: ... is that what you're saying?

P: ... yeah. Well the problem is ... yeah and see if it could be ... well I guess the same ... in geophysics, it's ... you're dealing in time but you're trying to interpret it in depth ...

S: Yeah.

P: ... and there's ... there's never 100% conversion from time to depth so if something is ... if something is wrong ...

S: In time, it may still be right in depth?

P: It could still be right in depth and it depends on ... but this one, for one of the companies, XXXXX were fuelled so that means that you've actually kind of made a discovery ...

S: Yeah.

P: ... so you've got some well data that you can link to the size rig. Hopefully, you've got more than one well that you can link to the size rig ...

S: Okay.

P: ... so that you're not ... you're not dealing with just one set of data.

S: So the first thing you'd do is then try to quantify ... am I putting words in your mouth?

P: Yeah, it's quantify.

S: Quantify the uncertainty?

P: That's right. You'd quantify the uncertainty so that you'd be ...

S: Okay.

P: ... looking for your ... your full range and if there was a difference in having done that, if there was a difference in ... in the ... in the range of presumably we're talking about a resource, seen as they're talking about ...

S: Yeah.

P: ... throwing resources at the project to get the oil price so you've made an oil discovery, yes I think you'd have to ... if there was a major difference in the spread of your risked resources, having reviewed with the geophysicist the data, you'd have to

then caution or advise the managing director that ... that may be the upside is not as great as he has been reporting ...

S: Okay.

P: ... and I guess it would be ... and it'll also depend on how if the company was consistent in that they just reported the same sort of reserves, so the same categories. So if you're a ... if you're basing your development on mean reserves and the mean reserves changed dramatically downwards then yes, you'd have to ... you'd have to caution the managing director and I would say have a strong recommendation that a development plan be reviewed.

S: Good. If this ... this happened in your company, is there a process that you'd automatically move into or would you be forced to sort of run by the seat of your pants for a while?

P: I think in ... in this case, it would probably be myself and XXXXX would ... I would work with John Idale to review the ... the geophysicist's interpretation and then if that was seen to be something you know, a major change, I would then work with XXXXX to have a look at the spread of the risks and what that meant in terms of reward but I guess this is already having had a discovery so ...

S: Yeah.

P: ... the ... in theory anyway, I would think that the spread is not going to be as great as pre-drill ...

S: Okay.

P: ... where you're going from the P10 to a dry hole ...

S: Yeah.

P: ... as far as your spread. You'd be in at least, in this case, you've got a discovery whereas I said hopefully more than one well ...

S: Yeah.

P: ... but if you have got one well, I guess anyway, your spread is somewhat less than pre-drill. Yeah, so we'd work with XXXXX and come to a ... a landing on what now the value spread is, having looked at the reserve spread and then talk with the managing director and ... and the Board. I think that would sort of be the process. Firstly, talk with the ... go through, as I said, our chief geophysicist ...

S: Yeah.

P: ... go through with our exploitation manager, carry that forward to the managing director and then if necessary, advise the Board.

S: Okay. So ... there is a process ...

P: Yeah.

S: Yeah, okay.

P: I mean that ... that's, as I say, in a company that ... that's got ...

S: Yeah, okay.

P: ... 16 or 17 people and ... and we do have a ... a Monday morning managing meeting where anything that's happened during the previous week is ... is already known by the people there because we have minutes that are spread around on the Friday before we have the meeting, so if there's any queries, there's queries of each of the people in turn and there's also then what's happening in the coming weeks so that if anyone needs some input into that, you know they can make it to that time. So I don't ... you know, in this sort of situation, I don't think you'd go to a manage ... you wouldn't go to a management meeting. You would actually go to the people who were the specialists in this particular field ...

S: Yeah.

P: ... and then ... and then to the managing director, yeah.

S: Okay, good. That's not specified though anywhere ...

P: No, that's not specified anywhere.

S: ... because this a unique type thing.

P: Yeah.

S: Yeah, okay. So no, that's fine. When you talked earlier about decision-making, you automatically mentioned XXXXX and you've got guys doing that ...

P: Yeah.

S: ... so you have some software tools ...

P: Yeah.

S: ... when those ... they may be used here, they may not but when they come to you, do you make your decision based on the numbers they present or is there something else involved?

P: Well yeah, that's as I said earlier on, it becomes ... from where I'm coming from, it becomes a mixture of how much weight to put on the final EMV numbers and ... and the list or ... and the numbering of the prospects that we ... that we drill. You know, do we drill only those prospects which are EMV positive and of the greatest

EMV positive or which will give us the ... the cheapest discovery rate for oil or do we take some which are slightly less EMV positive but because they are in the right neighbourhood, either close to a producing field, so that means development cost is cheap or close to a discovery and are a discovery type look-a-like. Now I mean that should be taken into account with your geological risk. It should but whether it is entirely, that's the sort of decisions that have to be made at the moment, yeah.

S: Okay. So would I be right in reflecting back to you that yes, the ... you do do those numbers but there's some still concern over them?

P: There's still some concern over them. I mean there's still some geological and local knowledge input to go into them and I guess what we're looking at now is this so called parents and children-type ...

S: Yeah.

P: ... where yes, we do have a number of prospects which we think are drillable and they are at the ... near the head of our seriatim but we do then have a number of so-called children prospects, which if the parent is successful, the children would be looked at much more favourably and may be displace other ...

S: Yeah.

P: ... prospects form that seriatim because they ... their ... obviously their geological risk would reduce dramatically if ... if the parent prospect was successful, yeah.

S: Yeah.

P: Likewise if the parent prospect is not successful, then they would remain ... well, they're risking but obviously become worse but they would remain at the ... we've sort of not got them at the bottom of the seriatim. We've gone sort of tucked to one side.

S: Yeah, quarantine until you know.

P: Quarantine, yes.

S: Yeah.

P: Yeah. So there's ... there's ... there's different ways I guess of cutting the cake and working out its value, and then as soon as you drill a well, the knowledge of that well be it dry or ... or a producer will then influence a number of other ... other prospects, and also the ranking of those prospects. So I guess in a way, we are putting geological input into that with this parent/child ...

S: Yeah.

P: ... relationship but also there's a sort of a more general geological input into it as well.

S: Okay, and it sounds like it's a group thing by the way you ...

P: It is. It is, yes. It is.

S: Okay. Taking you totally to a different ball game. Do you hire people? Is that a decision you make?

P: We do.

S: You personally?

P: Yes.

S: Or do you have input into that decision?

P: No. I would ... well, I would say though we need a well site geologist, Joe Bloggs is available and I'm going to ...

S: Employ him to do it?

P: ... employ him, yeah.

S: Okay. Is there a process you go through to choose Joe Bloggs?

P: Generally on a ... on an oil site type, it's really by personal knowledge.

S: Okay. So you wouldn't put him through a risking process and value his risks ...

P: Personally ...

S: ... against someone else's or?

P: Personally no but people are ... are being employed on not so much on a risking basis but by interview you know for jobs where the person is unknown and we're going through an agency, so ...

S: Okay ...

P: ... it sort of becomes ...

S: ... and that's fairly defined what you ...

P: Yeah, that's right.

S: ... use your agency for?

P: There's an agency and then normally because ... I think because XXXXX has done a psychology degree, there's usually a psychological assessment as well ...

S: Okay.

P: ... and that seems to be standard, yeah for ... for ... I was going to say non-technical but it has ... had also occurred for ... for one group ... one technical employee as well ...

S: Okay.

P: ... yeah, that I'm aware of, yeah but yeah, so I'm aware of it occurring in ... in a number of non-technical people where it goes through ... a selection through an agency, an interview process and then a psychological profile.

S: Okay. So that's fairly well defined?

P: That's defined, yes.

S: It actually to me ... I don't know ... it sounds more defined than choosing a prospect. I don't know.

P: [Interrupted – phone ringing].

S: That was deliberately controversial.

P: No, I think when you go through something like 130 or 140 prospects and do them all in the same way and then go through risking, the geological risk, the possible recovery factor, the company share and then you come up with a risk recoverable number and then you come through an assumed ... you know how much it's going to cost and what the price of oil is going to be at the end, and you come out with an EMV and then if you fiddle around and say well if we're to farm out, would the EMV go up or go down and if it goes down, then you just decide you're not going to farm it out, I think we probably ... I think we probably have a few more steps, which ...

S: Good.

P: ... but then I mean still all right at the end. You sort of ... you may make up your mind that you won't drill that prospect first, we'll drill it second but I mean it'll ...

S: It'll still there.

P: It'll set within ... what ... what we're saying at the moment is that given that we have got a few farm outs done, that we're looking to do more farm outs, that to meet our corporate objectives, we will need to drill XXXXX oil exploration wells in '06/'07. I mean that's ... that's ... that's how it is at the present time. Now if we are particularly lucky in one or more and may be this project, as I said, under the

XXXXXX formation, under XXXXXX which is not ... we don't actually have that in as a ... as a drillable ...

S: Okay.

P: ... prospect because it ... because we're not drilling ...

S: No. It's an in well bore project.

P: Yeah. All we're doing is ... is opening a sliding sleeve ...

S: Yes.

P: ... in a wire line unit and running it through. I mean you know, if that was to work and to be interpreted so that we could say yes, we do have proven reserves in that formation, which is not counted in any of our reserves at them moment, then that may change what we have to drill. I mean if may not. I mean everyone might say you beauty, you know we're starting off with ...

S: Yeah.

P: ... x hundred thousand barrels [inaudible – overtalking] ...

S: You've got a big start.

P: ... let's ... let's still go and spend the money on that. Mind you, someone else might say well that gives us more money to spend on a ... something else.

S: That's right. Okay. So the final one just to try and wrap it all up, so we've been through a what a decision is and what you think it is and how it's done. The second was decision types, different ...

P: Yeah.

S: ... types of decisions and then processes or ... and tools so you know, Rose's software ...

P: Yeah.

S: ... is a tool ...

P: Yeah.

S: ... to help with the process and it appears that processes could be slightly different, they're tailored to the type of decision being made. The final one that we're looking at is what we're calling look backs ...

P: Yeah.

S: ... so when you make a decision, the actual outcome of the decision is independent of what decision is made because you've got how it's implemented and chance still exists.

P: Exists, oh yeah sure, yeah.

S: So all of those go on and the classic one I've always liked is the old AAPG t-shirt that that had a normal fault symbol and the words normal fault, reverse fault symbol, reverse fault and then a dry hole symbol, engineers' fault, so how the project's implemented has an out ... is impacting on the outcome. So is there a formal look back on the implementation so that when you make a decision, you say right, we're going to drill it this way and using these muds and this sort of logging suite and all that sort of thing, and then you look back and say yes, we did do that and then the next part of the question is what about the actual outcome? You know, we said there was going to be ...

P: Yes.

S: ... two million barrels there ...

P: Yeah.

S: ... and is there?

P: We ... we have a couple of levels of process. We have a consultant who comes in on a monthly basis and looks at prospects to be drilled and he's a structural geologist so ... I mean he ... he has relatively limited high expertise but a fairly wide general expertise and so he looks at prospects to be drilled, he also then looks at prospects that were drilled and talks with the people who were involved in the mapping and myself, you know who were involved in the decisions to actually drill it and then also a little bit with ... with at XXXXX's level but it's mainly at the technical level and to sort of sort out okay, now this is ... this is what happened and this is the result. Now I guess with successful wells, the ongoing thing is not so much why was it successful but how successful was it? You know, how much have you got, and ... and what pools have ... have you made discoveries and how did the pre-drill structure match the ... the post-drill ...

S: Okay.

P: ... structure and what ... what are the reserves? Now, so ... and then when it's a dry hole, okay what went wrong? You know, what do you think was the ... was the ...

S: What did we miss?

P: What ... what did we miss in the geological factors that ... that wasn't there, and then ... then I guess you know, that then influences you in ... especially with the dry hole and what you think of the prospects around it.

S: Okay. So there is a process of then updating ...

P: That's right.

S: ... the risking around it?

P: Around it, yes.

S: Okay.

P: And that then ...

S: Feeds through.

P: ... feeds through into this seriatim and right at the moment, we're waiting on a test of a well that we couldn't test because of unstable hole to see if I can upgrade two prospects that I want to drill that are currently slightly in the red but if this ...

S: Works.

P: ... testing with its completion rig works in the next couple of days then both of these prospects will be upgraded to ...

S: Into the green.

P: ... into the green, yeah to the positive EMV. Now, on a higher level again, through XXXXX, he's ... he's sort of contracted to us to come in a couple of days ... it's really about a couple of days every half ... to look at how we're dealing with the prospects and so he's dealing with mainly XXXXX but myself, and so we've just had this ... XXXXX is off overseas at the moment and he's back in about 10 days' time and XXXXX will come in and sort of finish it off. So what XXXXX has done is he's given him say 10 prospects that we've drilled in the last two years, what we had before we drilled them and what we've got afterwards so that we're looking at why our biases are coming up to these prospects and whether we're changing as we go through or whether we're consistently or ... and how close we are. I mean they're always out. There's always factors where you're out.

S: That's right. The one thing you can be sure of ...

P: Yeah.

S: ... is you're off.

P: So ... so say at that level then ... then XXXXX will be coming in say you know, two or three days a year. I mean because we're not ... we're not like XXXXX drilling ...

S: Oh yeah.

P: ... you know, squillions of wells, we can look at half a dozen. As I said, you know this year ... this last year, we drilled XXXXX exploration wells. So if we look at eight or 10 of those prospects, may be a couple that we didn't drill and we thought what we drilled were better, then we'll get an ... we'll get an idea of where our biases are and hopefully can adjust our pre-drill thinking ...

S: Yeah.

P: ... before we make a decision on you know, to drill or not to drill, and ... and try and see how close were are post-drill to ... I mean you're always going to be wrong. That's ... as soon as you drill, you're always going to be wrong ...

S: That's right.

P: ... but it's just that degree.

S: You've got to ...

P: It's the degree to which you are wrong, yeah and sort of on ... on yet another level, which really doesn't just impact on drilling, it impacts on all things, if we have any incidents or problems like incidents like health and safety but problems in drilling, then we do an incident report.

S: Okay, which requires that.

P: Yeah, yeah and as part of XXXXX's drilling, he has a lessons learned thing so I mean that's ... that's more like the mechanical aspects of ...

S: Yeah.

P: ... the drilling as well.

S: But it's the same principles.

P: It's the same sort of principle, yeah.

S: Yeah. So the company has a very formal look back process ...

P: Yeah, so ...

S: ... right across the board?

P: Yeah, so it's ...

S: Yeah, cascaded right through.

P: Four levels I suppose. I guess it's four levels, yeah.

S: Yeah.

P: So it does get caught somewhere along the line and yeah, it's interesting. This well that we couldn't drill, there wasn't enough casing in the hole. That was sort of reported as insufficient casing, so you know ...

S: That's right.

P: ... the follow-up wells all have ...

S: Deeper casing.

P: ... deeper casing so you know, that problem won't be there, yeah. But it's ... yeah, it's an interesting ... it's an interesting cycle of ... I guess it's sort of like the ... you know, the ... I'm just trying to think of companies getting accreditation for certain things when ... you know, do they have the cycle of improvement?

S: That's right.

P: I guess as long as you use it but don't sort of let it take you over then ... and you're continually worrying about this improvement and not doing anything ...

S: That's a good point. It's all very well to have the process as long as it doesn't stop you doing it.

P: That's right. If you never do anything, you're never going to make a mistake so that's ... you know ...

S: That's right.

P: ... some of the politicians type ...

S: Yeah, I was going to try and hold back on that one. That was [inaudible] success. Oh no, that's great.

P: I'd better not take ...

S: Okay, well that's covered it all XXXXX.

P: Okay.

S: Much appreciated you going through that because what ... what happens now is obviously the reason I'm taping it is to transcribe it ...

P: Yeah. I'll be interested to see how it ...

S: Yeah, see how it all comes out.

P: ... all that turns out, yeah.

S: So that's where you might see all ...

End of recording

***Interviewee: Participant Q (Q)**

***Interviewer: Steve Mackie (S)**

S: Decision making, what is a decision, how do you know if you've made a good one, and do you use, personally, any specific processes in making decisions? So, they're the three main areas that I wanted to talk about.

Q: Not consciously, but I suppose subconsciously we might, yeah.

S: Okay, so what is a decision to you?

Q: Well you gave me a clue didn't you? In your email, you said it's when you commit to committing ... decide to commit resources. I'm not sure I agree on that but that's a good start isn't it?

S: Yeah, well that's ... that's part of it, I think ...

Q: Yeah, yeah, yeah, I don't commit resources or follow a particular course of action but ...

S: Yes, because if you look at the whole thing ...

Q: When you're ... when you're at a fork in the road and you decide whether ... this way or that way and it may ... one direction may involve committing resources and the other may not, so either one is a decision obviously or in particular ... follow a particular course of action, you may get ... you may make a decision not to do anything.

S: Which is a decision, yeah.

Q: Yeah, yeah.

S: Okay, so all of those sorts of things.

Q: Benign neglect usually, solves a lot of problems.

S: I like that yeah, I like that one, that might get quoted. Okay ...

Q: Well it seems like an urgent problem today, in a couple of days it may have just gone away.

S: Yes, and we feel like we've got to answer it but we may not have to.

Q: Yeah.

S: Okay, as ... your position within this company requires you to make decisions I would assume, what ... how would you describe those decisions? If I was to use the word type ...

- Q: They're getting bigger every day, spending money.
- S: Okay, so the first one that you'd decide is how to ... how and where to spend the money, okay? Any other types of decisions that you would make?
- Q: Personnel decisions, policy decisions, [inaudible].
- S: Okay, so ... so it's a broad spectrum at your level across those areas.
- Q: Yeah.
- S: Okay, so the big question then with all of those types of decisions, and you've been doing that for a while, do you have a process? You mentioned [inaudible]
- Q: Well I don't think I do but maybe if we talk about on the major side I do, nothing ... nothing conscious [inaudible]
- S: Okay, there's no formal process, you know, XXXXX doesn't have a book that says this is how you make a decision sort of thing?
- Q: No.
- S: No.
- Q: XXXXX doesn't have many books or written things, that's part of our culture, that's part of our culture. We were very rigorous about things [inaudible].
- S: Don't write down [inaudible]
- Q: Well we try to avoid paperwork, yeah, yeah.
- S: Okay, so there's nothing formal, but then you might use an informal process of some kind.
- Q: Well for example, in evaluating whether or not to drill a well, there's a very formal process but it's not written down.
- S: Okay, it's just understood.
- Q: That's right, yeah.
- S: Okay, and is that done by one person or is a group of people involved? So is it group decision making or is it individual decision making?
- Q: Oh, generally I would say it's a group decision, sometimes if there's a disagreement within the group, somebody has to make a call, but generally ... generally the talk of ... talk amongst ourselves and try to reach a consensus on for example,

with the farmin, recommend a farmin or whether or not to [inaudible] technical decision like that.

S: Yeah okay, and in making that decision, so let's use a well, the decision to drill a well, do you actually use tools to do all of that? By tools I mean spreadsheets or some specific sort of ...

Q: Oh yeah, we use a package or ...

S: Some sort of risk analysis techniques that you'd be familiar with?

Q: Okay, yeah. So a series of programs or spreadsheets or databases and all that sort of ... that ... that ...

S: Goes into it?

Q: Yeah, yeah, yeah.

S: Okay, well let me show you ...

Q: So generally you ... for example, wells we'd generally use the EMV approach with a ... with a, you know, probabilistic approach to assessment of reserves[inaudible] and rigorous assessment of risk using the various parameters and then an EMV approach to decide whether or not to proceed. ...

S: And would you choose the best EMV?

Q: Yeah, yeah, although ... although not always but yeah, not always, not always, but yeah.

S: Okay, what might be some of the exceptions because the ..?

Q: Oh long-term ... long-term gas project which isn't necessarily appropriate in terms of the NPV or EMV analysis, so EMVs and NPVs I think tend to ... tend to favour necessarily short-term things, so something that was a strategic entry to an area or a long-term view would be you know, we might say we're prepared to suffer a very low EMV or to ... for a particular reason, if it suited our other strategic reasons.

S: Okay, so you would weight some other objectives higher than the monetary objective?

Q: Yeah, subjectively, not ... yeah.

S: Yeah, yeah, so there's no real ... yes it'd be a subjective thing, okay.

Q: Well if we were ... if somebody was bringing a well to me or I was taking it to the Board...well we don't take wells to them but we would be attempting to demonstrate that it has a positive EMV, they don't come to you with negative EMVs.

S: Not very often. Okay, okay so is there a filtering process prior to it getting to you or ..?

Q: Oh yeah, yeah, I mean but ... see a lot of it's done at budget time, the ... the budget approved and generally we wouldn't expect any well to be in the budget that's not ... that's not EMV positive or it has [inaudible] some other reason and then once it's in the budget then more or less the decision whether or not to ... to actually drill that prospect is then up to XXXXX or the rest of the team. If there's something outside the budget, there'd be a lot of filtering going on I think before it got to me.

S: Okay.

Q: Yeah.

S: Okay, so there's all that, the standard process if I can call it that.

Q: Oh yeah, we're a proper company.

S: I'm not making an accusation. I was very tempted to ask you about the XXXXX acquisition

Q: Oh, well you can ask me that.

S: I'm sure there was a strong process in all of that, yeah. Is there any ... how would you describe it?

Q: The process?

S: That process, yeah.

Q: Oh, well there was a very rigorous attempt at valuating the assets, but in ... it's like a lot of these ... a very small change and a few assumptions just have a huge difference in value.

S: Each.

Q: And what do you pay?

S: That's right, so can I step back one and ... and just shut me down if I'm ...

Q: Yeah.

S: Over the line, but the decision to decide to look at XXXXX ...

Q: Oh, well it was immediate ... I don't know I won't say it's intuitive but XXXXX and I both knew that you know, it was blindingly obvious that it was a very strategically important or asset that would be of strategic interest to XXXXX

S: Because you'd been watching it, monitoring it for a while?

Q: Well yeah, and we knew the sort of ... we knew the sort of things we want, we hadn't thought about XXXXX for a while but yeah, we thought of ... it sort of came further through our minds from time to time.

S: And that's the ... that's why I'm talking about the process because.

Q: Yeah, but we already had enough, we ... you know, we have enough agreement between ourselves or understanding of what sort of things we want to do and what sort of things you know, which sort of direction the company's going so when it became ... looked like there might be a chance that XXXXX would fall ... fall into somewhere we could grab it, then we started working on it.

S: Yeah okay, no, that's good, that's the sort of thing that backs up my hunches about how process actually occurs, it's never just this walk up to a fork in the road and make a decision but that things have been happening for a long period of time.

Q: Yeah, yeah, yeah and XXXXX's a very good example for us because it was an easy decision to say yes look at it, the only reason you wouldn't look at it is if you thought it was impossible, and it looked a big stretch, it looked nearly impossible but not quite.

S: Yeah, and then you then make a whole series of little decisions as to how to make that work.

Q: That's right, that's right, yeah, yeah, yeah. You know, something ... other ... other things of that size of course we would've dismissed out of hand because it wasn't ... didn't fit together what we were doing or it looked too hard or it wasn't something we understood or ... any ... any sort of number of reasons.

S: So there's sort of a ... if I use a high jump analogy, you know the bar's here so therefore I can give it a go, but lower or higher or ...

Q: Well yeah, I mean informally we have a number of criteria on our minds regarding the sort of things we'll look at whether it's a [inaudible] position, we don't want to articulate them all that often but we know what they are which is things like it has to be something either we're familiar with or is rec ... or the operator's somebody we're comfortable with, this is [inaudible] or it's a recommended by someone that we know well or something, you know we have ... we have to either know something about it or it has to be brought to us by somebody we trust. Or if ... or if they were ... you know, if it was something that you know, neither of those, we tended not to look at it unless it was ...

S: Significantly matched to what you're seeking.

Q: [inaudible] appeared to be outstanding and then we'd have to [inaudible]

S: Okay, so that's the classic smell test.

- Q: And it ... and it has to fit together in some way with what we're doing.
- S: Yes, you've got a vision, you know what your blocks are needed to meet that.
- Q: Yeah, that's right, yeah.
- S: Okay, good. Let me throw one at you as a curly.
- Q: Oh, yeah.
- S: So here ... here's a decision, this is number 15 in my ...
- Q: In your bag of tricks.
- S: Bag of tricks, just have a read through it and just tell me ... you know, I'm more interested in how you would go about making the decision rather than what it actually is.
- Q: Yeah, six months, well they've been working too bloody long on the development plan. In the final review [inaudible]. What do the senior reviewers do? Tell the managing director immediately [inaudible] if there's an uncertainty on reserves, aren't we going to look at it before we decide whether we're going to recommend participation, is that the ... is that ... or are you looking for something deeper than that?
- S: No, no, no, it's ... it's whatever comes out first because it's ... what's happening is ...
- Q: If this was ... if this was XXXXX, for example if we say we're talking ... for example, if we're talking about the XXXXX gas project which XXXXX has been telling everybody that we've got 400 BCF reserves and we're about to announce a gas project and sign gas contracts right? And we've just discovered that XXXXX stuffs up the mapping, the phase is wrong, reserves could be wrong.
- S: Yeah, how do you handle that? What do you do?
- Q: Well we're not the operator, but if we were the operator, I would say if I was XXXXX I'd say XXXXX, hang on, we've got to backtrack, we may have an embarrassing announcement to make, we have to look at the reserves.
- S: Okay.
- Q: Yeah.
- S: Okay, so number one.
- Q: And I wouldn't ... I wouldn't give it back to XXXXX I'd ask XXXXX to do it and to do it quickly.

S: Okay, so ... so in your head you've got ... raised all those same things, you've raised trust, working with people you trust, you're looking at that trust issue, you've raised a time issue, the way you've talked about that appears to me as you'd need to do it quickly, but not too quickly so quickly, and you need to keep people informed as to how that's going, okay, that's good. What sort of values would you be using to judge whether XXXXX's done the right job?

Q: I trust XXXXX.

S: Okay, so ...

Q: I'd give it to somebody who ... I'd say ... in this situation I'd say XXXXX will you have a look at it and see if this is a material issue or not, and he would probably give me an answer very quickly, he'd say yes it could be, he'd either say no it's not or it might be and I need to look at it further or something, yeah.

S: Okay, so ... so you know how he operates and you then trust this guy?

Q: Oh yeah, and I ... probably any number of geophysicists I could ask the same question of here, but yeah he's yeah, he's probably ...

S: Well that's a good example.

Q: Yeah, yeah.

S: Okay, so ...

Q: I mean some people I wouldn't ask that question of ...

S: Yeah, and ...

Q: None of them work here mind.

S: Can I ask why you wouldn't? What are the reasons you wouldn't?

Q: Oh, through experience, I'd know if they weren't going to give me a quick, straight answer.

S: Okay, good, so ... so you're after information upfront so you know how to make decisions as you go.

Q: But a lot of that, you know a lot of that, as you notice when you work with people, particular individuals, you know how to interpret what they're telling you. I mean if you don't know them, you don't know what they'll do. This is you know, somebody might say this is a huge problem and it may not be any problem at all.

S: Yes, so then it's huge.

Q: That's right, oh this is huge, I've done it all wrong, but it may make absolutely no difference whatsoever.

S: Yes, okay and by working with people you know what they mean by ...

Q: Yeah.

S: What they say.

Q: Yeah, so if ... you know, if XXXXX ever goes academic [inaudible] I've ... I've mapped this and I've just realised that the phase is all wrong and I'd say well what the hell does that mean? I don't know if that means anything other than you know, somebody who can give you a more pragmatic answer.

S: So there's an experience level, a trust level, so there's a whole lot of values actually going into the decision.

Q: M-hmm.

S: Okay?

Q: Yeah, yeah.

S: Good and it's ... it's more or less a subconscious process but you were able to come out with it straight away so it's something that you've got happening in your head.

Q: Yeah, yeah, yeah.

S: Okay, if ... if this were a totally different decision you know, like I don't know, make anything up, do you think you would approach it in a similar way?

Q: Oh, a lot of it's get ... to do with getting somebody who ... well it's not me, if I can't do it.

S: Yeah.

Q: You know if it was some sort of technical problem, I might look at it myself but it's to get somebody whose opinion you're sure you can rely on.

S: Similar process.

Q: And ... but also ... but also ... and then the communication thing to make sure that no one ... you know, people don't like surprises unless you know them.

S: Yeah, especially the market, okay.

Q: [inaudible] we're trying to cover one up.

- S: Oh no, that doesn't work does it?
- Q: No, and you know, certainly here and most places you know, if somebody makes a mistake, somebody makes a mistake and those hap ... those things happen.
- S: Yeah, and you've just got to ...
- Q: [inaudible] work through it.
- S: Yeah okay, the next part of what I wanted to talk about, so that's the decision itself and how it's made, and how you go about it, do you have any ... no, let me phrase it a different way. When you think of a decision, what do you think a good decision is, how ... how do you judge whether it's good or not?
- Q: Oh, I think one where you've properly evaluated all the things you should've considered.
- S: Okay, so ...
- Q: You have ... you haven't missed something that you should've thought about.
- S: Okay, good. So I'll pursue that because you're the very first person I've interviewed who's actually said that.
- Q: Yeah?
- S: Yeah, and I'll expose what the others have said, I don't want to [inaudible], most people choose the outcome so that if the outcome is good then the decision is good.
- Q: What a bunch of rubbish.
- S: Good answer. Why do you say that?
- Q: Oh, because you can make exactly the right decision and still be wrong.
- S: Okay, okay, because there's chance involved.
- Q: Yeah, so well that's you know, really that's what we try to do, make sure we've considered all the ... all the issues, the range of possible outcomes, the full range of possible outcomes and both technical, commercial, financial sense and then make your call, and I don't know that you can do much more than that unless you ... I mean if you keep making the wrong call you're probably ...
- S: You know this ... that's actually one of the things that I ... because what I'm
- Q: You probably don't survive, in the long run.
- S: It's in the long run, that's it, yeah.

Q: Yeah, yeah.

S: And that's ... that's exactly what my premise says, my thesis is that if this process, whatever your process is, but a process that's tailored and that considers all of the information, then in the long run you're going to get the better outcome. The other thing that does, if you use probabilistic maths, it actually says you have the most likely, best outcome for each individual decision as well.

Q: That's right yeah, yeah.

S: So ... and in the long run, people who just run by the seat of their pants may have gamblers luck or whatever you want to have and then they'll crater.

Q: Yeah.

S: Okay, no that's good because you've taken into account the process of implementing a decision which can affect how the outcome is as well as the chance. Do you have any feedback loops or decisions?

Q: Not for everything, but we do certainly in terms of assessment of reserves and success rates and that sort of thing, we do the normal sort of thing, look back on the actual against what we've predicted and see how we're going and try ... and so we do that. We ... in theory we would look back on our acquisitions [inaudible] different but an acquisition where you've paid something for an asset.

S: So you know ...

Q: And we started doing that with XXXXX but it became so ... for XXXXX being our first acquisition, after about a year it was so obvious that the acquisition was a huge success, we stopped doing it right? We didn't make any ...

S: No ... no one [inaudible] of enquiry [inaudible]

Q: Yeah, XXXXX was another acquisition but it'll take a long time to know, hopefully I'll be gone by the time, and if someone was like what did we do that for? [inaudible] XXXXX [inaudible] that was bloody stupid or one of the [inaudible] and XXXXX, they still have the same thing I mean [inaudible]

S: Long-term.

Q: Long term, we'll obviously be looking in the next year or two, particularly very closely at how we're going, here's what we predicted, but in the end I mean you know.

S: Yeah, the circumstances change while all that's going on.

Q: Yeah, yeah, and so something totally unexpected will happen, either good or bad to make the ...

S: Do you have flags ... for these long-term ones do you sort of have flags that are at the short term? So after one year this is a flag, a red flag something's going wrong or ..?

Q: No, nothing formal like that I mean I guess we ... we haven't been around long enough to have formal procedures like that, but we would look back, we will look back at the end of ... about 12 months from now, we'll look back on how the first year ... we always can obviously look back on a ... on our budgeting process and [inaudible].

S: Okay.

Q: We're more a looking forward company to be honest.

S: Okay, alright and that's ... and that's fine because each company has the way they do things and ... and as they say I don't think anything is hard and fast.

Q: Yeah, yeah, yeah.

S: So if you do ... do you have any look-backs on the implementation, so not just the outcome but when you made the decision for example to take over XXXXX, you would have had in your mind how that was going to be done.

Q: Yeah, yeah, yeah.

S: Do you look back on implementing it as to whether that is the way you decided it?

Q: Oh, it would be something that would be discussed at board level if it was a variance from what you ...

S: Okay, so you're tracking something?

Q: Yeah, what do you mean by implementing? Like?

S: What do I mean? For example, well you've made the decision to drill ... I've just been in the JV meetings, so [inaudible] and you are going ... you've now said right, we've made that decision so sell and so you need to go and look after native title so on and so you need to clear with the government, so is there any process to look that that's actually been implemented that way, that you wanted it implemented?

Q: Nothing formal.

S: Nothing formal, no.

Q: It's the more you know, the key managers sitting down together every couple of weeks where [inaudible] every two weeks [inaudible] actually I wouldn't do that again.

S: Okay.

Q: And so we tried doing it this way, for example XXXXX looks after native title so we tried doing it this time, that didn't work, we'll do it another way, so that sort of thing yeah.

S: Okay, yeah so that is discussed. So at an informal level, that's ...

Q: It's certainly done in an informal way, yeah. [inaudible] usually go along on yeah, yeah.

S: Okay, and that I pick up is an expectation with you.

Q: I mean I know Native Title is a classic of that because we're making it up as we go along and nobody did these two or three years ago.

S: Yeah, very complex type sort of decision.

Q: Yeah, yeah and so ... you know, like the way we negotiate the agreements with ... or you know, the ... the ... the clearance procedures or the agreements procedures or it'll involve a little bit different and Queensland agreements are different to the South Australian ones and whether it's better or worse, time will tell but we'll learn from that, yeah.

S: Yes, so you [inaudible] you used the word, it's this learning environment.

Q: Yeah, yeah.

S: Okay, finally then, and this is really just to get a feel for how you feel about it, if you were to judge your decision, your personal and company decision making rules, processes, whatever words you want to use against your competitors, how ... if ... if it was zero to five, zero being we're way worse than everyone else, five we're better than everyone else, where about would you put it?

Q: Four, I'd have to say at least four.

S: Okay so ...

Q: I think we do ... yeah, when we make decisions, we make them quickly.

S: Yeah and they're two of the key criteria?

Q: Yeah and we move on.

S: Okay.

Q: And I think we do ... and I think we, for a company of our size in particular, we do things very rigorously.

S: Good.

Q: That's why we sneak up on people but no one suspects it, they think we're a bunch of cowboys.

S: I can reveal that one of the people I interviewed, and everyone does remain nameless.

Q: Yeah, yeah.

S: Actually talked about XXXXX's decision to enter XXXXX and they assessed it as being ludicrous, but they now look back at it and say no, that was a very good decision.

Q: That's right, yeah. Well you know, we've been prepared to take risks.

S: Yes and you value ... you've got judgement on that risk.

Q: Yeah I mean you either sit still and you die, or you take some risks and ...

S: And see what you get.

Q: And you die trying. People said we paid too much for XXXXX as well and then a loss turned out to be a brilliant acquisition, partly because of oil price, but a lot just because of you know, reserves and the technical work, a bit of serendipity, XXXXX's a bit the same but really you know, the reserves are way more than ... than anyone expected... you know, they may not be 40,000,000 barrels but they're certainly not five.

S: Yeah and if you'd have made your decision on five, you wouldn't have [inaudible]

Q: [inaudible] no, at the time we made it about ... [inaudible] reserves were about 10 and we needed about 15 to make ... get our money back, and of course now the increased oil price needs to be [inaudible] and the gas, the gas we got for free and it's quite a big project now so ... yeah we're just doing that, yeah.

S: No, you're doing well.

Q: Well we've had a lot of luck but you know. [inaudible] have always been prepared to back the technical people and have a go.

S: Yeah, that comes across in the word trust you used several times.

Q: Yeah, there's a lot ... a lot of empowerment, huge empowerment to XXXXX, right [inaudible] from the managing director to me, to me all the way down the line.

S: Okay, well I'm going to turn it off because that's all I'm after so ...

Q: Okay, alright.

End of recording

***Interviewee: Participant R (R)**

***Interviewer: Steve Mackie (S)**

S: To start off with, what do you think a decision is?

R: Very good question. Usually a decision involves either a couple or several points where you make a decision on which [recording skip] stop.

S: That whole ... have flexibility sitting there.

R: Yeah. Okay.

S: When you said a couple, you were going to talk about different alternatives and [inaudible, overtalking].

R: Yeah, different alternatives which is between them, or it might be yes, no, this is yes, this is going to happen, no, we're not going to do that. They're different types of decisions.

S: Tough words. [laughs] Okay, so in your situation as an exploration manager, what decisions would you make?

R: I would be involved in making decisions.

S: Okay. So some you would be involved in, some you would actually make?

R: Yeah.

S: Okay.

R: The types of decisions, whether to drill a well or seismic, up seismic, [recording skip] to in the company by people, but I suppose that's just something you have to deal with too.

S: Yeah. So all of those you would decide or you would have input to?

R: I would have input to. Some I would actually have the [inaudible, overtalking].

S: Okay, so which ones would they be?

R: Actually I'll just qualify what I said. I'm very much a person that [recording skip] out the person that has the best [recording skip] he will be putting in 90% of the information and I'd be trying to make a value judgement on it.

S: Okay. So you use group decision making a lot?

R: Yeah, but in the end, the ...

S: How do you know which ... who's the person who finally says yes or no? In other words, how do you know it's you who has to make the decision and not that you have to go to XXXXX?

R: Oh, most companies have got limits on expenditure, so it's often an expenditure thing like, you know, half a million limit on the decision of my well. [recording skip] we put up a budget [recording skip], budget has to be approved [recording skip] sit outside the budget for different [recording skip] ultimately I suppose that [recording skip], we make a recommendation.

S: If it's outside budget, but if it's inside budget ...

R: If it's inside budget, then providing it's less than half a million dollars, in my instance, I can inform the people that count.

S: And keep others informed.

R: Yeah.

S: Now the reason I ask that is one of the definitions that I use in making a decision is the allocation of resources, usually a dollar thing, that is the resource. And so the real decision maker is exactly as you've got it set up, whichever resource it is. But when I first talked of types of decisions, what did your mind run to? Have you ever thought of different types?

R: I haven't really thought about [recording skip] decisions [recording skip] type by either a financial ways of defining type, I think.

S: Yeah, okay. No there's ... oh, look ...

R: Well, there's probably a lot more than two.

S: But no, two that you come to mind immediately like that and you ... do you think that you would use, well, let's deal personally and then whether XXXXX has a formal process, but do you personally think you would deal with those ... a yes, no decision in the same way as you would with one that has flexibility built in down the track?

R: I think the ones that I spent a lot more time on those. I think that because you have to evaluate different scenario outcomes [recording skip].

S: Yeah, well one of the things that I have found in all the work I've done to try and develop these different types is exactly that, and all the ambiguity, and that is that when we make a decision, we've got some form of value judgement coming and we value this more than this, more weight, the different objectives and if you've got more than one objective, sometimes you have to trade off between them and it becomes [recording skip] and that's really what you've just said. If there's only two, well, it's easy if [recording skip].

R: Yes, we have found that.

S: Good, that matches theory. [laughs] Okay, what about in XXXXX itself? Is there a defined decision making process? You know, is there a book on XXXXX's shelf or your shelf of someone's shelf that says this is how we do it here?

R: No, no. The only thing I think that's clearly defined is the [recording skip] right. It goes [recording skip], I don't know that that can [recording skip] companies, harder to do it that way.

S: Okay. So would I be putting words in your mouth if I said that what you are saying is the bigger the company, the more formal the process?

R: I would think so. That would be ...

S: That's an intuitive thing?

R: Yeah. I mean, I've worked for XXXXX, XXXXX when they were sort of small and got bigger, and I don't know if that's a good thing, it's hard to define. I don't know how you'd handle it differently.

S: That's with ... we've found that. That's definitely the case.

R: Certainly I haven't ... I was involved in the process of trying to simplify it with XXXXX and I think we got 32 signatures down to about 8, but it's [inaudible, overtalking] quite a few people handling it.

S: The thing I found fascinating is I've interviewed a lot of government people for this as well, and their decision making [recording skip] of them are even enacted in law. In the Act it actually tells them how to do it. We don't have that at all.

R: No, you can't [inaudible].

S: [laughs] Okay, so that's type. In a process that you would go through, you mentioned that you get someone in. If you had to make the decision, you'd get someone in and they'd do 90% of the work and then you'd make a value judgement. Is that how you approach most of the decisions you have to do?

R: I suppose getting ... perhaps, deciding on a well location or [recording skip] you have the people doing the work to set up a ... they would do the work, then they would have a bit of a [recording skip] may or may not involve me at the time [recording skip] although you get [inaudible, overtalking].

S: So, what sort of things are you looking for? Say, for example, on well?

R: On well? Several things I look for anyway. First up, I need to somehow be [inaudible, overtalking]. I've got to, in my own mind, be comfortable. Well, that gets the technical side of it out of the way and once you've got that side done [recording

skip] you're expecting by having great technical work and I've reviewed a lot of great technical opportunities.

S: But there are different ...

R: If they don't stack up economically, you got to get the technical stuff right first, then ...

S: Yes.

R: So we can't just grab the economics and accept it.

S: And how do you get a feel for whether the technical work has been well done, meets the requirements?

R: Used to get on a workstation and look at it. [laughs] I'm finding that a bit more difficult now, which is why we've got these peer reviews going. So we now, hopefully, XXXXX and XXXXX as chief geologist and geophysicist, have the time to [recording skip] the comfort I've lost by not being able to have a look myself, which we used to, 'cause there are only three of us doing the work. They pick that up, but [recording skip] we try to ... we've got a fair understanding of [recording skip] to know, to do, they will alert ...

S: Yes, there's a culture here that has that openness.

R: Yes.

S: So they feel comfortable talking about it?

R: Yes.

S: Okay, good. 'Cause what I'm really looking at are these soft sides, the human side. One of the things coming through very clearly is what I'm actually calling a trust heuristic. Any senior managers like you described, don't have the time to look [recording skip]. They choose one or two people that they actually do trust. That person says it, whereas if this person says it, they're going to have that checked out. But it's just ... and the word heuristic to me is just a process that I use in my head. So you're using a very similar sort of thing. What about the tools that you use within your technical, just based on joint venture meetings I've been to, you were using the standard suite of tools that's available. What about on the financial side, 'cause you said you've got to do both? Are you comfortable with the tools that are being used in that decision making process?

R: I'm comfortable enough, but not totally comfortable in handline that side of [recording skip] there's recognition here already.

S: So you can see it coming?

R: Yeah, yeah.

S: Okay.

R: And I'm sure XXXXX can [inaudible, overtalking].

S: It's actually the case right across the board, that many oil and gas companies develop the tools for decision making in [recording skip] technical and very well, but then they just simply run a spreadsheet and you've used huge probabilistic distributions in your technical stuff and you choose one number to run the [inaudible, overtalking].

R: Yeah, well is that right? \$XXX a barrel NPV. We put some thought into how we get that \$XXX a barrel. We could do a bit better and I think where we start coming undone with that sort of work overseas in XXXXX [recording skip] whole new ball game. We've done that.

S: Yes, because you've got to develop the trust that [inaudible, overtalking].

R: And we also have to ... what they're doing, rather than just the trust, we just have to ...

S: Yeah. What process are they using?

R: Yeah.

S: And the final part of the discussion is this feedback loop, you know, this ever learning sort of idea. In decision making, the outcome is not always related to the decision and I'm sure we've all had experiences with that. You know, we've decided to do this but when it comes to actually doing it, something else happens. There's chance involved. So you know, Crows are a good example. They did all the training to be in the Grand Final but chance had it that they weren't there. So there's got to be a feedback loop, a learning loop. Do you have any formal feedback loop on any technical or economic or HR type stuff at all?

R: I suppose we've always been telling ourselves that we wanted to [recording skip] the way we want, okay, because we've just been too busy.

S: Yeah, yeah. And that's one of the problems.

R: No, we do at the end of every year, resource base that we're expecting to find, basically. All the general stuff that we use [recording skip] probably not quite completing the loop, apart from saying well, yeah, we'd like to do that so we have [recording skip] on that, it hasn't got ...

S: And that is normal. [laughs] My experience in these interviews is that that's absolutely normal.

R: Yeah. But we do check our performance. 'Cause it gets muddy a bit here because we keep buying things.

S: And that is actually one of the things that I've found, that many companies in their purchasing, when they buy a company or an asset of some kind, they have some benchmarks in there and what fails to occur over time is that those are looked at again, you know, [recording skip] because the time frame is longer. You know, for a well, it's 60 days at most, sort of thing. As for a company, it might be five or ten years and then everything changes.

R: Yeah, I'm sure that's really done [recording skip]. We actually have our wells and our results [inaudible] big spreadsheet [recording skip] back over various basins.

S: So you can develop statistics from that?

R: Yeah, you can. [laughs] [loud noise].

S: Yeah, I was going to say ...

R: They do that on a regular basis.

S: It happened in XXXXX's office when I was interviewing him too. Okay, so it is a bird. I thought there were kids with a football, but then I looked at the trees.

R: No, they fall down in the garden. They shake it off and fly off again.

S: My parents had that in the home I grew up in. There was a big glass area where they would [recording skip] be reflection or something. Okay. So we've discussed types, we've discussed the processes, we've discussed the feedback. Now, to take a decision, something that you may have decided, that actually worked or didn't work, doesn't really matter, and talk about the process you actually used in making that decision. Anything that you'd be comfortable to talk about?

R: We've talked about ... well, how about hiring?

S: Yeah, okay. 'Cause you've been advertising for graduates?

R: Yeah, we have. I can tell you the process we went through. It's probably a little bit different to other companies [recording skip] made a decision local when we hired the graduates ...

S: Can I ask if there was a reason for that?

R: We thought the XXXXX here ...

S: XXXXX.

R: ... were doing a good job and we thought that we've always tried to support them by providing an Honours student project and [recording skip] there, was particularly relevant.

S: So you've done some background, the research, and you've sort of matched where you were headed.

R: Yeah. And we thought if, you know, we should have been able to find an acceptable graduate and in fact a very good quality graduate amongst the ... of course we had the proviso at the end of course that if we didn't, we'd go elsewhere and advertise [recording skip] papers, we advertised at the school and the university as well.

S: And you got applicants?

R: And we got applicants in. That instance, we didn't have 400 applicants. 80% are utter rubbish. We deal with [inaudible] because we see them at meetings, [inaudible] so we thought that was a reasonable ... it's not one that we follow. That was the first thing.

S: Good.

R: We then had to actually say get off your bum to get their applications in at times which I felt was quite strange, really. 'Cause we [recording skip] knowing XXXXX quite well. You know, I'd ring up and say we haven't got many applications in. That kicked him up the bum. He said, oh but so-and-so, they were so excited about getting an application in, but they haven't done it yet, that person.

S: It's the same even with scholarships, there's \$2000 sitting there and, oh yeah, I'll get around to it.

R: That was the process and in terms of selecting who to interview, I would usually first up have a look at the [recording skip] split, maybe one other person. XXXXX may skim through. More often that not, we sort of agree. And if we had any disagreement, like he's [recording skip] decision. If we had any disagreement, may then have [inaudible] come in, sit down, have a yak with each three of us. Like this guy, he's a stand-out candidate, he's offered the job subject to the ... doesn't eat with his feet and can communicate. In between that, we'd obviously talk [recording skip] one very important one is that if you're not going to fit in with culture, it doesn't matter how good they are, if they will be people who are going to work well in a small team environment ...

S: And do you have any guides as to how that fits? Or is it just a feel?

R: It's a feel. It's something you can't ... and actually quantify. You can't actually write it down, because it's a feeling you get ... bore out when you're talking to people. And I know other companies like [recording skip] ah, [inaudible] situations, personality tests and then they set you up, blindfold you and when they blindfold you and [recording skip].

S: I've actually done that.

R: Have you? Yes. No, I don't know, I think if you're with it enough, you should be able to glean stuff from actually sitting back well enough.

S: Okay. So when you did that, that's a bigger company sort of thing? Is that why [inaudible, overtalking] XXXXX more human?

R: I think [inaudible, overtalking] human resources something.

S: Okay, because you've opted not to have one, which I think is a smart move. Okay, that's good. Then when you've got this feel, say you were, I don't know if you've ever been at this situation, you've got two candidates, both seem as technically good as each other, both have excellent referees, both come across well in interviews and dinners ...

R: How do you decide?

S: Yeah.

R: No. If it got down to that, if technically they were very similar and [recording skip] more weight, then just a slight different on their social ability and the fitting in, really an issue on that [recording skip] that is.

R: Other than that, he thought ...

S: Because it is something that is needed for [recording skip]. Okay. Well let me just reflect back what I heard you say. So the process you went through ... this is me, so there was a search system at the start and you'd actually narrowed that search based on past experience and that is you want it to be local because it fitted with what you had?

R: Yeah.

S: So you've had a search system. Then you began actually putting people through a process and you talked of a little matrix that you tick off things, so there was a tool that you used there. Then you used judgement based on that tool, through some form of group decision making, you got together and talked about it. And then at the end, you would expect one would come out and that's the person you'd hire, but if that wasn't the case, if you had to actually choose, you then enunciated which ones you would weight higher and essentially there's a weighting of objectives going on?

R: Yeah. That's a pretty good summary. Much more concise than mine.

S: Oh, no, no. I'm talking in terms of ... 'cause when I come back to listen to this, I've got to see which process you've actually used without having to listen to the whole thing again. Okay. So that's good. So that's a standard process, that is actually very classic decision making process you've fitting in over the top of [recording skip]. Okay. Well that's actually all I wanted to discuss now.

R: That's alright.

S: It's as easy at that. I appreciate your time very much.

End of recording

***Interviewee: Participant S (S)**

***Interviewer: Steve Mackie (M)**

M: I've given you the background. Is this working? Yes. Okay, so, the start of it is really to try and get a feel for your decision making. So what you think about decision making, what influences come into that, even down to what you would classify a decision as. So, in your position, you obviously make lots of decisions in your assessments. How long would you say decision making has been part of what you do?

S: My background is in reserves and in a lot of staff type jobs, advisory type jobs, and so a lot of times what I'm doing is evaluating either people's recommendations or their technical judgements and seeing whether or not I think they have made the right sorts of decisions in terms of reserve categorisations and things like that. So that's something really more of what I've done in the past. And then, so if you count that as decisions, it's probably not the exact same type as decision as far as do we drill this well or not, that you're looking at with some of your candidates. But then the things that I've been doing since I've been in more of a leadership role are working with guys like XXXXX and all of our colleagues to try to advance the tools we're using and make decisions on career development and training for people. So it's a number of different types of decisions. So I don't know, it's hard to say, either a year or it could be 20 years, you know, depending on the types of decisions you're considering.

M: So what do you mean by decision? What's a decision to you?

S: I'm not sure.

M: I mean, I know how we define it.

S: I know how we define it, so I can go with the context of ...

M: [inaudible, overtalking].

S: Allocate resources and achieve a desired objective. Okay.

M: So we're saying that it needs to be conscious, that it's not a subconscious thing, that it's the way you can tell who a decision maker is, is because they're the person who allocates the resources. And the reason you're doing it is get some objective.

S: Okay. And so resources can be time, money.

M: People, machines. All of those sorts of things. So what this brings out in my mind anyway is the idea that some decisions I make, other decisions I have input into, and someone else makes.

S: So that makes it easier to answer the question then because probably for a long time I've had input into decisions and for a shorter time I've had been the decision maker and I would say even now in the position that I'm in, you when a company as

big as XXXXX, somebody else often has the final authority to say yes you can fund a project again, or yes you can do this, even if we're the ones thinking that we're making that decision. I mean, we could certainly say yes or no. But ...

M: The ultimate decision of where the money's coming from is someone else, and you're really just making a recommendation.

S: Yeah, often.

M: And based on that sort of breakup, what sort of percentage of the decisions in your thinking, what percentage is actually decision making as opposed to decision input?

S: I would say probably decision making is maybe, I'd guess, 20 to 25%.

M: And that's about normal, yeah. The higher up you go in the hierarchical company, obviously that gets bigger and bigger.

S: Right. I would think that you would get much higher percentages if you talked to someone at a higher level within any company.

M: Interesting.

S: Oh, [inaudible].

M: So it's an interesting concept. Okay. The other end of it is the good decision question which leads us to our concept of process. You know where we're coming from, but what about you personally? When you're asked what is a good decision, what's the first sort of thing you think of?

S: If you've made a good decision, it should be ... I mean, it's nice if it ends up being the right one, but that's not always the only criteria for a good decision, I think. It can also be that you've investigated all the options and made the logical decision, even if the result doesn't end up being what you had hoped would happen. And I think that we're seeing more ability in our culture to do that which we kind of view as positive, because there's not quite as much shoot the messenger as there was. And so, and that's all kind of around that culture of being able to make a decision that's a good or correct decision without it having to be the right choice.

M: Okay, so when you say our culture, you mean XXXXX ?

S: Yes.

M: Okay. So the company decision of what a good decision is, is getting more to processes?

S: Yeah. It's getting more to processes, yeah.

M: Okay. 'Cause as I go through this, I'll be looking at what you think and then how that fits with your company think. So I'm trying to pull apart ... that's where I'm trying to get rid of the motivational biases if they exist there.

S: Okay.

M: The other thing that fascinated me at the beginning, I don't know if you use the word because we have just used it, but you talked of different types of decisions. So you said it depends on the type of decision as to whether I'm making decisions or I'm not.

S: Oh, I guess what I meant there probably could have been alluding to the input versus the actual making of the decision. I can decide what training course I'm sending someone to, or whether I'm moving XXXX to XXXXX, or things like, you know, there are things that are under my control and there are things that I can decide that it's a good idea for us to fund XXXXX again and tell my manager that we're funding XXXXX again and try to get him and everyone else to sign on the dotted line. So I'm not really making that decision. I'm inputting that.

M: So the way you use the word type in the beginning was really this someone takes some of the input?

S: Probably so. I think that's more likely to be what I meant as opposed to not... because I remember seeing your paper and we talked with XXXXX a little bit about your project back in XXXXX a few weeks ago when they were there. But I don't remember the way in exactly in which you're using the types of decisions.

M: So when you use the word type of decision, do you use it often or are you using it because I used it in the introduction?

S: I don't know. I don't think that I commonly consider "type" of decision. That could be an anchoring bias.

M: [laughs]. Very good.

S: Or a recency, or something. I just heard that.

M: That's right. That's why I ask. Okay, well let me run through this typing that I do, and then I'll explain how I got it and then I'll use some of the scenarios that I use. So essentially the end point, at the end of this working up a taxonomy, we worked out that underlying all ... and we believe it's generic decisions, so not just oil and gas, although that's what we came from, these four dimensions. The first one is complexity which deals with obviously how complex the decision is, and that could be that it's a decision that has lots of other decisions that flow on from it, or it could be that there is a lot of analysis needs to go on in order to make a decision. It can run from high to low. Task constraints, you know, you've talked of time and capital. They're the two main ones. But resources are a big one. You can think of hundreds of constraints. And what we've found is that it is not necessarily what the constraints are, but the number of them. So that in our taxonomy, we've run it as an increasing number of constraints.

Ambiguity is the word we've used to talk about the value functions, so when you're making a decision, you're going to use value functions that put it together. XXXXX talked about EV, but the other one is you may put a value function on living in XXXXX as his example. And therefore the more of these value functions you put in, you're going to have to then begin weighting the value functions. And that's where ambiguity begins to come in because you're never ... one moment you may weight the living environment, the next moment you may weight the salary. And so that's where we're saying ambiguity gets there. So essentially the way ambiguity increases is the number of increasing value functions. And then the final one is the environment of information structure, so that is essentially we've called it a dependency structure, so in a high dependency structure, it's the information to get to make the decision, get another piece of information that's actually the same as the ones I already had, and so it doesn't really affect making the decision.

S: Okay. So the dependency amounts at the information that you get? Okay.

M: That's it, as opposed to low dependency. I've never made this decision before. There's no process lined up as to how to do it. I'm just going to have to wend my way through it. So obviously the more to this side of the taxonomy, the more difficult the decision is, the more to this side. And that's why we've come up with all of these sorts of ... 'cause they're just lines along this dimension. Just talk about that. So how did we get there? We put together 20 decision scenarios from the oil and gas industry and essentially asked people to compare how similar or dissimilar they were. And from the psych guys, they've used that methodology to actually pull apart lots of other decisions and find out what underlies the way people make decisions. So it's a proven technique that I'd never heard of before, but implemented it and it actually worked very well. So the reason I background that is 'cause I've got all 20 scenarios here and what I want to do with people is now, instead of taking about whether they're similar or dissimilar, actually just choose a couple at random to have you talk through the process you would use to make the decision. So rather than what is your decisions, try and vocalise what's happening in your head as you're making the decision. Is that clear?

S: Sure.

M: Okay. So, I haven't gone down to the bottom end, so I'll start with number 20. So if you just read through that.

S: You want me to read this one out loud?

M: No, I know what it is, yeah.

S: Okay, so in this example, we're shifting proved out of ... we're shifting 20% out of proved into probable, basically, based on SPE guidelines, which is interesting to me because if anything, in the system that I work in, we go by the SEC guidelines which are already much more conservative than the SPE guidelines. And this whole scenario is ...

M: Is opposite to what you're used to.

S: It's opposite to what I'm used to. So, but then, given that observation that this would be a totally hypothetical example, for some company?

M: Yes.

S: So ...

M: But it's not too fictitious.

S: Perhaps in some cases. But I can only respond as a hypothetical.

M: Where SEC doesn't apply.

S: Doesn't apply? Right, absolutely. Okay, so the market response by removing 20% of the value of the share price, what should the company do? I guess though rather than wanting to know exactly what the company should do, you want to know how I would attack this?

M: That's correct.

S: Okay. So I guess I would want to investigate and understand whether or not the hypothetical company did a good job explaining the difference in the two bases of prove reserves in that point, and show what are proved and probable in the old bases was and in the new bases, so that you're not just showing proven. ... I guess another thing to consider is whether or not that the market's response is correct. Maybe it's appropriate that the market responded that way. And so the company should consider that as a possibility and maybe they don't do anything. Maybe they just suck it up. And that should have been anticipated as an outcome.

M: So how would you go about actually making that decision to decide whether the market is correct or the market isn't correct?

S: Interesting question because I don't think I'm the person who'll be doing that.

M: Okay. So it's beyond your experience?

S: Yeah.

M: Okay. So what you're now going to say is I have no idea, but ...

S: I have no idea but ... [laughs]. I would think that someone in the X group would verify that the hypothetical company did it all right, before it had ever happened. So I guess you would have to go with the assumption that the task has been done correctly, but I think that the company would be tempted to check all of those things. Was this a decision or a response that was anticipated and if so, they've already planned that they wouldn't respond. If not, why didn't the company anticipate this and not for a shoot the messenger kind of reason, but how could they improve their anticipation of that kind of response and what should be done about it. So I think

that someone at the XXXXX level of a company like that, would talk to technical groups and make some sort of more corporate response than someone like me would ever be involved in. I don't know. I'm kind of struggling with it.

M: And that's fine. If I flip that over, what I've done is type it and this one comes out as a very ...

S: That's a hard decision to make because, yes, ...

M: So much is going on there.

S: So many things are happening there.

M: That's correct. And now that I've got your initial response, let me talk about it a bit more. This is such a complex sort of decision. Do you think it could be made by one person?

S: Oh, no. I don't think it should be made by one person. I think that in the end, the final decision would be made by one person, but I think it would have input from a great number of people, from a number of different parts of the company. And presumably even in a much smaller organisation, it's complex enough that it would ... and to use your own words, there are so many tasks, so many issues to look at, it's ambiguous because there are so many different factors. There could be soft factors in the market also. You know, there's a million things that could be going on, but I think a company would be taking input from a number of people before one guy finally makes a decision.

M: Okay, good. So one of the things that I'm investing is the more difficult the decision, the more people involved in the input. Is that a recommended process or does that actually make the decision more difficult itself?

S: Well, I think that the ... it's not just a matter of the difficulty of the decision, but the impact of the decision. So I don't know if you have that kind of built in. But we have a kind of, at least in our XXXXXX process ..., what we would talk about is kind of a fit for purpose criteria. And so if you could expand that thought process and apply it here, you know, the more complex or the higher impact or value, then the more work you do. And you might use that as an analogue where in a similar manner, the more of your complexity task, constraints and ambiguities that you get, or as you say, the more difficult your decision, it becomes fit for purpose to do more work or involve more people or consider more pressure.

M: That's a good one. That's a little heuristic that can be used. Okay. Having used that one to get the juices going, are there some decisions ... and really what I've asked people is to either come up with one or two decisions that you've made in the recent past, hopefully one that's had a good outcome, and one that's had a bad outcome. And talk about what the decision was and what process you actually used and why you think one's good and the other bad.

S: So, decision ... okay. So a decision that I recently made was to ... let's see. What do we want to go on record with?

M: Yeah, and that's the problem. [laughs].

S: Okay. What I can do, I'll keep the person anonymous, but to organise a transfer for someone recently. Person X was very interested in moving overseas from XXXX and had kind of a general background in combination with some of the speciality work that we do. And was needing to get some additional training prior to moving. And so just in terms of the decision to move Person X into our group and then overseas, that was our general plan, for some additional training and then the move. And the prior team, you know, was pushing back, so from a standpoint of resource availability, it was hard to pull that person, even though before we could move overseas, Person X needed it to be pulled. And you know, I guess I ... well I kind of decided that for this person's career development, that's what we were going to do. And it became more of a negotiation and convincing of other people that that's what we were going to do and why we needed to do it and so forth. Some of the good components about it were that there was a lot of ... well let's see. What kinds of things did we consider? We considered if we don't make this move for the person, they're going to be ... it's kind of a two stage thing. We don't make a move into the group, Person X going to be less prepared to move overseas. If we don't move Person X overseas at some point, they might be unsatisfied and move overseas potentially with some other company and we didn't want to risk that. So it became a high priority, in spite of the fact that there were resource constraints for the original team, and training constraints for the individual, we decided to go ahead and try to make this happen. And there was actually a call from the overseas location that they were needing someone anyway. So for a number of reasons, it was a reasonable thing to do. But timing wise, it didn't end up being ideal because there was pull from the prior organisation and pull from the future organisation and so the amount of time Person X was able to spend doing development in my shop, working with the other guys, was more limited. So good and bad outcomes. I mean, the final outcome was good, but the path which we got there wasn't ideal. And I'm struggling with whether that's the kind of decision we need.

M: That's perfect. That is perfect.

S: Okay. It's a ... I mean, there were certainly multiple components to it.

M: Yes. So if we go through that, because you've tweaked a whole lot of things for me. I hope I just remember them all. If we try to type that decision, let me tell you what I'm hearing and then you can tell me whether I've heard it right or not. It actually wasn't all that complex a decision because ...

S: Right. We'll move Person X from a, to b, to c.

M: That's it.

S: Right.

M: The constraints however became, were very difficult within the decision. And that was ... it wasn't just a constraint on the group that Person X was leaving, it was the constraint of the group that X was going to eventually go to as well as the constraint ...

S: Constraint within my group.

M: Yep. So each of those begins to add up. Was it ambiguous? I believe no, because the value function was we value this person enough that we'll go through this in order to keep the person. So you know, the value function you're using is probably just one, back down this end. The environment of the information structure. In other words, have we been through this before? Is there something we could have learned from the last time we went through this? I haven't heard.

S: Well, I guess that's an interesting point. In my role ... the job that I have right now, I've had for little less than a year, so I've moved people around, but nowhere near in such a complicated manner and I had not yet moved anyone overseas. And so I had no idea of the impacts of Visa constraints and all the other factors that become involved in getting someone lines up. So yeah, somebody knows how to do that, but did I have all that experience? So I'm at least in the middle, if not further over.

M: So these two dimensions are low, these two dimensions are high.

S: And that doesn't look like anything on your board.

M: So I'll put it up there. So as I hear it, it's something that looks like that.

S: Yeah, that's kind of an odd one, isn't it?

M: Yes. That's why I liked it. Don't come across them too often. Okay, now, and the process you went through appears to be a negotiation type process?

S: I think so, yeah, really on both ends because the individual wanted to move and we wanted to move individual. So then it becomes in our organisation a matter of finding the right job fit for that person. So I look at all of the overseas locations that need those type of skills and say, you know, there are three spots in three different countries. You know, what's the timing on all of those locations, what other candidates are available, what ability do I have to secure the opportunity for my candidate versus some other person's candidate, and so on. There are a lot of other factors. And then I guess the other points are that it becomes a matter of not just timing, but how soon can we pull X from the other group. We wanted to have X in our group for about six months, but we ended up getting squeezed on both ends because when the opportunity finally became available, and we had it identified, we thought it would take several months to get the opportunity firmed up and then several months to get all the paper processing. And then it ended up turning around much quicker than that even though we were told it would often take three to four months.

M: So it's like [inaudible]. And so the reason I jumped on ... I think it's an excellent example, is because it actually highlights another part of decision making that's

not often talked about, and that is when you make the outcome itself, it's hard to so ... I feel for the poor person that's going to be transcribing, 'cause I'm drawing. But that's fine. When you have an outcome, there are three things that actually influence it. That is the decision itself, but then there is implementation and there's the chance factors like you said, you know, it should have taken six months, but it could have been done in three, so that's a chance thing. But what you're discussing here is a lot of this implementation process. So when you're looking at whether the decision had a good outcome or a bad outcome, you know, you've sort of said well the decision itself, the process we used, was actually quite good. But implementing it didn't come about as well as we would like because of the chance factors that are going on. And one of the things that I'm looking at is we talk about feedback loops, look at the outcome, post project review, whatever word you want to use, but you look at the outcome and how is that different from what we decided, how can we improve. But the other feedback loop that I think is just as important is this implementation feedback loop. So when I make the decision, I have an expectation of how it's going to be implemented and do I look at how it's implemented and how I can then improve the implementation or at least when I'm making the decision the next time around, I will consider that more often.

S: So, you know, I'm not ... on the implementation piece of that, I think that in my mind, it might have been ideal if X had been in a group a little longer, but I still don't see that as negative implementation because we were able to accomplish what our ending goal was and still satisfy the minimum requirements for having X in our group. So had that whole thing fallen apart, I would have said that I agree with you more on the challenges of the implementation. But I don't really see that as a big negative.

M: Good. So I've mis-heard that. Thanks for clarifying that.

S: It would have been ... I think a little bit of it is just the experience factor of it being a bit of a new process for me and not being completely sure how the flow would work with moving someone overseas, but yeah, I'll admit that I had kind of a map in my mind of how long different stages might take, and things. But with loads of people, we would just move them directly from whatever they're in, just straight to the next one.

M: Whereas this one, you wanted to train them up prior to going.

S: Yeah, we wanted to give X an opportunity to work a little bit more closely with some of the group before X left.

M: Okay. Well thanks for sharing that one. That leads me into the last part of the interview which actually talks about were there actually processes laid down in some law book, XXXXX book of how to transfer people, and you pulled it off the shelf and you know, it says do this, do this, do this. Or did you have to discover it all for yourself as you went?

S: The law books? There probably are fairly well fairly well documented processes. As far as some steps of it, you know, it's very procedural. Fill out this form,

you talk to these people, you negotiate the process with those people and other parts of it are a little softer, I think. You get XXXX involved and it becomes more complex, I guess, if you go back to your taxonomy. The number of people. So I can say, yeah, I'm moving person A from ... project one, project two, project three or country one, country two, whatever way you want to look at it and I can say yes, that's going to happen and I know what forms to fill out and things. But there are lots of other steps that are involved as far as selling houses and all those kinds of things and there are definitely manuals and procedures for all that. I just don't happen to be aware of all of them because they aren't my piece of ...

M: Expertise that's required?

S: Right. They aren't my piece of the implementation, I guess.

M: So you'd say that XXXX has formal processes, but certain people are responsible for parts of that process, and they should know it.

S: Yeah, so I know my piece of it. Somebody else knows the pieces that ... well, I don't know, buddy, you got to go and talk to so and so about that.

M: In the decision making, the formal process, we've talked about a process for transferring a person. Is the person generic that is applies across the board or is it specific to transferring people? Or in other words, is the process documented in such a way it would also apply as to how to shift, say, a lead to a prospect to a drillable prospect?

S: A lead to a prospect to a drillable prospect? Well, there is certainly a classification system and a set of criteria that you would look at and databases that we track those things in, just like we would track people and where they are. And so it might be similar in some ways. I mean obviously, you're looking at more technical types of criteria.

M: Yeah. I'm looking at whether the process that a company has is very specific to a specific type of thing, or whether it's a generic process. So for example back earlier, you talked of this fit for purpose criteria. That's a sort of generic thing that you can overlay on top of any process that's going on. And I'm just looking as to whether ...

S: Transferring people, I would think, would be quite different really and I mean, there is a process, it's similar in terms of the fact that there's going to be a process and a structure that we use to do that, that the technical teams go through and they review processes and things and the decision maker is going to say, yeah, it's ready to progress. It's going to pass that gate, there's a gate review process at different places. But it's a different set of criteria.

M: Good. Within your expertise area now, so within your XXXX area, tools and processes, I assume, are fairly well defined?

S: Yeah, they are, and there are options within this fit for purpose concept that we talked about before to choose different tools or different levels of detail, I guess, depending on the complexity of the project, the size of the project. But, we have a standard set of recommended practices and I would say that particularly within the XXX stage of process.

M: Okay. So it depends on where you are in the decision train.

S: It depends where you are in the decision train. It's going to be a different tool set and level of worker type. But there would still be what we would still be what we consider to be best practices and then there would be exceptions to that.

M: So you have a concept of best practice and what fits that? Okay. Do you use any external software, methodologies, ideas at all, or is it all internally XXXXX generated.

S: Our XXX software is for XXX roles, and it's also often used (for other roles) but not exclusively, is an external vendor product.

M: So you do use external things as well?

S: And obviously our interpretation software and things like that are now all extremely [inaudible].

M: And the reason for that?

S: Well, the reason we do it for the XXX software is so that our limited number of experts don't have to get wrapped up completely in developing software. You know, we narrow (the work focus of) our experts [inaudible],

M: Get the job done. The final bit of it is this feedback loop. So do you have a formal feedback loop, so a post-project review or post-project testing, or what?

S: Yes, we do. So we have a pre-drill, post-drill loop. There's a drill well evaluation process and so then I suppose with regard to other types of decisions, are there feedbacks and I guess it depends on the type of decision we're talking about. So is there a feedback loop on the transfer process? Well, very informal, I'd say.

M: So, formal for well, informal for people.

S: Yeah. There's a formal feedback process, you know, as you know, for performance. So on the people side, there are some processes that are quite formal. But I haven't gotten any formalised direct feedback on the process of moving this person overseas, for example, but we get performance feedback in a very formalised way.

M: Do you ever then look at this implementation? So in other words, when you're looking at ... you normally look at the outcome, but in the feedback do you ever look at the implementation? So in other words, perhaps if we had implemented it this way, we may have got a more optimal outcome?

S: Implemented the same decision differently or ...

M: Yes. Or actually looking at our decision, when we made the decision, we had in mind that this would be how it was implemented. Do you ever go back and check that that is how it's implemented?

S: Well I guess in the example that we talked about, informally we did because we thought it would be move at about this date, we'll be there for about this long, move on about that date. But I don't think that it's unusual to expect that there's some flexibility in those things. So it depends on how much out of gauge they are, whether or not it appears to be a problem with implementation or an expected amount of ...

M: Driven by how far out.

S: Right.

M: So for example, right now, @Risk from Palisade have added a new module to Microsoft project, so that dates can have uncertainties around them.

S: Oh, okay. Yeah.

M: So you're using the same principle of uncertainty that we're used to in oil and gas, but you're now applying it to project management which is tending to be what you're talking about.

S: Yeah, and I think that's a good build on the answer, depending on the type of situation that you're looking at because as you mentioned, a lot of the answer to the evaluation that we're doing in XXX is around sizing and risking of volumes and presence of hydrocarbons and things and what sub-factors, succeed or fail to make that happen. But some of the other types of uncertainties that happen on the softer side or on the people side tend to be more around product planning and dates and things. So who do you have, how long will it actually take, did you remember to unpack everything and look at two weeks vacation? No-one has only two weeks of vacation. You can't plug that into the project plan, you know. There's x number of holidays and x number of weeks on vacation and we're all XXX now so we have lots more weeks than we used to.

M: That's it. It's interesting. Okay, that covers it.

S: [inaudible, overtalking] that is even remotely what you're [inaudible].

M: There's no right answers, so you don't pass or fail.

S: Okay. Well, thank goodness.

M: It's not like XXXXX's. You won't get a feedback as to whether ... the one number I am after, though, and this just helps me feel how strongly your feeling about what you've talked about, and that is if you were to compare your processes, so your

company's processes of decision making with a competitor, or a group of competitors and that doesn't matter who they are, but people you see as competitors, on a scale of zero to five, zero being we're way worse than they are, to five, we're miles better than they are, where do you think you would put it?

S: That's interesting because I think it depends a little bit on ... I think we're way better at some stuff and not as ... maybe more average or not as good at some other things. And so that's kind of hard.

M: So which ones do you think you're way better at?

S: I think we're very good at most of our technical processes.

M: Okay. So, XXXX for technical process.

S: And I think we're improving on the softer side of things, but that ... we talked about the XXXXX that used to exist versus the ...

M: XXXXX that exists now.

S: The XXXXX that exists today, and I think that there is a big change, but there's still room to improve on these things.

M: So it's more around XXX for the softer side?

S: Yes.

M: That's terrific. That just helps me get a feel for what we've talked about. Thank you.

S: Alright, you're welcome.

M: Was it painful?

End of recording

***Interviewee: Participant T (T)**

***Interviewer: Steve Mackie (S)**

S: I don't believe that everyone is in frequent decision.

T: Right.

S: Just talk about that.

T: The things what ...

S: What you'd actually talk about, yeah.

T: Okay.

S: So when you say that you ... you know, your role's a technical role, and decision making's infrequent, what do you think a decision is?

T: Well my perception of a decision is perhaps a slightly old-fashioned view of a manager kind of saying yay or nay to something involving allotting resources or budget, or committing to an action, like drilling a well or doing a project or going on some path, yeah a strategy, a path, a pursuit, business objectives.

S: Okay.

T: Yeah.

S: That's our definition.

T: Right.

S: Exactly right, so here's a ... here's a just flash [inaudible], decision is conscious, so as opposed to some decisions are actually ... some things that people may call decisions are subconscious, but we're saying it's conscious, it's irrevocable, so having made the decision, you can't actually change it. That ... that is difficult because some people say as I'm implementing, I can be modifying as I go.

T: Yeah, yeah and I suppose in some circumstances, if you wish to back up and go down a different path, that could be possible.

S: Correct.

T: It might be embarrassing, but it's possible.

S: That's right.

T: Yeah.

S: It's an irrevocable allocation of resources which is exactly what you've just described, in order to achieve a desired objective. So very simple terms.

T: Right.

S: So based on that, do you think you make decisions?

T: I probably make more decisions at home than I make at work.

S: Okay, okay, okay.

T: I mean at work sometimes I make them in terms of the resource being my time, yeah, so I suppose in that case, yes. If the resource is my time, I have to decide which of the competing priorities is going to receive my attention on any given day, week, month or whatever, and that is a deliberate act of allocating resources, and it's conscious, yes, so yes.

S: Good.

T: Yeah.

S: And that's what we try to get to, that everyone's involved in making decisions, they're actually the very basis of how we actually live, and ... and we tend to think that other people may govern what's going on, and ... and they have an influence, and ... but it's the dec ... we are making decisions, but that then leads us to the next question, which is okay if I'm making decisions, how come I didn't think these were decisions and that what other people higher up the chain of command were making was a decision?

T: I think we also from the ... from the ... from the conceptual road block that management ... the word management describes people above others, regardless of what level you're at, so if you're a vice president, management is the president and the executives.

S: I was saying to XXXXX, I wondered if I interviewed a couple of CEOs that they would seem to indicate that the person who made the decision was the shareholder.

T: Yeah, that's just a slightly different perspective on yeah, yeah.

S: Yeah.

T: They're answerable to a different body of people.

S: That's right.

T: But think ... I think part of the reason why many people don't believe they make a lot of decision is it's kind of a second nature, it's like breathing, you don't think to yourself I am now going to make a decision, it's just something which you do, and only when you've thought about the definition and had a conversation like

this, you maybe appreciate that more things that you do in your everyday business are decisions rather than just going about your business, yeah.

S: That's right.

T: But I think there is perception of us that we just ... the word decision I think in a vernacular sense within petroleum industry is associated with the you know, the high powered executives and board rooms and managers, you know, spouting sagacious advice over a meeting to yeah, so it's probably a perception issue.

S: Do I take over XXXXX or ..?

T: Yeah, yeah.

S: And ... and what I lead onto from here is because it's a ... a decision is as you've now described it, more or less an everyday thing, the reason I believe most of us don't actually think that we're making decisions at the beginning is some of them are subconscious, but others, it's because we actually think of decisions as different types of decisions, so that if I were to ask you did you make day to day decisions, you may say yes, whereas if I say did you make a decision in the last week about taking over a company?

T: No, yeah.

S: And so we tend to actually think of them as different types.

T: Right, yeah.

S: And that's why I'm chasing this down.

T: Right and there's also ... there's also other ways you could look at it, 'cause I noticed the bottom bullet point here is two or more alternatives, a decision involving the choice between two alternatives is a completely different process than a decision involving the choice of many alternatives.

S: Correct.

T: Yeah because if it's only two, looking at it from a very perhaps naive standpoint, its potential is simpler, it's certainly more attractable in terms of its under ... in terms of understanding what you have to work with, whereas more alternatives theoretically could lead one down the path of doing more analysis, being so overwhelmed that you just guess or go with your gut or follow [inaudible].

S: Yeah, because there's too much information.

T: Too much information, I can't be bothered, this one looks good, let's go for it, yeah. It's like trying to pick the mortgage company you know, there's so many out there, it's just this bewildering blizzard of information about who's got the best rate and blah, blah, blah. In the end it usually boils down to which reps been nicest on the phone.

S: That's right, who will give you the money.

T: Yeah, yeah, so ...

S: We actually ... that's actually part of what we've found in this taxonomy, that you've seen me talk about ... because what you've described is one of the dimensions of that taxonomy, and we've found that the four things that underlie all decisions are its complexity, the number of constraints, we ... we initially thought it might be the type of constraints, so in other words, if I've got to make a time constraint decision, is that going to be different from a capital constraint decision? But it turns out that based on the way we've analysed this, it's simply the number of constraints which is what you've talked about there.

T: Right.

S: Ambiguity is the value function that you're using to judge.

T: Yeah.

S: So if you just ...

T: If it's clear cut or not.

S: That's it, and the more of them there are, the less clear cut it becomes, and that's why we've called it ambiguity, and the last dimension is information structure, and by that we mean more of this type of information doesn't actually help me make the decision, it just adds information, whereas a low dependence structure is one where if I add another piece of information, yes that really does help me make a better decision.

T: Yeah.

S: Yeah, so they're the things that underlie it and you've talked about intuitively several of those in the way you've talked. So the way we got this was putting together 20 different petroleum scenarios, decision making scenarios, just hypotheticals that have been pulled out of the air, based on experience, they've got to come from somewhere, but you know, they're not exactly what happened. And ask people to compare their similarities.

T: Right.

S: And let them choose what they were going to base that on, and these were the things that distilled out as the reason they separated and combined things together.

T: Right.

S: So that's how we came up with it. I was going to give you a copy of the paper that runs through it.

T: Right.

S: So you can get an understanding. But what I want to do is actually give you one of those scenarios to talk about, these are those flash cards we talked about, and I'm just choosing them at random for people, and it's in a Monte Carlo simulator, if you very rarely sample from the extremes, and I notice I've not been giving one and two and ... but anyway.

T: You live [inaudible].

S: That's right.

T: Yeah.

S: Okay, so this is scenario number five, so if you just want to have a quick read through that and tell me ... have a read and then we can talk about it.

T: Okay.

S: Okay, now what I want you to do is ...is as you've thought about it, I don't actually want to know what your decision is, but rather what process you have gone through in thinking about it or will go through in trying to come up with it.

T: Right, well I guess ... I guess what you'd have to do is you'd have to prioritise which element of the situation is the most critical to address first, it's kind of like the medical triage analogy, so my perception would be ... preventing loss of further life would be the first priority which would be evacuation of the site, the second priority would be the environment, although you know, the environment's important, you can clean it up whereas you can't bring people back to life, so that would be the second priority, so having gotten everyone out, let the fire rage if necessary, then tackle the environmental issues, you know, put a boom around it or a bit of foam on it or whatever it takes to mitigate that impact is the second priority. And then the third priority should be the actual capital infrastructure which is the least important, although obviously expensive, it can always be replaced, so you know if the ... if the drilling rig's buckling and melting and what have you, well that's just too bad, we can buy another one. And so then bringing skilled people in to put out the fire would be my third priority, so my ... my strategy for this decision will be prioritisation of the importance of the various elements who were affected by the incident, were the people coming first, the environment second and the actual steelwork and the kick blast.

S: Okay, yeah. So you've gone through a real defined process as you've thought about that. Can I ask you a couple of questions about it?

T: Sure.

S: When you started thinking about trying to solve the situation if I can call it that, did you actually have a yes/no question in your head about whether I have to do this myself or should I get others involved?

T: I didn't really think about that to be honest, I ... I was thinking more in the collective of what the body of people involved should do.

S: Okay, so ...

T: I'm not ... does this ... I mean this ... this flash card doesn't actually speak in the first person to tell you what your role is.

S: That's right.

T: So of course, whatever your role is would be part of whatever strategy was implemented, and so if you were a fire fighter, you'd be coming in to deal with the problem of the burning, if you're a medical evacuation specialist, helicopter pilot, you'd be in there ...

S: Doing ...

T: Pulling the people out first.

S: People out. Okay, okay, so when you were responding, you were responding as a group.

T: Yeah.

S: Yes?

T: Is the kind of ... the overall ...

S: In your head you saw people sitting in a room sort of making decisions about how to do it or ..?

T: I would imagine that there would be ... my hope would be that there would be one person directing the whole thing, not a group of people.

S: But why ... why that?

T: Because I would imagine it with a group of people, there would be a ... the process would be retarded by discussion of conflicting priorities.

S: Okay.

T: Even if they were implicit rather than explicit.

S: So because of this ... the character of this sort of decision, can be achieved much better with group information but one ... one controller?

T: Yeah, and it's like fire chief on 9/11 you know, he just told everyone what to do and they went and did it, if there'd been some committee sat in some building, it would've been a mess.

S: Even more horrendous.

T: Yeah.

S: Okay, let me flip that over, because what we've done is typed this type of decision by saying yeah it's very complex, lots of constraints in here, high ambiguity as you've picked up very strongly, but we've said well hold on you know, maybe more information isn't going to help in actually making the decision.

T: Yeah well I think that's true, because I think the ... there's an emergency aspect here which means that you ... regardless of whether it would help or not, you've just got to get on with it, give them your best gut feel as to what you feel you should be doing, because the more you fap around waiting for information, maybe there's people dying out there, you know, there's oil leaking into some wildlife reserve or whatever it is, you know, so you have to go with the best information you have right now, and stay with your convictions and get on with it, because the somewhat emergency nature of the situation.

S: No, that's good, so emergency leads to strong ... these are my words, strong leadership.

T: Yeah.

S: Because we need the one man ... one person.

T: Somebody directing the orchestra.

S: Yeah, yeah, very good.

T: Yeah.

S: Okay, thank you. Can I give you another one?

T: Sure.

S: Try another one, because these are very different. This one's number 15.

T: Okay.

S: So, walk me through how you or the group you're in would go about making this decision.

T: Right, well I think the senior reviewers, the first thing they would have to do would be to have a conversation with each other to make sure that this error really is what it seems.

S: Okay, so does the error exist?

T: Yes, you know, so we don't jump the gun and start all sorts of rabbits running around and then try and have to rein them in when we realise oh well maybe it's not as bad as what we thought, so that would be the first thing, you know, have some kind of senior peer review to make sure that the ... the error really exists. If the ... if it's found out that the error does exist, then I think it's behest of those senior reviewers to communicate the problem, up the technical chain to the point where that synapses to the executives, and in the interest of full disclosure, they have to tell all the interested parties that there's a problem and kind of fess up, and then the managing director then has to obviously make a ... a judgement about how that information's going to be released.

S: Okay.

T: And I think finally the other thing is that somebody needs to probably look at the way that the company is being run in terms of assigning high profile tasks to staff that maybe do not have the necessary experience, or have had inadequate mentoring, so I don't think anyone would blame the young geophysicist, it's probably [inaudible] deficiency in the way that that person was mentored or monitored, and so that would require the group involved to critically appraise how they were allocating resources. You know, if this is such a big flagship project, then maybe that person should have had some help.

S: Okay.

T: Yeah.

S: So there's a learning phase.

T: A learning phase yeah, but I think the ... you know, my perception is that you, you know, the truth sets you free and you are ... you own up to the problem and take it from there, yeah. And it's full disclosure all the way, up and down, yeah so the senior ... the senior reviewers I think first of all need to make sure there is a problem, understand what the problem is, and then make sure that the people that are talking at the higher level, understand the implications, and can therefore make additional statements to modify the original press release or wherever it was out to the marketplace.

S: Okay, no, that's good. With the juices flowing, let's ... let's have a look at this one, so this one is ... we've typed as fairly complex or difficult, I ...

T: Yeah it's [inaudible] stakeholders.

S: That's right.

T: Yeah.

S: Yeah, and it's going through that, and these ...

T: You've got technical and ... and company credibility, the individual reputations within the company, and you've got the collective company reputation to the outside world.

S: Yeah, so all of those are involved. Any ... you said that you didn't make too many decisions, but think about decisions that you have made over the last say six to eight weeks. Is there any ... even ones that we may classify way back here, that you would feel comfortable just saying what the decision situation was and how you went about making the decision?

T: Sure, I mean what ... what ... what ... I guess one of the decisions that I have to make often, now having understood the definition of decision that you're interested in exploring, is the allocation for my own personal time, because I'm one of the company's XXXXX, I've got no shortage of people knocking on my door and calling me and sending me emails wanting help, and because of the type of person I am, I like to help them, but over the years I've realised that that just can't be fitted into a normal lifetime, and particularly in the last six to eight weeks, I've been preparing for this and that, and so I've had other draws on my time, plus moving house. I've had other draws on my time which have limited my ability to make everyone happy and [inaudible] the help they need. So I've had to be very disciplined about which pleas for help I've actually agreed to, and some people have not bluntly, but had to politely say I'm sorry, I can't help you. And the criterion that I've usually used to make those decisions are my perception of the true nature of the emergency, which is a judgement based on past experience about whether that person is the cry wolf type or whether they really do need this help right now on this project, and there's a second dimension to it as well. When people ask you for help, you often know the person who's asking you because you've worked with them for years or you know who they are, and it's like anything in life and anything in ... even in science, different people have different strengths, intellectual and conceptual strengths, and within the pool of people that I help, which is theoretically everybody, there are people who clearly have a lot of building room ahead of them for absorbing more skill and information about assessment, there's a lot of growth potential because they get it, and then there are other people who, in the nicest possible way, aren't tuned in to what assessment's about, their skills lie elsewhere, and they're skilled people, as is everybody, but no amount of persistence will really get that person to a high level of expertise and assessment. So I have to make the decision about you know, how much time do I allocate to person a and person b? If person a is the one who's adept with assessment concepts and I think has running room, I'm much more likely to not only answer the question that they pose, but also kind of build the discretion beyond that into the kind of hinterland that the question came from, try and build the skill in that person, and therefore promote their own self sufficiency. The second person who maybe doesn't have that running room, I'm much more likely just to tell them what button to push. Not to be mean or to get rid of them, but just to get them over the hurdle that they're facing so that they can get on, but not invest a lot of time in a discretion which probably won't flower beyond that point.

S: And the choice ... how you categorise these people is based on your past experience with them?

T: Yes, yes it's based on past experience, and of course that's a dangerous one because sometimes that can be misleading, or if I've never met the person before, I don't know, but most people I have seen because I've taught training classes or I've worked with them on projects and so I know a little bit about them, and you can usually tell from the way the question is asked, whether which category or where in this spectrum this person lies, just because of the you know, the words they use and the type of question they ask, you can usually determine whether they just need quick help, show me which button to press so I can get this picture out to the manager and then I don't care anything else about assessment or I really only use this software, I really want to apply these concepts, and show me how to make this happen, and what else I can get out of it that's important for people to know. So a lot of it is subtle clues to do with verbal and body language, previous experience, usage of the correct terminology in the question, and ... and ... and ... and interaction with people at training classes.

S: Okay, so would I be right in saying that XXXXX doesn't have a book on the shelf that you can pull off and helps you through this sort of decision making process?

T: Then no, no. I mean I don't think this type of decision is any different from the kind of decision we make every day when we're interacting with people outside of work you know, if we meet someone in the street who's just been hit by a car and they need a ... you know, they're bleeding, you obviously pay much more attention to them than you know, somebody who's griping about the fact that they can't find the bus stop, you know, you just say it's over there and you know, you don't go into a debate about placement of the bus stops and whether it's the most efficient way of getting round the city, it's just it's over there, whereas the person who's been hit by a car, clearly there's ... there's much more depth to the problem that has to be addressed, yeah.

S: Okay, the process you've just gone through, if we've got to break that down, well let's break the decision down first and then we'll talk about the process, so that type of decision, deciding how to allocate time under a time constraint world, on this taxonomy, how do you think you'd go about doing that? So ... so how complex a decision would that be?

T: It can be relatively complex, it obviously depends on how much is going on, you know, on a quiet week it's a low.

S: Well so depending on the number of constraints you've got

T: Right, yeah.

S: So the complexity is really how do I answer ...

T: Yeah, which is probably the low.

S: Which is low, but the number of constraints would really change it you know, it could be here or it could be way out here.

T: Yes, yes.

S: Okay.

T: Ambiguity is probably relatively low, with the exception of whether you misread the situation, you know, which can happen.

S: Yeah, yeah, so again it might be low, but it could be in the middle. The environment and information structure, in other words have I don't this sort of thing before, is more information going to help me make the decision or ..?

T: It can do, sometimes you'll get for example, a semi-specific one, you'll get a phone call from someone and they'll say I need help to do this assessment and I can't get a soft way to create the chart that I need to do, and you think yeah, okay, well that doesn't sound terribly important to me, which is yeah. It's ... it's the ...

S: High.

T: High, right.

S: Because you've been through that.

T: Right, and then the following day you get then another phone call which is the more information piece where they say that things I was ... left you a message about yesterday, I realise you haven't got back to me yet. The reason I need to put this chart together is because I've got a presentation to the boss on Friday to add these resources to the company's books, so now we're ... we go to the other end of that scale because the additional information has provided you with the context that this really is quite important, it's not just some bloke fiddling around with some calculation and he can't figure out which screen to go through, he actually really does need this for the good of the group, himself and the company, right? Yeah, so what we've seen is that even within this situation that you've described, on two of these axes it could be shifting [inaudible].

T: Depends on the circumstances.

S: That's right.

T: Yeah.

S: And the process that you would use, would it change if these axes change? So for example on day one when he first phones and asks how to make the chart, the decision you've made is I'll leave this alone, but day two when he phones back and you probably phone him back and give him some ideas, so the decision that you made is different.

T: The decision is different but ...

S: But the process would change.

T: I think the process would stay exactly the same, and the analogy that I use for my job is medical triage.

S: Okay.

T: Yeah, you know, who's bleeding the most, who's making the most or the least noise? You know, noise is often inversely related to need.

S: Yes.

T: You know it's like me teaching first aid, deal with the quiet ones first, because they're probably the ones that are in the biggest trouble.

S: That's it.

T: Yeah, so ... so it is medical triage, and that's how I approach that type of decision.

S: Yeah, so you have a whole series of hurdles and it depends on how many are jumped as to how you're going to respond.

T: Yeah, how many people ... how many people are in the ... are in the emergency room, what's the scale of injuries and when ... when do they need to be fixed by? You know if this guy doesn't need the chart 'til the end of December, clearly the decision is a different one than if he needs it tomorrow afternoon, but the process is the same. The fact that he doesn't need it 'til the end of December, immediately drops him on the triage, yeah. If somebody says I need it tomorrow afternoon, they go up.

S: Yeah.

T: Yeah. Or if two people need something on the same day, the one that's the more complex problem ...

S: You'll put your time into first.

T: That goes up, and then you've got this overlay of attractability, you know, is this person ... this sounds very, very ... very, very blunt thing to say, but quite frankly, is this person worth investing the intellectual time in? Not the person because it's not the person ...

S: The situation.

T: Yeah, so is this person somebody that's going to run with what I tell them, and grow it, and not only be less likely to come back and ask further questions, but actually then be able to tell other people, or is this person just looking for a widget to take away? In other words you know, the which button do I push and then I'm not really interested beyond that, so you know, no amount of kind of quixotic education or attempt with that person is going to get them to like assessment anymore, or to want to do assessment anymore, they just want to know which button to press, and if you realise that upfront, it makes it a whole lot easier.

S: Excellent, excellent, that is all I'm after.

T: Okay.

S: So I really appreciate that.

T: Sure.

S: No, that helps me see ... because I like this idea of the medical triage, that's a good one. And do they give ... they ... does XXXXX give you any time management training at all?

T: Yes, you can go on time management training, I've never been on it.

S: Okay.

T: Yeah, probably to my demerit.

S: No.

T: I'm just self taught like most people.

S: Yeah, well that's why I asked the question, because when it comes to decision making, a lot of people nut it out themselves.

T: Yeah.

S: And I just ... I'm not investigating training as to whether that helps but yeah.

T: Yeah, no, the answer is yes, they do offer that class, it's open enrolment, so you know, you can go to your boss and say can I go on this one day time management class, \$500, sure, off you go. The number of people who take those classes is probably relatively small, I should imagine there's a lot of pride involved in that. With me it's probably a bit of pride [inaudible] to that, but it's probably just you know, the old haven't got round to it yet, you know, but I'm sure we could probably all benefit including me.

S: Well that's good.

T: Yeah.

S: Okay, terrific, thanks for that, no that's been helpful because what you've actually ...

End of recording

APPENDIX 5

Summary Notes of the non Digitally Recorded Semi-Structured Interviews

***Interviewee: Participant U (U)**

***Interviewer: Steve Mackie (S)**

Roles and Responsibilities

- We are technical specialists and make technical decisions – allocation of funds and resources is made by the managers
- Decisions are made by committee
- Our work is organised by project and is therefore goal focussed

Decision Types

- I type decisions by whether they impact the company or me
- If constraints are lowered risk aversion surfaces
- If complexity increases more levels of approval are required

Decision-Making Processes and Tools

- Projects are governed by gate processes
- Collective inquiry allows every one's input

Learning Feedback

- Rolling 5 yr look back

***Interviewee: Participant V**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- A decision is the selection of a course of action from a number of alternatives
- Decision makers are those with the appropriate level of delegated authority
- Decisions are made by teams and approved by individuals
- A good decisions needs clearly defined objectives
- Ask these questions:
 - What information do I have?
 - What are my constraints?
 - What tools are “best practice” workflows? Only deviate from them as an exception
 - Have I considered the “full life” of the project?
- I am analytical (most technical people are) and most managers are sensate how do I get the message across to them?

Decision Types

- If complexity increases we use the same process but it is part of a different budget process – shifts from production to exploration.

Decision-Making Processes and Tools

- We have very formal processes but we also have informal ones
 - Processes consist of:
 - Integrated project teams
 - Gate reviews
 - Integrated team interaction
 - Fit for purpose assessments
- Tools consist of:
 - Internally developed databases, matrices and templates that are available globally – these are the defined “best practice workflows
 - Monte Carlo simulations
 - Experimental design
- Tools are used to bring consistency to global operations
- But how are you going to get breakthroughs when you use a “standard” workflow

Learning Feedback

- Peer review symposia are held every 2 years
- We do have gate reviews of KPIs but we need full “life cycle” KPIs

***Interviewee: Participant W**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- Technical decisions are made by technical specialists – business decisions are made by the managers
- Individuals tend to be process focussed whereas the company tends to be outcome focussed

Decision Types

- If constraints are dropped the decisions changes because there are less arms on the decision tree
- As complexity increases there will be the need for more people to get involved in the decision and there will be more questions leading to a difficult approval process
- Lower value decisions are made much more simply and quickly

***Interviewee: Participant X**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- Day-to-day decisions are operational and are made individually
- High, more strategic, decisions will involve multiple inputs from many people with diverse types of analysis
- Technical decision-making is the responsibility of professional staff based on their best technical judgement, their training and experience
- Financial limits / ownership determine approval levels
- We use a highly analytical approach incorporating data, technical interpretations and estimates of uncertainty
- We are looking for decisions that have no regrets or surprises, the technical results withstand scrutiny from informed peers, which are internally consistent and used the appropriate data

Decision Types

- Decisions are different based on:
 - Immediacy – time available to make decision
 - Complexity – number of factors to consider
 - Consequences – impact of right or wrong decision
 - Control – how much and what type of advice

Decision-Making Processes and Tools

- We often use rapid trial and error methods rather than spending time on defining one “right” (which will inevitably be wrong) answer
- We use a thought (analytical) process rather than a mandated process
- Our processes are more like frameworks – application is variable depending on the purpose
- Main frameworks:
 - Project Alignment – the work is defined and stewarded by project and project gates control analysis along the project pathway
 - The way we work – consists of collective inquiry; fit for purpose application; full comprehension of all data and people; multiple scenarios and understanding uncertainty

***Interviewee: Participant Y**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- A decision is a change in action but it is usually buried under recommendations
- A good decision requires that we make sure we view all aspects of the problem and avoid the temptation to jump in too narrowly

Decision Types

- If the time constraint increases then need to pull more resources and not worry so much about totally quantifying risk
- Constraints impact resources

Decision-Making Processes and Tools

- I like leaving things out on a layout table so others passing by can comment – very informal!

Learning Feedback

- Need to make sure that we are comparing apples with apples so therefore we need similar frameworks when the review is done as when the project was approved

***Interviewee: Participant Z**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- A decision is making a choice from a variety of options according to a predefined set of criteria
- We use gate meetings at specific milestones within the project
- I make decisions by evaluating the data leading to developing a series of scenarios from which I choose the “best” but the company is interested in the outcome. It assumes that the technical people have used the process and therefore all they need to look at is the outcome
- All participants in the project stay within “line of sight.” Managers actually feed down the objectives to the staff

Decision Types

- If constraints are increased it accelerates the need for data and resources
- Need to add the big picture early in the decision-making process so as to expand alternatives

Decision-Making Processes and Tools

- Our processes are beyond formal they are inculcated formal
- The integrated nature of tools facilitates integrated workflows, eg, Petrel actually requires geologists, geophysicists and engineers to work and talk together to the same picture

Learning Feedback

- Learning feedback occurs as part of the gate process but its difficult because people get transferred so quickly that by the time the project is finished most people involved in it are no longer available on site

***Interviewee: Participant AA**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- Accountability is prime as it relates to projects being stewarded
- Specialists are involved along with cross functional databases

Decision Types

- If ambiguity increases the same process is used but the level of trust also needs to increase. No one is asked did you do this or that it is assumed that you have and that is monitored via the gate process
- Technology is used as increased resources

Decision-Making Processes and Tools

- Management continues to talk to teams to take informal processes to formal ones and then finally to being part of the culture
- Leadership directs “fit for purpose” and the “way we work”
- Our risk assessment software allows Monte Carlo simulation within decision trees. Input can come from technical specialists directly into the tool

Learning Feedback

- All professionals have access to “global share” and can therefore learn from any project but it requires discipline to actually subscribe to it.
- The culture motivates personal involvement in using “global share”

***Interviewee: Participant AB**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- The professional is kept “honest” by the process
- There is a tension between the technical individual who is process driven and the company which is outcome driven

Decision-Making Processes and Tools

- Petrel facilitates a community of ideas and quick feedback

Learning Feedback

- Within individual technical decisions very quick feedback is extremely valuable
- Time delay in feedback makes it difficult

***Interviewee: Participant AC**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- Decisions are more or less subconscious – they are just what you do to get your job done and you don't realise it's a decision until you talk about them

Decision-Making Processes and Tools

- Decision-making processes go from subconscious to informal to formal to part of the culture. The things that make this happen are:
 - Subconscious to informal – the idea of decision-making drops
 - Informal to formal – the process gets documented
 - Formal to inculcated – everyone keeps talking about it

***Interviewee: Participant AD**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- The Australian culture facilitates and leads to non-stop collaboration
- I have seen differences in culture stymie collaboration

Decision Types

- As information type and structure change the need for Value of Information analysis becomes more important

Decision-Making Processes and Tools

- The mind is the most important tool
- As a manager I need to trust in the process as well as the person
- I need to clearly communicate to the team what is required

Learning Feedback

- This is perhaps the area we don't do as well in

***Interviewee: Participant AE**

***Interviewer: Steve Mackie**

Roles and Responsibilities

- Leaders need to be directly honest with people about their work
- We need to pay attention to the long term versus short term effects
- We develop trust from our managers by having a good record of past decisions
- Expertise is what blends all the various aspects coming into decisions
- The personality of the leader has a big impact on how decisions are made

Decision Types

- As ambiguity increases we run the risk of getting too blind to our original objectives – keep a “clear line of sight”

Decision-Making Processes and Tools

- Formal processes are fine but I like using the “skunk works” approach to shorten time taken

Learning Feedback

- This needs to occur all the time and in every way possible. What the good of being “wrong” if we can’t learn from it.
- If you can only do things that are “right” you are going to do the same thing over and over again and then never have any breakthroughs

***Interviewee: Participant AF**

***Interviewer: Steve Mackie**

Roles and Responsibilities

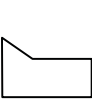
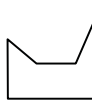
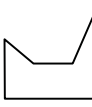

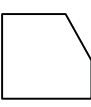

- Don't forget the human brain – it makes the decisions










Decision –Making Processes and Tools






- There are multiple individual technical decisions but just one formal business decision
- The link between the technical decision and the management decision relies on trust and experience
- We need to be technically honest so that management develops trust in our decisions
- Confidence, experience and attitude blend to make up trustworthiness
- The link between management's decisions and technical decisions relies on clear communication

APPENDIX 6

Decision Scenarios

Number	Decision Scenario	Complexity	Task Constraint	Ambiguity	Structure of Information Environment	Decision Type	Tree-Fitting Cluster	Additive Cluster	Number of Words
1	Company A has offshore exploration acreage with deep-water targets. The license requires them to drill an exploration well by the end of the second year. It is now 15 months into the license term. They have identified 5 prospects but none is drill ready. Finance for the well is allocated into the next financial year's budget. The government is keen to have a well drilled in the basin earlier rather than later. A deep-water drilling rig will be available in one month. Should they contract it and if so for how many slots?	Mid	Single	Single value function	High Dependency		Blue	B	94
2	A group of equity investors, whose focus is onshore petroleum exploration, want to float a new exploration company. They desire to have some new acreage as part of the IPO because it attracts the profile of investor they desire. They have applied for some acreage but it has not yet been granted because of priority in native title negotiations. The equity market for petroleum appears to be waning. Do they commence the float and leave out the new acreage or do they wait for the new acreage to be granted before floating?	Mid	Single	Single value function	Low Dependency		Yellow	B, D	93
3	A medium sized petroleum exploration company has invested six months in having a small team working on the prospectivity of an offshore area that is due for acreage release. The team has established a strong case for an active petroleum system and identified several prospects. They believe other companies have also gained this knowledge. They predict that bidding will be "fierce" for the central blocks of the release and that they may not have the financial resources to bid as much as they believe the blocks are worth. Do they go it alone and submit a bid that assumes they will farm out, as soon as the blocks are awarded or do they commence negotiations with other explorers to reduce their interest ahead of the bidding round?	Mid	Single	Single value function	Low Dependency		Yellow	B, D	128
4	After nine months work, a major prospectivity review has yielded a seriatim of over 20 drillable prospects. Most of the prospects are within one play and the review had concluded that the critical risk is hydrocarbon type – oil is economic in this area but gas is not. The team believe that drilling one of the prospects will reduce the risk profile of the remaining prospects significantly if they can prove the hydrocarbon type is oil. The play area is a long distance from any current drilling rigs and the cost of mobilisation will be significant. Do they contract a drilling rig to drill just the test prospect or do they take advantage of the mobilization cost and contract the rig to drill the seriatim?	Low	Single	Single value function	High Dependency		Blue	A, B	125
5	Whilst drilling a very large prospect in an extremely environmentally sensitive area the drilling rig has taken a gas kick and caught on fire resulting in the loss of two lives. Head office is contacted immediately via satellite phone. What should their first move be?	High	Multiple	Multiple value functions	High Dependency		Green	C	46
6	A company has been exploring in a known hydrocarbon province for over 20 years. The inventory of drillable prospects continues to grow at about 8 to 10 prospects per year as more seismic is acquired. The prospects all have the same low-risk profile simply varying in size. How does the company decide how many prospects to drill each year and how should they rank the inventory?	Low	Single	Single value function	High Dependency		Purple	A, B	67

7	A company has been exploring in a known hydrocarbon province for over 20 years. The inventory of offshore prospects continues to grow at about 8 to 10 prospects per year. The company has a high probability of success – high payoff, low probability of success – low payoff. How does the company decide how many prospects to drill each year and how should they rank the inventory?	Low	Single	Single value function	High Dependency		Purple	A, B	82
8	Whilst drilling a key exploration well an unproven hard drilling zone just above the predicted target is intersected. Many expensive drill bits are used with only minimal penetration. The drilling department determines that the fastest way to drill the section is to use a certain type of drill bit that will cavitate the hole in normal drilling regimes – such as in the target interval. If this drill bit is used the hole will be too large for electric logging equipment to determine the key petrophysical parameters. The well is a key test for the exploration group to determine the prospectivity of the region and it is essential that they obtain uncontaminated petrophysical data. The drilling department is rewarded for being as close to prognosed drilling time as possible. What do they do?	High	Single	Multiple value functions	High Dependency		Red	B, C	133
9	A petroleum company wants to rank all its assets in order to determine the optimal high value assets to explore. The company has a high probability of success – high payoff, low probability of success – low payoff. The metrics for the various sectors of the company are not – and probably cannot be – equivalent. How do they allocate the limited capital?	Low	Single	Single value function	High Dependency		Purple	A, B	61
10	An oil and gas company has announced the discovery of the largest oil field found in the last 10 years and in order to take advantage of the high oil price it has fast tracked development of the field. The fast tracking is expected to have first oil production 18 months from discovery. Due to the high profile nature of the project the company is keeping the share market continuously informed. Executives re informed that the ongoing appraisal drilling has resulted in a major reduction in reserves so that the platform design is now far too large. Should they notify the market and if so how?	High	Multiple	Multiple value functions	Low Dependency		Green	C, D	107
11	The drilling team is currently drilling a "standard" well in a known basin. They have drilled this sort of well over 100 times before. But suddenly they start losing circulation. Within a few hours they will have the drill pipe stuck in the hole resulting in a major fishing job. What do they do?	High	Multiple	Multiple value functions	High Dependency		Green	C	55
12	Company Z has been very active in the Basin C area for over 30 years and has come to understand the petroleum system very well. In the latest bid round they were successful in winning all their companies and thus obtaining all the blocks they are interested in. But they are facing a budgetary bind for a couple of years. How should this be solved?	Mid	Single	Single value function	Low Dependency		Yellow	B, D	71
13	A very large oil and gas exploration and development company has an aging staff profile. Many of their senior technical people have been in the industry for many years, developing a large pool of experience and applicable knowledge. Very few of them wish to move into the management stream, preferring to stay technical. The problem is that there is little chance of promotion (and therefore, resulting pay increases) by staying in the technical area. All promotion occurs outside the staff area in the management stream. This is leading to many of the company's most experienced staff leaving. The HR group has been charged with solving the problem. Where do they start?	High	Single	Multiple value functions	High Dependency		Red	B, C	112
14	The petroleum engineering group has just finished evaluating one of the company's key producing wells. They believe that they can increase production by up to 20% per year by recompleting one of the producing zones using a new, untested technique. But in order to do this, they will have to take the well off line for up to 30 days. What should management do?	Low	Single	Multiple value functions	High Dependency		Blue	A, B, C	65
15	An integrated development team has been working for 6 months on putting together the development plan for one of the company's key offshore fields. In the final review of the static and dynamic models the Chief Geophysicist notices that the young geophysicist, who was initially assigned to the team to give him exposure to critical projects, has misinterpreted a phase change on the reservoir reflector. This means that the static and dynamic models will be incorrect but the reviewers do not know if it will lead to an increase or decrease in the announced reserves. The	Mid	Multiple	Multiple value functions	Low Dependency		Green	C, D	143

16	<p>Managing Director, however, not knowing this situation, has just let the market know that the company has been "throwing resources" at the project in order for it to come on stream early to take advantage of a high oil price. What do the senior reviewers do?</p>	Low	Multiple	Multiple value functions	High Dependency		Red	A, C	150
17	<p>A new venture team has been reviewing seismic data in an area that is upcoming for acreage release. They have spotted some very positive looking amplitude anomalies in the key reservoir section and believe they indicate an active petroleum system. They decide to invest several months of more detailed review and specifically arrange AVO processing of the data to confirm their opinion. This analysis shows that there is a high likelihood that the anomalies are hydrocarbons. The company now asks other major companies to become involved in a bid. These companies are also excited by what they see and together they decided to submit a very high bid of 5 wells in the first 3 years in order to be assumed of winning the block. They do. Assured of their prebidding work they decided to drill 2 of the wells in the first year. These wells are unsuccessful. The amplitude anomalies turn out to be density changes in the reservoir. Does the company drill the other 3 wells?</p>	Low	Multiple	Single value function	Low Dependency		Blue	A, D	169
18	<p>The senior management of a very established oil and gas company believes that its staff must be passionate about their work and are renown for the bonuses they give to staff for proposing and championing a well to be drilled. They are very happy that they have been successful in the past. But they are not happy that they are not getting other competitors are improving their success ratios (up to 50%) by implementing risk analysis into their decision-making. They decide to invest in implementing this new strategy. It takes over 12 months of high-cost consultants to bed down the new procedures. At the end of this year the success ratio has fallen to 25%. Believing this to simply be the result of all the upheaval they give the new system one more year. The success rate falls to 20%. They are now very concerned. What do they do?</p>	Low	Multiple	Multiple value functions	High Dependency		Red	A, C	148
19	<p>The engineering group have been reviewing how to improve production from a satellite offshore field. A small unmanned production platform has been installed on the field with four wells tied in. The produced hydrocarbons are then piped 5 kilometres to the nearby main field production platform where CO₂ is extracted prior to sending the hydrocarbon stream to shore. The ownership of the satellite field is different to that of the main field but the operator is the same for both. The operator determines that increasing compression can increase production from the satellite field. The compression is installed on the main platform because it cannot be fitted to the satellite field. The cost of the compression is \$5 million. The cost of production from the satellite field the owners of that field pay for the installation. This costs in excess of \$5 million but the joint venture is assured that increased production will payback within 4 months. Once the compression is commissioned production from the satellite field decreases! In fact the pressure differences have been taken up by the wells in the main field connected to the main platform! The joint venture is "not happy." What do they do?</p>	Mid	Multiple	Multiple value functions	High Dependency		Red	C	195
20	<p>A major oil producing company has been keeping the market informed of its reserve base by releasing its Proven reserves every year for the last 10 years. It has determined that it is important that reserves are now classified by the newly established SPE guidelines. They implement a major change within the corporation to achieve this but believe it will better help them manage their reserve base. This change results in shifting reserves from the company's "old" Proven category to the new "SPE Proven plus Probable" category. The company makes sure they clearly tell the market that the change is being implemented. The table in the press release shows the new reserves for the company. The company's current reserves with those of one leader. This year's table shows 20%. The company's reserves are more than last year with a subscript note leading the astute reader to the explanation of the change in reserves reporting. The market responds by removing 20% of the value of the share price. What should the company do?</p>	High	Multiple	Multiple value functions	Low Dependency		Green	C, D	176

APPENDIX 7

Submission for approval of the
University of Adelaide's
Human Research Ethics Committee



DEPARTMENT OF PSYCHOLOGY

TO: Chairman, Department Human Ethics Subcommittee

REQUEST FOR APPROVAL OF HUMAN RESEARCH PROJECT

DECLARATION OF COMPLIANCE WITH GUIDELINES FOR RESEARCH PROJECTS UNDERTAKEN OR SUPERVISED BY RESEARCHERS IN THE DEPARTMENT OF PSYCHOLOGY.

Title of Project:

Human Decision-Making Processes and Outcomes Under Uncertainty in the Oil and Gas Industry

Responsible investigator/s (staff member/s of Psychology Department): Dr Michael Lee

Other investigators (including external supervisors, research assistants, and Honours, Masters or Research students)

Name	Department/Organisation	Role
Steven Mackie	Australian School of Petroleum	PhD Candidate
Dr Matthew Welsh	Australian School of Petroleum	Postdoctoral Fellow
Dr Steve Begg	Australian School of Petroleum	Professor
Dr Reidar Bratvold	Australian School of Petroleum	Professor

Notes:

- Please follow the attached format for the application.
- Do you propose to seek written consent? YES/NO
If YES, append the Consent Form to the Application.
- The Subcommittee considers applications in the light of the University's guidelines for human experimentation, and the National Statement on Ethical Conduct in Research Involving Humans. These are available in the Departmental Ethics File, with the application forms. The relevant website address is www.adelaide.edu.au/secretariat/ethics/human/index.htm
- It is University policy that data gathering may not commence until the Application has been approved. The first named Responsible Investigator will be notified of the Subcommittee's decision, and any recommendations for revision.
- Complete Applications are normally retained for monitoring by the University Human Ethics Committee.
-

DECLARATION

We/I conscientiously believe that the proposed questionnaires, interview schedules, psychological tests and procedures comply with the University Council's guidelines for human experimentation and the National Statement on Ethical Conduct in Research Involving Humans.

Responsible Investigator/s:.....	Investigator/s:.....	Date:.....
Other Investigator/s:.....		Date:.....
.....		Date:.....
.....		Date:.....
.....		Date:.....

THE UNIVERSITY OF ADELAIDE – HUMAN RESEARCH ETHICS COMMITTEE

Applications will be considered in terms of the University's guidelines on the ethics of human research, based on the requirements of the National Statement on Ethical Conduct in Research Involving Humans, 1999 - refer application information material, including the list of headings applying to all applications. Submit the completed application including Information Sheet and Consent Form (ELEVEN copies in total), to the Secretary, Human Research Ethics Committee, Research Ethics and Compliance Unit, Room 661 Wills Building, The University of Adelaide
Ph. (08) 8303 6028, Fax (08) 8303 7325, email sabine.schreiber@adelaide.edu.au

APPLICATION FOR ETHICAL APPROVAL OF PROJECT INVOLVING HUMAN SUBJECTS - COVER SHEET - SUMMARISING PROTOCOL & INCLUDING INVESTIGATORS' SIGNATURES

Please attach this to the front of the application

<p>APPLICANT Name include title Professor/Dr/Ms/Mr and Position</p> <p>Dr Michael Lee – Associate Professor</p>
<p>DEPARTMENT including campus/institution contact address</p> <p>Department of Psychology – North Terrace</p>
<p>Phone No and email address</p> <p>(08) 8303 6096 – michael.lee@adelaide.edu.au</p>
<p>OTHERS INVOLVED</p> <p>Steve Mackie – Australian School of Petroleum – PhD candidate Dr Matthew Welsh – Australian School of Petroleum – Postdoctoral Fellow Dr Steve Begg – Australian School of Petroleum – Professor Dr Reidar Bratvold – Australian School of Petroleum – Professor</p> <p>If this is a student project please indicate name/department/candidature</p>
<p>PROJECT TITLE</p> <p>Human Decision-Making Process and Outcomes Under Uncertainty in the Oil and Gas Industry</p>
<p>LOCATION OF RESEARCH</p> <p>North Terrace</p>
<p>DATE PROJECT TO BEGIN</p> <p>1st April 2005</p>
<p>ESTIMATED DURATION OF PROJECT</p> <p>3 months</p>
<p>SOURCE OF FUNDING</p> <p>ARC Linkage Grant – Linkage Project LP0453894</p>

AIMS OF PROJECT please give concise description in lay terms	
<p>This project is a pair-wise comparison exercise to determine “similarity” of oil and gas industry decisions. Subjects will be told that they will be shown two oil and gas decisions scenarios and then asked to judge their similarity on a 5-point scale.</p>	
ETHICAL IMPLICATIONS OF PROJECT	
<p>Subjects will be required to sit in front of a computer screen for up to 2 hours, doing tasks that are no more cognitively demanding than those they would usually do for work or study. All monitors and seating will be subject to ergonomic design. The information sheet and consent form are attached.</p>	
PLAN/DESIGN OF PROJECT brief description in lay terms	
<p>20 decision scenarios relative to the oil and gas industry have been written. A sample scenario is:</p> <p>“Company A has offshore exploration acreage with deep-water targets. The license requires them to drill an exploration well by the end of the second year. It is now 15 months into the license term. They have identified 5 prospects but none is drill ready. Finance for the well is allocated into the next financial year’s budget. The government is keen to have a well drilled in the basin earlier rather than later. A deep-water drilling rig will be available in one month. Should they contract it and if so for how many slots?”</p> <p>Subjects will be given an information sheet (attached), which describes what is to occur and assures them of confidentiality. They will be asked to sign a consent form (attached) prior to the exercise. On each trial, subjects will be shown, on a computer monitor, two of the scenarios, drawn at random, and asked to compare their “similarity” on a 5-point scale, using a standard graphical user interface. The exercise will continue until either all the possible pairings are complete or until the subject decides to finish. If the subject finished prior to completing all possible combinations the next subject will continue to provide ratings from the point where the previous subject decided to finish. We aim to collect data from 30 sets of the full pairings. We will use existing software successfully applied by Lee, Pincombe and Welsh (submitted) to follow essentially the same experimental design (previously approved through the Psychology subcommittee) with a different text corpus.</p>	
DRUGS	
Will drugs be administered to subjects?	YES/ NO
• If so give name of drug(s)	
• Dosage:	
• Method of administration	
Is the administration for therapeutic purposes?	YES / NO
Will the project be conducted under the Clinical Trials Notification (CTN) Scheme?	YES / NO
Clinical Trials Exemption (CTX) Scheme?	YES / NO
Is Commonwealth Department of Health permission required?	YES / NO
If so, has permission been obtained?	YES / NO

SUBJECTS

- **Source:**

Oil and gas industry professionals and post-graduate students via e-mail request

- **Age range:**

20 – 75

- **Selection criteria:**

Voluntary from the local oil and gas professional societies – Society of Petroleum Engineers (SPE) and Petroleum Exploration Society of Australia (PESA) – and the Australian School of Petroleum.

- **Exclusion criteria**

Nil

SIGNATURE OF ALL INVESTIGATORS NAMED IN THE PROTOCOL

Date 29th March 2005

APPENDIX 8

Participant Request

To: "XXXXX, Xxxxx" <xxxxx@xxxxx.xxx.xx>
Subject: Request for Assistance
Date: Thu, 07 Apr 2005 10:15:14 +0930
From: Steve Mackie <steven.mackie@adelaide.edu.au>

Xxxxx,

As part of my PhD research, which is investigating how to improve decision-making in the oil and gas industry, I wish to conduct a study that is seeking to define a taxonomy of decisions made in the upstream oil and gas industry. The study will consist of having participants do a pair-wise comparison of 20 decision scenarios to determine their similarity. The comparisons should take about 1 hour and will be undertaken on a laptop computer at the participant's convenience.

In order to obtain a sufficient sample to gain meaningful data I need approximately 30 participants. I have been given approval to use about 15 postgraduates from the Australian School of Petroleum and 15 industry professionals - school staff included.

I am contacting you to ask whether you would like to participate. I have checked with your supervisors and they have approved your participation. The Human Ethics Committee has cleared the study. I have attached an information sheet and consent form. If you would like to participate would you please contact me and I will arrange for a convenient time.

Thanks

Steve

--

Steve Mackie
Australian School of Petroleum
Adelaide University
North Terrace
Adelaide SA 5005
Australia
Phone: +61 8 8303 8048
Mobile: +61 411 092 721
Fax: +61 8 8303 8030
e-mail: steven.mackie@adelaide.edu.au

This email message is intended only for the addressee(s) and contains information which may be confidential and/or copyright. If you are not the intended recipient please do not read, save, forward, disclose, or copy the contents of this email. If this email has been sent to you in error, please notify the sender by reply email and delete this email and any copies or links to this email completely and immediately from your system. No representation is made that this email is free of viruses. Virus scanning is recommended and is the responsibility of the recipient.

APPENDIX 9

Information Sheet



AUSTRALIAN SCHOOL OF PETROLEUM UNIVERSITY OF ADELAIDE

INFORMATION SHEET

Information to participants in a pair-wise analysis of oil and gas decisions

Thank you for volunteering to participate in this study. This research forms part of a PhD research project titled: *Human Decision-Making Processes and Outcomes Under Uncertainty in the Upstream Oil and Gas Industry*, which is investigating how to improve decision-making in the oil and gas industry. The research is being undertaken at the Australian School of Petroleum at the University of Adelaide.

This part of the study is seeking to define a taxonomy of decisions made in the upstream oil and gas industry. Our thesis is that if the actual decisions being made can be characterised then which decision processes which will lead to optimal decision-making can be determined for each category of decision.

In this study you will be shown, on the computer monitor, two decision scenarios with a 5-point scale bar underneath. We would like you to read the two scenarios and determine how **similar** they are to each other. Simply enter your assessment by clicking on the most appropriate button and the next pair of scenarios will be shown to you. There are 20 such scenarios and they will be shown to you in an order – the top screen will carry the same scenario and you will be presented with 19 other scenarios in the bottom screen. Each participant will see two main scenarios and therefore will see 38 comparisons in total. Time is not a factor in our study and so you can take as long as you like to make your determination but remember that you cannot log out until all 38 comparisons have been completed. So the amount of time you volunteer to be involved is totally up to you. You should also be aware that you may withdraw at any time as well. You can be assured that all data collected during this project will be anonymous and individual results are confidential. To this end would you please complete the attached consent form?

We are hoping to have 30 volunteers, like yourself, do the exercise in order to give us sufficient data to seek to determine what elements are critical for characterising oil and gas decisions and which ones are not. We will be using the results of this exercise to determine an oil and gas decision-making taxonomy. So watch out for publication of the results – you can be very pleased to say: “I was part of that research!”

If you have any questions during the exercise Steve Mackie, the principal researcher, will be available to assist you by phoning 0411 092 721, or you can contact the convenor of the ethics subcommittee in the Department of Psychology, Dr. Paul Delfabbro on (08) 8303 5774 or e-mail paul.delfabbro@adelaide.edu.au.

Thank you again for participating and enjoy the read.

APPENDIX 10

Consent Form

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

**STANDARD CONSENT FORM
FOR PEOPLE WHO ARE SUBJECTS IN A RESEARCH PROJECT**

1. I, (please print name)

consent to take part in the research project entitled: Human Decision-Making Processes and Outcomes Under Uncertainty in the Upstream Oil and Gas Industry

2. I acknowledge that I have read the attached Information Sheet entitled: "Information to participants in a pair-wise analysis of oil and gas decisions"
3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.
4. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.
5. I understand that I am free to withdraw from the project at any time.
6. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

.....
(signature)

.....
(date)

WITNESS

I have described to (name of subject)

the nature of the procedures to be carried out. In my opinion she/he understood the explanation.

Status in Project:

Name:

.....
(signature)

.....
(date)

APPENDIX 11a

MATLAB Data Collection Algorithms

DecisionScenario.m
DataCompiler.m

File: DecisionScenario.m

```

function varargout = DecisionScenario(varargin)
% DECISIONSCENARIO M-file for DecisionScenario.fig (matthew.welsh@adelaide.edu.au)
%   DECISIONSCENARIO by itself, creates a new DECISIONSCENARIO or raises the
%   existing singleton*.
%
%   H = DECISIONSCENARIO returns the handle to a new DECISIONSCENARIO or the han-
dle to
%   the existing singleton*.
%
%   DECISIONSCENARIO('CALLBACK',hObject,eventData,handles,...) calls the local
%   function named CALLBACK in DECISIONSCENARIO.M with the given input arguments.
%
%   DECISIONSCENARIO('Property','Value',...) creates a new DECISIONSCENARIO or raises
the
%   existing singleton*. Starting from the left, property value pairs are
%   applied to the GUI before DecisionScenario_OpeningFunction gets called. An
%   unrecognized property name or invalid value makes property application
%   stop. All inputs are passed to DecisionScenario_OpeningFcn via varargin.
%
%   *See GUI Options on GUIDE's Tools menu. Choose "GUI allows only one
%   instance to run (singleton)".
%
% See also: GUIDE, GUIDATA, GUIHANDLES

% Copyright 2002-2003 The MathWorks, Inc.

% Edit the above text to modify the response to help DecisionScenario

% Last Modified by GUIDE v2.5 31-Mar-2005 17:35:54

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',    mfilename, ...
                  'gui_Singleton', gui_Singleton, ...
                  'gui_OpeningFcn', @DecisionScenario_OpeningFcn, ...
                  'gui_OutputFcn', @DecisionScenario_OutputFcn, ...
                  'gui_LayoutFcn', [] , ...
                  'gui_Callback', []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargout
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT

% --- Executes just before DecisionScenario is made visible.
function DecisionScenario_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB

```

```
% handles structure with handles and user data (see GUIDATA)
% varargin command line arguments to DecisionScenario (see VARARGIN)

% Choose default command line output for DecisionScenario
handles.output = 'Yes';

% Update handles structure
guidata(hObject, handles);

% Insert custom Title and Text if specified by the user
% Hint: when choosing keywords, be sure they are not easily confused
% with existing figure properties. See the output of set(figure) for
% a list of figure properties.
if(nargin > 3)
    for index = 1:2:(nargin-3),
        if nargin-3==index, break, end
        switch lower(varargin{index})
            case 'title'
                set(hObject, 'Name', varargin{index+1});
            case 'string'
                set(handles.text1, 'String', varargin{index+1});
            end
        end
    end
end

% Determine the position of the dialog - centered on the callback figure
% if available, else, centered on the screen
FigPos=get(0,'DefaultFigurePosition');
OldUnits = get(hObject, 'Units');
set(hObject, 'Units', 'pixels');
OldPos = get(hObject,'Position');
FigWidth = OldPos(3);
FigHeight = OldPos(4);
if isempty(gcf)
    ScreenUnits=get(0,'Units');
    set(0,'Units','pixels');
    ScreenSize=get(0,'ScreenSize');
    set(0,'Units',ScreenUnits);

    FigPos(1)=1/2*(ScreenSize(3)-FigWidth);
    FigPos(2)=2/3*(ScreenSize(4)-FigHeight);
else
    GCBFOldUnits = get(gcf,'Units');
    set(gcf,'Units','pixels');
    GCBFPos = get(gcf,'Position');
    set(gcf,'Units',GCBFOldUnits);
    FigPos(1:2) = [(GCBFPos(1) + GCBFPos(3) / 2) - FigWidth / 2, ...
        (GCBFPos(2) + GCBFPos(4) / 2) - FigHeight / 2];
end
FigPos(3:4)=[FigWidth FigHeight];
set(hObject, 'Position', FigPos);
set(hObject, 'Units', OldUnits);

% Show a question icon from dialogicons.mat - variables questIconData
% and questIconMap
load dialogicons.mat

IconData=questIconData;
```

```
questIconMap(256,:) = get(handles.figure1, 'Color');
IconCMap=questIconMap;

Img=image(IconData, 'Parent', handles.axes1);
set(handles.figure1, 'Colormap', IconCMap);

set(handles.axes1, ...
    'Visible', 'off', ...
    'YDir' , 'reverse' , ...
    'XLim' , get(Img,'XData'), ...
    'YLim' , get(Img,'YData') ...
    );

% Make the GUI modal
set(handles.figure1, 'WindowStyle', 'modal')

% UIWAIT makes DecisionScenario wait for user response (see UIRESUME)
uiwait(handles.figure1);

% --- Outputs from this function are returned to the command line.
function varargout = DecisionScenario_OutputFcn(hObject, eventdata, handles)
% varargout cell array for returning output args (see VARARGOUT);
% hObject handle to figure
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

% The figure can be deleted now
delete(handles.figure1);

% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton1 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)

handles.output = get(hObject, 'String');

% Update handles structure
guidata(hObject, handles);

% Use UIRESUME instead of delete because the OutputFcn needs
% to get the updated handles structure.
uiresume(handles.figure1);

% --- Executes on button press in pushbutton2.
function pushbutton2_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton2 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)

handles.output = get(hObject, 'String');

% Update handles structure
guidata(hObject, handles);
```

```
% Use UIRESUME instead of delete because the OutputFcn needs
% to get the updated handles structure.
uiresume(handles.figure1);

% --- Executes when user attempts to close figure1.
function figure1_CloseRequestFcn(hObject, eventdata, handles)
% hObject    handle to figure1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

if isequal(get(handles.figure1, 'waitstatus'), 'waiting')
    % The GUI is still in UIWAIT, us UIRESUME
    uiresume(handles.figure1);
else
    % The GUI is no longer waiting, just close it
    delete(handles.figure1);
end

% --- Executes on key press over figure1 with no controls selected.
function figure1_KeyPressFcn(hObject, eventdata, handles)
% hObject    handle to figure1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Check for "enter" or "escape"
if isequal(get(hObject,'CurrentKey'),'escape')
    % User said no by hitting escape
    handles.output = 'No';

    % Update handles structure
    guidata(hObject, handles);

    uiresume(handles.figure1);
end

if isequal(get(hObject,'CurrentKey'),'return')
    uiresume(handles.figure1);
end

% No Similarity button
% --- Executes on button press in pushbutton8.
function pushbutton8_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton8 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global trial SubjectNo masterpattern Q1 Q2 data documents;
% records button press as a similarity of 1
data(trial)=1;
% Updates the trial number
trial=trial+1;
% unless the trial are complete, this updates the trial number shown on
% the GUI
if trial<39
    set(findobj('Tag','text7'),'String',int2str(trial));
end
% if trial number is 39, indicates that the session is over and tells the
% subject how to end the session after thanking them.
if trial==39
```

```
set(Q1,'String','Trials Completed - Thank You','FontSize',20,'ForegroundColor','b');
set(Q2,'String','Please press the "Finished" button to end your session','FontSize',16);
% locks buttons once 38 trials are completed
set(findobj('Tag','pushbutton8'),'Enable','inactive');
set(findobj('Tag','pushbutton9'),'Enable','inactive');
set(findobj('Tag','pushbutton10'),'Enable','inactive');
set(findobj('Tag','pushbutton11'),'Enable','inactive');
set(findobj('Tag','pushbutton12'),'Enable','inactive');
% if subject is still doing first 19 trials this sets the first question
% as document (SubjectNo*2-1(or 21 or 41)) so, subject 12, for example has
% document 12*2-21 = 3 as their first question for this entire set
% Question 2, by contrast, changes according to the current trial number
% in accordance with the masterpattern matrix
elseif trial<20
    if SubjectNo<11
        set(Q1,'String',documents(SubjectNo*2-1,:));
        set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
    elseif SubjectNo<21
        set(Q1,'String',documents(SubjectNo*2-21,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
    elseif SubjectNo>=21
        set(Q1,'String',documents(SubjectNo*2-41,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
    end
% this section does exactly the same as the above except that it changes
% the first question to reflect the fact that one complete set of trials
% has been completed. Question 1 now becomes the next document in the
% documents matrix - e.g., for the above example (Subject 12) it is 4.
elseif trial<39
    if SubjectNo<11
        set(Q1,'String',documents(SubjectNo*2,:));
        set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
    elseif SubjectNo<21
        set(Q1,'String',documents(SubjectNo*2-20,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
    elseif SubjectNo>=21
        set(Q1,'String',documents(SubjectNo*2-40,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
    end
end
end

% A Little Similar button
% --- Executes on button press in pushbutton9.
function pushbutton9_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton9 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% See pushbutton8 for comments
global trial SubjectNo masterpattern Q1 Q2 data documents;
data(trial)=2;
trial=trial+1;
if trial<39
    set(findobj('Tag','text7'),'String',int2str(trial));
end
if trial==39
    set(Q1,'String','Trials Completed - Thank You','FontSize',20,'ForegroundColor','b');
    set(Q2,'String','Please press the "Finished" button to end your session','FontSize',16);
```

```
set(findobj('Tag','pushbutton8'),'Enable','inactive');
set(findobj('Tag','pushbutton9'),'Enable','inactive');
set(findobj('Tag','pushbutton10'),'Enable','inactive');
set(findobj('Tag','pushbutton11'),'Enable','inactive');
set(findobj('Tag','pushbutton12'),'Enable','inactive');
elseif trial<20
if SubjectNo<11
set(Q1,'String',documents(SubjectNo*2-1,:));
set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
elseif SubjectNo<21
set(Q1,'String',documents(SubjectNo*2-21,:));
set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
elseif SubjectNo>=21
set(Q1,'String',documents(SubjectNo*2-41,:));
set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
end
elseif trial<39
if SubjectNo<11
set(Q1,'String',documents(SubjectNo*2,:));
set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
elseif SubjectNo<21
set(Q1,'String',documents(SubjectNo*2-20,:));
set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
elseif SubjectNo>=21
set(Q1,'String',documents(SubjectNo*2-40,:));
set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
end
end

% Somewhat Similar button
% --- Executes on button press in pushbutton10.
function pushbutton10_Callback(hObject, eventdata, handles)
% hObject handle to pushbutton10 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)

% See pushbutton8 for comments
global trial SubjectNo masterpattern Q1 Q2 data documents;
data(trial)=3;
trial=trial+1;
if trial<39
set(findobj('Tag','text7'),'String',int2str(trial));
end
if trial==39
set(Q1,'String','Trials Completed - Thank You','FontSize',20,'ForegroundColor','b');
set(Q2,'String','Please press the "Finished" button to end your session','FontSize',16);
set(findobj('Tag','pushbutton8'),'Enable','inactive');
set(findobj('Tag','pushbutton9'),'Enable','inactive');
set(findobj('Tag','pushbutton10'),'Enable','inactive');
set(findobj('Tag','pushbutton11'),'Enable','inactive');
set(findobj('Tag','pushbutton12'),'Enable','inactive');
elseif trial<20
if SubjectNo<11
set(Q1,'String',documents(SubjectNo*2-1,:));
set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
elseif SubjectNo<21
set(Q1,'String',documents(SubjectNo*2-21,:));
set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
```

```
elseif SubjectNo>=21
    set(Q1,'String',documents(SubjectNo*2-41,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:));
end
elseif trial<39
if SubjectNo<11
    set(Q1,'String',documents(SubjectNo*2,:));
    set(Q2,'String',documents(masterpattern(SubjectNo,trial,:));
elseif SubjectNo<21
    set(Q1,'String',documents(SubjectNo*2-20,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:));
elseif SubjectNo>=21
    set(Q1,'String',documents(SubjectNo*2-40,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:));
end
end

% Quite Similar button
% --- Executes on button press in pushbutton11.
function pushbutton11_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton11 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% See pushbutton8 for comments
global trial SubjectNo masterpattern Q1 Q2 data documents;
data(trial)=4;
trial=trial+1;
if trial<39
    set(findobj('Tag','text7'),'String',int2str(trial));
end
if trial==39
    set(Q1,'String','Trials Completed - Thank You','FontSize',20,'ForegroundColor','b');
    set(Q2,'String','Please press the "Finished" button to end your session','FontSize',16);
    set(findobj('Tag','pushbutton8'),'Enable','inactive');
    set(findobj('Tag','pushbutton9'),'Enable','inactive');
    set(findobj('Tag','pushbutton10'),'Enable','inactive');
    set(findobj('Tag','pushbutton11'),'Enable','inactive');
    set(findobj('Tag','pushbutton12'),'Enable','inactive');
elseif trial<20
if SubjectNo<11
    set(Q1,'String',documents(SubjectNo*2-1,:));
    set(Q2,'String',documents(masterpattern(SubjectNo,trial,:));
elseif SubjectNo<21
    set(Q1,'String',documents(SubjectNo*2-21,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:));
elseif SubjectNo>=21
    set(Q1,'String',documents(SubjectNo*2-41,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:));
end
elseif trial<39
if SubjectNo<11
    set(Q1,'String',documents(SubjectNo*2,:));
    set(Q2,'String',documents(masterpattern(SubjectNo,trial,:));
elseif SubjectNo<21
    set(Q1,'String',documents(SubjectNo*2-20,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:));
elseif SubjectNo>=21
```

```
    set(Q1,'String',documents(SubjectNo*2-40,:));
    set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
end
end

% Very Similar button
% --- Executes on button press in pushbutton12.
function pushbutton12_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton12 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% See pushbutton8 for comments
global trial SubjectNo masterpattern Q1 Q2 data documents;
data(trial)=5;
trial=trial+1;
if trial<39
    set(findobj('Tag','text7'),'String',int2str(trial));
end
if trial==39
    set(Q1,'String','Trials Completed - Thank You','FontSize',20,'ForegroundColor','b');
    set(Q2,'String','Please press the "Finished" button to end your session','FontSize',16);
    set(findobj('Tag','pushbutton8'),'Enable','inactive');
    set(findobj('Tag','pushbutton9'),'Enable','inactive');
    set(findobj('Tag','pushbutton10'),'Enable','inactive');
    set(findobj('Tag','pushbutton11'),'Enable','inactive');
    set(findobj('Tag','pushbutton12'),'Enable','inactive');
elseif trial<20
    if SubjectNo<11
        set(Q1,'String',documents(SubjectNo*2-1,:));
        set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
    elseif SubjectNo<21
        set(Q1,'String',documents(SubjectNo*2-21,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
    elseif SubjectNo>=21
        set(Q1,'String',documents(SubjectNo*2-41,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
    end
elseif trial<39
    if SubjectNo<11
        set(Q1,'String',documents(SubjectNo*2,:));
        set(Q2,'String',documents(masterpattern(SubjectNo,trial,:)));
    elseif SubjectNo<21
        set(Q1,'String',documents(SubjectNo*2-20,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:)));
    elseif SubjectNo>=21
        set(Q1,'String',documents(SubjectNo*2-40,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:)));
    end
end

% This is the area in which the first decision is displayed
function edit1_Callback(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit1 as text
```

```
%    str2double(get(hObject,'String')) returns contents of edit1 as a double

% --- Executes during object creation, after setting all properties.
function edit1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%    See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end

% This is the area in which the second decision is displayed
function edit2_Callback(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit2 as text
%    str2double(get(hObject,'String')) returns contents of edit2 as a double

% --- Executes during object creation, after setting all properties.
function edit2_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%    See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end

% This is the Start button that reads the subject number
% and sets the Decision pairs accordingly
% It also starts the count of trials
% --- Executes on button press in pushbutton13.
function pushbutton13_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton13 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global documents SubjectNo trial masterpattern Q1 Q2 data participants;
SubjectNo=str2num(get(findobj('Tag','edit3'),'String'));
participants=[participants SubjectNo];
trial=1;
data=zeros(1,38);
%Sets the set counter to 1
set(findobj('Tag','text11'),'String','1');
% Starts the trial counter at 1
set(findobj('Tag','text7'),'String',int2str(trial));
% Sets the questions according to the subject and trial numbers
Q1=findobj('Tag','edit1'); % Q1 = Question 1 text box
Q2=findobj('Tag','edit2'); % Q2 = Question 2 text box
```

```
% warns experimenter that subject number has not been entered
if isempty(SubjectNo)==1;
    set(findobj('Tag','text4'),'String','Please enter subject number before proceeding');
    set(findobj('Tag','text4'),'ForegroundColor','r');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','k');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','r');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','k');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','r');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','k');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','r');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','k');
    pause(.25);
    set(findobj('Tag','text4'),'String','Please indicate, using the buttons below, how similar you feel
these two decisions are');
elseif SubjectNo<11
    set(Q1,'String',documents(SubjectNo*2-1,:));
    set(Q2,'String',documents(masterpattern(SubjectNo,trial,:));
elseif SubjectNo>=11
    if SubjectNo<21
        set(Q1,'String',documents(SubjectNo*2-21,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-10,trial,:));
    end
    if SubjectNo>=21
        set(Q1,'String',documents(SubjectNo*2-41,:));
        set(Q2,'String',documents(masterpattern(SubjectNo-20,trial,:));
    end
end
end
% deactivates the Start button so it can't reset the experiment
% but only if a subject number has been entered
if isempty(SubjectNo)==0
    set(findobj('Tag','pushbutton13'),'Enable','inactive');
end

% Ends the series of trials and saves the data
% --- Executes on button press in pushbutton14.
function pushbutton14_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton14 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global trial documents participants masterpattern data SubjectNo;
if trial<39
    set(findobj('Tag','text4'),'String','Please complete remaining trial(s) before closing this window');
    set(findobj('Tag','text4'),'ForegroundColor','r');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','k');
    pause(.25);
    set(findobj('Tag','text4'),'ForegroundColor','r');
```

```

pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','k');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','r');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','k');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','r');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','k');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','r');
pause(.25);
set(findobj('Tag','text4'),'ForegroundColor','k');
pause(.25);
set(findobj('Tag','text4'),'String','Please indicate, using the buttons below, how similar you feel
these two decisions are');
elseif trial==39
    save BasicData.mat documents masterpattern participants;
    filename=['Subject' int2str(SubjectNo) 'data'];
    save(filename,'data');
    clear all;
    close(findobj('Tag','figure1'));
end;

% The subject number is entered here
function edit3_Callback(hObject, eventdata, handles)
% hObject    handle to edit3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit3 as text
%       str2double(get(hObject,'String')) returns contents of edit3 as a double
% --- Executes during object creation, after setting all properties.
global participant SubjectNo;
participant=[participant SubjectNo];

function edit3_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end

```

File: DataCompiler.m

```

% Decision Taxonomy Similarity Data Compiler (matthew.welsh@adelaide.edu.au)

% Opens the masterpattern matrix
load BasicData.mat masterpattern;

```



```
% renames masterpattern for ease of coding
mp=masterpattern;

% This statement needs to vary with how many subjects there are. Currently we
% are aiming at 30, so it mirrors this.
% This makes 'i' the subject number which we can use in later lines to
% determine the indices of various data points.
% similarity matrix to hold subjects data
sim=zeros(60,20);

for i=1:30
    % this determines the name of the data file to be opened
    filename=['Subject' int2str(i) 'data.mat'];
    % this opens it
    load(filename,'data');
    % this reshapes the 1x38 matrix into a 2x19 one maintaining the order
    % within the two rows 1-19 and 20-38 (I hope).
    data2=reshape(data,19,2)';
    % converts 2x19 data into 2 rows of 2x20 data using masterpattern.
    % index1 and index2 are the row identifiers for each subject i. 30
    % subjects therefore fill 60 rows of the sim matrix.
    index1=2*i-1;
    index2=2*i;
    for j=1:19;
        % this determines the column indices of the results and should
        % basically just shift the 19 data points such that there are no
        % self comparisons in the sim matrix
        if i<11
            index3=mp(i,j);
            index4=mp(i,j+19);
            sim(index1,index3)=data2(1,j);
            sim(index2,index4)=data2(2,j);
        elseif i<21
            index3=mp(i-10,j);
            index4=mp(i-10,j+19);
            sim(index1,index3)=data2(1,j);
            sim(index2,index4)=data2(2,j);
        elseif i<31
            index3=mp(i-20,j);
            index4=mp(i-20,j+19);
            sim(index1,index3)=data2(1,j);
            sim(index2,index4)=data2(2,j);
        end
    end
    % this clears the data variable ready to be replaced in the next
    % iteration
    clear data;
end

% Need to calculate the mean similarity and the variance of each possible
% combination of decision scenarios/documents.
% Given 30 subjects, each completing 38 scenario pairs, we end up with each
% pair being examined 6 times - as each subject looks at two of the 20
% documents and compares these to every other document.
% e.g., Subject 1 sees document 1 in combination with documents 2 through
% 19 and then, after this set, sees document 2 in combination with document
% 1 and documents 3 through 19.
% Due to the structuring of the experiment, Subject 1 assesses the 1v2
```

```

% document pair twice - once as 1v2 and then again as 2v1 later. Other than
% this, each pair is assessed only once by any subject but, given 30
% subjects we should get 6 full sets of data.
% Q - which of the 1200 cells of the sim matrix are equivalent and should,
% therefore be averaged/varianced?
% The matrix is, effectively a stack of 3 20x20 matrices so every 20th line
% is a repeat. It is also reflected around the self-line such that cell
% (1,2) and cell (2,1) are the same.
% So, we need to create a 20x20 matrix for the mean and one for the
% variance (StDev) measure but only calculate values in one half thereof.

mean_sim=zeros(20);
std_sim=zeros(20);
% this collects the 6 cells that correspond to each cell in the new matrices
% into a vector to allow the mean and std functions to be used.
for i=1:20
    for j=1:20
        if j<i
            mean_set=[sim(i,j) sim(i+20,j) sim(i+40,j) sim(j,i) sim(j+20,i) sim(j+40,i)];
            mean_sim(i,j)=mean(mean_set);
            std_sim(i,j)=std(mean_set);
        end
    end
end

% Also need a reliability measure: each subject has assessed a single pair
% of questions twice. For subject 1 it is (1,2) and (2,1).
% this vector will hold the 30 reliability measures - i.e., the difference
% between the estimates of similarity on the two attempts.
reliable=zeros(1,30);
reliable2=zeros(1,30);
for i=1:30
    if i<11
        reliable(i)=abs(sim(2*i-1,2*i)-sim(2*i,2*i-1));
    elseif i<21
        reliable(i)=abs(sim(2*i-21,2*i-20)-sim(2*i-20,2*i-21));
    elseif i<31
        reliable(i)=abs(sim(2*i-41,2*i-40)-sim(2*i-40,2*i-41));
    end
end

%calculates the mean absolute difference between comparisons
mean_rely=mean(reliable) % this displays

% calculates percentage of cases where agreement is observed
for i=1:30
    if reliable(i)==0
        reliable2(i)=1;
    end
end
percent_rely=sum(reliable2)/length(reliable2) % this displays too

% Finally, the important variables are saved to a file

save DTsimilarity.mat mean_sim std_sim mean_rely percent_rely sim reliable reliable2;

clear all;

```

APPENDIX 11b

MATLAB Data Analysis Algorithms

addtreegrow.m
treesim.m
adclusgrow.m
clustersim.m

File: Addtreegrow.m

```

function [adjacency,lengths,vaf,bic]=addtreegrow(proximity,precision,labels,evidence,patience)

% ADDTREEGROW grows an additive tree model (michael.lee@psychology.adelaide.edu.au)
% [adjacency,lengths,vaf,bic]=addtreegrow(proximity,precision,labels,evidence,patience)
%
% PROXIMITY is an NxN symmetric matrix of pairwise proximities (required)
% PRECISION specifies the mean standard error of the similarities (required)
% LABELS is a string array naming each object in the similarity matrix (numbered by default)
% EVIDENCE specifies the increase over the minimum BIC value for terminating (default=6)
% PATIENCE specifies the number of local-minima restarts attempted without improvement (de-
fault=1)
%
% ADJACENCY returns an (N+BESTNUMBERNODES)x(N+BESTNUMBERNODES) adjacency
matrix
% defining the tree topology using the 'best' number of internal nodes
% LENGTHS returns a vector of length (N+BESTNUMBERNODES) containing the arc-lengths
% for the tree using the 'best' number of internal nodes
% VAF returns the variance of the proximity data accounted for by the generated models
% BIC returns the Bayesian Information Criteria for by the generated models

% check the number of arguments
error(nargchk(2,5,nargin));

% check the proximity matrix
[n check]=size(proximity);
if check~=n
    error('proximity matrix must be square');
end;
if ~isequal(proximity,proximity')
    error('proximity matrix must be symmetric');
end;

% check the precision
if precision<=0
    error('precision must be positive');
end;

% set default arguments as necessary
if nargin<3, labels='1'; for i=2:n labels=char(labels,int2str(i)); end; end;
if nargin<4, evidence=6; end;
if nargin<5, patience=1; end;

% check the object labels
[check junk]=size(labels);
if check~=n
    error('number of labels must match size of matrix');
end;

% check the evidence
if evidence<=0
    error('evidence must be positive');
end;

% check the maximum number of trials

```

```
if (patience<1)|| (patience~=round(patience))
    error('patience must be a positive integer');
end;

%rename variables
maxtries=patience;
d=proximity;
sigma=precision;
sig=sigma;
labs=labels;

% normalise proximities to lie between 0 and 1, and scale precision
reshift=min(min(d));
d=d-reshift;
rescale=max(max(d));
d=d/rescale;
sig=sig/rescale;

% calculate the variance of the distance matrix
dbar=(sum(sum(d))-trace(d))/n/(n-1);
temp=(d-dbar*ones(n)).^2;
vard=.5*(sum(sum(temp))-trace(temp));

% express the distance matrix as a column vector
flatd=[];
for i=1:n-1
    for j=i+1:n
        flatd=[flatd ;d(i,j)];
    end;
end;

% matlab options
warning off;

% init other variables and constants
npairs=round(n*(n-1)/2);
maxtries=2;
evidence=10;
adjacency=[];
lengths=[];

% fit star tree
m=1
wm=zeros(npairs,n);
c=1;
for i=1:n-1
    for j=i+1:n
        wm(c,i)=1;
        wm(c,j)=1;
        c=c+1;
    end;
end;

% find arc-lengths and evaluate sum-squared error
w=max(wm\flatd,0);
sse=sum((wm*w-flatd).^2);

% create adjacency matrix g from x
```

```

best=zeros(m+n);
for i=2:m+n
    best(i,1)=1;
end;

bestw=[0:w];

vaf=[0 1-sse/vard];
err=[vard sum((wm*w-flatd).^2)];
bic=err/sigma^2+([0:1]+n-1)*log(npairs);

minbic=min(bic);
currentbic=bic(end);
besterr=min(err);

if bic(2)<bic(1)
    adjacency=best+best';
    lengths=bestw;
end;

msg=sprintf('best tree found: accounts for %1.2f percent of the variance',vaf(2)*100);
disp(msg);
pause(.01);

% draw results
figure(1);clf;hold on;
plot([0:m],bic,'k-', 'linewidth',1);
rng=get(gca,'ylim');
axis([-1 m+1 rng(1) rng(2)]);
axis([-1 m+1 minbic-2 minbic+2*evidence]);
xlabel('Number of Nodes','fontsize',14,'fontweight','bold');
ylabel('Bayesian Information Criterion','fontsize',14,'fontweight','bold');
ax1=gca;
set(ax1,'xtick',[0:m]);
ax2=axes('Position',get(ax1,'Position'),'YAxisLocation','right','Color','none');
axis([-1 m+1 0 100]);
set(ax2,'xtick',[0:m]);
p=line([0:m],100*vaf,'Color','k','LineStyle','--','Parent',ax2,'linewidth',1);
ylabel('Percentage Variance Accounted For','fontsize',14,'fontweight','bold');
pause(.001);

displaytree(d,best+best',bestw,labs,0,.5,2,.1);
pause(.1);

while currentbic-minbic<evidence

    if m==1
        % setup two-internal-node tree
        m=m+1
        x=zeros(m+n,1);
        x(1)=0;
        x(2)=1;

        %for i=m+1:m+n
        % x(i)=ceil(rand*m);
        %end;

        x([1:n]+m)=1;

```

```
%basis=ceil(rand*n);
%onenode=find(d(basis,.)<mean(mean(d)));
%twonode=find(d(basis,.)>=mean(mean(d)));
%x(onenode+m)=1;
%x(twonode+m)=2;

candidates=[1:n];
parents=[1 2];
else
% average errors per internal node
res=zeros(n);
c=1;
for j=1:n-1;
    for k=j+1:n
        res(j,k)=resid(c);
        c=c+1;
    end;
end;
res=res+res';
for i=1:m
    stimlist=find(bestx==i)-m;
    stimlist=stimlist(find(stimlist>0));
    avsse(i)=sum(sum(res(stimlist,:)));
end;
% set internal topology
[val ind]=max(avsse);
%candidates=find(bestx(m+1:end)==ind);
candidates=find(bestx==ind)-m;
candidates=candidates(find(candidates>0));
x=[bestx(1:m);ind;bestx(m+1:end)];
labs(candidates,:)
m=m+1
parents=[ind m];
end;

foundbetter=0;

% main hillclimbing loop
failedtries=0;

while failedtries<maxtries

    failedthisgo=1;
    list=randperm(length(candidates));
    listind=1;

    while listind<length(list)
        node=candidates(list(listind))+m;

        % swap parent
        oldx=x;
        if x(node)==parents(1)
            x(node)=parents(2);
        else
            x(node)=parents(1);
        end;
    end;
```

```
% create adjacency matrix g from x
g=zeros(m+n);
for i=2:m+n
    g(i,x(i))=1;
end;

% find edges in unique path between every pair
% find parent list of each terminal node
pl=zeros(n,m);
for i=1:n
    current=find(g(m+i,:)==1);
    pl(i,current)=1;
    while current~=1
        current=find(g(current,:)==1);
        pl(i,current)=1;
    end;
end;

% object pairs x weight matrix for non-negative least squares
wm=zeros(npairs,m+n-1);
c=0;
for i=1:n-1
    for j=i+1:n
        c=c+1;
        pairmeet=max(intersect(find(pl(i,:)==1),find(pl(j,:)==1)));
        current=m+i;
        wm(c,current)=1;
        while find(g(current,:)==1)~=pairmeet
            current=find(g(current,:)==1);
            wm(c,current)=1;
        end;
        current=m+j;
        wm(c,current)=1;
        while find(g(current,:)==1)~=pairmeet
            current=find(g(current,:)==1);
            wm(c,current)=1;
        end;
    end;
end;

% find arc-lengths and evaluate sum-squared error
%[w sse]=lsqnonneg(wm,flatd,[],options);
w=max(wm\flatd,0);
resid=(wm*w-flatd).^2;
sse=sum(resid);

if sse<besterr
    failedthisgo=0;
    foundbetter=1;
    besterr=sse;
    failedtries=0;
    bestvaf=1-besterr/var;
    bestx=x;
    best=g;
    bestw=w;
    bestresid=resid;
```

```

    msg=sprintf('better tree found: accounts for %1.2f percent of the variance',bestvaf*100);
    disp(msg);
    pause(.01);
else
    x=oldx;
end;

listind=listind+1;

end; % while listind

if failedthisgo==1
    failedtries=failedtries+1;
    shake=candidates(ceil(rand*length(candidates)))+m;
    if x(shake)==parents(1)
        x(shake)=parents(2);
    else
        x(shake)=parents(1);
    end;
end;
end; %while failedtries

if foundbetter==0
    bestx=[bestx(1:m);1;bestx(m+1:end)];
    bestw=[bestw(1:m);0;bestw(m+1:end)];
    best=zeros(m+n);
    for i=2:m+n
        best(i,bestx(i))=1;
    end;
end;

err=[err besterr];
currentbic=besterr/sigma^2+(m+n-1)*log(npairs);
bic=[bic currentbic];
vaf=[vaf 1-besterr/vars];
if currentbic<minbic
    minbic=currentbic;
    adjacency=best+best';
    lengths=bestw;
end;

% draw results
figure(1);clf;hold on;
plot([0:m],bic,'k-','linewidth',1);
rng=get(gca,'ylim');
axis([-1 m+1 rng(1) rng(2)]);
axis([-1 m+1 minbic-2 minbic+2*evidence]);
xlabel('Number of Clusters','fontsize',14,'fontweight','bold');
ylabel('Bayesian Information Criterion','fontsize',14,'fontweight','bold');
ax1=gca;
set(ax1,'xtick',[0:m]);
ax2=axes('Position',get(ax1,'Position'),'YAxisLocation','right','Color','none');
axis([-1 m+1 0 100]);
set(ax2,'xtick',[0:m]);
p=line([0:m],100*vaf,'Color','k','LineStyle','--','Parent',ax2,'linewidth',1);
ylabel('Percentage Variance Accounted For','fontsize',14,'fontweight','bold');
pause(0.001);

```

```

displaytree(d,best+best',bestw,labs,0,.5,10,.1);
pause(0.001);

end; % while currentbic

```

File: Treesim.m

% TREESIM runs the ADDTREEGROW algorithm a specified number of times and saves the optimal answer (matthew.welsh@adelaide.edu.au)

```

% load file here
load dt_data;
% set up batch stuff
% How many repetitions should be attempted?
reps=100;
% These define values required for addtreegrow
% this is the increase over the minimum BIC required to terminate
evidence=10;
% Number of local minima restarts attempted without improvement
patience=1;
% This is defining an empty matrix for recording BIC values but seems to
% be referring to an unknown value 'maxcl'... which probably refers to a
% maximum number of clusters that, therefore, should be defined.
maxcl=length(s); % 20 as we have 20 documents and this => vaf(100)
bic=zeros(reps,maxcl);
% Same but for variance accounted for...
vaf=zeros(reps,maxcl);
% Count of the number of clusters actually found - starting at zero
maxactualcl=0;
% Best value of BIC seen so far, starting ridiculously high
bestglobalb=10e10;

% repeatedly run growing algorithm
% saving best
for i=1:reps
    [f,w,v,b]=addtreegrow(d,sigma_emp,labs);
    % [adjacency,lengths,vaf,bic]=addtreegrow(proximity,precision,labels,evidence,patience);
    % This part records the values generated if they are the best seen
    if min(b)<bestglobalb
        bestglobalb=min(b);
        bestglobalclusters=f;
        bestglobalw=w;
        bestglobalv=v;
        % adding a key to find the best value amongst those seen
        % This should allow me to find the appropriate cells in the BIC and
        % VAF matrices for plotting
        key=i;
    end;
    if length(b)>maxactualcl+1
        maxactualcl=length(b)-1;
    end;
    bic(i,1:length(b))=b;
    vaf(i,1:length(v))=v;
end;

```

```

% display it etc as appropriate now
% This removes any nonexistent clusters from the vectors to be plotted
for i=1:20
    if bic(key,i)>0
        bic2(i)=bic(key,i);
        vaf2(i)=vaf(key,i);
    end
end
% This closes any currently open figure
pause(2);
close;
pause(1);
% This plots the BIC and VAF values against the number of clusters
figure(1);clf;hold on;
plot([0:length(bic2)-1],bic2,'k-','linewidth',1);
rng=get(gca,'ylim');
%axis([-1 m+1 rng(1) rng(2)]);
axis([-1 length(bic2)+1 min(bic2)-2 min(bic2)+2*evidence]);
xlabel('Number of Clusters','fontsize',14,'fontweight','bold');
ylabel('Bayesian Information Criterion','fontsize',14,'fontweight','bold');
ax1=gca;
set(ax1,'xtick',[0:length(bic2)]);
ax2=axes('Position',get(ax1,'Position'),'YAxisLocation','right','Color','none');
axis([-1 length(bic2)+1 0 100]);
set(ax2,'xtick',[0:length(bic2)]);
p=line([0:length(bic2)-1],100*vaf2,'Color','k','LineStyle','--','Parent',ax2,'linewidth',1);
ylabel('Percentage Variance Accounted For','fontsize',14,'fontweight','bold');
pause(1);

displaytree(d,bestglobalclusters,bestglobalw,labs,0,.5,10,.1);
pause(0.01);

```

File: Adclusgrow.m

```

function [clusters,weights,vaf,bic]=adclusgrow(similarity,precision,labels,evidence,patience)

% ADCLUSGROW grows an additive clustering model (michael.lee@adelaide.edu.au)
% [clusters,weights,vaf,bic]=adclusgrow(similarity,precision,labels,evidence,patience)
%
% SIMILARITY is an NxN symmetric matrix of pairwise similarities (required)
% PRECISION specifies the mean standard error of the similarities (required)
% LABELS is a string array naming each object in the similarity matrix (numbered by default)
% EVIDENCE specifies the increase over the minimum BIC value for terminating (default=6)
% PATIENCE specifies the number of local-minima restarts attempted without improvement (default=1)
%
% CLUSTERS returns an Nx(BESTNUMBERCLUSTERS+1) matrix defining derived cluster membership plus the universal cluster
% WEIGHTS returns a vector of length (BESTNUMBERCLUSTERS+1) containing the weights of the clusters
% VAF returns the variance of the similarity data accounted for by the generated models
% BIC returns the Bayesian Information Criteria for by the generated models

% check the number of arguments

```

```
error(nargchk(2,5,nargin));

% check the similarity matrix
[n check]=size(similarity);
if check~=n
    error('similarity matrix must be square');
end;
if ~isequal(similarity,similarity')
    error('similarity matrix must be symmetric');
end;

% check the precision
if precision<=0
    error('precision must be positive');
end;

% set default arguments as necessary
if nargin<3, labels='1'; for i=2:n labels=char(labels,int2str(i)); end; end;
if nargin<4, evidence=6; end;
if nargin<5, patience=1; end;

% check the object labels
[check junk]=size(labels);
if check~=n
    error('number of labels must match size of matrix');
end;

% check the evidence
if evidence<=0
    error('evidence must be positive');
end;

% check the maximum number of trials
if (patience<1)|(patience~=round(patience))
    error('patience must be a positive integer');
end;

% rename variables
maxpatience=patience;
s=similarity;
sig=precision;
labs=labels;

% matlab
warning off;

% normalise similarities to lie between 0 and 1, and scale precision
reshift=min(min(s));
s=s-reshift;
rescale=max(max(s));
s=s/rescale;
sig=sig/rescale;

% calculate the variance of the similarity matrix
sbar=(sum(sum(s))-trace(s))/n/(n-1);
temp=(s-sbar*ones(n)).^2;
vard=.5*(sum(sum(temp))-trace(temp));
```

```
% express the similarity matrix as a column vector
flats=[];
for i=1:n-1
    for j=i+1:n
        flats=[flats;s(i,j)];
    end;
end;

% init other variables and constants
npairs=round(n*(n-1)/2);
m=1;
newbic=0;
oldbic=1*log(n*(n-1)/2)+vard/sig^2;
minbic=oldbic;
fbx=[];
fbw=[];
fbm=0;
bic=[oldbic];
vaf=[0];
%matlab 5.3
%options=optimset('display','off');

thresh=.5;

% keep adding clusters while the most recent model has a BIC
% at least evidence above the lowest BIC found
while newbic-minbic<evidence

    if m>1
        oldbic=newbic;
    end;

    % choose starting vector
    % uses ADDI-S idea of adding most (averagely) similar
    % until less than *half* within-cluster similarity
    if m==1
        % first pair
        [row col]=find(s==max(max(tril(s,-1)))); %tril(s,-1) is tril without diagonal
        ind=find(row~=col);
        row=row(ind);col=col(ind);
        ind=ceil(rand*length(row));row=row(ind);col=col(ind); %break ties randomly
        new=[row col];
        ins=(sum(sum(s(new,new)))-trace(s(new,new)))/length(new); %average within new sim
        avs=zeros(n,1);
        for i=1:n
            if nnz(ismember(new,i))==0
                avs(i)=mean(s(new,i)); %average similarity to new
            end;
        end;
        while nnz(avs)>0
            [val ind]=max(avs);
            if avs(ind)>thresh*ins
                new=[new ind];
                ins=(sum(sum(s(new,new)))-trace(s(new,new)))/length(new); %average within new sim
                avs(ind)=0;
            else
                avs(ind)=0;
            end;
        end;
    end;
end;
```

```
    end;
end;
x=zeros(n,1);
x(new)=1;
else
    tmps=s-bestseenh;
    tmps=max(tmps,0);
    [row col]=find(tmps==max(max(tril(tmps,-1))))); %tril(s,-1) is tril without diagonal
    ind=find(row~=col);
    row=row(ind);col=col(ind);
    ind=ceil(rand*length(row));row=row(ind);col=col(ind); %break ties randomly
    new=[row col];
    ins=(sum(sum(tmps(new,new)))-trace(tmps(new,new)))/length(new); %average within new
sim
    avs=zeros(n,1);
    for i=1:n
        if nnz(ismember(new,i))==0
            avs(i)=mean(tmps(new,i)); %average similarity to new
        end;
    end;
    while nnz(avs)>0
        [val ind]=max(avs);
        if avs(ind)>thresh*ins
            new=[new ind];
            ins=(sum(sum(tmps(new,new)))-trace(tmps(new,new)))/length(new); %average within
new sim
            avs(ind)=0;
        else
            avs(ind)=0;
        end;
    end;
    newx=zeros(n,1);
    newx(new)=1;
    x=[bestseenx;newx];
end;

% reset/recalculate for new cardinality
patience=0;
veclength=n*m;
bestseenx=x;
bestw=zeros(m+1,1);
bestseennerr=vard;

% how many local minima for fixed cardinality
while patience<maxpatience

    % hill-climb on the surface
    alldone=0;
    while alldone==0

        % random order in which bits will be flipped
        fliptry=randperm(veclength);

        % find one step
        trycount=0;
        moveon=0;
        while moveon==0
            trycount=trycount+1;
```

```
x(fliptry(trycount))=1-x(fliptry(trycount));

% augment x with universal cluster
f=reshape(x,n,m);
f=[f ones(n,1)];

% form of cluster membership needed for non-negative least squares
flatf=zeros(npairs,m+1);
count=0;
for a=1:n-1
    for b=a+1:n
        count=count+1;
        flatf(count,:)=f(a,:).*f(b,:);
    end;
end;

% find weights (nnls, lsqnonneg and slash versions)

%w=diag(nnls(flatf,flats));

%[w sse]=lsqnonneg(flatf,flats,[],options);
%w=diag(w);

w=diag(max(flatf/flats,0));

% evaluate solution
sh=f*w*f';
se=(s-sh).^2;
sse=.5*(sum(sum(se))-trace(se));

% see if best solution
if sse<bestseenerr
    patience=0;
    bestseenerr=sse;
    bestseenx=x;
    bestseenw=diag(w)';
    bestseensh=sh;
    moveon=1;
else
    x(fliptry(trycount))=1-x(fliptry(trycount));
end;

if trycount==veclength
    moveon=1;
    alldone=1;
end;
end; % move on

end; % all done

% a random selection of 3 bits are flipped to try and shake out of a local min
% there is no principled reason for choosing 3
x=bestseenx;
scrambleflip=randperm(veclength);
x(scrambleflip(1:3))=1-x(scrambleflip(1:3));
patience=patience+1;
```

```

end; % while patience

% display cluster membership labels for best solution
msg=strcat('Clusters=',num2str(m),'', 'Variance Explained=',num2str(100*(1-bestseenerr/vard)));
disp(msg)
for i=1:m
    msg=strcat(num2str(bestseenw(i),3),':');
    for j=1:n
        if bestseenx((i-1)*n+j)==1
            msg=strcat(msg,'',(labs(j,:)),'');
        end;
    end;
    disp(msg(1:end-1))
end;
msg=strcat(num2str(bestseenw(m+1),3),':additive constant');
disp(msg)

% calculate new BIC and VAF
newbic=(m+1)*log(n*(n-1)/2)+bestseenerr/sig^2;
bic=[bic newbic];
vaf=[vaf 1-bestseenerr/vard];

% see if model has best BIC
if newbic<minbic
    minbic=newbic;
    fbx=bestseenx;
    fbw=bestseenw;
    fbm=m;
end;

% draw results
figure(1);clf;hold on;
plot([0:m],bic,'k-', 'linewidth',1);
rng=get(gca,'ylim');
%axis([-1 m+1 rng(1) rng(2)]);
axis([-1 m+1 minbic-2 minbic+2*evidence]);
xlabel('Number of Clusters','fontsize',14,'fontweight','bold');
ylabel('Bayesian Information Criterion','fontsize',14,'fontweight','bold');
ax1=gca;
set(ax1,'xtick',[0:m]);
ax2=axes('Position',get(ax1,'Position'),'YAxisLocation','right','Color','none');
axis([-1 m+1 0 100]);
set(ax2,'xtick',[0:m]);
p=line([0:m],100*vaf,'Color','k','LineStyle','--','Parent',ax2,'linewidth',1);
ylabel('Percentage Variance Accounted For','fontsize',14,'fontweight','bold');
pause(.001);

% now ready to add a cluster
m=m+1;

end; % while newbic-oldbic

% return variables
if fbm>0
    clusters=reshape(fbx,n,fbm);
    weights=fbw;
else
    clusters=[];
end;

```



```
weights=[];
end;
```

File: Clustersim.m

```
% CLUSTERSIM runs the ADCLUSGROW algorithm a specified number of times and saves the
optimal answer (matthew.welsh@adelaide.edu.au)
```

```
% load file here
load dt_data;
% set up batch stuff
% How many repetitions should be attempted?
reps=100;
% These define values required for adclusgrow
% this is the increase over the minimum BIC required to terminate
evidence=10;
% Number of local minima restarts attempted without improvement
patience=1;
% This is defining an empty matrix for recording BIC values but seems to
% be referring to an unknown value 'maxcl'... which probably refers to a
% maximum number of clusters that, therefore, should be defined.
maxcl=length(s); % 20 as we have 20 documents and this => vaf(100)
bic=zeros(reps,maxcl);
% Same but for variance accounted for...
vaf=zeros(reps,maxcl);
% Count of the number of clusters actually found - starting at zero
maxactualcl=0;
% Best value of BIC seen so far, starting ridiculously high
bestglobalb=10e10;
% repeatedly run growing algorithm
% saving best
for i=1:reps
    [f,w,v,b]=adclusgrow(s,sigma_emp,labs);
    % [clusters,weights,vaf,bic]=adclusgrow(similarity,precision,labels,evidence,patience);
    % This part records the values generated if they are the best seen
    if min(b)<bestglobalb
        bestglobalb=min(b);
        bestglobalclusters=f;
        bestglobalw=w;
        bestglobalv=v;
        % adding a key to find the best value amongst those seen
        % This should allow me to find the appropriate cells in the BIC and
        % VAF matrices for plotting
        key=i;
    end;
    if length(b)>maxactualcl+1
        maxactualcl=length(b)-1;
    end;
    bic(i,1:length(b))=b;
    vaf(i,1:length(v))=v;
end;

% display it etc as appropriate now
% This removes any nonexistent clusters from the vectors to be plotted
for i=1:20
```

```

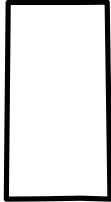
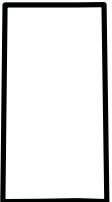
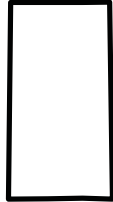
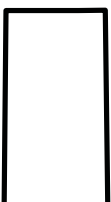
if bic(key,i)>0
    bic2(i)=bic(key,i);
    vaf2(i)=vaf(key,i);
end
end
% This closes any currently open figure
pause(2);
close;
pause(1);
% This plots the BIC and VAF values against the number of clusters
figure(1);clf;hold on;
plot([0:length(bic2)-1],bic2,'k-','linewidth',1);
rng=get(gca,'ylim');
%axis([-1 m+1 rng(1) rng(2)]);
axis([-1 length(bic2)+1 min(bic2)-2 min(bic2)+2*evidence]);
xlabel('Number of Clusters','fontsize',14,'fontweight','bold');
ylabel('Bayesian Information Criterion','fontsize',14,'fontweight','bold');
ax1=gca;
set(ax1,'xtick',[0:length(bic2)]);
ax2=axes('Position',get(ax1,'Position'),'YAxisLocation','right','Color','none');
axis([-1 length(bic2)+1 0 100]);
set(ax2,'xtick',[0:length(bic2)]);
p=line([0:length(bic2)-1],100*vaf2,'Color','k','LineStyle','--','Parent',ax2,'linewidth',1);
ylabel('Percentage Variance Accounted For','fontsize',14,'fontweight','bold');
pause(1);

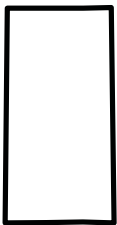
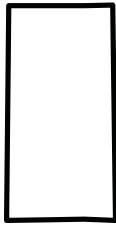
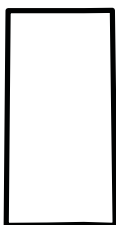
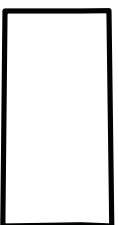
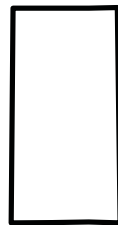
```

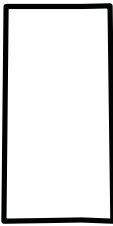
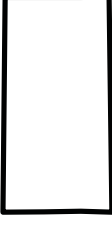




APPENDIX 12

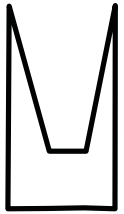
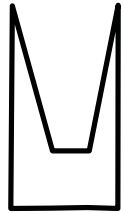



Decision Process and Decision Type

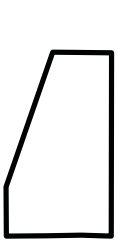





Interviews – Decision Process and Decision Type

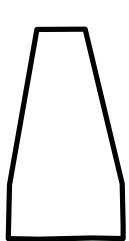
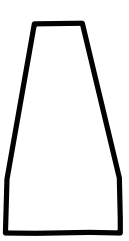




Person	Type	Individual Process									
		Framing		Modeling		Assessing		Feedback			
		Problem	Objectives	Alternatives		Consequence	Sensitivity	Outcome	Implement		
D		Talk to others to help clarify	Not done	Not done	Remodel	Not done	Not done	Not done	Not done	Not done	
K		"go" / "no go"	Not clearly defined	Range of scenarios	Very de-tailed formal processes	Very formal scenarios and contingency plans	Very formal scenarios and contingency plans	Feedback both within and outside process	Contingency plans		
L		Working through problems without explicitly stating so	Explicitly stating Objective or Alternatives	A checklist in hand	Not described	Peer review process and milestone reviews Peer Review really only works when the person is a peer – common respect	Has everyone been in the communication?	Feedback both within and outside process	Not done		
M		"go" / "no go"	Defined by matrix and stated up front	Defined by matrix and stated up front	Very de-tailed formal process; decision trees; Vol	Very formal scenarios and contingency plans	Very formal scenarios and contingency plans	Feedback both within and outside process	Contingency plans; well quality index – self measuring		


O		Large amount of back ground-ing and de-termining what needed answering Makes deci-sion and then justifies	Devolved from the problem definition	Seems to fall into past ex-perience	Very com-plex model-ing	Play offs and trade offs	Averaging but built us-ing probabili-ty	Fast loop and slow loop used as words to de-scribe deci-sions	Not de-scribed
P		Makes deci-sion and then justifies	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Q		Talk to oth-ers to help clarify	NPV BUT . . . Strategic fit	No alterna-tives – go or no go	Formal processes and tools	Error bars of 20%	Not done	Some after 1 year but very informal	Informal learning as you go
Q		Not deter-mined	Immediate answer	Not done	Based on trust	Need to know staff	Not done	Not done	Not done
S		Investigates the problem from all an-gles before even think-ing of what to do	Moves into scenario planning	Not dis-cussed	Has to oc-cur in group discussion based on trust	Not done	Not done	Not done	Not done

T		Questions others to understand the problem	Formulated on the go	Not done	Many processes	Formulated on the go	Not done	Use as a learning pattern	Not done
V		"go" / "no go"	Defined by matrix and stated up front	Defined by matrix and stated up front	Very detailed formal process; decision trees; Vol	Very formal scenarios and contingency plans	Very formal scenarios and contingency plans	Feedback both within and outside process	Contingency plans; well quality index – self measuring
F		Not discussed but seems objectives have not been defined or even talked about	Not done	Not done	Mapping modeling NPV	Not done	Not done	Not done	Formally no but informally some recon because of size and nature
M		Followed Klein's model through use of teams	Follows NDM process	Not done	Strong use of trust heuristic	Not done	Not done	Feedback during process	Not done
T		Followed Klein's model through use of teams	Follows NDM process	Not done	Not done	Not done	Not done	Not done	Not done
W		Not discussed but seems objectives have not been defined or even	Not done Just jump in and do!	Not done	Not done	Not done	Not done	Not done	Not done

J		Defined via group discussion Needs and wants SWAT	Three to four key	Three main options	Standard multi-objective model	Some but not formal	Some but not formal	Not done	Informal look backs because of concerns
K		Not done DM process is focused on people; consensus discussion	Not done DM process is more an approval process	Scenarios	Value – NPV Plenty of applications; Crystal Ball used in probabilistic economics	Contingency plans	Risk situations checked, formal scenario plans	Early stage peer review – within process Formal outside process	Formal outside process
B		Formal rigid transparent	Defined ahead of undertaking	As given	Spreadsheets and group discussion Separate teams	Consequences clearly reviewed	Scenarios and different weights	Formal – but covering	A lot of iteration
G		Tailored through the decision-making	Set the objectives as step 1	Get a group together to develop	Large numbers of tools	Look at various scenarios	Not done	Prescribed but not always done	Usually for operational decisions but rarely done
Z		Made assumption and went to work completing it	Single objective – keep staff	Two alternatives tracked in parallel	No modeling	Not done	Not done	Not done	Not done

J		Used "Blink": intuitive	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
C		Discussion over ownership and the search for options	Two prime objectives mentioned	Search for alternatives	White boards, reboards and search and spreadsheets	Post project comparisons with others	Not done	No feedback – Oh that's a good idea!	Not done	Not done
R		Not openly defined	Not defined - intuitive	As given	Talking to people	Weighting if equal top	Not done	No feedback – too busy	Not done	Not done
S		Very formal discussion	Looked at objectives of each stakeholder	Developed alternatives that met each stakeholder position	Used all sorts of formal and informal tools	Not done	Not done	Short term very formal via annual performance review	Not done	Long term not done.
T		Understood that there must be some formulation but not done	Has some listed as part of the generic exercise	Based on past experience	Different tools used based on the people asking for time	Not done	Not done	Uses a medical triage process	Not done	Not done
Y		Group discussion	Need to clearly understand resources	Consider more alternatives Expand options	No modeling	Not done	Not done	Not done	Not done	Not done

F		Made decision in head and starts implementing	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
U		Investigate via committee	Jump to conclusion	Some alternatives discussed but really a list of "don'ts"	Not done	Not done	Not done	Not done	Not done	Not done
AA		Group consensus	None discussed	None discussed	Not done	Not done	Not done	Not done	Learn via feedback - informal	Learn via feedback - informal
E		Not often Implement process – go into automatic	Not done	Not done	Benchmarking networking data-bases	Not done	Auditing	Ad hoc based on anomalies	Ad hoc based on anomalies	Ad hoc based on anomalies
N		Some clarification by talking with others	Match to developed strategy (long and short) and budget	Two clearly defined	Risking and portfolio analysis	Not done	Not done	Feedback during process but not outside process	Not done	Not done
U		Cognitive recognition – follow the simple do	Life cycle planning	Nil	NPV ranking Portfolio	Not done	Not done	Not done	Not done	Not done

V		Known decision within organization – follow handbook	Known corporate objectives	Nil – follow handbook	Ranking	Not done	Not done	Not done	Not done
---	---	--	----------------------------	-----------------------	---------	----------	----------	----------	----------

