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The Role of Intuition in the Decision Process of Expert Ski Guides

A thesis

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of the requirements for the Degree

of

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“The job of heli-ski guides [is] to always be observant for the unexpected, and to continually test conditions. The decisions by heli-ski guides have a very low shelf life”.

Madam Justice Koenigsberg (1996)
Supreme Court of British Columbia, Case No. C922041

ABSTRACT

High quality decision-making can be produced through a sophisticated analytical process in addition to an intuitive process. A high quality intuitive process is dependent on an extensive repertoire of previous patterns generated by decision outcomes. Intuition is frequently poorly understood and often dismissed as unreliable and irrelevant. Yet there is a noteworthy sector within the literature that suggests otherwise (Glöckner, 2009; Smith, 2007). Termed dual-process (Evans, 2010), the combined strength of intuition and analysis forms the basis of how expert ski guides make decisions in avalanche terrain. Typically, the quality of the decision process is described as being contingent on the evolved expertise of the decision maker. Deliberate practice (Ericsson, Krampe, & Tesch-Romer, 1993) aimed at the development of context specific expertise provides the foundation.

Ski guides are charged with the role of conducting guests through a constantly changing, hazardous environment with the goal of maximizing the guests' rewards, within a risk envelope that does not eliminate the potential for a fatality. The challenge for ski guides is to formulate an operational context within a feedback environment that is plagued with inconsistencies and burdened with massive negative consequences. The ski guide decision process is influenced by the depth and breadth of expertise, with rapid pattern recognition generating a sense of confidence. However misleading environmental feedback can complicate the perception of decision quality. When nothing bad happens, poor decisions can masquerade as good ones. This may support the development of a faulty pattern recognition process.

Research that helps to describe the innovative practices and extant knowledge of mountain guiding will help to harmonise theory and practice. There is considerable knowledge entrenched within the daily activities of the Canadian mechanized ski industry, as the average annual fatality rate is just under one and a half fatalities per 100,000 skier days. However it is arguable that even this number of fatalities is too many and all efforts should be made to reduce the number of fatalities.

Data were contributed over two seasons (2008/09 and 2009/10) by a self-selected group of 35 heli-ski and snowcat-ski guides working in British Columbia. Mixed methods were used to analyse three sources of data. An initial quantitative analysis of the participants' background experience and 96 event reports (62 good day reports and 34 near-miss reports) was used to provoke qualitative questions of interview data.

The findings of this study address the issue of how and when intuition plays a role in ski guide decision-making. Decision-making in avalanche terrain is a complex process and professional guides have well developed strategies to help them manage the challenges. Years of training in analytical decision processes are supported by a wealth of available snowpack and weather information. Guiding teams provide a valuable peer support network to further the sophistication of the decision process. Yet despite the wealth of information available to support an analytical decision, most decisions are influenced by an intuitive factor.

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Chapter 1

Standing at the top of a pristine wilderness peak, the ski guide prepares a group of eleven guests for the rewards of a 1500 metre descent through deep, untracked powder. Weather, snowpack and terrain usage data have been gathered throughout the winter, enabling the guide to carefully analyse the present hazard according to well-developed industry standards. This has all come together, resulting in a decision to ski this slope. As the guide slides over to the edge of the steep slope, a feeling emerges from somewhere within the guide. It is a bad feeling. He cannot figure out the source of the feeling, only that something is not right.

In the morning meeting with the other guides, it had been decided that this run should be safe to ski. But right here, right now, with eleven guests looking to him for a decision and eager to ski the slope, his gut, or his intuition told him something was wrong, something did not feel right. What should he do?

1.1 Introduction

The overall aim of this research project was to examine whether highly experienced heli-ski and snowcat-ski guides used intuition as a component of their decision process. Decisions that resulted in near-miss events were examined, as were decisions that resulted in no negative consequences. Canadian ski guides have been trained to use an analytical decision process, yet anecdotal evidence suggests that intuition also plays a role.

The first chapter introduces the reader to the layout of the thesis and establishes the research question. The meanings of key words that are used throughout the document are established including: hazard, risk, consequence, near-miss, good day, dual process, intuition, analysis and confidence. A brief overview of each chapter provides the skeletal framework of the dissertation. The introductory chapter concludes with a section on my role as the researcher.

1.2 Background Literature

Decision-making in avalanche terrain is a complex process; so professional backcountry ski guides need well-developed strategies to help them navigate through the challenges. Guides are charged with the role of conducting guests through a

constantly changing, hazardous, wilderness environment with the goal of maximizing the guests' rewards (deep powder skiing) within a risk envelope that does not eliminate the potential for a fatality (Bruns, 1996; Canadian Mountain Holidays, 2007). In many ways these challenges are exacerbated when mechanical means such as helicopters and snow cats are used to facilitate access to terrain. Over the course of a day, a ski group that uses a four minute helicopter ride to get to the top of each ski run will travel through far more potential avalanche terrain than a ski touring group that takes three to four hours to get to the same place. A typical day of heli-skiing may include over 7000 metres of downhill skiing, while a typical day of ski touring may involve 1500 metres of ascent and 1500 metres of descent. The ski touring guide not only makes fewer avalanche hazard-related decisions, but he also has the opportunity to enter the terrain slowly and develop a *feel* for the nature of the environment.

The majority of decisions that a ski guide makes are related to hazard management, with the greatest challenge being the assessment of avalanche risk. There is a significant body of knowledge related to decision making in hazardous environments within the judgment and decision making literature. However, much of this theoretical knowledge has not been applied to the practical field of ski guiding. This study connects the praxis of ski guide decision-making with the theoretical underpinnings of the academic literature.

Locating this research question within the literature was not an easy task as it overlapped three distinct bodies of knowledge; judgment and decision-making (JDM), adventure leadership, and snow science. Each of these bodies of knowledge brought a sequentially tighter focus to the research question. The JDM literature anchored in cognitive psychology provided the theoretical basis of decision-making for the other two literatures. Adventure leadership addressed the issues of a broad range of adventure activities and philosophies. Snow science specifically targeted the issue of human interactions with snow dynamics. The research question fits best within the realm of snow sciences, even if it was not an entirely comfortable fit. However the question borrowed theories from JDM and applied them to both snow science and adventure leadership.

The judgment and decision-making literature has suggested that decision-making has two components, analysis and intuition that contribute toward a final decision solution (Evans, 2008; Hogarth, 2005). Analysis can be thought of as the product of careful thought and reflection, whereas intuition can be considered the product of our learned experiences or expertise (Evans, 2010). Expertise is thought to range along a continuum and is generated through the depth and breadth of experiences (Hammond & Klein, 1993). The ability to rapidly recognize previously experienced patterns and match them with the current situation comes from these many and varied experiences and can generate a sense of confidence (Gigerenzer & Goldstein, 1996). However misleading environmental feedback can complicate the perception of decision quality. For example, when nothing bad happens, poor decisions can masquerade as good ones. This notion of non-event feedback has the potential to support the development of a faulty pattern recognition process with a corresponding negative effect on the quality of future intuitive responses (Hogarth, 1980). Related questions that have been asked within the literature include: why can a deliberate analytical thought process be discarded at the last minute in favour of a sudden intuitive feeling, or how can a strong intuitive feeling, which promotes a sense of complete confidence be so radically wrong?

Snow science is the body of knowledge concerned with the theory and practice of snow avalanches. There are two avenues of research within the snow science literature: the snow scientists who quantitatively study the physics and mechanics of the snow avalanche phenomenon and the social scientists that study human interaction with that phenomenon. The snow scientists have conducted the majority of research within snow studies, with significantly less research from social scientists. The results from the predominantly quantitative studies of avalanche mechanics contribute to new ways of testing and understanding the avalanche environment. These are of great benefit to the end user, particularly the ski guide, however it is the results from the social scientists' studies that can contribute to how these snowpack tests are used and how the results can be applied to the challenge of making decisions on the selection of safe skiing terrain for guests.

Decision-making within an avalanche context has been researched, but not extensively. The majority of these social studies have been conducted on amateur or

recreational level decision makers (Hägeli, McCammon, Jamieson, Israelson, & Statham, 2006). Most of these studies have taken a heuristics and bias approach, looking at the heuristics or ‘rules of thumb’ commonly employed and the frequent flaws, or heuristic biases that practitioners are susceptible to (McCammon, 2002). Expert decision-making in avalanche terrain is a relatively untouched area.

During the early development of heli-skiing, in the late 1960’s and early ‘70’s, ski guides did not have a well defined analytical pathway to direct their decision strategy; instead they used their intuition (Cardon, 2004). This has changed over the last twenty years as an analytical support structure has been built and decision support tools have been created. It has reached the point that the use of intuitive strategies is frowned upon, likely because the role of intuition is poorly understood. Current industry training and practices encourage practitioners to use scientific resources such as advanced snowpack tests to form the basis for their decisions (McClung & Schaerer, 2006). There are many sophisticated tools, which can be integrated into an analytical decision process. While there is great value in these tests, a reliance on the strength and weight of this evidence within the decision process, overshadows the role that intuition plays. The significance of the intuitive response in avalanche decision-making has been downplayed, possibly due to an ignorance of the process, and is undervalued in the Canadian avalanche industry.

1.2.1 The Knowledge Gap

The development and use of intuition by expert decision makers has been the focus of considerable research in other fields such as nursing (Benner, 1984) and fire fighting (Klein, 1998). A more complete picture of how intuition plays a role in the decision process of ski guides and further, how it contributes to feelings of confidence has not been studied. Previous snow science studies have recognized that intuition is a component of the decision process, but deeper questions such as how and when ski guides apply intuition in the decision process have not been addressed (Adams, 2005; Grímsdóttir, 2004; Hägeli, 2005). Inferences can be drawn from previous research conclusions, but my contribution will be to look at an environment that has working sample of experts and is significantly different in numerous aspects. See Chapter 3 for a more elaborate discussion of the knowledge gap.

The context that sets ski guiding apart from other complex and consequential decision environments has four distinct characteristics. The first two are unique to ski guiding, while the second two are not unique, but when layered on top of the first two create additional complexities.

- A unique physical environment
 - A winter mountain setting with localized microclimates can generate widely varying snowpack stability due to changing temperature, variations in wind speed and direction, and precipitation amounts and rates of accumulation. The hazard to a skier presented by this environment will change temporally and spatially. The hazard will be linked to how and where the skier is placed in the environment.
- A unique feedback environment
 - Feedback from the physical environment can be absent or misleading. A non-event, typically characterised by a slope not avalanching, could be misconstrued as a good decision.
 - The best feedback comes from a group of guides (rather than a single individual) who are working together. Additional feedback comes from other guides working in the same region through the daily snowpack information exchange.
- Professional Environment
 - Guest expectations and the guide's desire to accommodate those needs can play a significant role in the decision process.
- Corporate Environment
 - The goal of a successful heli-ski or cat-ski ski operator is ultimately to make money. Opportunities for financial success hinge on guest satisfaction.

New and useful insights will be generated through an analysis of whether the presence or absence of feedback has an impact on the development and use of intuition. Ski guiding is a novel environment that may provide a greater understanding of the decision-making phenomenon.

Within an individual, the development of the potential to have and use intuition well has generally been thought to depend on a high level of expertise (Harteis, Koch, & Morgenthaler, 2008; Kahneman & Klein, 2009). The development of expertise has typically been linked to the learning that is generated through a series of experiences. These experiences need to fulfil the concept of deliberate practice (Ericsson et al., 1993). The final essential piece of the puzzle is feedback on decisions made, which is solicited and internalized from both internal and external sources. This feedback shapes the learning and speeds the expertise-building process (Hogarth, Gibbs, McKenzie, & Marquis, 1991).

The feedback loop potentially plays a critical role in the development of a sophisticated and nuanced decision-making process. It has been argued that feedback is the key determinant in the development of intuition, particularly in light of potential, yet unrealized adverse consequences (Hogarth et al., 1991). Ski guides are typically reluctant to test their hypotheses on slope stability when the consequence of being wrong is potentially deadly. As a result, guides have learned to deliberately create avalanches, but only on small test slopes. This is achieved by selecting the weakest part of a slope, typically a convex roll. Convex rolls are found at the point where the slope angle begins to steepen. The snowpack is under greater tension at this point and more easily triggered (McClung & Schaerer, 2006). The guide will ski across the convexity to test the snowpack stability, recognizing that if he is successful, he may be caught in the resulting avalanche. This is typically best done on slopes that do not have the potential to produce avalanches capable of fully burying and killing a skier.

Avalanche control teams have the luxury of using explosive control to test their theories without putting themselves at personal risk. Ski guiding companies do not make extensive use of explosive avalanche control due to the vastness of the typical operation and the cost of explosives. Unfortunately, the application of

explosives to a slope may still provide a non-result. The implications of the non-result may be harder to interpret and may lead to feelings of over-confidence.

Within the ski guiding industry, people have questioned research into intuition and mentioned the challenge of ‘measuring’ intuition. Although it may be hard to do, it does not mean it should not be done. Smith (2007) developed the Smith Intuition Instrument, but this was not a good fit with ski guiding as it included factors that were not applicable such as spiritual, sensing energy and reassuring feelings. Other studies used decision times (Glöckner, 2009), eye-tracking (Horstmann, Ahlgrimm, & Glöckner, 2009) and Cognitive Style tests (Allinson & Hayes, 1996). I looked for a simpler gauge that could measure, or assess intuition in a field setting based on whether feelings were present or not, strong or weak, good or bad.

There may be challenges to the measurement of intuition, but there are certainly strategies that will facilitate data collection and interpretation. These strategies are addressed in future chapters. The search for meaning within guides’ decision strategies is a considerable challenge, however it addresses a substantial need. There are numerous implications of having this information. The most dramatic is the potential for fewer avalanche accidents. A reduction in injuries and fatalities for professionally guided groups will reflect well on the ski guiding industry. Lessons learned by professionals will likely have a ‘trickle down effect’ to recreational users.

Based on my review of the literature, found in Chapter 3, gaps exist specifically in the snow science knowledge base, and more generally within the adventure leadership literature. Previous research has failed to significantly integrate and apply the theories and models of expert decision-making within the JDM literature into the adventure leadership or the snow science literatures. The works of Adams (2005) and Grímsdóttir (2004) laid the foundation upon which this current research is founded.

Dual process models of decision-making have been developed and used to evaluate the decision-making of other risk-based decision environments such as aviation and fire-fighting, but they have not been applied to wilderness ski guiding (Evans, 2011; Kahneman & Klein, 2009). The intent of my research was to use a

testing out research strategy to explore the boundaries of these previous research generalizations and to apply JDM theories of heuristics and biases and naturalistic decision-making to ski guide decision-making (Phillips & Pugh, 2005). This strategy had the potential to generate new knowledge that could be applied to one or more of the three bodies of knowledge.

1.2.2 The Research Issues

The research issues addressed by this study concern the degree to which intuition plays a role in the decision-making process of heli-ski and snowcat-ski guides in British Columbia, within a culture that supports and encourages analytical decision-making. The decision culture of the Canadian professional ski guiding industry is described in Chapter Two. The Association of Canadian Mountain Guides, the Canadian Ski Guide Association, the Canadian Avalanche Association and HeliCat Canada all teach and support a well-developed analytical decision structure.

This research investigated whether decision strategies could be more successful if there was an increased emphasis on the intuitive response. Inherent within an investigation of intuition is an assessment of the influence of expertise, as much of the literature suggests that more sophisticated intuitive responses are associated with increased expertise. Connected to this theme is a discussion of whether good and bad feelings, known as somatic markers, can be reliable indicators for decision responses. Two additional elements that are related to the intuitive decision-making issue are questions related to how feelings of confidence are generated and the impact that feedback has on the development of intuition.

1.3 Definitions

The following terms, which are described briefly here, will be used extensively through the document. They will be described in greater depth in the appropriate chapter.

Snow Avalanche

Snow avalanches vary in size and destructive potential. They are comprised mainly of snow, but may also contain ice and dirt (McClung & Schaerer, 2006). They can be triggered naturally, or by humans or animals.

Hazard

The occupational health and safety definition suggests that hazards have the potential to cause harm or damage (Canadian Centre for Occupational Health and Safety, 2012).

Avalanche Hazard

Avalanche hazard is based on the likelihood and degree of harm occurring. This can be measured through an estimation of the destructive potential of an avalanche overlaid by a likelihood or probability statement (Statham, 2008a).

Avalanche Risk

An avalanche risk definition is based on the premise that specific avalanche-related elements at risk are exposed and vulnerable to a hazard. For the purpose of this study, the elements at risk are people and occasionally the helicopters and snowcats that transport them.

Exposure

Exposure refers to the location within the terrain of the element at risk and the length of time that the element is there. Ski guides have more control over their exposure to hazards than any other component of the risk management equation, as they can choose both the timing and the location of their travel. Exposure can be estimated through an analysis of location and duration. This is the only factor that the ski guide has complete control over, thus it plays a huge role in ski guide decision-making (Statham, 2008a).

Vulnerability

Vulnerability is a measure of how easily the element at risk will be damaged by the magnitude of the avalanche. It is related to the layers of protection that are available. For example, a small avalanche might only bury a skier up to his waist, while the same size avalanche would be powerful enough to sweep a climber off a cliff. It has been suggested that experienced ski guides are less vulnerable than the guests that they guide because they will have quicker reactions when they are caught

in an avalanche (Wylie, 2004, personal communication). These quicker reactions may help them to escape the avalanche.

Consequence

What is the worst that could happen? Consequence is related to the location in the terrain, the degree of vulnerability and the destructive potential of the avalanche (Statham, 2008a).

Near-miss and Incident

A near-miss is an incident with the potential for serious consequences, but without these consequences becoming reality (Kessels-Habraken, Van der Schaaf, De Jonge, & Rutte, 2010). In an adventure scenario this might mean that although there was potential for harm; none occurred, no first aid was required and no equipment was damaged or lost. An accident is more severe and has been described as incident that progressed to the point where injury or damage occurred (Ritwik, 2002). For the ski guide this means that first aid was required, equipment was lost, or damaged, or the ski-programme was interrupted. The concepts of incident and near-miss are related, as an incident can occur in which the consequences or outcome could have been far worse (Orasanu, 1998). For example: A skier is caught in an avalanche, is dragged down the slope for 100 meters, loses his skis and is partially buried. The avalanche was large enough to fully bury and kill the skier, so the worst-case scenario did not become reality.

Good Day

For the purpose of this study, participants were asked to describe challenging days that ended well. These were not easy days. The decision-making was complex, but at the end of the day, there had been no incidents or near-misses and the day's objective had been achieved.

Intuition

There are a variety of terms used interchangeably with intuition including: gut feeling, hunch, know-how, and tacit knowledge. However intuition is different from insight and instinct. Intuition is characterized by easily accessible thoughts that do not require much in the way of reflection. Intuitive responses are: fast, effortless, can be impacted by emotions, governed by habit and can be difficult to control (Herbig, Bussing, & Ewert, 2001; Kahneman & Klein, 2009). Whereas insight

involves an incubation period (Hodgkinson, Langan-Fox, & Sadler-Smith, 2008) and instincts are equated with innate abilities (Lieberman, 2000).

Analysis

Analytical responses use reasoning and are: slow, require effort, are potentially rule-based, and are consciously controlled (Hogarth, 2005; Kahneman & Tversky, 1973).

Dual Process Theory

Dual process theories provide an explanation of the interaction between two types of cognitive processing; intuition and analysis (Evans, 2008, 2010). Type 1 (intuition) and Type 2 (analysis) are activated independently in different parts of the brain and at different speeds (Salas, Rosen, & DiazGranados, 2010; Sinclair, 2010). The default-interventionist theory suggests that intuition is the default process unless a need for analysis is detected (Evans, 2006).

Mechanized Ski Guide

Mechanized ski guide is the term used to describe ski guides when they are working for a helicopter or snowcat ski-guiding operation.

1.4 Thesis Outline and Description

Chapter Two describes the physical and professional setting of ski guide decision-making, and examines potential sources of the research questions. An assessment of the unique elements of commercial ski guiding is used to clarify the challenges faced in the decision-making process. This is a high-risk environment with potentially fatal consequences in the event of a bad decision. The physical environment is constantly changing. The weather is the primary contributor to this change, so a ski guide is constantly evaluating the effect of previous and current weather conditions and future weather predictions on the snowpack structure. From this, a hazard and risk assessment must be completed. The professional setting plays an important role, as the training and certification of guides is key to their success, but only one part of their development of expertise. Tied in with the expertise of the guides are the expectations placed on them by the companies that they work for and the guests that are attracted to the \$1000/day addiction known as heli-skiing or cat-skiing.

Chapter Three situates the research question within the literature. This is complicated by the nature of the research area, as it straddles three bodies of literature. As described earlier, avalanche decision-making is examined in this document within a context of snow science, even if the question of intuition is somewhat of an unconventional topic within a predominantly geosciences and engineering focus. In addition, looking at the question from a broader context of adventure-based decision-making demanded an investigation of the literature of outdoor and adventure leadership. However, the even broader and more complex field of judgment and decision-making within cognitive psychology provided the base of theories and models from which to evaluate ski-guiding decision-making. Throughout the chapter, the literature surrounding the research questions has been described and evaluated, clarifying the gap that existed prior to my research.

Chapter Four describes the philosophy of the research approach. The methodology and methods are described and justified given the nature of this study. A research plan is laid out in detail describing the logical progression of data collection and analysis. A discussion of the limitations of the methods concludes the section.

The research findings and associated discussion are presented in Chapters Five, Six, Seven and Eight. Each of the chapters has been organized around a theme: Chapter Five – Expertise, Chapter Six – Decision filters as found in the event reports, Chapter Seven – Decision processes as found in the event reports, and Chapter Eight – An analysis of dual process as found in the final interviews. The findings from the analysis of the questionnaire and interview data are revealed to the reader in these four chapters.

Analysis is initiated in Chapter Five through quantitative means and leads to intense qualitative analysis and discussion in Chapters Six, Seven and Eight. Using standard methods of qualitative data analysis (Seidel, 1998), I generated data codes and formed them into themes. These themes are discussed and linked back to the foundation literature. I have substantiated my explanation of the ski guide decision-making process by linking an interpretation of the participants' experiences with the theoretical discussions within the literature. Chapter Eight uses qualitative data analysis on the data from Study 3.

The final chapter unites the outcomes from the three studies and provides theoretical implications for future research, practical implications for the ski guiding industry and the conclusion. The Appendices include copies of the two web-based questionnaires, the first set of interview questions, and the second set of interview questions.

1.5 Scope

1.5.1 Sample Data

This study was a qualitative analysis of a small number of ski guides, representing just fewer than 10% of the approximately 350 active ski guides who operated in British Columbia from 2008 to 2011. Although the majority of the research participants self-selected some of the participants were solicited. The initial invitation to participate in the study went out to the membership of the HeliCat Canada, which represents the majority of the Canadian heli-ski and snowcat-ski operators. Seven companies responded to the invitation. I attended their respective pre-season annual trainings and offered the opportunity to participate directly to the guides. From an initial group of sixty guides who indicated interest in the project, thirty-five contributed reports, thirty-one of which were used in the analysis. Four participants were not included in the data sets because their contributions were incomplete. Limitations including the implications of a self-selection bias are discussed further in the methods chapter.

This study was not an analysis of all aspects of ski guide decision-making, nor was it limited to avalanche specific decisions. It was focused on the role that intuition played within the realm of decision responses. Although guest interactions factored into the ski guide's decision process, this study did not analyse the guests' motivations, only the impact those expressed, implied and anticipated expectations had on the guides.

Data were collected over two winters, 2008-2009 and 2009-2010. The winters were described by avalanche professionals as being particularly challenging due to the persistent nature of numerous weak layers within the snowpack and the high consequence of potential avalanches (Klassen, 2010a). It was an unforgiving

environment and the results of the study may have been different in more lenient years.

1.5.2 My Role as the Researcher

This section describes how my beliefs about the nature of reality have developed and subsequently how my approach to this research question has been formed. As an active mountain guide and a researcher, I brought a particular blend of knowledge and skills to this project. I provided an opportunity for ski guides to contribute information about their successes and their near-misses, without concern for retrospective evaluation from their peer group or employers, as the reporting structure was designed to provide anonymity. My concern for the protection of the integrity of the data and the confidentiality of the participants precluded me from publicly linking data with any participant. This issue is further discussed in the ethics section.

Clearly the lens through which I engaged in this research was coloured by the proximity that I had with the study group, as I was native within the population that was studied (Palys, 1997). I saw this as a benefit that I brought to the study as it made it much easier to build rapport and get the participants to open up and discuss their thoughts and actions. Pitts and Miller-Day (2007) argue that building rapport in the process of developing a trusting relationship is essential in research that includes qualitative elements. Although Palys (1997) did not necessarily support the notion that it was difficult to really understand a group of participants unless one was actually a member of that group, he acknowledged that being aware of one's personal limitations as a researcher was essential.

I was able to blend the strengths of being both an insider and outsider with this group of research participants. I have only worked part-time in the heli-ski industry and never worked as a cat ski guide. This left me outside the personal knowledge of the effect of continuous involvement with an operational environment. However, I have worked as a heli-ski guide for over 100 days, which was sufficient to gain an appreciation of the challenges faced by heli-ski and snowcat-ski guides. In this way I was able to demonstrate an understanding of the environmental context,

yet still presented an outsider's objectivity with the ability to ask seemingly obvious questions that an insider might miss due to over-familiarity.

The researcher has been described as a *bricoleur* who is able to utilize a combination of methodological, interpretive and narrative strategies (Denzin & Lincoln, 2003). I fit that description, having developed a multi-faceted set of skills through my varied experiences as a mountain guide, educator and graduate student. My personal practical experience in outdoor leadership evolved over the last 30 years, as I moved through various stages of development. The foundation of my expertise was built during a ten-year period with Outward Bound Western Canada. It was concurrently refined through post-secondary schooling in outdoor leadership at the University of Calgary. This blend of university during the winter and Outward Bound during the summer was an effective way of turning theory into practice.

The philosophical foundations of Outward Bound are anchored in personal growth and development through interactions with others in small group settings (Godfrey, 1980; Walsh & Golins, 1976). As an instructor I was responsible for fostering the personal development of participants and facilitating group dynamics. I became well versed in the skills of debriefing and facilitating interpersonal feedback. I began my leadership role with Outward Bound as a volunteer instructor, moved up through the ranks to senior instructor, and spent the last four years as a course director. It was during those last four years that I also became certified as an assistant climbing and ski guide with the Association of Canadian Mountain Guides (ACMG). This brought a transition to new opportunities in the guiding field and I became a full-time guide with Yamnuska Mountain School.

I followed an opportunity to pursue graduate studies in curriculum development for adventure studies, with Bill March at the University of Calgary the following year. March, an internationally certified mountain guide (IFMGA) and former deputy director of Plas-y-Brenin National Outdoor Centre in Wales, was one of the founding members of the University of Calgary Outdoor Pursuits Program. March had been a key figure in the development of outdoor leadership training and certification in Britain during the 1970s. He brought this expertise to the emerging Canadian outdoor leadership training industry in 1978 and enriched the lives of a generation of up-and-coming outdoor leaders.

I continued to work as a guide during my graduate studies and for a year afterwards. At that point a challenge presented itself in the form of a new adventure leadership program. In 1992, I helped to develop the Adventure Guide Diploma at the University College of the Cariboo (now Thompson Rivers University (TRU)). Since then, as part of my continued professional development as an instructor and assistant professor with TRU:

- I completed my international guiding certification (IFMGA) in 1996,
- Worked as a heli-ski guide for Canadian Mountain Holidays, Mike Wiegele Heli-skiing, Coast Range Heli-skiing and Northern Escape Heli-skiing;
- Worked as a mountaineering guide for Yamnuska and the Alpine Club of Canada; and
- Worked as an examiner on the Association of Canadian Mountain Guides on ski and alpine exams.

I became particularly interested in the decision-making process in 2002. The desire to rigorously pursue a greater understanding of decision-making in the mountain environment was triggered by a discussion with Jean Paul Vion, the Director of Mountain Guide Training at Ecole National de Ski et Alpinisme (ENSA) in Chamonix, France. He expressed frustration with the lack of tools in current practice to train new guides in decision-making. That discussion sparked a four-month research project in 2003; I visited guide-training programs in France, Canada, the UK and the USA. I looked at 'best practices' in the training of apprentice guides. One of the outcomes from this project was the desire to pursue the topic of decision-making in greater depth, in particular the impact of human factors and the role of expertise.

In a typical year, I have the opportunity to work with over twenty ACMG guides through TRU Adventure Programs and an additional ten guides in my professional development capacity. Critical reflection on my performance over the years as a trained and certified mountain guide and as an outdoor educator has been an integral part of my professional practice. I have compared my professional decision-making to other guides within the mountain guiding industry in Canada and I find myself on the conservative end of the risk acceptance spectrum. Another difference between others in the guiding community and me is that my academic

background may lead to a more analytical and introspective orientation to my decision-making. I acknowledge this bias as having a potential impact on the collection and interpretation of data and I have a heightened sense of situational awareness regarding this potential bias.

I have attempted to reduce the use of technical jargon and acronyms in this thesis. Although technical writing in research publications can serve to connect the author with an elite group, it has the potential to complicate communication with other fields and the public. Furthermore research which is externally focussed and seeks to merely justify its existence through the acquisition of research funds but with limited practical application serves limited purpose (Allison, 2006). There was a need for research that had a foundation in the academic world, was grounded in practical applicability and helped to generate understanding of a phenomenon within both the research group and the broader population. It is likely that this has been the case for research in the area of adventure leadership, particularly that of mountain guiding. Research that helped to describe the innovative practices and extant knowledge of the field has helped theory and practice to be more in harmony.

So in light of my background as a guide, an educator and a researcher I felt equipped to undertake this research project. With one foot anchored in the practicality of ski guiding in avalanche terrain and the other in the world of academia I felt uniquely placed to make a contribution to the on-going development of decision-making research.

Chapter 2 - The Physical and Professional Setting

2.1 Introduction

HeliCat Canada, which represents 28 heli-ski and snowcat-ski operators, claim that 95% of the global market for commercial heli-skiing and snowcat-skiing is delivered in British Columbia (HeliCat-Canada, 2008). The Canadian commercial ski guiding industry has capitalized on this opportunity by building a support network and training program for an estimated 350 active ski guides. The requirements to become a Canadian ski guide are arguably the most rigorous in the world (Association of Canadian Mountain Guides, 1999; Canadian Ski Guide Association, 2007). The rigours of the training are pitted against the inherent challenges of the environment. Despite this, guests die every year (British Columbia Coroners Service, 2003a). The commercial operators do not hide these facts from their guests and are actively engaged in risk optimization strategies, which balance safety, risk and reward (Canadian Mountain Holidays, 2007).

2.2 Physical Environment

The mountainous geography of British Columbia provides the opportunity to engage in commercially guided, wilderness skiing. Mountain terrain coupled with cold temperatures and regular flows of moisture from the Pacific create an excellent environment for deep powder skiing. British Columbia covers an area of 944,735 square kilometres, with 75% of the area considered mountainous including 20,300 square kilometres considered alpine rock peaks and glaciers (Province of British Columbia, 2012; Shangaan Webservices Inc., 2012).

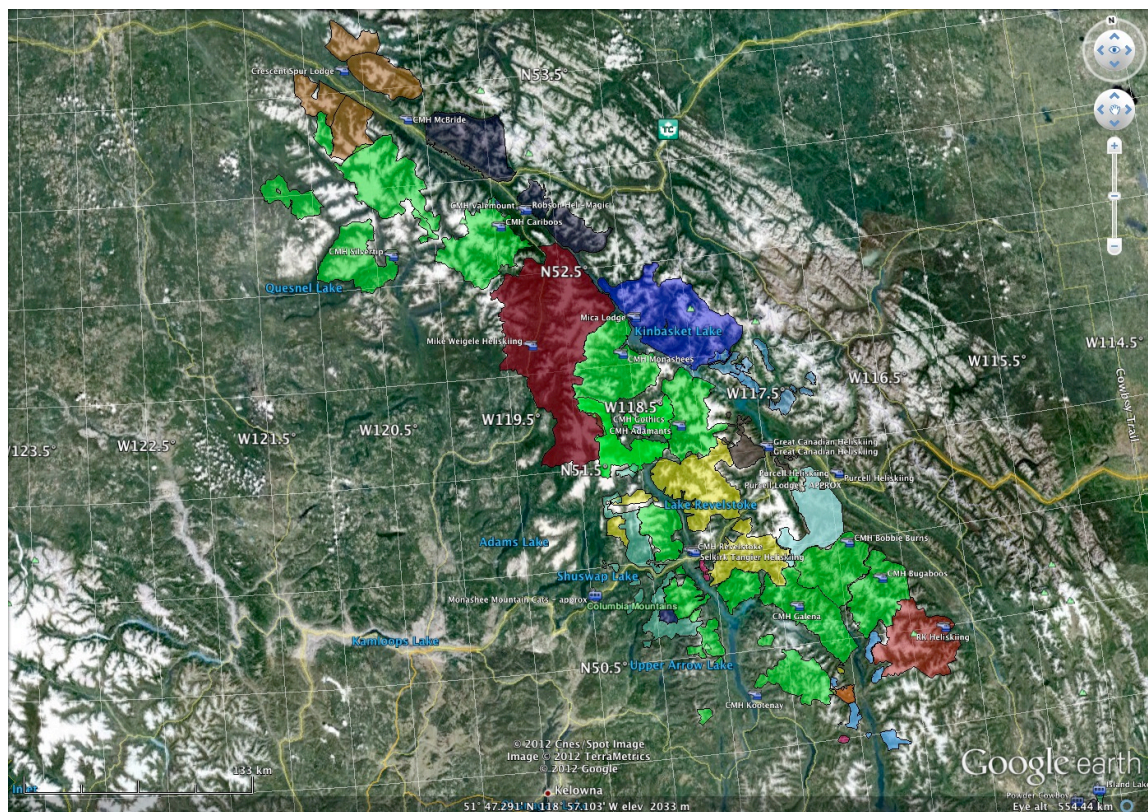
Most of British Columbia, 94%, is designated as public or Crown lands and is managed by the provincial government. The Integrated Land Management Bureau of the Ministry of Natural Resource Operations is responsible for granting land tenures to commercial operators under the British Columbia Land Act (Ministry of Natural Resource Operations, 2012; Queen's Printer, 2011). These land tenures are exclusive for commercial recreation activities, but do not preclude the public or other commercial operations such as logging or mining from accessing the land.

Collectively, the commercial heli-ski and snowcat-ski operators have secured land tenures that give them exclusive commercial rights to use the land during the winter for skiing operations. These tenures cover 104,518 square kilometres, which is about the same size land area as Iceland. The average heli-ski tenure is 4,300 square kilometres, while the average snowcat tenure is 82 square kilometres (Harley, 2002). The altitude of the terrain that is used by operations ranges from 3,500 metres (11,500 feet) down to 600 metres (1,960 feet).

2.2.1 Winter Mountain Environment

Three primary air masses are responsible for generating weather conditions in Western Canada: the Pacific, the Aleutian and the Continental (Canadian Avalanche Association, 2011). The predominant weather pattern comes from the west, driven by the pattern of the jet stream. Moist air off the Pacific rises as it crosses the BC coast and hits the Coast Range Mountains. The temperate climate produces rain at sea level and vast amounts of moist snow in the mountains. The air mass loses a large amount of its moisture, but not all of it. When the moisture flow next hits the Interior Mountain Ranges, it is forced higher and the temperatures are generally cooler, producing copious amounts of dry light powder (McClung & Schaerer, 2006). This is where most of the heli-ski and snowcat-ski operators are located. Figure 1 (Google Earth, 2009) shows the concentration and extent of commercial ski-guiding tenures in the Columbia Mountains of British Columbia. Little moisture is left in the air mass as it rises over the Rocky Mountains and collides with the cold air of the Continental Arctic air mass.

Figure 1 Interior British Columbia Commercial Ski-guiding Operations



Two primary weather patterns have been identified that influence the weather pattern in Western Canada and can cause dramatic changes from winter to winter. With the primary weather patterns originating in the Pacific, dramatically higher or lower water temperature significantly influences the winter storms that hit British Columbia. The two primary patterns have been termed La Nina and El Nino. La Nina results from cooler Pacific water temperatures, while El Nino results from warmer water temperatures (Wood, 1998).

2.3 Professional Environment

2.3.1 The Canadian Heli-ski and Snowcat-ski Guiding Industry

Mechanized skiing is defined as a commercial activity, which uses a helicopter or a snowcat to transport guests and guides uphill with the intent of accessing wilderness or high mountain skiing (HeliCat-Canada, 2008). The industry began in April 1965 when Hans Gmoser used a small helicopter in the Bugaboo Mountains to ferry his ski touring guests back up the mountain for additional ski runs

(Donahue, 2008). The company name was Canadian Mountain Holidays (CMH) and it has grown to become the largest heli-ski company in the world (Canadian Mountain Holidays, 2008). Other pioneers were quick to seize the opportunity to build a new industry. Canadian Mountain Holidays expanded to a second operational base in Valemount. Mike Wiegele set up a competing operation in Valemount. Both operations were based out of the only hotel in town and competed for ski terrain in the Cariboo Mountains (Donahue, 2008). Shortly thereafter, Rudi Gertsch set up an operation in Golden BC and Peter Schlunneger chose Revelstoke as his base (Rossiter, 1980; Touche, 1980).

Canadian Mountain Holidays now has nine backcountry lodge operations and three front country hotel operations, utilizing over 15,000 square kilometres of terrain. Their client base exceeds 7000 guests per year and accounts for close to 50,000 user days. Taking care of these guests is a team of over one hundred certified guides (Canadian Mountain Holidays, 2008).

The majority of the heli-ski and snowcat-ski operators have linked up to form an association to represent their needs called HeliCat Canada (HeliCat-Canada, 2008). There is no legal requirement to be a member of HeliCat Canada, so not all mechanized ski-guiding operations are members. Between the HeliCat Canada membership and the additional eight or so non-members, the industry delivers close to 100,000 skier days per year.

2.3.2 Commercial Operational Context

HeliCat Canada commissioned a socio-economic study in 2002 (Harley, 2002). On an annual basis, the commercial mechanized ski guiding industry serviced approximately 28,000 skiers for 95,000 skier-days. Eighty-eight percent of the guests were from outside Canada. Their direct spending was \$92.6 million in 1999/2000.

HeliCat Canada also commissioned a study of guest expectations, which was conducted by Tanner and Associates (2006). Table 1 shows the guest profile.

Table 1 Guest profiles for heli-ski and snowcat-ski operations

	Heli-ski	Cat-ski
Expert skiers	81%	73%
Median age	46.9	45.2
Occupation – Professional	62%	55%
Income Median	CAN \$124,000	CAN \$111,000

In this study, nine out of ten heli-skiers rated having a competent guide as essential to a good heli-skiing experience; 7.4/10 rated personal safety as a concern, with 7.3/10 rating avalanches as their primary concern. Similarly 8.6/10 cat-skiers rated having a competent guide as essential to a good skiing experience.

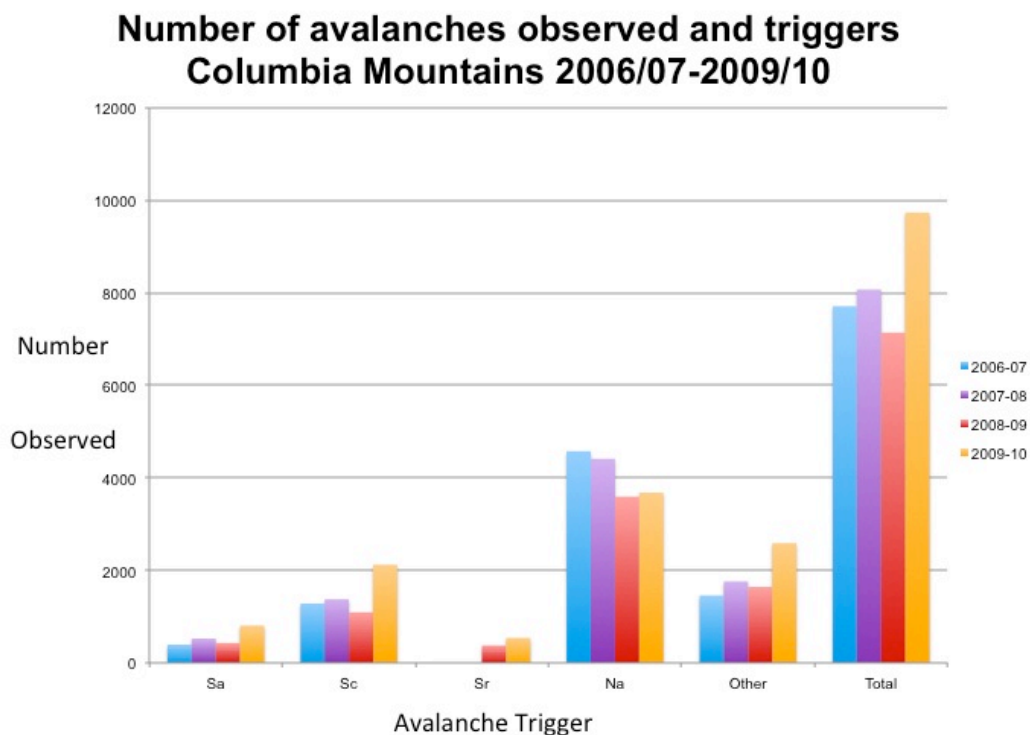
The industry began formally sharing weather and snowpack information in 1991. This became known as the InfoEx (Canadian Avalanche Association, 2012a). The concept of sharing of information was initiated by Canadian Mountain Holidays as a way of pooling valuable snowpack information amongst their numerous backcountry lodges. Initially this was achieved through a complex series of radio links. All the lodges, from the Cariboos in the north, to the Bugaboos in the south were able to have a daily discussion on snowpack concerns (Canadian Mountain Holidays, 2008). The InfoEx has now evolved into an integral element of hazard forecasting to the point where it is an expectation of a professional, mechanized ski guiding operation (British Columbia Coroners Service, 2005).

In its current form, InfoEx users pay an annual subscription rate to access the information. In discussion with the chair of the InfoEx Advisory Group, Brad Harrison (personal communication, December 2011), it was stated that there is now an expectation that all subscribers contribute avalanche, snowpack and weather observations on a daily basis. There are 115 subscribers, most of who are in British Columbia and Alberta. With over 10,000 data points per day this represents a wealth of information. The forecasters at the Canadian Avalanche Centre use the information as the basis for the Public Avalanche Bulletins. If they had to go out and collect the data themselves, it is estimated that it would cost in excess of \$2 million annually (Canadian Avalanche Association, 2012a).

2.3.2.1 Number of Fatalities

The Canadian Avalanche Centre has documented 79 fatalities in the heli-ski and snowcat-ski guiding industry since 1974 for an average of 2.1 fatalities per year (Canadian Avalanche Centre, 2012). Over the last ten-year period (2003-2012) the average annual fatality rate has dropped to 1.3. During the period of the study, in the Columbia Mountains, there were 1903 skier-triggered avalanches in 2008-2009 and 3469 in 2009-2010. Although the guides caused the majority of these skier-triggered avalanches deliberately, 23% were triggered accidentally and would include both near misses and involvements (Figure 2). The observed triggers included: Skier – accidental (Sa), Skier – controlled (Sc), Skier – remote (Sr), Natural (Na), and Other.

Figure 2 Avalanche Observations in the Columbia Mountains 2006-2010



2.3.3 Training and Certification

2.3.3.1 Avalanche Certification Process

The Canadian Avalanche Association is responsible for representing avalanche professionals by setting technical standards and delivering training and

certification courses. There are three levels of the professional training courses. The first level is a prerequisite for entry into the guide certification courses and assistant level exams. The second level is a prerequisite for the full guide exams. The third level prepares upper level avalanche workers for employment in operational planning and risk management (Canadian Avalanche Association, 2012b). The cost in Table 2 is for Levels One and Two.

2.3.3.2 The Guide Certification Process

There are two certifying bodies for ski guiding in Canada, the Association of Canadian Mountain Guides (ACMG) and the Canadian Ski Guides Association (CSGA). The ACMG also certifies climbing guiding activities, while the CSGA does not.

Association of Canadian Mountain Guides

The ACMG was formed in 1963 and in 1972 was accepted into the International Federation of Mountain Guides Associations (IFMGA). Training and certification is conducted through Thompson Rivers University - Adventure Studies Department. To become a mountain guide requires a commitment to one hundred and fourteen days of training courses and examinations at a cost of \$26,345. This only reflects the course costs and does not include food, accommodation or travel. Table 2 also shows the cost for earning just the Ski Guide certification. Also not included is the prerequisite training and experience needed to make an application for entry into the training and certification program and the skill maturation to progress from the assistant level to the full guide exam.

Table 2 Costs to complete ACMG Mountain Guide certification

	Training Courses (days)	Exam (Days)	Total (Days)	Costs \$ CDN
ACMG Ski Guide	20	18	38	9,375
ACMG Mountain Guide	36	46	82	21,145
CAA Avalanche (1+2)	15	7	22	4,500
First Aid	8	2	10	700
Total for a Ski Guide	43	27	70	14,575
Total for a Mountain Guide	59	55	114	26,345

The Canadian Ski Guides Association (CSGA) is a mechanized ski guide certification program, which began running courses in 1990 and was incorporated in 1996. The British Columbia Helicopter Skiing and Snowcat Operators Association (BCHSSOA, now known as HeliCat Canada) recognized the CSGA Level 1 and 2 courses as meeting the criteria for a Tail-guide and Assistant Guide. The Level 3 (Lead Guide) course was audited by BCHSSOA, but formal recognition was not completed until 2010. In 2004 a rift developed between BCHSSOA and the CSGA, with the BCHSSOA only recognizing Level 1 and 2 CSGA guides certified prior to 2004. This rift within the guiding community was largely resolved in 2011. Table 3 shows the costs and the number of days required for all the courses and exams to reach Level 3 certification.

Table 3 Cost to complete CSGA Level 3 Guide certification

	Training Courses (days)	Exam (Days)	Total (Days)	Costs \$ CDN
CSGA Level 1, 2 and 3	7	28	35	6,850
Glacier Skills Course	7	0	7	1,200
CAA Avalanche	15	7	22	4,500
CSIA Level 1, 2 and 3	0	10	10	1,133
First Aid	8	2	10	700
Total for CSGA Level 3	37	47	84	14,383

2.3.4 Corporate and Guest Profile

2.3.4.1 The Guiding Team

A typical mechanized skiing operation utilizes a team of guides ranging from two to twenty-five guides at any one time. The actual number of guides will depend on the size of the operation and the number of guests. At the small end of the scale, utilizing one helicopter, two guides will work with a group of four guests. At the other end of the scale, Mike Wiegele Helicopter Skiing, at maximum capacity uses twenty-five to thirty guides and nine helicopters of various sizes, to service over one hundred and thirty guests.

Guests are formed into ski groups based on the size of the helicopter. Small helicopters carry 4-5 guests and large helicopters up to 11 guests. Operators typically offer two styles of experience. The standard offering maximizes the efficiency of the helicopter by servicing multiple groups with a single helicopter. The private package provides a single group with the services of a guide and a helicopter. In a standard operation, each helicopter services from one to four ski groups each led by a guide. One of the guides is the designated Lead Guide. The Lead Guide is responsible for creating and implementing a plan for the day that balances the need to provide a safe, high quality skiing experience with the need to optimize the operational logistics, typically by carefully controlling helicopter flight time.

2.3.4.2 Scales of Heli-ski Operations

Small or ‘Boutique’ heli-ski operations use one or two small helicopters (A-Star or Bell 407). Each helicopter fits 4-5 guests and will service one to three groups, or up to 15 guests. Medium-sized heli-ski operations use one or two larger helicopters (Bell 205 or 212). Each helicopter fits up to 11 guests and will service one to four groups, or up to 44 guests. Large operations use various combinations of small and large helicopters to cater to 75-100+ guests.

2.3.4.3 Scales of Cat-ski Operations

Snowcat operators tend to have fewer guests as each snowcat can only service one group at a time compared to a helicopter, which can sequentially transport multiple groups. Small operations utilize a single snowcat carrying up to 14 guests, while medium sized operations use two snowcats, each carrying up to 14 guests.

2.3.5 A Day in the Life of a Ski Guide

Although there are numerous variations based on the operational context, a typical guiding day has a certain flow to it. The decision process begins early with the development of a hazard forecast and a risk management plan for the day. The active management of hazards during the day follows this. The final step is a review of the day’s activities and a summary of observations in preparation for the following day.

2.3.5.1 In the Office

The day begins early, usually at about 06:00. The industry standard is to use a structured, well-defined analytical process to facilitate the flow of the morning guides’ meeting. See Appendix 1 for the Canadian Avalanche Association A.M. Avalanche Hazard and Risk Analysis Worksheet. This structured process begins with a reassessment of the conditions observed on the previous day. The observations made by the nearest neighbouring operations are included in the analysis. The overnight weather changes that might impact snowpack stability are factored into snowpack stability and hazard forecast for the day. Finally, the initial terrain selection occurs.

The first question to be addressed is: ‘What is happening with the weather?’ With the increased usage of remote weather telemetry and the Internet, a far greater quantity and quality of information is available. It is easy to become absorbed by the computer and neglect the sage advice of the old European guides to “go out and sniff the air” (Kranabitter, personal communication, April 1988). This may strengthen a connection between the intuitive, somatic response from smelling the air, feeling the air pressure and observing the sky, clouds and wind, with the cognitive process of analysing the weather report. The second question is: “Did anything significant happen yesterday to other operators in the region? Did they see similar conditions to what we observed yesterday?”

This information is accessed through the InfoEx. The information reported includes: avalanche observations, snowpack structure and stability assessment, field summaries, and weather observations. Avalanche observations are the most interesting component as both naturally occurring and human triggered are reported. This is critical event feedback as it demonstrates how easily avalanches can be triggered. Of particular interest to the ski guide are the reports of avalanches triggered by humans, both deliberately and accidentally. The skier-triggered accidental avalanche is arguably the most significant information to be added into the decision-making process, as it represents direct feedback. This aids in accuracy calibration and hence confidence in decision-making.

Once the weather forecast and the InfoEx report have been assimilated by the guiding team, it is necessary to make a stability forecast for the operation. This forecast is based on the stability assessment completed at the end of the previous day, supplemented by the InfoEx, and modified by the weather forecast. The final step in daily risk management is to complete the ‘run list’ (Cardon, 2004). This is a list of all the ski runs or lines available to the company within their land tenure as granted by the British Columbia Ministry of Natural Resource Operations. The larger companies will have hundreds of potential runs on the list, so the guiding team must efficiently generate a plan for the day. This will mean analysing a sufficient number of runs to meet the operational needs of the day. Each run is coded as green, red, or yellow. A green run is available for use and a red run is not. Yellow is given to runs, for which there is insufficient or inconclusive information. Once the guiding

team is in the field and able to gather more information, a face-to-face meeting is required to move a run from yellow to green. The decision-making process of the run list is critical and can turn into a long, drawn out debate at a point in the day when there is not a great deal of extra time available. In most if not all operations, each guide has the power of a veto when it comes to greening a run.

2.3.5.2 In the Field

The lead guide will typically select one or two areas within the company's operational land tenure for the day's activities. This will require the careful selection of a sequence of runs, which will be efficient and provide high quality skiing. To achieve optimal use of the helicopter, the lead guide must select runs such that the helicopter is constantly ferrying groups up the mountain. Efficiency is lost when the helicopter spends more time lifting a group or when it has to wait for a group to finish their run.

The cost of the helicopter is based on flight time and fuel consumption. Flight time is typically calculated by a Hobb's meter, which measures the amount of time that sufficient power is being applied to the rotating blades such that it is capable of flight. This would include the time that a machine is in a hover landing and when it is actually in the air. Flight time costs between \$2000 and \$4000 per hour depending on the size of the helicopter. Time spent on the ground with the engine idling is only charged at the rate of fuel consumption (200 – 300 litres per hour). This makes for frequent time-critical decisions while in the air. At \$60 per minute, or \$1 per second it is incumbent upon the guide in the helicopter to make rapid decisions as to where to go.

The helicopter is a useful tool for viewing and assessing the terrain about to be skied, however excessive flight times will quickly erode the day's financial margin. It typically takes three to five minutes to fly from the bottom of a run up to the next run. During this time the lead guide must assess the hazards and select a line for descent on what might be over one thousand vertical metres of complex terrain. The other guides within the helicopter group have an easier time, as they will have the lead guide's tracks to follow. Information about snowpack stability and other hazards will be shared within the guiding team by radio.

The momentum of the helicopter and ski groups' progress is significant. This can result in guides rushing their groups to the bottom of the run and the waiting helicopter, if anything slows their progress such as a lost ski. This may create the impression that there is minimal time for hazard assessment. Some operations will have an additional guide in the field, conducting snowpack stability assessments.

Lunch is typically served out in the field. The helicopter lands and shuts down. Once the guides have served the guests, there is time for a quick guides meeting. Yellow runs can be discussed with regards to the conditions observed up to that point, and decisions can be made to change them to green or to red. It is also an opportunity to strategize the remainder of the day. Some guests may want to ski longer than others. It may be possible to reorganize the groups such that one or more helicopter loads fly back to the base early.

The lead guide must also keep track of the amount of fuel remaining in order to plan when the helicopter will have to fly back for fuel. Typically, the helicopter will refuel two to three times during the day. Optimal efficiency is acquired when the helicopter needs to refuel at the same time that a group is ready to fly back to the base.

2.3.5.3 End of the Day

Once all the groups are back in at the end of the day, the guides will convene for another meeting. Snowpack and avalanche observations will be recorded and an assessment of the snowpack stability will be generated. This information will be shared with the rest of the industry through the InfoEx. Depending on the culture of the guiding group, there may be the opportunity to reflect on issues or concerns that evolved during the day.

2.4 Summary

The physical and professional settings of mechanized ski guiding operations in Western Canada are unique. The guides who work in these settings are the front-line decision makers charged with managing guest safety in a constantly changing and unforgiving environment. The response to this challenging environment has been to develop what is arguably the most rigorous and sophisticated ski guide certification process in the world. Supplementing this, the avalanche hazard

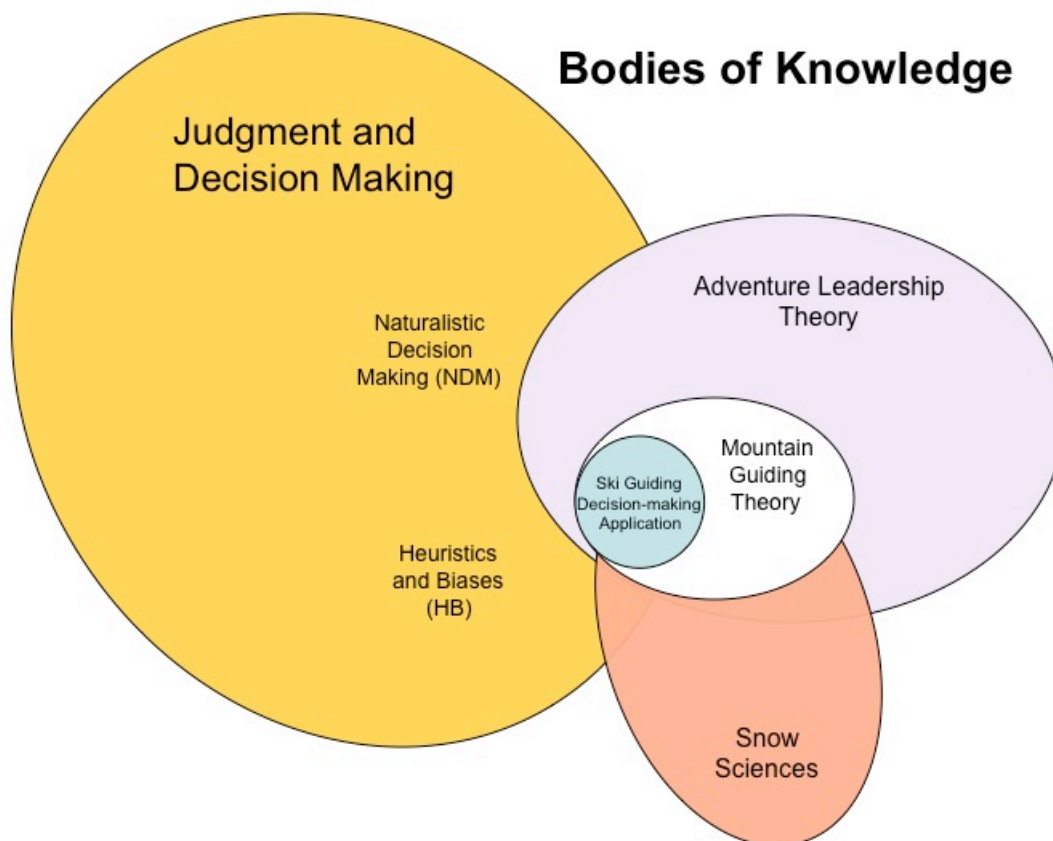
forecasting process has been continually improved through the joint efforts of the guiding associations and the avalanche association. Unfortunately fatalities still occur. The fatality rate can be considered a finite measure of decision success. Entrenched knowledge is equated to pattern recognition, which forms the basis for intuitive responses. The quality of intuitive responses, based on pattern recognition has contributed to the decision success of ski guides. However there is a gap between the advances made in the avalanche-related analytical decision process and the potential application of cognitive psychology theories.

Chapter 3 - Literature Review - The Decision Process of Ski Guides

3.1 Introduction

This programme of research was interdisciplinary in nature in that the literature upon which it was based came from three distinct bodies of knowledge. The largest and most developed body of knowledge was the Judgment and Decision Making (JDM) literature. The adventure leadership literature provided a more focused discussion of decision making within an outdoor adventure skills context. The final body of knowledge was snow sciences, which although dominated by the hard sciences, has seen a growing number of contributions from the social sciences. Mountain guiding and more specifically ski guiding, as a subset of adventure leadership, is a practical field but has a growing body of theoretical underpinnings. The focus of this research was the point of convergence for these three bodies of knowledge - expert ski guide decision-making (Figure 3). The relative sizes of the balloons in the figure are not drawn to scale as the size of the judgment and decision-making literature vastly exceeds the other two bodies of knowledge. A central theme running through these bodies of knowledge was the role that expertise played in the decision process.

Figure 3 Ski guiding within three bodies of knowledge



3.2 Ski Guide Decision-making

The criteria individuals use and much of the decision-making related knowledge base in professional, ski guiding has remained poorly understood even to active practicing professionals. Expert ski guides might have difficulty expressing how all the elements of their field-based, risk management decision process come together (Adams, 2005). They might be able to articulate the procedure that they use, but not necessarily the source of some of their knowledge; some things they just know (Grímsdóttir, 2004). Their ability to articulate most, but not all the factors that help them make good decisions can likely be attributed to the depth of their personal practical experience, or their expertise. The ability of an expert to articulate the source of their knowledge is a hallmark of professionalism and generates credibility within the respective client groups (Benner, 1984).

Although mountain guiding has been taking place in Canada since 1897, the documented theory and practice was not formally structured into a training manual

until 1991 (ACMG, 1999). The Technical Handbook for Professional Mountain Guides was rewritten in 1996 and 1999 and yet still only contained four pages on judgment and decision-making. The Canadian Avalanche Association has taken a more proactive approach and developed a four day decision-making training module as part of the Level 2 professional training course (CAA, 2008). This course rapidly gained respect from practicing professionals and has been acknowledged as a valuable professional development opportunity. As evidence of the desire for greater understanding of the decision-making process, the course has been full since its inception in 2002.

A benefit of making this knowledge about how and why mountain guides make decisions, evident and understandable to the general public will allow guides to be judged less on the visual aesthetics of a demonstrated performance and more on their underlying knowledge base. The safety record of the ski guiding industry is only one measure of professional competence.

The Canadian Avalanche Centre (CAC) is responsible for public safety. An increasing number of recreational winter backcountry users have been educated in risk management strategies through the efforts of the CAC. This has resulted in an increased level of awareness of acceptable travel practices, particularly during periods of high hazard. However there can be conflict between public regional, hazard warnings issued by the Canadian Avalanche Centre and guiding operations that have generated a hazard forecast for their specific location.

An example of increased public scrutiny was triggered by two events. The first occurred on January 20th 2003, when six guests and one employee died in an avalanche in the Columbia Mountains of British Columbia, while being led by an experienced mountain guide. The public perception of this event was that the guide must have made an overt error, regardless of the underlying decision process that evolved leading up to the event (British Columbia Coroners Service, 2003b; Kerasote, 2003). The second event occurred twelve days later. Seven teenagers died in an avalanche while on a school trip in Glacier National Park, less than thirty kilometres away from the first accident (Cloutier, 2003). These two events placed tremendous public scrutiny on wilderness ski guiding, adventure education in schools and the responsibilities of public land managers (Statham, 2004).

More specifically, avalanche related decision-making, which is a sub-set or component of mountain guiding decision-making has been the subject of much debate and discussion with increasing intensity and frequency, beginning with the 2002 International Snow Science Workshop (ISSW). At the ISSW 2002, the topic of decision-making was split between the larger subject headings of Education and Forecasting and covered by only three authors. However McCammon's (2002) seminal work on the use of heuristics sparked great interest within the avalanche community and launched a new line of inquiry. The ISSW 2004 included a much greater acknowledgement of the significance of decision-making. It was included in the single subject heading of Risk Management, Decision-making and Information Delivery. Within that heading there were numerous papers specifically on decision-making. The discussion of decision-making intensified with works from Adams (2004), Atkins and McCammon (2004), Grímsdóttir (2004) McCammon and Hägeli (2004), and Stewart-Patterson (2004). This trend continued at ISSW's in 2006, 2008 and 2010 with contributions from Digiacomo (2006), Sole and Emery (2008), Hägeli and Atkins (2010) and Stewart-Patterson (2010).

The increased interest in the study of decision-making is not unique to the avalanche industry, or even adventure leadership. There is much to be learned from how other fields have approached the challenge of understanding the complexities of the decision-making process. Extensive research has been conducted in fields such as nursing, in which the participants face many challenges similar to those experienced by ski guides. Benner (1984) described how the increased sophistication of demonstrated decision processes within the practical field of nursing had occurred on an on-going basis without the benefit of research, however once research was conducted which articulated this expertise, it helped to develop a language that facilitated the description to the rest of the world. The public perception of the decision process used by nurses was elevated from a status as a loosely described art form, to a well defined professional practice supported by research (Benner, 1984; Rew & Barrow, 2007; Rew, 1987; Smith, 2009).

With an annual average fatality rate in commercial heli-ski and snowcat-ski guiding over the last ten years, of just under one and a half fatalities per 100,000 skier days, it is not unreasonable to suggest that there is considerable knowledge

entrenched within the daily activities of the practitioners (British Columbia Coroners Service, 2003a; Israelson, 2008). However it is arguable that even this number of fatalities is too many and efforts should be made to reduce the number of fatalities in professionally guided groups while still maintaining the spirit of adventure inherent within this risk-based activity. The results from my research will have direct application for practitioners and will have the potential to improve expert decision-making and thereby save lives.

3.3 Scope of the Review

I started the literature review in 2006 with an analysis of the Proceedings of the International Snow Science Workshops from 1994 to 2006. This provided a firm anchor as to the state of research in domain-specific, avalanche related decision-making. I used the database collections of peer-reviewed journals and periodicals available through the University of Edinburgh and Thompson Rivers University libraries to gather the majority of my references. I accessed the Adventure-based leadership research through the ERIC database. However, the PSYCArticles database became the prime search tool and was used extensively to access research within the larger field of cognitive psychology. The PubMed database was used to access related material from the field of Nursing and Medicine. Google Scholar was used as a generic search tool for areas such as Aviation, Military and Fire-fighting. Primary search terms included: decision-making, intuition, expertise, confidence, feedback and reflection. The libraries of the University of Edinburgh and Thompson Rivers University provided access to considerable additional resources. The search for additional material was on-going from 2006 to 2012 and included the proceedings of the ISSW 2008, 2009 and 2010 combined with continued searching of the databases.

3.4 Themes

Two intertwined themes emerged within the literature in the context of how ski guides make decisions. As I was studying expert ski guides, the literature on expertise formed the lens through which I examined the decision process. This literature crossed multiple domains. Entrenched within the decision-making

literature was an expert – novice distinction, with the recognition that these decision processes were different. The degree or extent to which experts made decisions differently from novices was of some debate. I distilled critical elements from the two themes and blended them together to form a solid rationale for the research I conducted. By blending the expertise theme with the decision process theme I was able to extract the essence of expert decision-making and apply it to the research question.

3.4.1 Expertise

Expertise was central to the analysis of the decision-making as experts make decisions differently from novices (Benner, 1984; Phillips, Klein, & Sieck, 2004; Starkes & Ericsson, 2003). Expertise was examined as a discrete research area and then applied as a filter for the JDM, adventure leadership and snow science literatures.

The works of Ericsson benchmarked the study of expertise. Ericsson, Krampe, and Tesch-Romer (1993) conducted a study on high level musicians and through an analysis of their diaries concluded that experts committed to roughly 10,000 hours of deliberate practice, typically over a 10 year period. This notion was supported by studies: on chess players (Charness, Krampe, & Mayr, 1996), in medicine (Patel, Kaufman, & Magder, 1996) and on athletes (wrestlers, skater and golfers) (Starkes et al., 1996). It is notable that even extraordinarily talented individuals like chess master Bobby Fischer needed nine years of preparation before he was at an internationally acclaimed level (Ericsson, Krampe, & Tesch-Romer, 1993).

However, it is important to recognize that ten years of experience does not make an expert. Experiences can be empty or full, with full experiences maximizing the learning potential inherent within a given situation. Weick (2001) describes the lack of learning associated with empty experiences as the repetition of similar events with little in the way of challenge or reflection. Turning experience into expertise may be more difficult when the decision environment is dependent on human behaviour rather than physical stimuli. For example, Costa and Porter (2003) found that mutual fund managers with ten years experience performed no better than their

less experienced peers. Shanteau (1992) suggests that physical stimuli are more valid than human behaviour stimuli. This would suggest that the heli-ski environment has some measure of validity. The environment is highly dependent on the effects of the weather and thus more valid; however the interactions of humans with the terrain may reduce the validity, as the guide chooses where to place the group in the terrain.

Vick (2002) stressed the importance of going beyond routine, everyday practice in the pursuit of challenging problems; expertise is gained through the resolution of difficult challenges. Vick (2002) also suggested that expertise was dependent on two integral elements: the size of the knowledge base and the speed at which it can be accessed. This equates to the definitions of pattern recognition and has been discussed further in this chapter (Kahneman & Klein, 2009; Sloman, 1996).

Ericsson, et al. (1993) defined an eminent performance or achievement as going beyond full mastery of the current knowledge base and the top level of achievement to ultimately develop a unique and innovative contribution to their field. These top levels of performance were not attributed simply to years of experience, but more so to years of deliberate and intense practice aimed at continual improvement (Starkes et al., 1996).

Benner (1984) studied the development of expertise in clinical nursing practice and described four incremental levels of expertise, shown in Table 4. A particularly salient point was how she described a “competent” person as reaching a stage where an understanding had developed as to the extent of one’s potential, and that as a competent practitioner, there was the capacity to develop further and become an expert. She suggested that they become more sensitive to incompetence and may become anxious and or take on additional responsibilities to the point that they begin to fail. They also may become so focused on identifying incompetence that they fail to recognize expertise. The anxiousness or worry that is felt is an intelligent concern as it is indicative of the development of a more sophisticated understanding of the extent of their ignorance.

Table 4 The four levels of expertise as described by Benner (1984)

Advanced Beginner	Competent	Proficient	Expert
Intuitive feelings of uncertainty may develop but judgments are not made about the patient's condition. They just kept a closer eye on them. They become anxious about reporting their feelings to more experienced nurses and doctors, not wanting to be labelled as "stupid"	Confidence increases due to experience Intuition comes in line with previous familiar events They become more willing to approach senior staff to discuss their understanding of the event	Immediate intuitive feelings that provide the basis for a decision. Quick understanding however, difficulty explaining how and why they came to their decision. The nurses felt that their decisions were good and so they presented in a firm manner and were willing to persuade others that they were right	Unconscious recognition of subtle changes. Under conditions of uncertainty, trends are seen from subtle changes Intuition triggers an analytical approach to generating more solid evidence Strong memories of previous events help to provide the basis for new decisions

3.4.1.1 Experts Compared to Novices

It is reasonable to expect experts to consistently demonstrate a more sophisticated decision process than novices, however there are a number of studies in which experts under-perform in relation to expectations. In a study of 161 avalanche experts and novices, Atkins and McCammon (2004) found that experts routinely outperformed recreationists in their ability to choose safe skiing terrain. However the differences in performance were not due to differences in knowledge, but to an inability on the part of the recreationists to apply their knowledge. They were lacking the domain specific experience needed to put their knowledge, facts, principles, rules and procedures into context (Atkins & McCammon, 2004).

However, experts do not always significantly outperform novices. In a study of intuitive confidence using predictions of National Football League point spreads, Simmons and Nelson (2006) found that people predicted their favourites to play better than underdogs against a point spread that evenly matched the two teams. The point spread is a technique used by bookmakers to set up a scenario where the two

opposing teams are evenly matched. Thus those who place bets are wagering whether or not they can predict the outcome more accurately than the expert bookmakers. Rather than setting the odds as to which team will win the match, the point spread indicates the extent, or the number of points by which a particular team will win. This is similar to the use of a handicap in a golf game or a sailing race. The results were not greatly different when a panel of eleven experts was matched up against thousands of fans who logged into Yahoo.com's fantasy sports website. Although the experts predicted the favourites to win more often than the fans did, the study found that the experts only predicted the outcomes correctly in 50.1% of the games.

Surowiecki (2004) suggested that experts are not good at calibrating their judgments and are no better than normal people in avoiding an overconfidence trap. Camerer and Johnson (1997) argued that experts are no better predictors than less expert decision makers and that a simple linear regression model will likely make more accurate predictions than an expert. In an analysis of 1,042 mutual funds from 1986 to 1995, Costa and Porter (2003) found that managers with over ten years of experience did not perform significantly better than their less experienced peers. Rarely did a mutual fund manager consistently outperform an Index fund that has no active decision-making associated with it and is just linked to one of the major stock market indexes.

Although these are notable cases of expert decision makers under-performing in relation to expectations, they are the exceptions rather than the rules. These cases seem to occur more frequently in invalid environments. There is some evidence that expert predictions compared to novice predictions of human behaviour in areas such as sport performance (Simmons & Nelson, 2006a) and the stock market (Costa & Porter, 2003) have been found to be less accurate than expert predictions compared to novice predictions of natural events (weather). The difficulty for expert predictions of human behaviour may lie in the high degree of variability within the human dynamic, whereas weather prediction or avalanche forecasting occurs in a more valid environment, as there is a reliance on natural phenomenon. Flaws in the expert decision process can likely be overcome through a number of strategies

including a process of regular calibration of the decision maker's confidence. Calibration can be attained through feedback from other experts.

3.4.2 Decision Process

3.4.2.1 Introduction

Much has been written about the risk management or risk control decision-making process, largely coming from the field of psychology. The most widely recognized term for this body of knowledge is judgment and decision-making (JDM). However many different fields have a deep-seated interest in how decisions are made. Although there is some debate within the JDM literature, it is generally accepted that decision-making includes two systems or processes, one analytical and one intuitive (Barrouillet, 2011; Kahneman & Tversky, 1973; Sloman, 1996). This is supported by functional magnetic resonance imaging (fMRI) scans, which have indicated that different parts of the brain are activated when participants respond analytically as opposed to intuitively (Lieberman, Jarcho, & Satpute, 2004).

The Dual Process literature gained a more predominant position around 2007-2009 and became more widely accepted. Evans (2010, 2011) clarifies the definition of Type 1 (intuitive) and Type 2 (analytical) processing. He does not classify intuitive processing as unconscious and analytical processing as conscious. He suggests that Type 1 outputs of feeling and emotion are accessible consciously and Type 2 processing can be dependent on controlled attention to subconscious cue identification.

Intuition and analysis are not mutually exclusive events or processes. The interaction between these two processes has generated considerable interest. The interaction between intuitive and analytical processes has been described as one of the key elements of decision-making (Kahneman & Tversky, 1973; Kahneman, 2011). The dynamic tension between intuitive thinking and rational thought has been the subject of numerous books in the public press (Brafman & Brafman, 2008; Gladwell, 2005; LeGault, 2006; Mlodinow, 2008). These publications often offer a sensationalized view into the decision process, thinly veiled by the illusion of empirical research. The cornerstone of these publications is Gladwell's 'Blink – The

Power of Thinking Without Thinking' (2005). Gladwell uses emotive, singular events to lend strength to his argument, but overall the argument lacks weight. To his credit, his concept of "thin slicing" is anchored in situational awareness and pattern recognition. These topics have been discussed with much more detail and analysis in the academic journals, particularly within the realm of Naturalistic Decision-Making (NDM) and Recognition-Primed Decision-Making (RPD).

The interaction has also been proposed as a continuum, with decisions that are fully analytical, fully intuitive or a mix somewhere in between (Hammond, 1993; Hogarth, 1980). Gigerenzer and Goldstein (1996, p. 651) described a variation on this theme with what they termed, "fast and frugal heuristics". They suggested that in environments with high levels of uncertainty, the analysis of too much information might lead to less accurate predictions than a fast and frugal heuristic termed Take the Best (TTB). This approach focused on two or three key indicators compared to the more complex and analytical Lens Model proposed by Brunswik (1955), which relied on the weighting of multiple cues. Small errors in multiple cues had the potential to generate an inflated error in the final decision. Small levels of uncertainty in only two or three cues might be more accurate. Gigerenzer and Goldstein's (1996) fast and frugal decision tree is really just a simple rule-based decision using the two or three most important cues. It is different from intuition. However, once a fast and frugal heuristic (decision tree) is learned, it can become a pattern to be recognized and subsequently integrated into an intuitive response.

It has been generally accepted that there is a link between decision-making and expertise (Ericsson, 1996). The concept of expertise and how its development affects the interplay between intuition and analysis can be applied to the context of avalanche risk management. A key element within the definition of expertise is the role that feedback plays in improving decision accuracy. This leads to the development of domain specific expertise as demonstrated through improvements in intuition accuracy and expressions of confidence (Hogarth et al., 2008). However a counter to the validity of the intuitive argument is the overuse of heuristics and biases (Hall, 2002). The development of avalanche risk management expertise is contingent on the existence and use of a feedback pathway and the avoidance of a dependency on heuristics.

3.4.2.2 Naturalistic Decision-making

Research on the decision processes used by mountain guides in a wilderness skiing environment likely falls within the broad realm of Naturalistic Decision-Making (NDM) (Kahneman, 2003; Weick, 2001; Zsombok & Klein, 1997). Klein (1998, p. 1) defined Naturalistic Decision-Making as “the study of how people use their experience to make decisions in field settings”. A subset of this area of research has been further developed by Klein (1993) and termed Recognition-Primed Decision-Making (RPD). The Recognition-primed model proposed by Klein hinges on the concept that expert decision makers use a singular evaluation approach rather than a comparative evaluation. In this singular approach, the decision maker selects the first option that works, rather than generating two or more options and then comparing them. Also termed satisficing, Simon (1997) describes the singular approach as the formulation of a decision that exceeds the minimum performance and outcome criteria established by the decision maker. Satisficing may not necessarily produce the best result, but it will be good enough (Schwartz et al., 2002). Experts seem to be able to generate this single useable option without having to compare it to others, whereas novices tend to rely on the generation of multiple options and subsequent comparison. Klein (1998) describes two key elements within the RPD concept, recognition and action. Recognition of key elements during the initial scene assessment builds a foundation for action. This potential action is then evaluated through a story building process with the intent of imagining possible outcomes.

The RPD Model is based on the assumption that recognition is the initial step in the decision process (Klein, 1998). There are two components to recognition. The need for a decision must be recognized first. This primes the second component, which is recognition of the decision environment. This central theme of recognition in RPD is based on the concept of situational awareness (SA), which has been described as the ability to maintain the big picture (Endsley, Farley, Jones, Midkiff, & Hansman, 1998; Endsley & Robertson, 2000; Endsley, 1997, 2006; Matthews, Strater, & Endsley, 2004). SA is a state of being and is considered important for all levels of mastery from novice to expert (Endsley, 2006). The correct identification

of the situational context and decision clues can lead to effective decision-making. This is different from a decision error that results from a poorly understood decision context. Experts can typically make rapid decisions based on situational awareness and pattern recognition (Klein, 2011).

Situational awareness can also be described as *who* is doing *what*, and *what is happening* around the event that will impact the process (Endsley, 1997). Situational awareness is the basis for pattern recognition. Pattern matching is dependent on the ability to identify critical cues. Not all features will be represented in similar patterns, so it is essential to identify the key elements of the pattern.

A diminished situational awareness reduces the number of possible beneficial solutions, as the potential patterns will be less well defined. Endsley (1997) describes three levels of situational awareness: perception of the critical environmental factors, comprehension of the significance of those key factors in the formation of a holistic picture of the decision environment, and the ability to project or forecast what could change within the decision environment. In novel situations, situational awareness may be restricted by the decision maker's working memory and the limits of his, or her attention span. Information overload can become an issue as decision complexity rises. According to Endsley experienced decision makers will develop mental models that represent previous patterns and corresponding levels of all three levels of SA. Well-developed models are able to account for dynamic situations and adapt previous schemata to new situations. Pattern matching is dependent on the ability to identify critical cues. Not all features will be represented in similar patterns, so it is essential to identify the key elements of the pattern.

As the decision maker experiences increased saturation in a particular environment through repeated exposure, there may be an expectation of more rapid recognition of patterns. Although Klein (1998) suggests that the expert has actions that are triggered in a single step for rapid 'automatic' decision responses, the speed of the response may compromise accuracy. Automaticity may result in things being missed through a lowering of situational awareness. When expectations of events do not match up with reality, it indicates the need to adapt goal selection to the decision

environment. For example, avalanches on low angle terrain would indicate the need to re-evaluate the hazard forecast.

There are features of the environment that will impact how well participants are able to maintain situational awareness (Endsley, 2006):

- The capacity of the system to produce high quality raw data.
- The design of the interface between the user and the access point to the data.
- The system complexity.
- The number of steps that are automated. Greater automation may decrease the user's awareness of the steps.
- Stress

There are also a number of human factors that effect the development and use of situational awareness including: attention span, working memory, goal orientation, expectations and pattern matching (Endsley, 2006). Of these, pattern matching is perhaps the most significant for the ski guide. SA is not considered transferable, as knowing what to look for and the meaning of what is perceived is context specific and dependent upon tacit knowledge and expertise. Experts are normally able to develop sophisticated mental models that incorporate an interconnected, systems-based interpretation of the environment.

For the ski guide, this would typically include an interpretation of the impact of a group of skiers on the snowpack and their location in the terrain. It would also include the implications of multiple groups in the same terrain, the logistics of the helicopter or snowcat and the transitions from one geographic feature to the next as the day progressed. Mental models facilitate the integration of individual elements of critical information into the decision process that may be filled with many pieces of apparently important information. This is important in the development of forecasts and the possible ramifications of a decision. A high quality mental model becomes the bridge that allows an expert to match the current situation with a

previously experienced pattern. Recognition of the critical cues allows for more rapid pattern matching.

Automaticity often develops with increased learning and practice (Endsley, 2006). The reduction in effort directed at simple tasks allows the decision maker to focus on more demanding tasks. For example a new heli-ski guide may become absorbed by the demands of terrain hazard assessment and not be able to direct attention at the challenge of managing the group. With increased skills and automaticity in terrain selection, the guide can focus more attention on group management. However there is a downside to automaticity. An expert may be able to adequately manage 'normal' situations with a diminished level of SA, but may not be prepared when an abnormal situation arises. The drift into complacency and automaticity is dangerous ground (Klein, 2011). Checklists have been used successfully as a way to avoid automaticity. It is important even for experts, to recognize when a situation is completely novel as previous patterns will likely be inadequate. In trying to make a pattern fit a current situation, the decision maker may be guilty of stretching a pattern beyond recognition in the search for a possible solution.

Lipshitz, Klein, Orasanu and Salas (2001) describe how a story building process can be used to seek solutions. It is typically used in three incremental approaches based on the complexities of the decision challenge. In the simplest form, immediate recognition of a problem and its solution is the simplest and most rapid response providing a quick 'if ...then' reaction. When confronted with a relatively simple scenario the decision maker's previous experience provides a template from which to solve the problem. The complexity increases with higher levels of uncertainty prompting slower recognition of the problem. This puts a question mark after the 'if'. Once the problem is recognized a solution can be quickly selected. In this situation, the decision maker uses a story-building process with the intent of imagining possible outcomes to generate a satisfactory solution.

At the highest level of complexity the decision maker must not only develop recognition of the problem, but then also must contemplate the possible outcome. This variation is typically used when a dynamic, shifting environment is

encountered. A single course of action can be generated and evaluated without the need to compare it to alternate strategies. Expertise has been described as the key factor that allows these strategies to be effective and will be explored later in this chapter.

Klein (1998) conducted studies on fire fighters, naval ship commanders, tank platoon leaders, infantry officers, and commercial pilots and suggested that RPD strategies were used in 80-95% of the cases. Experienced decision makers were able to recognize patterns within complex environments and rapidly develop solutions, which were adequate for the task. These rapidly produced solutions may not have been the most elegant, or best solutions, but they created results that were 'good enough.' Klein argues that RPD strategies are most likely to be used when the decision maker is reasonably experienced relative to the challenge and is faced by a high level of uncertainty, exacerbated by time pressure.

Lipshitz and Klein (1993, pp. 110-111) describe six components of RPD that are typically present in real world settings and acknowledge that RPD does not address all the concerns of NDM, particularly the issues of team and organizational constraints. These six components form the basis for the decision challenge. All six are well represented within the challenges faced by ski-guides.

1. Ill structured problems

Although the challenge, or the decision problem, for ski guides can be stated as the need to safely conduct the guests through potentially hazardous wilderness terrain, there is a large degree of spatial variability. The hazard associated with the snowpack stability varies considerably from place to place.

2. Uncertain dynamic environments

Winter weather conditions in the mountains change rapidly. Poor visibility poses a particular challenge for the guide by complicating the selection of a safe ski line. It is also an issue for the helicopter pilot while flying.

3. Shifting, ill-defined, or competing goals

Guest expectations may clash with safety parameters.

Particularly during times of poor snowpack stability and high

avalanche hazard, guest desires to ski the steep and deep lines may conflict with the guide's desire to keep everyone alive.

4. Action / feedback loops

Near-miss events and accidents provide more obvious feedback and might typically be reviewed extensively for lessons to be learned. However there may be minimal feedback and reflection on good decisions. It is unremarkable when nothing goes wrong.

5. Time pressure

Helicopter time is expensive. Efficient use of helicopter time is paramount particularly when decisions involve the sequential movement of multiple groups.

6. High stakes

There are two components to the high stakes: guests are paying \$1000/day or more and, guests may die because of poor decisions.

Klein (1998) suggests that analysis is not one of the strategies used by experts in these high stakes, time critical natural settings. Based on his research on fire-fighters, he suggests that the use of intuition and mental simulation, the development of metaphors and the telling of stories are much more appropriate strategies and claims that these areas have not been extensively studied in real-world JDM contexts.

When placed within the context of Naturalistic Decision-making (NDM) the question arises as to whether wilderness ski guiding is any different from other environments that pose risk-based challenges such as wilderness first aid. Although there are certainly many similarities between the decision environments of the wilderness first aid responder and the ski guide, there are also significant differences. The key element that stands out is the questionable reliability, or even existence of a feedback loop. For example, first aid for a traumatic injury benefits from a feedback loop. If the direct pressure on a wound is sufficient, the bleeding will stop. If it is insufficient, the bleeding will continue (Isaac & Goth, 1991). This provides the opportunity to react to the feedback and modify the strategy.

This is not the case for the ski guide where feedback may be entirely absent. There is certainly the potential for a poor decision to result in a fatality, but it is perhaps equally likely that nothing bad will happen at all. Poor decisions occasionally result in feedback in the form of near-misses or accidents, yet there will also be times when poor decisions do not result in any overt feedback.

At the other end of the ski-guiding decision spectrum, a good outcome is not necessarily attributable to a good decision. Explicit feedback rarely occurs on good guiding decisions. The most challenging scenario is that good decisions in ski guiding rarely result in direct feedback other than nothing bad happening. Although this could be considered a good outcome, if the decision process were flawed, it might create a template for future flawed decisions, perhaps with outcomes not as favourable. Inferences can be made as to the quality of the decision based on this non-result by those involved, such as other guides. The question as to whether this was a good or bad decision hinges on the perception of whether the actual outcome (nothing bad happened) was representative of existing conditions. If other guides within the operation considered the decision quality low, there is considerable opportunity for feedback and reflection.

The concept of spatial variability (Campbell & Jamieson, 2004) within the snow pack and the existence of 'super weak zones' plays a key role in understanding a likelihood statement regarding whether or not a slope is safe to ski. Spatial variability refers to the changes within the snowpack structure over the terrain. For example, a slope that is generally stable may have one or more localized areas of weakness where an avalanche can be triggered. These areas of weakness or super weak zones may be due to variations within snowpack distribution or underlying surface roughness (McClung & Schaerer, 2006). As it is difficult to specifically identify super weak zones, a slope may be categorized as being safe enough to commit a ski group to even though there may be isolated locations of triggerability. If the group skis the slope without anyone hitting a weak spot and triggering the slope, it can be described as non-event feedback. This is particularly relevant with regard to Hogarth et al.'s (2008) work on the complexity of the environment in which intuition is developed or learned, as described later in this chapter.

NDM researchers consider experts to have highly developed domain specific decision-making skills (Lipshitz, Klein, Orasanu, & Salas, 2001; Lipshitz & Klein, 1993; Lipshitz & Strauss, 1997). The primary consideration is that the expertise is situated in a context. The RPD model is based on the principle that rational choice and expected utility do not form the basis of decisions (Glöckner & Witteman, 2010; Klein, 1997). Instead previous experience that has evolved into expertise supports the decision process. Situational awareness allows for pattern recognition and the identification of whether the situation is typical or atypical. A typical situation can be matched with a previous response and an adequate course of action can be selected. Ross, Shafer and Klein (2006) suggest that NDM research can be used to generate decision training that contributes to cognitive authenticity. This term refers to domain specific perceptual skills that an expert would use to solve a problem.

3.4.2.3 A Two System Process

3.4.2.3.1 Dual Process

3.4.2.3.1.1 The Role of Intuition

Not only is there a lack of clarity within the literature as to exactly what intuition is, there are a variety of terms used interchangeably with intuition. Betsch (2008, p. 4) described intuition as “a process of thinking”, with inputs coming from memory and outputs surfacing as feelings. Myers (2002) equated intuition with common sense and argued that common sense is not so common, hence much of our naïve intuition is tied up in misconceptions such as the relative dangers of flying in a post 9/11 world versus commuting by car to work.

The role of intuition has been the subject of much debate generally along the line of whether it is a rational or irrational process (King, 2002). Easen and Wilcockson (1996, p. 672) described intuition as “an irrational process but with a rational basis”. There is however, consensus that as expertise develops, intuition becomes a more refined tool and is used more extensively; the challenge being to not become overly reliant on it (Kahneman & Klein, 2009). In this section I will clarify a definition of intuition and more specifically a definition of pattern recognition that I

will use for the purpose of my studies. These definitions clarify the context that I have used to craft the connection between intuition and expertise within the study.

3.4.2.3.1.1.1 Definition of Intuition

In a study of emergency room nurses, Cioffi (1997) argues that intuition plays a vital role in the decision-making process, as it is a subconscious way of knowing, based on experience. King (2002) investigated the use of intuition in non-expert nurses and found that intuition is used more by experienced (expert) decision makers than inexperienced (novice) ones. Easen and Wilcockson (1996) argue that a knowledge base built on experience provided the basis for pattern recognition. This in turn supported intuitive responses.

An intuitive response will likely generate a feeling or emotion that is identifiable at a conscious level. However the origin of the feeling cannot be identified (Evans, 2011). The conscious analysis of an intuitive response does not change its sub-conscious origins. The Default-interventionist theory would suggest that we would act on these rapid intuitions unless the intuitive solution does not satifcice the decision challenge (Alter, Oppenheimer, Epley, & Eyre, 2007).

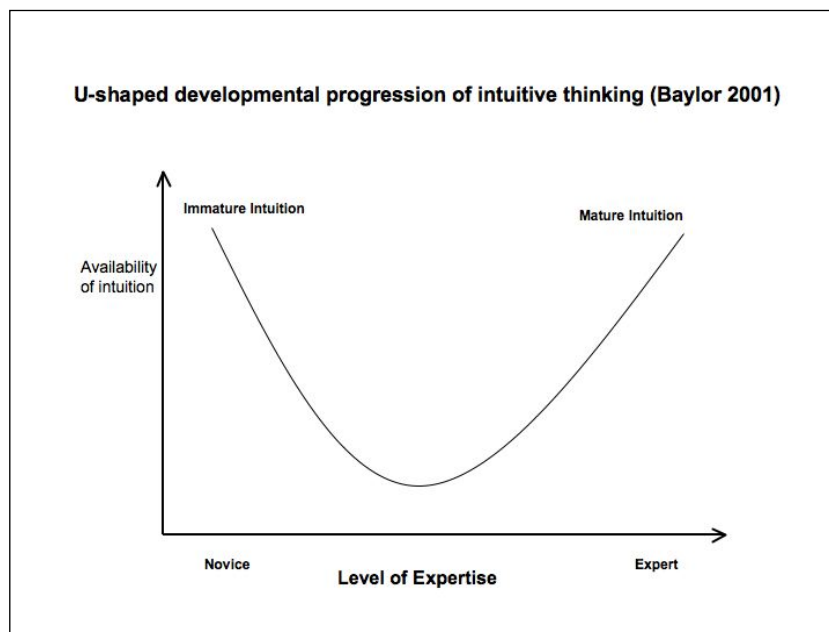
Not all authors supported the use of intuition, citing various concerns. Ruggiero (1997) voiced a concern that intuition should not be used in isolation or as a replacement for analytical thinking, as was not part of the conscious thought process. Whereas Herbig, Bussing, and Ewert (2001) equated intuition with tacit knowledge and described it as something which was acquired implicitly as part of work, and not necessarily something which was reflected upon. As a result it might contain erroneous or problematic content.

Kahneman, Slovic and Tversky (1999) described the use of two systems within the decision-making process. System 1 used perception and intuition. It was driven by easily accessible thoughts that did not require much in the way of reflection. Operations conducted under System 1 were: fast, effortless, implicit, could be emotionally charged, governed by habit and were difficult to control. System 2 used reasoning. Operations conducted under System 2 were: slower, serial, effortful, potentially rule-based, and were consciously controlled.

Dreyfus (2004) expanded on the definition by identifying six key aspects: pattern recognition, similarity recognition, common-sense understanding, skilled know-how, a sense of salience and deliberate rationality. Of these six aspects pattern recognition has been recognized as the most important (Benner, 1984; Klein, 1993; Simon, 1987).

Baylor (2001) described two qualitatively different types of intuition that were available for use, in relation to the development of expertise. She suggested that immature intuition was readily available at a novice level and mature intuition available at an expert level (Figure 4). As expertise was built and the ability to critically analyse and to develop controlled cognitive processes evolved, the use of intuition was potentially inhibited.

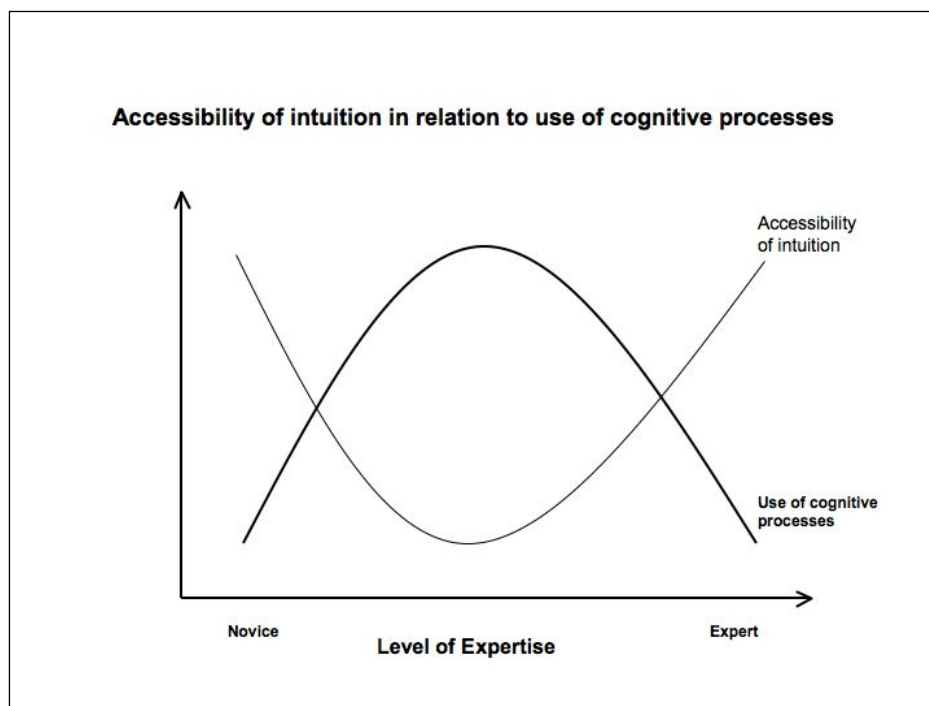
Figure 4 U-shaped progression of intuition (Baylor 2001)



Baylor used the term ‘availability’ when perhaps a more descriptive term is accessibility. A more convincing argument would be that not only is intuition still available, but it continues to mature as cognitive analytical skills develop. However, the newfound cognitive process may mask the significance of the intuitive input (Figure 5). According to the Default-Interventionist theory the strength of the intuitive response would be low and there would be a strong drive to find an answer analytically (Alter et al., 2007).

The significance of ‘immature intuition’ is questionable. It may be present and identifiable in the novice decision maker, however it should not be relied on as the majority of the research has recognised the domain-specificity of the intuitive process. Thus a novice decision maker would be unlikely to have domain specific experiences on which suitable intuitive responses could be based. Any intuition available at this novice stage will have to be generic and transferred from other perhaps closely related experiences.

Figure 5 A more complete picture integrates the use of cognitive processes with the accessibility of intuition (adapted from Baylor, 2001)



3.4.2.3.1.1.2 Arguments against the use of intuition

Easen and Wilcockson (1996) raised the question as to whether an intuitive decision could be considered ‘unprofessional’ as the decision would not have been the result of a rational process and might have been difficult to explain. They argued that the inability of the decision maker to explain this intuitive leap might have been due to a complete bypassing of the linear reasoning process.

When confronted with the reality of professional decisions being scrutinized by the courts in regards to legal liability, a ski guide or an outdoor leader might feel exposed when the only explanation they have in defence of their actions is ‘*It felt like*

the right thing to do at the time'. Easen and Wilcockson (1996) argued that compared to a yardstick of scientific and rational thought, intuitive thinking might be considered to be of lower quality and hence unprofessional. They argued that there were significant benefits to professionals when decisions based on intuition could be explained and accepted as valid, both internally to the decision maker and externally to other members of the profession, the public and the courts. The internal validation was an essential part of the intuitive process and was based on the decision maker's knowledge and experience.

3.4.2.3.2 Intuitive – Analytical Continuum

Hammond and Klein (1993) proposed a Cognitive Continuum Theory in which intuition and analysis were placed on a continuum. The decision process was described as a pendulum, swinging back and forth along the continuum. When a decision based on intuition was unsuccessful, the tendency was to move to a more analytical process. The reverse was also true when analysis failed intuition gained a greater role. An additional issue was that some tasks were more apt to be solved through an intuitive process while others were best solved through an analytical process. The cognitive continuum was dependent on the context of the environment and needed to match the demands of the task (Dunwoody, Haarbauer, Mahan, Marino, & Tang, 2000).

3.4.2.3.3 Somatic Markers

Damasio (1996) proposed the somatic marker hypothesis suggesting that people experience both positive and negative feelings that influenced the decision process. These feelings were triggered through pattern recognition and previous emotional states. Punishments or rewards earned through previous decisions established somatic markers which formed the basis for future decisions (Glöckner & Witteman, 2010). These somatic markers were immediate and experienced prior to the activation of a reasoning process. For example, a strong negative somatic response could be interpreted as a warning system, alerting the decision maker possible danger. *I have a bad feeling about this so I am not even going to think*

about going there. For the participants in my research, strong feelings - mostly negative, influenced their decision process.

3.4.2.3.4 Feedback

Hogarth et al. (2008) argued that the critical element in the development of intuition was the quality and quantity of feedback. He described feedback as being relevant or irrelevant, in relation to the seriousness of the consequences, which could be described as lenient or exacting. Intuition does not need to be very precise when consequences are lenient. A general direction can be sufficient. However, when consequences are exacting, there are significant consequences for minor errors. This produces an environment that can be described at its extremes as either ‘kind’ or ‘wicked’ (Hogarth et al., 1991). A ‘kind’ environment has relevant feedback and lenient consequences, compared to a ‘wicked’ environment, which has irrelevant feedback and exacting consequences.

This has particular significance to the decision-maker in avalanche terrain. The experience gained by expert ski guides might have been acquired in range of wicked and kind environments. Many decisions could be made when there is the potential for catastrophic consequences and minimal, or irrelevant feedback is generated. The “cultural capital or the inventory of intuitions that guide behaviour” (Hogarth et al., 2008, p. 91) has the potential to be tainted by this lack of relevant feedback, necessitating regular calibration.

Surowiecki (2004) suggested that although judgment calibration is important, both experts and non-experts have trouble maintaining an accurate estimation of the likelihood that judgments are correct. One of the challenges in decision calibration is the interpretation of feedback from a previous decision. Feedback can be of low quality or missing completely. For example: if a slope does not avalanche when I ski down it, the decision to ski the slope must have been a good one. This line of thinking may be flawed due to over-reliance on the feedback inherent within the activity, rather than incorporating a reflective component (Jamieson, 2006; Schön, 1990). Hogarth et al. (2008) argued that due to the ‘mere-exposure effect’, repeated exposure to an event without negative consequence can result in the context of the event being perceived positively.

Good decision-making should have a reflective component and be anchored by the notion of mindfulness (Weick, 2001). This pre-occupation with the anticipation of the unexpected rather than a satisfaction with previous performance is perhaps what separates good decision-makers from lucky ones and will help to address the issue of variable quality feedback (Hogarth et al., 2008; Wiseman, 2003).

3.4.2.3.5 Summary

There is no argument over whether intuition plays a role in the decision process. It is clearly acknowledged that if a decision maker's knowledge and experience is lacking, a decision based on intuition can be flawed and no better than a misguided guess (Dreyfus, 2004). One of the questions that must be addressed is whether or not, or to what degree, validation of intuitive responses can occur accurately through an internal or introspective process. The discussion revolves around the extent to which we can identify and subsequently trust our intuitive responses. Intuition has a nebulous distinction within the realm of decision-making and will benefit from further study that clarifies its development and use.

3.5 The Link Between Intuition and Expertise

3.5.1 Introduction

This section explores the link between the development of intuition and the development of expertise. There is consistent agreement within the JDM literature that as expertise develops, decision makers are rewarded with more refined intuitive responses. A key element within the definitions of expertise is the role that feedback plays in improving decision accuracy. This leads to the development of domain specific intuition and expertise, which clarifies some of the differences between experts and novices.

Schön used the term technical rationality to describe expertise. He considered “professional competence as the application of privileged knowledge to instrumental problems of practice” (1990, p. xi). Various authors (Benner, 1984; Dreyfus & Dreyfus, 2005; Dreyfus, 2004; Ericsson & Charness, 1994) identified stages of mastery, or levels of expertise which played a role in how efficiently a complex situation might be resolved. In studies ranging from nurses to chess

players, it has been identified and generally accepted that experts make decisions very differently from beginners (Atkins & McCammon, 2004; Benner, 1984; Galloway, 2002; Morrow et al., 2003; Starks & Ericsson, 2003). Typically, experts, compared to beginners, put more time into the analysis of the problem and consequently need less time to solve it. They can also quickly absorb more information and remember it in both the short and long-term (Wagner & Sternberg, 2002).

The trend in adventure leadership has been to develop a 'rule-based process' for novice decision makers and a 'principle-based process' for expert decision makers (Grímsdóttir, 2004; Hägeli et al., 2006; Wagner & Sternberg, 2002). This has led to a series of incremental questions including: who is an expert, how do you know when you have become an expert, and how do you make the transition from novice, rule-based decisions to expert, principle-based ones? Paley (1996) suggested that experts can be identified two ways, either through a peer assessment, or through the accomplishment of established performance criterion.

My research explored the challenges of the first question: who is an expert and how do they make decisions? I chose this to address the research gap illuminated by a large scale research project completed in Western Canada on how novice winter recreational backcountry users, including both skiers and snowmobilers make decisions (Hägeli et al., 2006) and the research conducted by Adams (2005) on avalanche professionals. The transition from novice to expert is likely topic for future research.

Ericsson (1996) described three important criteria in the empirical study of expert performance: reliability, reproducibility and predictability. The most important condition was that the expert performance occurred reliably in a specific set of circumstances. Ericsson argued that decision-making was best studied in a controlled laboratory setting, as it was more difficult to study expert performance in field settings in domains such as medicine, which posed a multitude of diverse challenges. Ski guiding in avalanche terrain might also fall in this category of being more difficult to study as it contains numerous variables.

Ericsson (1996) suggested that it was preferable to measure expert performance in an absolute manner with a constant set of challenges rather than in a

relative measure with fluctuating challenges. It would be easier to monitor changes over time with a constant set of challenges. This argument does not adequately address the challenges faced by ski guides as the environment is constantly evolving, so to study ski guide decision-making in a controlled lab setting would be contrived. To develop a more complete understanding of the role of intuition in the expert decision process of ski guides will require a study of their performance in a professional arena such as the complex winter mountain environment of Western Canada. The value of studying decision-making in this unique environment is rooted in the complexity of the problem, exacerbated by an unreliable environmental feedback mechanism and extrapolated over the immensity of the terrain. On an average winter day in British Columbia, 150 guides make high consequence decisions, with significant implications for the safety of their guests, on the use of an area twice the size of Switzerland. Heli-ski groups rapidly move through this terrain, requiring numerous high consequence decisions in the completion of upwards of 8000 metres of vertical descent in a single day. Although the InfoEx helps to pool knowledge about the snowpack structure, snow stability and the ease of triggering an avalanche, the potential for large degrees of variability from one area to its nearest neighbour adds a layer of complexity.

3.5.2 The Development of Expertise and Intuition

A number of conditions have been cited as being characteristic of events that foster the development of expertise and the subsequent impact on intuition. These included: a desire and motivation to improve, a well designed task that accommodated the learner's starting point, and timely access to high quality feedback (Ericsson, Krampe, & Tesch-Romer, 1993). The greatest potential for development occurred when tasks that met these criteria were repeated often. Of these characteristics, feedback whether generated externally or internally through a reflective process, was generally considered the most important (Balzer, Doherty, & O'Connor, 1989; Brown, 2006; Hogarth et al., 1991). A well-designed task performed by a highly motivated person can meet with limited success in the absence of high quality feedback (Balzer et al., 1989). For the ski guide, this can be the case all too often. Low-probability – high-consequence scenarios do not provide

consistent high-quality feedback (Klassen, 2010a). Ski guides cannot be dependent solely on environmental feedback as it can lack qualities that are truly representative of the decision complexity. Feedback that addresses not only what the correct answer was, but also includes elements of why the answer was correct can be much more effective in the development of decision-making skills (Hammond & Summers, 1972).

3.5.2.1 Pattern Recognition

Pattern recognition may be a crucial element in the decision-making process of ski guides as it can occur when previous experiences encompass a high degree of similarity or representativeness with a new situation. In this situation, intuition could be particularly accurate. This would allow experts to more rapidly access a greater amount of information and to come up with a better decision faster.

In a study of chess masters, Chase and Simon (1973) found that experts, compared to novices, had an increased ability to chunk information (identify patterned clusters), store it in long term memory and recall it later. In further studies, Gobet and Simon (1998) identified the template theory which predicted that experts would be able to develop far more elaborate chunking abilities, using both larger chunks and more of them.

Galloway (2002) suggested that building an extensive pattern recognition repertoire was an important part of becoming an expert outdoor leader. This would help leaders identify a greater complexity of response possibilities. Information could be retrieved from the experience-generated knowledge base through the visualization of mental images.

Pattern recognition is an integral part of how intuitive inferences help the decision maker. However, there is disagreement within the literature as to whether experts are more adept at using pattern recognition to forecast future events, or to look backward in the analysis of past events. Looking forward in time is a prediction (e.g. What is going to happen?). Whereas, looking backwards in time is a diagnostic inference (e.g. What has been going on that has led us to where we are now?). Hogarth et al. (2008) argued that experts seem to be more adroit at using backward inferences or diagnosis, as they are more able to absorb the details and to recognize

patterns quickly. This pattern recognition seems to be based in a greater understanding of what is normal versus what is abnormal. This contrasts with Vick's (2002) suggestion that experts use a forward reasoning process to more rapidly diagnose a situation, rather than a backward reasoning process. Vick's argument is supported by the findings of Patel et al. (1996) in their study of medical expertise. The forward reasoning process allowed for the identification of key factors and then a rapid selection of a seemingly obvious solution (Weick, 2001). Certainly, there is evidence that experts can use both processes; the argument is perhaps over which one is preferred or used first. For example, a backward reasoning process can be used to further check a solution derived by a forward reasoning process, and *vice versa*. This is how Kahneman, Slovic, and Tversky (1999) described what they call, the intuitive – analytical interaction.

In a study of avalanche professionals, Adams (2005) reported that 88% of her participants used some level of pattern recognition in their decision-making process. The sample group, generally described as experts, included 37 Canadian avalanche professionals: heli-ski guides, ski patrollers, highways avalanche control technicians and park wardens. Years of professional experience were used as the measure for expertise, with 80% exceeding 10 years. These years of professional experience of the avalanche experts had contributed to the accumulation of an extensive inventory of patterns. This helped them quickly make sense of new situations.

Pattern recognition is not necessarily the panacea for all decision problems. Bad patterns can also be formed. Hogarth et al. (1991) suggested that this could occur when decision feedback was absent or misleading. Ewert, Shellman and Glenn (2006) equated pattern matching with a possible instructor trap, the heuristic bias of familiarity. They suggested that a seemingly familiar pattern might provide an easy solution to a slightly different decision problem. A failure to recognize the subtleties of the differences could result in a poor decision.

3.5.2.2 Feedback

Of the elements of effective learning described by Ericsson and his co-authors (Ericsson, 1996; Ericsson, Krampe, & Tesch-Romer, 1993); defined task, appropriate difficulty, feedback, and error correction; feedback has been considered

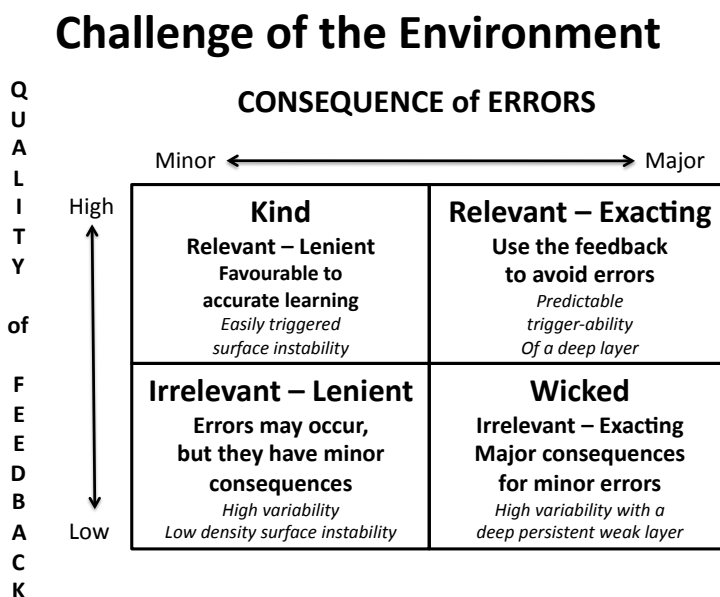
the critical element. The type, quality and quantity of feedback would be dependent on the characteristics of the operational environment. Other factors, which have been explored in this section, include the impact of near-misses, the timing of feedback and the significance of experiencing multiple environments in the development of intuition.

In environments with inconsistent or unreliable feedback such as ski guiding, the opportunity for improvement in decision accuracy may be minimal. Given the importance of decision accuracy in the avoidance of fatalities, it would seem crucial to develop strategies to overcome this lack of implicit feedback. There need to be ways to generate feedback beyond that which is implicit.

The ski guide faces the challenge of interpreting numerous, possibly conflicting environmental feedback clues, such as a lack of recent skier-triggered avalanche activity despite a known weakness within the snowpack. High quality feedback on the decision maker's interpretation of the environmental feedback could come from other experts. Teams of guides such as those used by most mechanized ski operations could likely benefit from some form of decision analysis during the traditional evening guides meeting. As intuitive responses based in pattern matching possibly play a critical role in the interpretation of environmental feedback, knowing if and how intuition is developed would be of great benefit to the guiding community and the greater community that hires guides to conduct them safely through hazardous terrain.

Hogarth et al. (2008) argued that the critical element in the development of intuition was the quality and quantity of feedback. Figure 6 shows how feedback can be relevant or irrelevant, in relation to the seriousness of the consequences, which can be described as lenient or exacting. Intuition does not need to be very precise when consequences are lenient. A general direction can be sufficient. However, when consequences are exacting, there are significant consequences for minor errors. This produced an environment that could be described at its extremes as either 'kind' or 'wicked'. A kind environment has relevant feedback and lenient consequences, compared to a wicked environment, which has irrelevant feedback and exacting consequences.

Figure 6 Learning environments for the development of intuition (Hogarth et al., 2008)



This has particular significance to the decision maker in avalanche terrain. The experience gained by expert ski guides might have been acquired in range of wicked and kind environments. Many decisions are made when there is the potential for catastrophic consequences and minimal, or irrelevant feedback is generated. The “cultural capital or the inventory of intuitions that guide behaviour” (Hogarth, 2008, p. 91) has the potential to be tainted by this lack of relevant feedback.

An analysis of the winters of 2006-2007 and 2007-2008 in British Columbia might provide an example of the role that the environment plays in the feedback process. Deep weak layers within the snowpack, which are notoriously difficult to assess in regards to the hazard they pose, plagued the winter of 2007-2008. The number of recreational avalanche fatalities in British Columbia was above average at eleven, yet there was not a single fatality in professional, guided groups (Klassen, 2008; Marshall, 2008). In contrast, the winter of 2006-2007 was characterized by frequent, regular storms and few, if any, persistent weak layers lingered in the snowpack. The total number of fatalities (5) in British Columbia was well below the five-year moving average, but 60% were commercial fatalities.

This conflicted with previous research, which indicated that avalanche experts typically had greater difficulty forecasting deep slab instabilities (Jamieson & Geldsetzer, 1999). This raised questions as to the environmental context that

occurred immediately prior to my two winters of data collection. Reports from guides suggested that the professional avalanche community was able to identify the different nature of the weather conditions and resultant snowpack instabilities. Patterns did not match previous experiences and doubt was a constant decision factor (Piché, 2008). Many near-miss events were reported, but they occurred sporadically and no consistent pattern of feedback. Numerous anomalous events were catalogued in the 2007-2008 InfoEx reports, which fell outside the pattern recognition of the reporting professionals.

The winter of 2007-2008 had many of the hallmarks of a wicked environment, with massive negative consequences and variable feedback (Hogarth et al., 1991), yet no guiding fatalities occurred. One can speculate that the guiding safety record was the result of conservative decision-making with an element of good luck. An avalanche event occurred relatively early in the season on January 6th, 2008 at the Big White ski area that punctuated the decision challenges. An avalanche released on a persistent weak layer deep within the snowpack on a slope inside the ski area boundary that was open to the public. Six people were buried resulting in one fatality. This avalanche prompted the professional community to be more prudent in their decision-making in the face of variable quality feedback and massive consequences (Brown, 2006).

The 'hard – easy' effect is another possible explanation of these outcomes (Suantak, Bolger, & Ferrell, 1996). Guides may have become over confident when the conditions were easy in 2006-2007, whereas they were less confident and hence more conservative in the wicked conditions of 2008-2009.

Unfortunately, these conditions may have laid the foundation for potentially dysfunctional patterns or bad intuitions. Intuitions formed in 2007-2008 could be considered highly suspect, as it might be overly presumptuous to assume that more good decisions were made that year and were the cause of the zero fatality rate.

Feedback received through the commitment of errors and the recognition that these errors had occurred provided a possible answer to the above questions. Weick (2001) suggested that when the number of perceived errors was low, there was minimal opportunity to learn. It was only once the errors were detected that feedback could be elicited. Errors, which were not perceived or recognized as such,

could be considered a false positive. For example, the decision to ski a particular slope will likely be considered valid when the result does not include a negative result such as an avalanche (Gonzales, 2008). Adjustment to detected errors increased the quality of the decision-making.

Lipshitz et al. (2001) suggested that making errors was not necessarily a problem. The focus needed to be on the identification of errors and the possible learning outcomes generated by them. Working towards an error-free performance in a highly complex unstable environment may in the end be detrimental to the learning process.

It is also necessary to consider the impact of exposure to multiple locations or environments on the development of intuition. It is possible that intuition developed differently for guides who moved from one operational area to another to develop their expertise. Being challenged to make difficult decisions on a more regular basis, compared to a guide who continues to work in the same location and subsequently has developed a greater depth of local knowledge, may in the end foster a more sophisticated inventory of intuitions (Tozer, Fazey, & Fazey, 2007).

Soman (2003) suggested that the evaluation of an experience and subsequent learning, could vary depending on the timing of when the feedback was elicited. This evaluation could occur through a reflective process or through the solicitation of feedback from others. A prospective evaluation is an anticipation of what will happen and occurs prior to the implementation of a decision. Whereas a retrospective evaluation is comprised of thinking back on what actually happened. The timing of the retrospective analysis was critical. Soman (2003) argued that a temporally proximal evaluation of an event was preferred and would carry more weight. He went on to suggest that adaptations occurred to the perception of previous events, with the memories of negative events, such as poor decisions that led to painful outcomes, diminishing over time. These painful memories were strongest immediately after the event and weaker as time went by. In this sense, multiple retrospective evaluations of the same event, conducted at different times, might lead to differing interpretations.

One of the challenges is the interpretation of feedback from a previous decision, particularly when the feedback was a non-event. Feedback can be of low

quality or missing completely. For example: if a slope does not avalanche when I ski down it, the decision to ski the slope must have been a good one. This line of thinking may be flawed due to over-reliance on the feedback inherent within the activity, rather than incorporating a reflective component (Jamieson, 2006; Schön, 1990). Hogarth et al. (2008) argued that due to the 'mere-exposure effect', repeated exposure to an event without negative consequence can result in the context of the event being perceived positively.

Feedback is an integral component of the improvement of decision accuracy. The issue of variable quality feedback can be addressed through a pre-occupation with the anticipation of the unexpected rather than a satisfaction with previous performance is perhaps what separates good decision-makers from lucky ones (Hogarth et al., 2008; Wiseman, 2003). Although errors provide an obvious trigger for the evaluation of feedback, further analysis of feedback can be stimulated by a reflective component.

3.5.2.3 Reflection

Reflection has the potential to become self-generated feedback. Certainly there is the need for reflection to be calibrated to avoid becoming overly critical or blind to seemingly obvious negative clues, but it does provide an avenue for improvement in decision accuracy.

Jensen, Gwyer, Shepard, and Hack (2000) suggested that the on-going development of expertise can be fostered through the process of continual reflection-in-action as demonstrated by a 'thinking out loud' process. Experts who challenged themselves with difficult cases could continue to expand the depth and breadth of their knowledge base through a reflective process. This self-monitoring, thinking process could be used to examine incoming data through the lens of their previous experience (Jensen, Gwyer, Shepard, & Hack, 2000).

Schön (1990) described how the element of surprise illuminates a hole in our previously held expectations. This gap can be swept aside or further examined through a reflective process for clues. Adams (2005), in a study of avalanche professionals, suggested that critical reflection was an essential component of deliberate practice and played a key role in the development of expertise.

Good decision-making should have a reflective component and be anchored by the notion of mindfulness (Weick, 2001). This pre-occupation with the anticipation of the unexpected rather than a satisfaction with previous performance is perhaps what separates good decision-makers from lucky ones and will help to address the issue of variable quality feedback (Hogarth et al., 2008; Wiseman, 2003)

3.5.2.4 Domain Specific Development

Wagner and Sternberg (2002) suggested that expertise should be considered domain-specific due to the extent of dedicated practice required. These domain specific activities could be divided into three categories: work, play and deliberate practice. Deliberate play at an early age was found likely to promote engagement in the activity and a willingness to engage in deliberate practice as the participant's skill set matured (Ward, Hodges, Starkes, & Williams, 2007). Intrinsic motivation was the greatest predictor of dedication to deliberate practice, with a lack of the deliberate intention to improve as barrier to expert performance.

Campitelli and Gobet (2011) argue that deliberate practice is a necessary component of expertise development, but question whether it alone is sufficient to acquire expertise. In their study of chess players, they found that there are highly talented people who can achieve mastery with less than the 10,000-hour benchmark of practice. They suggest that 10,000 hours is an average not a minimum. The achievement of expert levels of performance may be aided by above average cognitive abilities and starting at an early age. Assertions of handedness and season of birth were also predictors for expertise, but likely have less influence on ski guides than on chess masters. Gladwell (2008) argues that the opportunity to excel plays a very important roll in the acceleration of expertise development. For example, hockey players born in January gain access to better coaching sooner than their peers born in December.

Fadde and Klein (2010) suggest that deliberate performance is a way to accelerate the development of expertise. It intensifies the tenets of deliberate practice through four specific exercises: estimation, experimentation, extrapolation and explanation. Deliberate performance is conducted during routine work time and is aimed at improving domain expertise.

Mountain guiding has followed the lead of many professions and adopted a continued professional development (CPD) programme to ensure the on-going development of its members (Association of Canadian Mountain Guides, 2006; Canadian Avalanche Association, 2006). Within this domain specific development, there is the recognition that there are a number of levels or increments in the transition from novice to expert. For an aspiring apprentice mountain guide field days could easily fall into the three categories of: work, play and deliberate practice.

Reflecting on my twenty years of experience in student recruitment and selection into the Adventure Studies Department (over 500 students), play has typically been what inspired the pursuit of certification as a mountain professional. Extensive deliberate practice has been a required element in the preparation for mountain guiding exams. Work becomes an option once the first exam is passed.

For fully certified guides, deliberate practice might fall lower on the agenda due to increased work opportunities. Ericsson et al. (1993) suggested that work pressures might discourage the acquisition and development of new skills even though they could provide improved and more efficient strategies. The dilemma of how to spend limited time resources might be further complicated by extrinsic rewards associated with work such as money and social recognition. In contrast to this, deliberate practice not only generates no income, it usually incurs a financial burden, either through lost wages or direct financial costs. The motivation to continue with deliberate practice at this point would need to be based in an appreciation for the long-term benefits associated with becoming an expert. An increased emphasis on Fadde and Klein's (2010) four components of deliberate performance could potentially counteract the loss of deliberate practice time.

As may be the case in many professions, but perhaps more so in Adventure Leadership, the maturation process of becoming recognized within the peer group as an expert requires more time to be channelled into dedicated practice or work and less into play. This is particularly true for guides who hold full-time jobs within the field, but may be less of an issue for the guides who maintain an itinerant lifestyle with significant gaps in their annual employment during the 'off-seasons' of October-November and May-June.

Professional development programmes and courses can provide an opportunity for experienced practitioners to further develop their expertise. Both the Association of Canadian Mountain Guides (ACMG) and the Canadian Avalanche Association (CAA) require Continued Professional Development (CPD) as a component of active professional membership (ACMG, 2006; CAA, 2006). The CAA requirements are much more stringent than the ACMG requirements (Appendix 10). The CAA employs a points based system that requires members to demonstrate the continued development of their expertise in a minimum of three of the six available categories. These categories are: professional practice, formal learning activities, informal learning activities, participation in service activities, presentations, and contributions to knowledge.

It is no longer considered good enough to merely maintain a standard of competency. The professional mountain community in Canada, through the efforts of the Canadian Avalanche Association and the Association of Canadian Mountain Guides has modelled the requirement for continued professional development after the Association of Professional Engineers and Geoscientists of British Columbia. There are similarities with the CPD systems used by the medical and legal professions. The ACMG (2006, p. 1) has defined CPD as “the systematic maintenance, improvement and broadening of knowledge and skill, and the development of personal qualities necessary for the execution of professional and technical duties throughout the practitioner’s working life”. The emphasis is on improvement and broadening of knowledge, with the recognition that simply maintaining the guiding skill set at the level of certification is inadequate. New knowledge and continual learning are acknowledged as essential parts of the profession.

The Canadian Avalanche Association requirement for professional members to engage in Continued Professional Development (CPD) provides the clearest example of how continued professional development contributes to dedicated practice and the development of expertise. Professional members are required to “continuously upgrade their knowledge, training, qualifications and credentials”. The CAA CPD requirements are included as an appendix and are summarized here.

The requirements will be described and evaluated in regards to the how they influence the development of expertise in ski guides.

Professional Members must generate 240 CPD points over a three-year period, with a minimum of 80 points per year. Points must be accumulated in at least three of the six categories. They must maintain a three-year rolling average of 80 points. The categories are: professional practice, formal learning activities, informal learning activities, participation (service), presentations and contribution to knowledge. Members cannot earn their CPD points from just their professional practice. A minimum of three of the six categories must be used to generate points over a three-year period and there are maximums for each category.

Although professional practice can be up to 62.5% of the annual CPD points total, formal and informal learning activities combined can contribute up to the same amount. These learning activities are an integral part of the ski guide's pursuit of expertise. Three key events form the cornerstone of most ski guides' professional development: annual company pre-season training, the CAA Annual General Meeting CPD event, and the biannual International Snow Science Workshop (ISSW) conference. Every heli-ski and cat-ski company conducts a mandatory pre-season training session. These sessions typically involve presentations and workshops from leading researchers and industry experts such as Dr Bruce Jameison (University of Calgary Applied Snow and Avalanche Research Group), Dr Pascal Hägeli, and Manuel Genswein. The Annual CAA CPD event is well attended and each year is directed toward a theme. In 2012 the theme was the integration of new technology into standard common practice. The ISSW is the pivotal point in the transition of new research into practice. The theme of the conference is the 'Blending of Theory and Practice'. Although the event is the stage for the distribution of new research and knowledge, many practitioners not only attend the conference, but also make practice-based presentations generated through action research. Contributions to knowledge can comprise up to 37.7% of the annual total, and not only play an important role in the development of the individual practitioner, but also the profession of ski guiding. The CAA Membership Committee is required to annually

conduct a random audit of the membership. If a member is unable to demonstrate compliance with the CPD requirement a change in membership status is required.

A caveat to the benefit of participation in CPD events is that there may be a tendency to engage in 'safe' situations that demonstrate superior abilities, rather than risking new situations that might expose weaknesses. Dweck (2002) cautioned that a lack of willingness to engage in challenging learning opportunities can result in stagnation relative to peers who are inclined to push themselves into new situations. She goes on to suggest that self-handicapping may occur when people care more about looking good or smart than they do about doing something right or accomplishing something great.

As the above discussion demonstrates, development of expertise is based on motivation to succeed and practice, not innate abilities. 'Gifted' children will not become talented adults without hard work and the willingness to engage in intellectual and creative risks. The development of expertise comes at a cost however, as it is not easy or inexpensive to acquire and demands a high level of motivation and effort over a sustained period of time (Sternberg & Ericsson, 1996; Wagner & Sternberg, 2002). In an analysis of twenty members of the Canadian National Figure Skating Team, Starkes et al. (1996) found that both the skaters and their coaches rated 'desire' as the number one element in the likelihood of success. Good coaching and practice came second and third, while the coaches rated natural ability 6th and the athletes rated it 10th.

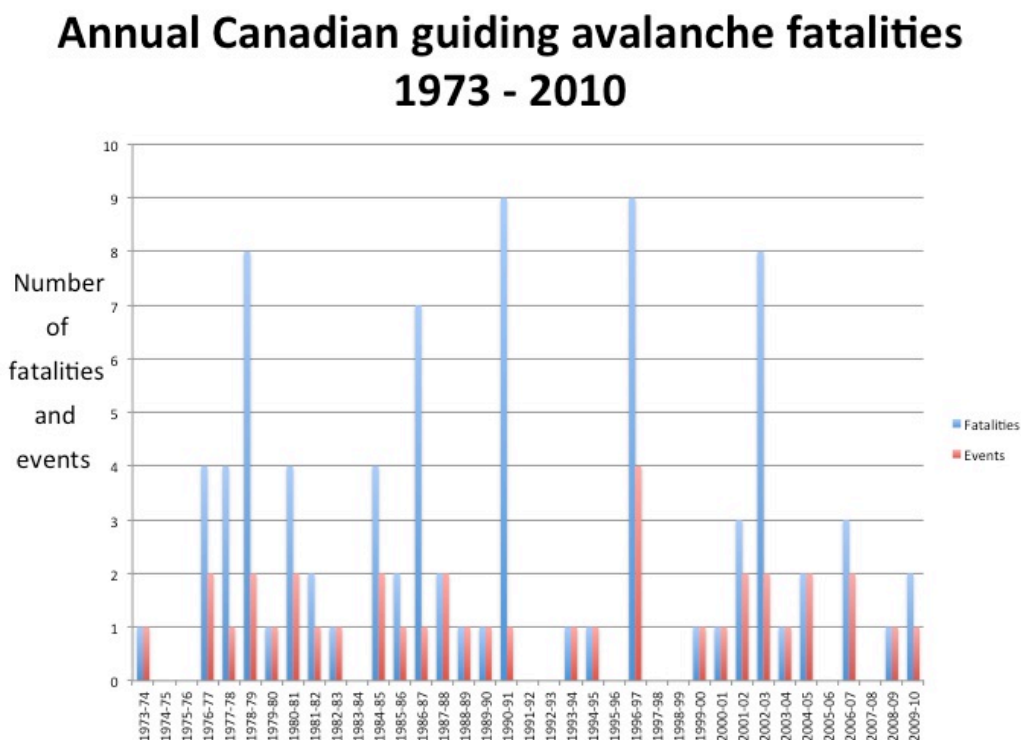
As decision makers move upward through the levels of expertise, there can be an increasing willingness to recognize the importance of and to act on intuitive feelings. The ability to use intuition can develop much more effectively. Inexperienced decision makers can develop their intuitive senses by talking with more experienced decision makers. This sharing of thoughts should help the less experienced to hone their skills. The domain specific nature of expertise and intuition requires that considerable time and effort is put into professional development activities. The willingness to engage in challenging CPD events and risk failure in front of a peer group will likely payoff in significant long-term benefits.

The expertise of the heli and snowcat guiding industry is exemplified through the relatively low number of fatalities, particularly for what many consider an extreme sport. The safety record of commercial heli and snowcat skiing is generally very good, but it does have some variability (Figure 7). In 1991, nine guests died in the worst avalanche accident in Canadian mechanized skiing history. For the following two seasons there were no commercial mechanized skiing avalanche fatalities. During the 1996/1997 season there were four fatal mechanized skiing avalanches resulting in nine fatalities. In the following two seasons there were no commercial guiding fatalities. Over the ten-year span from 2000/2001 to 2009/2010 there were 11 avalanche accidents resulting in 14 fatalities. This must be put into the context of the number of skiers and the volume of terrain covered during that time.

- 100,000 skier days per year
- 5000-8000 vertical metres of skiing per guest per day
- 8-14 runs per guided group per day
- 350 guides working per season
- 150 guides working each day
- The season is 5 months, or 150 days

This means that a guide typically makes about 1200 run decisions per year and that there are over 180,000 run decisions made industry-wide over the same time period. HeliCat Canada considers safety as the number one priority for the association members. Thousands of hours are dedicated to learning from the very few accidents that occur. Training events help to fulfil the roll of on-going dedicated practice (HeliCat-Canada, 2013).

Figure 7 Canadian guiding avalanche fatalities 1973-2010



3.5.3 Use of Intuitive Options

In this section a number of issues within the role of intuition has been explored including: the notion of subjective probability, the importance of pattern recognition, and a description of the challenge of choosing between non-intuitive and intuitive options.

Simmons and Nelson (2006) suggested that people tend to choose intuitive options rather than non-intuitive ones. They called this an intuitive bias. Intuitive options come to mind easily and because of this they promote confidence. When other information becomes known that counters the immediate intuitive response, there is less likelihood that it will be considered as valuable as the intuitive option. There are a number of possible explanations. Intuitive biases come from the integration of the two mental systems described by Kahneman (2003). Since the first system is based on intuition, it can provide a quick answer to a decision problem. There is potential for error to be introduced if a quick intuitive answer to an easy (but slightly different) question is used to answer a more complex question. The second

system, analysis, requires a much greater level of reflection and is therefore slower, but has the benefit of adding information that was initially neglected. Doubt is a phenomenon that can develop during this reflective period and could be considered “a meta-cognitive appreciation of one’s ability to think incompatible thoughts about the same thing” (Kahneman, 2003, p. 702).

In a study of avalanche professionals, Adams (2005) found that expert forecasters regularly used the non-primary option as a method for quality control, that is when the intuitive option was chosen, the non-intuitive option was used as a filter to check for biases and when the non-intuitive option was chosen, intuition was used as a final check. ‘Does this feel right?’ If both intuition and analysis run concurrently as two independent processes, they can be used as a series of checks and balances (Evans, 2010).

The intuitive response may win out due to a number of possible factors. Chaiken (1980) proposed a heuristic systemic model, which suggested that people are either unmotivated or unable due to overload, to update their initial intuitive response, whereas Kahnemann (2003) suggested that the second system was actually unable to sufficiently correct the initial assessment. This initial intuitive response became the ‘anchor’. As new information was processed, adjustments were made, but rarely did these adjustments go far enough. The key concept was accessibility. How easily did these intuitive thoughts come to mind? Was it hard work, or was it effortless?

Although there is general agreement as to the link between the development of expertise and the development of intuition; there is a lack of consensus within the literature as to the degree to which intuition should be trusted and used. Davidson (2005) argued that greater effort should be put into the use of the non-intuitive option and that the intuitive option had its place in the response to emergency situations, but was generally overused. Kahneman suggests that intuition was overused because it was easy. “People are not accustomed to thinking hard and are often content to trust a plausible judgment that quickly comes to mind” (2003, p. 699). Ruggiero (1997) included the caveat that novices were rarely blessed with accurate intuition as it could often be both uncontrollable and unreliable. He argued that the inclusion of

intuition in the decision-making process was a welcome addition, but should not be used in isolation.

3.5.3.1 Subjective Probability

3.5.3.1.1 Uncertainty

Dealing with uncertainty is an occupational hazard for ski guides (Statham, 2008a, 2008b). They are compelled to make life or death decisions on a daily basis with varying degrees of uncertainty. Likelihood judgments, or subjective probability assessments are qualitative expressions used to communicate the probability of an occurrence (Reagan, Mosteller, & Youtz, 1989) and are used in highly complex environments when decisions are required in the face of uncertainty (Vick, 2002). Clearly within the ski-guiding environment, there would be tremendous benefit to having a greater understanding of how intuition plays a role in the development of likelihood statements.

Lipshitz et al. defined uncertainty as “a sense of doubt that blocks or delays action” (2001, p. 337). Their definition was further broken down to identify three forms of uncertainty and described as: inadequate understanding or insufficiently situational awareness, incomplete, ambiguous, or unreliable information, and conflicting alternatives. Kahneman et al. (1999) argued that heuristic strategies were commonly used in these environments and allowed decision makers to estimate the probable outcome of an event by interpreting subjective information through a filter of personal experience. This was useful when there was a high level of uncertainty and no immediately obvious answer. However, there was disagreement within the literature. Betsch (2008) argued that intuition should not be equated with the shortcut strategies known as heuristic processes as suggested by Kahneman et al. (1999) and by Gilovich (1991), because these heuristics were contingent upon deliberation rather than intuition.

3.5.4 Intuition Leading to Confidence

In this section the connection is made between the use of intuition and feelings of confidence. Statham described ski guiding and avalanche forecasting as operating in an “untidy world of uncertainty” (2008, p. 4). The degree of uncertainty

experienced by a decision maker will likely be reflected in his or her level of confidence. High levels of uncertainty might be expected to produce low levels of confidence. Hogarth et al. (2008) suggested that this may not always be the case. In situations when high quality feedback on decision accuracy was not available, other measures could be used to measure the quality of the decision. The primary measure would be confidence. If there was a strong intuitive response, it could feel like ‘the right thing to do’, and expressions of confidence in this intuitive response would be used to validate the decision.

Simmons and Nelson (2006) argued that the primary task of a decision maker was to evaluate the need to switch from the intuitive choice to the non-intuitive option. Key information included the constraints that opposed or limited the initial intuitive response and the intuitive confidence, which supported the intuitive response. Generally the easier the intuitive response came to mind, the more likely it was to inspire confidence. In an investigation of predictions against point spreads in National Football League games, which included a series of fourteen quantitative studies, four hypotheses were proposed (Simmons & Nelson, 2006b):

1. Intuitive bias – people choose intuitive responses over equally credible non-intuitive responses.
2. Constraint magnitude – people choose the non-intuitive response when constraint information was strong.
3. Intuitive confidence – people choose intuitively when they were confident in their intuition.
4. Intuitive betrayal – people who choose non-intuitive responses were less confident.

Intuitive uncertainty was introduced through seemingly irrelevant sources. Simmons and Nelson (2006) used an uncertain start time for football games. These irrelevant sources that produced uncertainty, decreased intuitive confidence. On questionnaires, poor or difficult to read fonts also decreased intuitive confidence. Shappell and Wiegmann (2001) suggested that uncertainty was exacerbated when sensory input was outside the normal range. For the ski guide, sensory input could

be distorted by environmental factors such as: poor lighting, clouds obscuring vision, and noise from wind, or helicopters.

3.5.4.1 Confidence

Confidence, and in particular over-confidence, may be responsible for leading decision-makers astray in attempts to convince themselves of the accuracy of their decisions (Dobbins, Kroll, & Liu, 1998; Dunning, Griffin, Milojkovic, & Ross, 1990). As there is likely a link between confidence and accuracy, it would be important to know how well confidence is calibrated relative to accuracy. In a two-alternative choice situation there is a 50/50 chance of getting it right. If you know the answer then you will have 100% confidence and accuracy. If you have no idea then, you have a 50% chance of getting it right and therefore a 50% confidence rating (Merkle & Van Zandt, 2006).

Although the ski guiding environment is much more complex, it still comes down to the question ‘Can I safely bring my guests down this run?’ The answer must be a confident yes or a definitive no. Maybe, or perhaps would not good enough. There would be a decision point in the helicopter on the selection of a landing to drop the skiers off, and a commitment point as the skiers were poised at the top of the slope. If the slope is deemed unsafe after the group has committed it, an extraction could be difficult.

Simmons and Nelson (2006) suggested that although complete certainty was difficult to achieve, when intuitive confidence approached 100%, disconfirming information could become irrelevant. It would likely be difficult to convince someone to change their mind once they have high confidence in an intuitive response (Fischhoff, Slovic, & Lichtenstein, 1977). However, feelings of regret have been reported to become more prevalent when the initial intuitive choice was abandoned in favour of a non-intuitive choice that later proved to be wrong (Simmons & Nelson, 2006b).

A major issue for confidence statements is the relationship between confidence and accuracy. A number of researchers have (2006) described how a hard-easy effect (Gigerenzer, Hoffrage, & Kleinbölting, 1991; Merkle & Van Zandt, 2006), or difficulty effect (Griffin & Tversky, 1992) could occur, when a greater

overconfidence was exhibited on hard questions and slight under-confidence on very easy tasks. In a study of expert decision-making, Wright, Rowe and Bolger (1994) found that issues of calibration needed to be addressed when decision-making was perceived to be more difficult.

These confidence judgements were affected by both random error and cognitive biases. Cognitive bias was defined as a mental process that allowed people to feel that they knew more than they actually did (Merkle & Van Zandt, 2006). This promoted an inability to properly digest stimulus information, which negatively impacted the accuracy of confidence judgements. Overconfidence often resulted from an inability or unwillingness to adjust one's confidence far enough, as task difficulty changed (Einhorn & Hogarth, 1978; Koriat, Lichtenstein, & Fischhoff, 1980; Suantak et al., 1996). Adams (2005) described how ski guides could potentially fall into this trap in their perception of a sufficiently large margin of safety. One of her participants emphasised the importance of maintaining a margin that was "just a hair bigger than what I think I need".

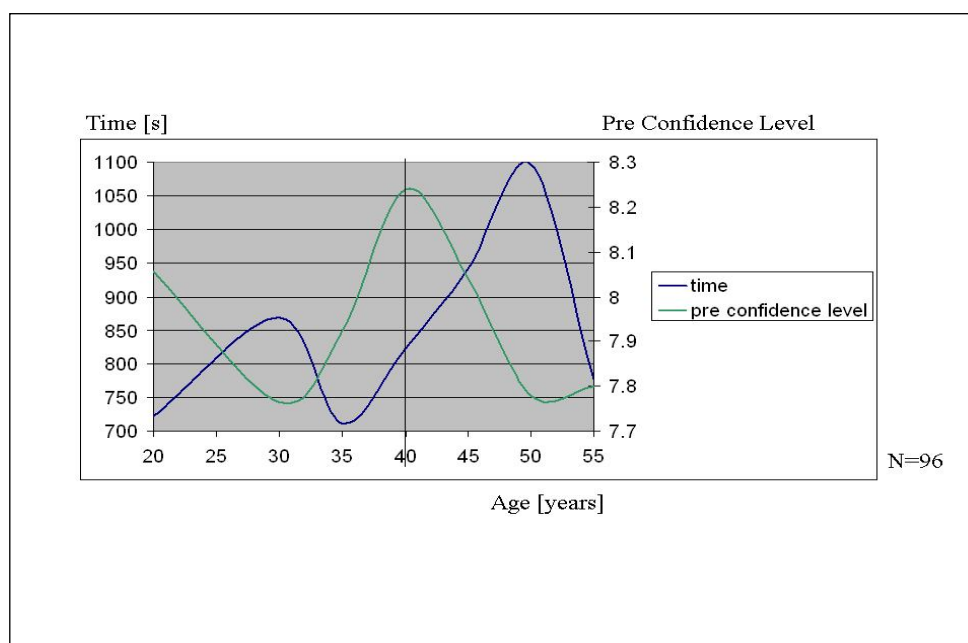
Baranski and Petrusic (1995) argued that the calibration of decision confidence and accuracy were important elements and required consistent effort. Surowiecki (2004) suggested that although judgement calibration was important, both experts and non-experts had trouble maintaining an accurate estimation of the likelihood that judgements are correct. One of the challenges in decision calibration is the interpretation of feedback from a previous decision.

In a study investigating the connection between a systematic approach and overall efficiency in avalanche rescue, Genswein (2008) tested 120 mountain and ski guides. The participants were asked to make a confidence prediction as to how well they expected to perform in a timed avalanche rescue scenario. Four avalanche transceivers were buried at various depths and distances apart. The guides were evaluated based on their time to successfully locate the four buried transceiver and the overall efficiency of their search methods. The 35-year-old guides had a low pre-confidence level, yet achieved the best performances. The 50-55 year-old guides had a similar, low level of pre-confidence, however they also had the worst performances. Strikingly, the middle ground from an age and expertise perspective, the 40-45 year-old participants had the highest level of pre-confidence, but only a

mediocre level of performance. Mitigating factors on the participants' speed and efficiency scores included familiarity with the supplied avalanche transceiver, recent rescue practice and fitness. Figure 8 shows the variation in rescue performance time in relation to age.

Relating these results to levels of expertise within the guiding community, the average age of completion for the full mountain guide certification in Canada is 35. These guides are at the peak of their dedicated practice in preparation for the final exam. The middle group is at the peak of their professional performance, and generally recognized as experts by their peer group. An explanation for their decreased performance in the avalanche rescue scenario might be that they are in a position of increased work demands and have less time available for dedicated practice and continued professional development.

Figure 8 Confidence and rescue performance time in relation to age (Genswein, 2008)



A question raised by this study was how widespread the “overestimation of one’s ability” was within the 40-45 year-old group (Genswein, 2008, p. 23). Did overconfidence apply just to technical rescue skills, which were typically practiced, but not used on a regular basis, or did it also apply more broadly to decision-making skills? Genswein (2008) also compared the degree to which guides were systematic in their approach to avalanche rescue, with their linguistic origin, which he also

termed mentality. He found Germanophones to be highly systematic and Francophones to be least systematic, with Anglophones in the middle. A systematic approach could be equated with a high level of cognitive, analytical processing and less intuitive input. There may be a connection between cultural origin and the use of decision processes that is worthy of further study. Perhaps Germanophones are more likely to use a cognitive decision process, and Francophones an intuitive process.

3.6 Summary of the Literature

3.6.1 Judgement and Decision-making Literature

There are many discussions within the judgement and decision-making literature and a variety of arguments. The discussion at the core of the literature centres on the decision process. The classic argument of the modern discussion was proposed by Brunswik (1955). He suggested that decision challenges should be viewed through an analytical lens. His model provided a method to break the decision challenge down into manageable pieces.

The next stage after Brunswik's analytical model was the recognition that a second decision process also contributed to decision-making. This second process was based in tacit knowledge and was more difficult to define. Intuition was thought to be a separate process from the better-defined analytical Brunswikian model. However there seemed to be an assumption that analytical thought was superior to intuition (Koriat et al., 1980).

The decision-making discussion has progressed well beyond the classic analytical decision model to incorporate an acceptance of the role that heuristics and intuition play. A discussion of dual process emerged and was centred on how the two processes interacted. Although most researchers acknowledged that both these processes occurred there was still considerable debate as to the nature of the interaction. The debate centred on whether the intuitive-analytical interaction occurred on a continuum (Hammond, 2010), or as two independent variables (Evans, 2011).

Stanovich, West and Toplak (2011) discussed how some researchers had equated heuristics with System 1 or intuitive processes. However, Gigerenzer (2007)

one of the foremost heuristics researchers preferred to describe heuristics as a process distinct from the System 1 and 2 terminology. Kruglanski and Gigerenzer (2011) argued that System 1 and System 2 shared some characteristics in that they were both essentially rule-based. They suggested that the relative accuracy of one system compared to the other system would be dependent on how well the selected decision rule matched the decision environment.

The discussion of the intuitive – analytical interaction is fragmented within the judgement and decision-making literature, as little has been done to blend the various theories together. The opposite appears to be the trend, as the various schools of thought have carved out their terrain and dug their arguments deeper. Kahneman and Klein (2009) have been the lone voices that have attempted to unite the arguments together.

3.6.2 Adventure Leadership Literature

Progress within the JDM literature has slowly made its way into the adventure literature. Recent research has recognized that theories generated by the JDM field have the potential to contribute to a greater understanding of decision-making by adventure leaders. However there is still much to be done to connect these two fields together.

Shooter, Sibthorp and Paisley (2009) discarded the long standing category of meta skills proposed by Priest (1986), suggesting instead that decision-making skills are tied to technical skills. They argued that the enactment of a decision was based on environmental considerations as they pertained to a technical skill and existed within an interpersonal context. My research goes beyond this argument with the integration and application of dual process theories (Evans, 2010).

3.6.3 Snow Science Literature

The discussion within the snow science literature is less well entrenched and there appears to be a greater acceptance of a variety of viewpoints. Specifically within the snow science literature the majority of research has been aimed at the heuristics and bias discussion (Furman et al., 2010; McCammon, 2002). This has

left a gap, as there has been little discussion of the application of dual process theories to avalanche related risk management decisions.

Adams (2004, 2005) and Stewart-Patterson (2004) initiated a human factors discussion in avalanche related expert decision-making, which complimented the research conducted by Grímsdóttir (2004) on expert ski guide's use of terrain knowledge. Adams touched on the role that intuition could play in the decision process, as her research focused on how experts could use a systems-based thought process. My current research follows the line of reasoning initiated by Adams' research, but goes much deeper, significantly adding to the depth of the discussion, with particular emphasis on the intuitive-analytical discourse.

Amateur, novice, or recreational decision-making has been examined by numerous authors (Furman et al., 2010; McCammon & Hägeli, 2004). There has been a move towards consensus within the snow science literature supporting the notion that amateurs need decision support tools and should be using a rule-based protocol in their selection of safe skiing terrain. McCammon and Hägeli (Hägeli et al., 2006; McCammon & Hägeli, 2004, 2005, 2006) argue that rule-based decision support tools have the potential to work well for amateur or recreational avalanche decision makers. Numerous decision support tools for amateurs have been generated for the European avalanche phenomenon including: Munter's Reduction Method, Larcher's Stop-or-go Method, and Bolognesi's NivoTest. Recognizing the shortcomings of applying a model based on European data to North American avalanche terrain usage, McCammon and Hägeli (2006) developed the Avaluator for North America.

Galloway (2005) acknowledges that there are major differences between experts and novices in their ability to be aware of the intricacies of the situation, which in turn modifies how and what they recognize in the situation. The more sophisticated mental models of experts allow them to not only pay greater attention to the finer details, but also to place those details in perspective within the big picture.

There has been little support for the use of rule-based decision support tools amongst avalanche professionals. McCammon and Hägeli (2005) suggested that

although rule-based strategies had been widely adopted by recreational backcountry users in Europe, they had not been widely used by professionals. Canadian avalanche experts have also argued against suggestions that rule-based decision support tools should supplant their more sophisticated principle-based decision process.

The suggestion that decision support tools designed for the recreational decision maker should also be used by expert, professional decision makers has met with considerable resistance. The primary concern has been that a rule-based system designed for a recreationist simplifies the decision scenario by reducing the number of variables. Avalanche experts have argued that they can manage and interpret greater amounts of raw data (Hägeli & Atkins, 2010). The conflict between the application of amateur decision support tools and expert principle-based decision-making has been exacerbated under certain snowpack conditions. The decision support tools may indicate a stop situation, while the expert decision process indicates the need for high levels of caution, but not a stop condition. Experts have argued that they are able to make more refined decisions in their selection of safe skiing terrain (Association of Canadian Mountain Guides, 1999). However, the strength and weight of this argument is diminished every time a professional has an accident during times of high hazard (British Columbia Coroners Service, 2005).

The use of the currently available decision aids by ski guides was rejected early in the thesis based on the premise that an expert would not use a tool made for an amateur. Outside of the ski-guiding context, there is also little support for rule-based strategies designed for amateurs to be used by expert decision makers (Metzger & Parasuraman, 2005)

Klein (2011) argues that procedures, or rules do not work for experts. He suggests that rules are training wheels and memory aids. They make routine operations easier. The downside is that the use of procedure erodes expertise, as the decision process drifts into automatic processing. Experts need to remain engaged, particularly in complex situations; experts need to know when to break the rules. They can do this by making their tacit knowledge more visible (Klein, 2011). Unfortunately, feedback on tacit knowledge tends to be procedure based rather than

about the use of tacit knowledge, the ‘what’ instead of the ‘why’. It is easier to give feedback on explicit procedural errors, such as which subtle cues and patterns were missed.

A tool that has been developed by the Canadian Avalanche Association for the expert avalanche decision maker is the AM and PM Hazard and Risk Worksheets (Appendix 1). In addition, HeliCat Canada provides guidelines on run selection. A run coding process is widely used in the industry. Runs coded Green are available for use that day by the guiding team. Runs coded Red are not available. Yellow runs require more information and a team decision. The protocol to make the decision to change a yellow run to a green run requires a face-to-face discussion within the guiding team.

In a broader context such as nursing, expert decision-making has been recognized as being different from novice decision-making (Benner, 1984). However the discussion as to whether avalanche experts should use decision support tools remains contentious. The argument has been made that ski guides can process larger amounts of raw data in their analytical decision process. However, no studies support this position. Expert avalanche decision makers have a successful history of good decisions, with relatively few fatalities in relation to the volume of terrain used. Whether ski guides are so successful because of their ability to analyse large amounts of raw data, or their intuitive processing through pattern recognition has not been researched. My research addresses a void in the discussion, adding to the discussion of how intuition plays a role in expert ski guide decision-making.

3.7 Gaps in the Literature

My research emerged from the literature in three areas and identified gaps in all three areas. The focus of the work has been to investigate ski guide decision-making, with the intent of addressing specific gaps within the snow science literature. In a broader context, it also addresses gaps in the adventure leadership literature and contributes to the discussion of the role of intuition within the JDM literature.

3.7.1 Snow Science

McCammon's (2002) benchmark study of recreational decision makers clearly established heuristic biases as a source of avalanche related decision errors. He found that simple rules of thumb, or heuristics were used to simplify the decision process used by recreational skiers in avalanche terrain. He found that a decision process based on the use of heuristics was susceptible to heuristic traps. Four heuristic traps were found to occur: familiarity, social proof, commitment and scarcity. He suggested that there was a positive correlation between the susceptibility of decision makers to fall into heuristic traps and the occurrence of avalanche accidents. However he concluded that simply knowing that heuristic traps could occur was insufficient. He suggested that finding a way to educate practitioners in methods of recognition and avoidance were needed. As his study investigated recreational avalanche accidents, it begged the question of whether expert avalanche practitioners could also fall prey to heuristic biases.

A follow-up study by McCammon and Hägeli (2004) that investigated decision support frameworks for recreational backcountry users solidified this line of thinking. They evaluated whether four decision support tools designed for European recreational skiers could work in North America. They suggested that the decision support tools had been embraced by recreational backcountry users, but had met with resistance from the professional guiding community. They found that the European tools had a number of deficiencies when they were applied in the North American context, based on U.S. accident data. Instead they suggested that a simpler checklist, focussed on seven specific clues, had the potential to help recreational users generate better decisions.

A subsequent study of winter backcountry recreation (Furman et al., 2010) used McCammon's work as a basis for an investigation of recreational heuristic-based decision-making that included risk-taking propensity and avalanche forecast variables. They found support for McCammon's heuristic traps, but that risk-taking propensity also played a role in the decision to ski a slope. They remarked that risk tolerance has not been investigated as to how it modifies a heuristics-based decision process.

Although the need for some form of avalanche decision support tool for amateur recreational decision makers, to aid in the avoidance of heuristic related decision errors was clearly established (Hägeli et al., 2006), it has yet to be determined whether decision support tools can facilitate expert decision-making.

Expert decision-making in avalanche terrain has been studied. Grímsdóttir's (2004) study of heli-ski guides focussed primarily on terrain selection and group management. She did not investigate the ski guide's decision process. Adams' (2005) study of avalanche professionals took a systems approach in her investigation of the human factors in expert decision-making. This study was the foundation upon which I constructed my research plan. The role of intuition was but one of the many human factors that she explored. There was room for further research that investigated the decision process used by ski guides and in particular the role that intuition played.

Hägeli and Atkins' (2010) study of expert ski guide decision-making looked to bridge the gap between expert decision-making and amateur decision-making. Their goal was to study how experts made decisions in avalanche terrain; with the aim of using expert decision filters to develop a decision support tool for amateurs.

These studies clearly left a gap in the snow science literature. Expert decision-making in avalanche terrain had not been studied in relation to recent advances made in the JDM literature, particularly in the area of dual process theories.

3.7.2 Adventure

The topic of instructor decision-making has been investigated in the adventure leadership literature, however the context has often been dependent on the hypothetical application of JDM models and theories and not on empirical studies (Cook, 1996; Guthrie, 1996; Watters, 2005). Galloway has been the notable exception to this with studies on medical decision-making in outdoor leadership (2007) and the development of useful tools to measure leader expertise (2003). Numerous ways to measure expertise have been utilised in the literature, but Galloway's (2003) Outdoor Leader Experience Use History (OLEUH) provided an excellent template. Galloway (2007) used both personal and professional measures of outdoor experience. Eight subscales were used: Professional Environment,

Professional Population, Professional Leadership, Professional Activity, Demographic, Personal Experience, Personal Environment, and Personal Activity, based on the assumption that accurate personal and professional trip logs were maintained over what could be a 30+ year career. The OLEUH would have provided a very accurate calculation of expertise for my research, if my research participants had accurately logged the eight subscales developed and tested by Galloway,

In my research, I used elements from the OLEUH. I used a more frugal process and combined it with the Canadian Avalanche Association's guidelines for Continued Professional Development (CPD). I used a less sophisticated measure of experience, preferring instead to focus on areas that would provide a high degree of accuracy and omitting possible inaccurate information based on selective memories. An empirical investigation of ski guide decision-making, anchored by the adventure leadership expertise literature and the JDM literature, may have the potential to generate a greater understanding of the adventure leadership decision process and fill a gap in the adventure literature.

3.7.3 Judgement and Decision-making

Within the JDM literature there are areas or gaps that my research might be able to address. There is considerable debate as to whether the intuitive and analytical processes run in parallel (Barrouillet, 2011b; Evans, 2010) or on a continuum (Dunwoody et al., 2000; Hammond & Summers, 1972; Hammond, 2010).

Hogarth (1980) described how the environmental context would impact the development of intuition. A low-feedback, high-consequence environment, such as that frequently experienced by ski guides would be termed "wicked" and have potential long-term negative effects on the quality of intuitive responses. More research is needed on the application of intuition in wicked environments.

3.8 The Research Questions

Generalizations made in the adventure leadership and judgement and decision-making literature have been used to form research questions that can be applied to the snow science literature. These questions centre on how intuition is used in the decision-making process. Two judgement and decision-making

perspectives have been used to create the framework of the research questions.

The heuristics and biases perspective supported a line of questioning based on generating an understanding of why experienced ski guides made seemingly foolish mistakes. Whereas, a naturalistic decision-making perspective supported a line of questions that investigated why so few ski-guiding fatalities occurred in relation to the amount of terrain covered.

The context that framed the research questions was based in the fatality rates recorded by the ski-guiding industry over the two seasons prior to the collection of data. Ski guides were successful in their decision-making in 2007-08 with no fatalities, but not in 2006-07 when five fatalities were recorded. What was different? Did something change in the ski guide decision-making process?

The primary research question addresses why ski guides have varying degrees of success in their decision-making. What factors contribute to good decision-making? As ski guides have been taught to use an analytical decision process through their training and certification, to what extent do they actually use analysis in their decision-making? Based on the dual-process models of decision-making, how did ski guides blend their use of intuition and analysis? A number of elements were considered as to their impact on the decision process. This included the influence of expertise, and the role of both professional and environmental feedback. These influences were potentially different on good days when nothing bad happened and on days when near-miss events occurred. The impact of the use of intuition and, or analysis on decision confidence also warrants investigation. The subsidiary questions include an examination of how confidence was affected by an intuitive response and how feedback could impact confidence and the future use of intuition.

3.9 Summary

The development and use of intuition by expert decision makers has been the focus of considerable research in other fields such as nursing (Benner, 1984) and fire fighting (Klein, 1998). A more complete picture of how intuition plays a role in the decision process of ski guides and further, how it contributes to feelings of confidence has not been studied. Inferences can be drawn from previous research

conclusions, but my contribution will be to look at a unique environment that is significantly different in numerous aspects. The analysis of decision-making with regards to the impact of the feedback process or lack thereof, on the development expertise and the subsequent use of intuition in this novel environment may provide new and useful insights into give a greater understanding of this phenomenon.

Within in the field of Naturalistic Decision-making and more specifically Recognition Primed Decision-making much has been said about the role of intuition, however there are gaps that demand further exploration. There is disagreement as to the role of the use of heuristics. Some authors equate heuristics with intuition, while others suggest that intuition is a separate process. The role of the ski-guiding environment is of particular interest, as it allows poor decisions to masquerade as good ones, thus it is critically important to understand the role that intuition plays in this decision process.

The use of intuition could be characterized by either good feelings or bad feelings, yet there is little in the literature that explains their relative significance. This research examines the gap between the application of intuitive somatic markers and the development of intuition within the decision process.

If there is an unrecognized flaw in the intuitive response, then the decision process can be compromised. This has been particularly acute when an instability within the snowpack has been deeply buried and has not been recently reactive to slope tests, creating a low probability, high consequence decision challenge. Termed a persistent weak layer, it has been the cause of many of the guiding related fatalities in Western Canada (Klassen, 2008; McClung & Schaerer, 2006).

A shortcoming in the intuitive process may have been due to the nature of the environment in which those intuitions were formed. Hogarth et al. (2008) described how the characteristics of the environment affected how intuitions were formed or learned. These environmental influences determined whether the intuitions were functional (good intuitions) or potentially dysfunctional (bad intuitions). If we knew that our intuitions had been formed under 'wicked' conditions, it would be possible to be more questioning or less trusting of them. For example a ski guide would likely have received immediate relevant feedback when dealing with an easily triggered storm snow instability (a kind environment), however feedback might have

been entirely absent when dealing with a deeply buried persistent weak layer (a wicked environment).

The nature of the environment has potential implications both for the development of intuition as described by Hogarth et al. (2008) and the use or value of intuition in a current decision-making process. Recognising the characteristics of the environment will help to contextualise the value of intuitions formed at that time and may also help to clarify whether or not additional emphasis should be placed on the intuitive response to a current challenge. The role of the environment in the evolution of intuition within the guiding decision process needs more study.

Research needs to be conducted, that accounts for the role of intuition within a culture that values hard facts and reasoning (Adams, 2005; McClung & Schaerer, 2006). The avalanche industry in Canada has developed a rigorous analytical process for snowpack stability assessment and forecasting. The intuitive process, or Kahneman et al.'s (1999) System 1 has not been well understood in a field dominated by excellence in hard science research. A complicating factor is the element of luck or chance, be it good or bad and the ability to separate out true quality decisions from just lucky ones.

Hogarth et al. (2008) suggested that self-insight might be difficult for experts with highly developed skills and that the perspective of an external coach could help to improve intuitive skills. They argued that it would be possible to replace misleading intuitions with correct ones and suggested that people can be trained to reduce their tendency to abandon good decision-making principles.

Ski guiding likely represents the height of decision complexity within the field of adventure leadership, perhaps equivalent to guiding Himalayan peaks above 8000 meters. The research question that I propose has not been extensively studied. My research centres on how guides make decisions to manage risk in an environment that is constantly evolving and provides little feedback when good decisions are made. I argue that there are factors within the challenges of the wilderness ski guiding decision process, which are in need of further study.

Chapter 4 – Research Methodology

4.1 Introduction

This chapter explains the methodological framework that I used to address the research question. I applied the three elements of inquiry as described by Creswell (2003): knowledge claims, methodology which described the underlying principles, and the specific methods, which were used to gather data. The human element of how the researcher sees the world created the lens through which all of these parts were viewed and was addressed first chapter. Allison and Pomeroy (2000) suggested that recognizing the researcher's lens and his or her underlying knowledge base helps to contextualize and generate greater understanding of the research.

The question of whether human actions can be described as a series of patterns that are recognizable and consistent in nature, or whether our universe is ruled by random unconnected behaviours and events is central to the essence of research into human behaviour. If we subscribe to the notion of a chaotic world, then any attempt to generate an understanding of human behaviour is destined to fail (Palys, 1997; Ponterotto, 2005). My research is based on the assumption that an individual's pattern of behaviour can be interpreted and analysed. It may be an inductive fallacy to assume that the observed decision processes of ski guides will follow similar patterns in the future, however to assume otherwise throws into question the rationale for trying to generate understanding of the phenomenon.

4.2 Philosophy of Approach - Theoretical Perspectives

4.2.1 Introduction

The 'philosophy of science' has been defined as the conceptual underpinnings of a systemic quest for knowledge (Ponterotto, 2005). Within this quest are a number of key assumptions about the ontology, epistemology, axiology and methodology. These assumptions are based on our beliefs about reality and how we construct knowledge within that reality (Allison, 2000). This section describes the theoretical perspectives of research, in particular the concept of the research

paradigm, which formed the basis for the philosophical and conceptual context of the study.

4.2.2 Qualitative and Quantitative

It is arguable that the paradigm wars of years past are over and have been replaced by a more open attitude of acceptance (Cherryholmes, 1992; Creswell, 2003). Creswell (2003) suggested that researchers should not feel forced to declare their allegiance to a single paradigm and be restricted in their selection of methods. Tashakkori (1998) advocated the use of a pluralistic approach in the selection of mixed methods, drawing from both quantitative and qualitative strategies of inquiry. Miles and Huberman (1994) summarized this approach with the suggestion that both words and numbers could be used together to generate a more complete understanding of the world.

Palys (1997) struggled with the division of research perspectives into the two distinct camps of quantitative and qualitative traditions, but felt that it was still an adequate description of what was actually happening. He argued that linking the terms positivism and quantitative might not do justice to the current state of research. Ponterotto (2005) described how both quantitative and qualitative methods could be empirical in nature as data were collected, analysed and interpreted in both cases. Table 5 provides a comparison between quantitative and qualitative research strategies. In this table goals, research design, sample selection, data collection methods, and the presentation of findings have been presented.

Table 5 Characteristics of qualitative and quantitative research (Merriam, 1998, p. 9)

	Qualitative	Quantitative
Focus	Quality	Quantity
Philosophical roots	Phenomenology	Positivism
Associated phrases	Fieldwork, ethnographic, naturalistic, grounded, constructivist	Experimental, empirical, statistical
Goals	Understanding, description, discovery, meaning, hypothesis generating	Prediction, control, description, confirmation, hypothesis testing
Design	Flexible, evolving, emergent	Predetermined, structured
Sample	Small, non-random, purposeful	Large, random, representative
Data Collection	Researcher as primary instrument, interviews, observations, documents	Inanimate instruments (scales, tests, surveys, questionnaires, computers)
Mode of analysis	Inductive (by researcher)	Deductive (by statistical methods)
Findings	Comprehensive, holistic, expansive, richly descriptive	Precise, numerical

Denzin and Lincoln described the differences between qualitative and quantitative research.

Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry... In contrast quantitative studies emphasize the measurement and analysis of causal relationships between variables, not processes. (2003a, p. 13)

My research used mixed methods; it blended results from a quantitative study into the development of a qualitative line of inquiry through two further studies. The combination of qualitative and quantitative strategies allowed me to conduct a more in-depth qualitative analysis of possible correlational links that had been indicated by the suggestions of causal relationships in the quantitative analysis.

4.2.3 Elements of a Paradigm

Denzin and Lincoln (2003b) listed four elements which help to describe a paradigm: axiology, epistemology, ontology and methodology. These elements have been described in terms of their application to the predominantly qualitative implications of this research.

Ponterotto (2005) described axiology as being concerned with the researcher's values and how they formed an integral component of the paradigm. These values, or biases had to be described and accommodated both in the acquisition of data and its interpretation. Although these biases needed to be

bracketed, they also provided an opportunity to enhance the level of engagement and interaction between the participant and the researcher.

Denzin and Lincoln (2003b) equated epistemology with the concern for the relationship between what is known and the researcher. This could also be described as the interaction between the nature of knowledge and the researcher's underlying assumptions and values. Epistemology refers to the interaction between the researcher and the participant. In a qualitative study "...reality is socially constructed and, therefore, the dynamic interaction between researcher and participant is central to capturing and describing the 'lived experience' (*Erlebnis*) of the participant" (Ponterotto, 2005, p. 131).

Ontology refers to the nature of reality as it is interpreted (Denzin & Lincoln, 2003a). The positivist view is that there is a singular reality which must be identified and measured (Ponterotto, 2005). Whereas the constructivist position takes the view that reality is subjectively interpreted through the lens of an individual's lived experiences (Ponterotto, 2005)

4.2.3.1 Comparing Paradigms

In the postpositive paradigm a probable cause is linked to an effect or outcome. The scientific method has been described as starting with a theory followed by the collection of data, which when analysed either reinforces the original theory or suggests that changes to the theory are necessary (Creswell, 2003).

This is significantly different from the socially constructed knowledge claim, in which individuals create subjective meaning to what they see and do. As perspectives vary from person to person, the understanding of a phenomenon can increase in its complexity. Thus one of the goals of the constructivist view has been to examine a phenomenon from the participants' vantage points and to obtain and retain as much as possible of their perspectives (Creswell, 2003). Table 6 illustrates the comparison between positivist and constructionist views.

Table 6 Contrasting interpretive paradigms (Denzin & Lincoln, 2003a, p. 34)

Paradigm	Criteria	Form of Theory	Type of Narration
Positivist/ postpositivist	Internal, external validity	Logical-deductive	Scientific report
Constructivist	Trustworthiness, credibility, transferability, confirmability	Substantive-formal	Interpretive case studies, ethnographic fiction

Palys (1997) described how qualitative methods could be used to focus on this unique contextual setting, from the perspective of the individuals fully engaged within that setting. The participants' own words were frequently used to describe the phenomenon. This method was empirical in nature, in that data were collected, analysed and ultimately interpreted. Palys (1997) further argued that when studying human behaviour, an analysis would be incomplete if it did not account for the perceptions of the participants.

A pragmatic approach to research has recognized that the central theme of a problem was more important than the methods by which it was investigated (Bottofff, 1997; Cherryholmes, 1992; Creswell, 2003; Tashakkori, 1998). All manners of methods were considered in the quest for understanding thus giving rise to what has been termed a 'mixed methods' approach. Tashakkori (1998) described 'mixed methods' as the combination of both qualitative and quantitative methods within a single study, drawing on the strengths and potentially offsetting the weaknesses of each.

There is subtlety in the blending of quantitative and qualitative methods and a need to recognize the strong statements made for and against each paradigm. Ponterotto (2005, p. 127) argued strongly against the 'postpositivizing' of qualitative studies, describing it as driving the proverbial round peg into the square hole. The examples he gave included: literature driven semi-structured interviews and the establishment of theme categories before the study.

However Guba and Lincoln (1989) disputed the pragmatic argument stating that there was no need to choose between the positivist and the constructivist paradigms. They argued that the significant differences were at the ontological and

epistemological levels, in that they “...*do not matter* in the day to day conduct of inquiry *because methods and paradigms are independent*”, and that it will likely work well to blend the two (Guba & Lincoln, 1989, p. 157, italics in original). They contended that although the method may just be a tool, the user of the tool must be able to articulate the paradigmatic implications for the way in which the method was used. I recognized the need to address this study of human behaviour from the perspective of the practitioners, yet I felt that the addition of a positivist perspective would contribute to a greater understanding of the issue.

Charmaz (2003) proposed the term ‘grounded theory’ to describe a constructivist perspective that assumed the existence of multiple realities. Ponterotto (2005) expanded on this with idea that these multiple realities were equally valid. In grounded theory, reality was understood through meaning created in the mind of the individual. The meaning was explored through a reflective process initiated by the researcher and based on engagement with the participant. This co-constructed reality was interpreted through interaction. The essence of grounded theory was that it had to be functional and offer possible solutions to real problems (Charmaz, 2003). He suggested that this could be achieved by generating data, which were of high quality and great depth. He termed this: thick, rich data. The data were collected through a variety of methods including direct observations, formal and informal interviews, and reflective journaling. Thick, rich data were highly descriptive and helped to paint an elaborate picture of the phenomenon.

The literature review included the search terms: decision-making, intuition, expertise, confidence, feedback and reflection. In my examination of the literature on empirical research into decision-making from 1975 to the present, the majority of studies were quantitative in nature (Dobbins, Kroll, & Liu, 1998; Einhorn & Hogarth, 1978; Merkle & Van Zandt, 2006; Morrow et al., 2003; Wierzbicki, 1997; Woolhouse & Bayne, 2000). There were far fewer qualitative studies (Herbig, Bussing, & Ewert, 2001; Jensen, Gwyer, Shepard, & Hack, 2000; King, 2002). Haverkamp, Morrow, & Ponterotto (2005) argued that qualitative and mixed methods had been under utilized in psychology research. In addition, Klein (1993) argued that research on experts had rarely been conducted in a dynamic real

environment with changing information, and conditions. More typically it had been conducted in static decision environments.

4.3 Research Plan

4.3.1 Research Strategies

Quantitative research, like photography, excels at producing images characterized by precision. Qualitative research, like portraiture, can offer a glimpse of “what resides beneath.” Both photography and painting require great skill, and both qualify as art; the analogy can be extended to quantitative and qualitative research in that both require skill, and both qualify as science (Haverkamp, Morrow, & Ponterotto, 2005, p. 124).

4.3.1.1 Introduction

Creswell (2003) suggested that there were three criteria for selecting an approach to research: the creation of a good match between the problem and the methodology, the personal experiences of the researcher and the audience that the research is directed towards, with the first criterion being primary. Thorne (199) described the match between the problem and the methodology as the epistemological integrity. Assumptions about the nature of knowledge must be consistent with the methodology of the research process. There needs to be a defensible continuity to the research argument, from the question through to the interpretation of the data. Representative credibility is important in that the discussion of results is consistent with the method in which the phenomenon was studied.

The use of a variety of research methods, also termed triangulation, can generate increased credibility. The basic principle of triangulation is to generate greater understanding through multiple views of the same event or object. However disagreement between findings can lead to confusion in the determination of which finding is the correct one. One solution is to further investigate anomalous views to determine whether they should be given greater or lesser weight. It can also help to generate an audit trail, which would allow other researchers the opportunity to follow the logic of the research. The essence of thick descriptions is to provide sufficient

evidence for the reader to come to the same conclusions as the author (Thorne, 1997).

A pragmatic approach to the methodology and the use of mixed methods allowed me to take advantage of elements of both qualitative and quantitative approaches. The nature of the study of intuition demanded a methodology that encompassed a variety of data sources. This research was predominantly qualitative in nature, however quantitative strategies were added to generate a more complete description-based analysis. The intent was to generate a greater understanding of how experts actually made decisions, not how they should make them. To achieve this goal, the research was both idiographic, in that it focussed on the nature of an individual's response and emic, it used terms that were meaningful to those research participants (Lipshitz, Klein, Orasanu, & Salas, 2001). The idiographic research perspective helped to create a depth of understanding of the complexity of ski guiding and the emic considerations were oriented around the unique behaviours of these individuals (Ponterotto, 2005). It was necessary to generate an understanding of the participants' personal practical knowledge, which Connelly and Clandinin (1988) defined as a person's knowledge base that had been generated through direct practical applications. Vick (2002) suggested that there was merit in the development of research that connected the study of expertise based in personal practical knowledge, with the study of heuristics and biases, which would reduce the current state of speculation.

One of the challenges in presenting a concise description of qualitative research findings is to retain the meaning as described by the participants (Morse, 1997). Phenomenological research has been used to generate an understanding of an experience as perceived by those experiencing it (Cohen, Kahn, & Steeves, 2000). An understanding of the extent to which ski guides are dependent on their expertise to maximize the efficient use of intuition and subsequent feelings of confidence in their decision process has not been generated through mere descriptions of the people involved. It has come through intricate and detailed descriptions and analysis of the attributes of these people (Palys, 1997).

Ponterotto (2005) described the relativist position on the nature of reality, or ontology as being based on the subjective interpretation of a situation. As such there

were multiple possible interpretations based on the participant's perception. Factors such as previous experience, the social context and the degree of engagement between the researcher and the participant, all affected the interpretation of reality. Thick descriptions of the phenomenon could be used to create an interpretation. As there was no single truth to be discovered, other researchers interacting with different participants may not construct the same reality.

This section explores a variety of research strategies in light of the research methods employed in previous related studies. This has created a reference point on which to base the appropriate research methods used in this study.

4.3.1.2 Research methodology in adventure-based decision-making

As described in the literature review, I found four works in human factor snow science related decision-making that were significant to my research. Three were from Western Canada and one from New Zealand. Each of the four researchers used distinctly different methods of collecting and analysing data.

Adams' thesis 'A Systems Approach to Human Factors and Expert Decision-Making within Canadian Avalanche Phenomena' (2005) was the most closely aligned with my research. Adams used an inductive grounded theory approach. Grounded theory methods are based on a systematic collection and analysis of data and use an inductive process to generate theory (Charmaz, 2003). This approach was needed as little empirical research had been conducted that addressed the issue of expert decision-making in the avalanche field. The phenomenon had not been well explored or explained by the existing research base.

A qualitative, semi-structured survey was used to initially invite and pre-screen participants. Two focus groups of nine avalanche experts were then formed. Each group met for a three-hour session. From a methodological perspective the two focus groups provided the richest data. This direct interaction with avalanche professionals allowed researchers to gain access to the knowledge and expertise of their participants at a more personal level. The participants were willing to actively engage in the research process. Adam's participants reflected on their many years of experience to provide answers to the focus group questions. My intent is to conduct

interviews much sooner after a significant event, ideally within thirty days of any significant event.

Adams provided a number of recommendations for future research, including the development of an approach that focussed on the good decisions that participants had made. She suggested that this strength-based approach to the examination of avalanche decision-making would provide greater understanding of the phenomenon. She also suggested that there would be benefit to an analysis of human factors influences in accidents and narrow escapes. These recommendations formed the basis for my research.

Davidson (2005) developed a process for the analysis of factors which contributed to accidents. His causal factor analysis results contributed to our understanding of how accidents occur and helped to form many of the questions in my near-miss survey. Davidson used a quantitative analysis of existing historical data to generate a sample of eighteen incidents. These incidents were further analysed qualitatively using a 'Delphi panel' of outdoor adventure experts.

The Delphi technique was developed during the cold war era as a tool for anticipating future US defence requirements and forecasting the implications of new technology. It is now widely used as a research technique when multiple expert opinions are desirable, but gathering a group of experts is logistically not possible (Pollard & Pollard, 2004). The Delphi process incorporated feedback from the involved instructor after the first round analysis from the group of experts. In Davidson's study, the feedback from the instructor was in many cases defensive in nature. The Delphi panel of experts learned and changed through the successive iterations, with more emphasis placed on instructor error in early incidents and not as much on management system error. Each expert member of the panel analysed six incidents, which was enough to learn the process and yet not be too overwhelming.

The Delphi process is a powerful tool and is particularly well suited to the analysis of negative outcome incidents. However it is also somewhat cumbersome and had limited potential for my study due to the need to assimilate data from decisions generated over numerous field days.

According to Grímsdóttir(Grímsdóttir & McClung, 2006) (2004), expert ski guides had difficulty describing how they make high quality decisions on a

consistent basis. Grímsdóttir's mixed methods study began with a quantitative risk-based analysis of skier triggered avalanches using reports compiled by the CMH software program – Snowbase, focussing on the terrain selected and the associated snowpack stability rating for that day. Recognizing that a statistical study alone would not provide a complete picture of avalanche terrain risk management, the second part of her study used a structured questionnaire and interviews with guides to generate further understanding of the decision process. The questionnaire and interview focussed on the role of terrain selection and group management as tools to mitigate risk. The interview was conducted using photographs of heli-ski runs to generate a hypothetical situation. Some of the pictures were of runs that had been skied that day, while others were runs that had not been used but were still within the operation and familiar to the guides. The guides were asked to discuss their terrain selection choices based either on the actual stability of the day or on a hypothetical stability rating.

The final component of triangulation in her study was direct observation with the intent of creating context for her as a researcher. In the analysis of interview and direct observation data, she identified lack of feedback as being a critical impediment in the development of ski guiding expertise. One of the participants suggested asking the question “How many times have I been somewhere I shouldn't have been, but I didn't get the evidence to tell me I shouldn't have been there?” (Grímsdóttir, 2004, p. 134). She also suggested that getting the guides to tell stories about their toughest decisions was a potential avenue for research into the perspective of the guide. The mixed methods used in this study created a somewhat complete picture of how observed and expressed terrain selection compared with the recorded avalanche incidents database.

Hägeli et al (2006) have developed an Advanced Decision Framework for Amateur Recreationists (ADFAR). The initial outcome from this work was a decision tool named the ‘Avaluator’, which is now into its second iteration. In a study of existing decision tools, McCammon and Hägeli (2005) evaluated the applicability of European rule-based models to North American conditions. They found that a simple checklist was a promising area for future development. Longland, Haider, Hägeli and Breadmore (2006) argued that a rule-based decision

system was preferable for recreationists as they generally did not have the expertise to use a knowledge-based method. Although aimed at the amateur user, a component of their study focussed on the strategies employed by professionals. This helped to clarify the significant differences in the decision processes of amateur and professional avalanche terrain users, in particular the role that intuition potentially plays.

In a somewhat less related, non-adventure based study, Regehr, Goldberg, & Hughes (2002) used mixed methods for their data collection of post-event stress in paramedics. To collect quantitative data, they used a number of Likert-type scales including the 'Impact of Events' scale developed by Zilberg, Weiss, and Horowitz (1982). For the qualitative data collection, they used a convenience sample selected from volunteers that came from the quantitative participant group. These participants were offered the opportunity to explore their experiences more fully through a semi-structured interview process. Purposeful sampling was used to select a wide range of participants with varying levels of experiences and length of service.

Post-event, paramedics reported that they reviewed their performance with their peer group to ensure that all actions had been performed correctly. This cognitive strategy focused on the technical aspects of the performance. Thus, each event had the potential to be reframed as a positive learning experience. Even though respondents recognized the importance of sharing their experiences, the 'macho attitude' that prevailed, limited discussion of the underlying fears and concerns.

A mixed methods approach was employed successfully in three of these studies. A quantitative analysis was used in the initial stage to either select promising cases or to frame the context for which a more in depth qualitative analysis could be conducted. This approach seems to have worked well for the challenge of generating greater understanding of the decision process in adventure leadership.

4.3.2 Research Methods

Merriam suggests that "rigor in a qualitative research derives from the researcher's presence, the nature of the interaction between researcher and

participants, the triangulation of data, the interpretation of perceptions, and rich, thick description” (1998, p. 151).

4.3.2.1 Introduction

I used mixed methods in my research as it allowed me to use of a variety of methods to generate greater understanding of the phenomenon by looking at it from a variety of angles and using a variety of tools (Denzin & Lincoln, 2003a). I examined two distinct perspectives of the decision – outcome interaction. Both perspectives focused on good outcomes, as participants were more open and forthcoming when it came to discussing the details of such events.

I analysed days when nothing bad happened, termed good days, and days when near misses occurred. The analysis of good days was based on the assumption that as nothing bad had happened, the decision process could be considered good. The intent of this analysis was to extract the good qualities of the decision process. The analysis of near miss events was based on the premise that there was a flaw or shortcoming in the decision process, which could have led to a disastrous outcome. The intent of this analysis was to learn from mistakes. The criteria that I used to denote a near-miss occurrence was indicated either through environmental feedback, for example an accidentally skier triggered avalanche with no involvement, or through retrospective analysis by the guide, guests or fellow guides.

There were both opportunities and limitations inherent within the environment that I studied. I attempted to capitalize on the opportunities and minimize the impact of the limitations. Recognizing that one of the prime limitations was the time constraint that ski guides experienced, data collection was optimized to create a balance of maximum research gain and minimum impact on the guides and guiding operations.

4.3.2.2 Study Population

In 2008, the entire population of active, certified, mountain and ski guides in Canada was approximately 350. This included members from both the Association of Canadian Mountain Guides (ACMG) and the Canadian Ski Guides Association (CSGA). There were 216 Association of Canadian Mountain Guides (ACMG) certified guides, 128 of them were mountain guides and the other 88 were ski guides

(ACMG, 2007). An analysis of the 2010 ACMG membership indicated that 65% had earned their assistant guide certification prior to 2000. According to Ericsson's definition they could potentially qualify to be considered experts (1996). The gender mix may or may not have been relevant to this research, however 11% of the ski guides and 6.5% of the mountain guides were female. The primary goal of this study was not to investigate gender differences in decision strategies. There were roughly another 130 active members of the Canadian Ski Guides Association (CSGA), twenty-three of whom were Level 3 Guides (CSGA, 2007). This is the highest level within the CSGA certification process and most would qualify as ten-year plus veterans.

4.3.2.2.1 Sample Selection

Merriam (1998) described several ways of choosing a sample population. Termed purposeful sampling, I used three of the suggested methods: maximum variation, convenience, and network. The main criterion was to achieve maximum variation; however in addition there was a certain amount of convenience and networking in the sample selection. To realize this goal, I selected participants from a wide variety of work environments, including both large and small heli-ski operations and two cat-ski operations. The participants came from both Canadian guide certification schemes.

Patton (2002) argued that there were no rules for sample size in qualitative research. My intent was to recruit fifty participants, from the combined memberships of the ACMG and the CSGA for the following reasons (Long, 2007).

1. Logistics – This was the maximum number of participants that I could accommodate in the research design. I needed to be able to review their survey contributions and then conduct interviews.
 - a. The participants worked in small groups. Thus more than one participant was interviewed in a single onsite visit.
 - b. I was able to visit the seven participating operations multiple times over the two seasons of data collection.
2. Richness of data

- a. The number of participants was small enough to ensure high quality engagement and the collection of rich data. Given a finite amount of researcher time, I could spend more time with fewer participants thus generating greater rapport with the participants.

It was very difficult to select a random probability sample for this study. The purposeful sampling that I used facilitated the exploration of the relationship between the participant and the phenomenon. Although I cared about the greater implications of the study, the intent of the research was to study a specific group of guides in Western Canada. The two threads of guiding and avalanche terrain provided some degree of generalizability to the global population of 6000 IFMGA certified guides in 23 countries.

I used the following attributes or criteria to help identify information-rich participants (Merriam, 1998):

1. Certified guide (ACMG, CSGA, IFMGA)
2. Worked in the mechanized ski industry for at least 3 years
3. Ten years experience as a ski guide
4. Engaged in deliberate practice as per ACMG and CAA CPD requirements

I ended up with potentially thirty participants with which to conduct more in-depth interviews. This fit with Kvale's (1996) suggestion that a good number of interview participants was fifteen, plus or minus ten, with the emphasis placed on the importance of quality rather than quantity. Ponterotto (2005) supported this notion of thick, high quality description rather than a larger number of lower quality descriptions. I aimed on the slightly on the high side as I anticipated there might be an element of attrition (Shadish, 2002). I worked hard to maintain high quality interactions with all participants in the hope of reducing or eliminating attrition. The prime consideration was to sample to the point of saturation, when no significant new information was coming in (Guba & Lincoln, 1989; Merriam, 1998)

During the period from September 2007 to May 2008, I actively recruited participants at the corporate and individual levels within the guiding community. The results of this recruitment were that seven companies indicated they would participate in the study. I was invited to present at annual pre-season training

sessions and to solicit individual guides. The participating companies were: Canadian Mountain Holidays, Coast Range Heli-skiing, Mike Wiegele Heli-skiing, Selkirk Tangiers Heli-skiing, Eagle Pass Heli-skiing, White Grizzly Snowcat Skiing and Selkirk Wilderness Skiing. Guides from two operational nodes of Canadian Mountain Holidays participated. To achieve my target of thirty participants, I needed an average of four participants from each company.

4.3.2.2.1.1 Sample Population Demographics

The 30 participants all worked for heli-ski or snowcat-ski operations in British Columbia during the period of November 2008 to March 2011. There was a range of length and intensity of employment. Some worked long, full-time seasons (20+ weeks), while others worked part-time and, or shorter seasons. The sample population statistics are reported in Chapter 5.

The average age was 40 (SD = 7.8), with a range of 26 to 58. There were twenty-six male participants and four female participants, which was similar to the ratio observed in the guiding community more generally.

4.3.2.2.1.2 Operations

Although the participants primarily worked at seven different companies (five heli-ski, two snowcat), some of the participants worked at multiple operations. The seven primary locations included: two small, one medium and two large heli-ski operations, and two medium sized cat operations. The profile of the sample selection was similar to the profile of the heli and snowcat industry. The participants came from all sectors (Heli and Cat; large and small). They represented a cross section of the British Columbia mechanized ski industry (HeliCat-Canada, 2008).

4.3.2.2.1.3 The Training and Certification of Expertise

Participating guides were trained and certified by one or both of the Canadian guiding associations, the Association of Canadian Mountain Guides (ACMG) and the Canadian Ski Guides Association (CSGA). These two certification programs were described in detail in Chapter 2. As each certifying process was linked to a specific experience building process, there was a variety of expertise generated. Guides from the two associations worked together at many, but certainly not all of

the mechanized ski operators. Within my participant group, there were six IFMGA guides, nine ACMG Ski guides and six CSGA Level 3 guides. Twenty-three participants had completed the CAA Level 2 certification. Additionally there were seven ACMG assistant ski guides and two CSGA level 2 guides. During the period of this study some of those assistant guides and level 2 guides completed the next levels of certification.

4.3.2.3 Strategies for Data Collection

4.3.2.3.1 Introduction

Palys (1997) described the person-to-person exchange of information as a fundamental process of social science research. There are numerous, commonly used, interactive data collection methods; the two most frequently used are surveys and interviews. These methods are versatile and provide direct responses from the participants. Palys described three components of these methods of data collection. The researcher needed to begin by establishing an ethical context that promoted honest and comprehensive responses. The questions needed to be designed carefully so that they provoked a reflective response. Finally, the greatest challenge for the researcher was to generate understanding of the participants' responses. This section describes the data collection methods that were used.

4.3.2.3.2 Self-Reporting

Self-reporting, or introspective self-evaluations have been widely used in social science research however there are a number of recognized limitations (Bray, Huffman, & Fletcher, 1999). Nisbett and Wilson (1977) went as far as to discredit the process of introspection as a valid data collection method. They supported the notion that although verbal self-reports might provide interesting information, they should not be used as the sole or core data on which analysis was based. They suggested that people have difficulty accurately reporting the existence of certain stimuli and, or their responses to those stimuli. A number of authors have countered Nisbett and Wilson's argument, and suggested that verbal reports can be used and that strategies can be employed to produce valid data (Ericsson & Simon, 1980; Smith & Miller, 1978; White, 1980). Data legitimacy would depend on the

perceptions of the participants and the self-reporting strategies employed (Bray, Huffman, & Fletcher, 1999). Wright, Rowe and Bolger (1994) found that a self-assessment of expertise correlated positively with forecasting performance.

Self-reporting or verbalization has been reported to occur either concurrently or retrospectively (Ericsson & Simon, 1980). A concurrent 'think aloud' strategy was good for verbalizing thought processes that were occurring in short term memory. This can be useful during direct observation. However, verbalizing of the task may cause considerable overload on the participants during some complex tasks. Although verbalizing the degree to which intuition was used in the decision process was subordinate to the actual task of safely conducting a ski group through avalanche terrain, it would seem to be a simple description of what actually happened. However verbalization of expert intuition may be difficult, as it may not be occurring at a conscious level (Ericsson & Simon, 1980). Asking expert ski guides to verbalize their intuitive thought processes during stressful ski descents could potentially slow down the decision-making process and endanger lives.

A retrospective verbalization is the description of a task that occurred earlier. Retrospective verbalizations held promise for this research as the context could be specified within the questions to help the respondent focus and retrieve more in-depth information from memory (Ericsson & Simon, 1980). The question style could either provide a list of potential answers or be open to all available information. The challenge when a fixed set of potential answers was provided was that they needed to reflect the possible answer range from the participant's perspective. If the list of potential answers did not include a participant's preferred choice, a second best answer could be used. Typically the researcher might not even know that the answer was the participant's second choice. Open questions provided more opportunity for participants to accurately describe their answers.

Ericsson and Simon (1980) suggested that there were a number of criteria which would increase the extent to which a retrospective self-report corresponded to actual events.

1. The self-report was generated relatively soon after the event had occurred.
2. The recording procedure was user friendly and was not time consuming.
3. The information to be recorded was accessible at a conscious level.

Smith and Miller (1978) suggested that the issue was less about whether participants had retrospective access to their decision processes, and more about the conditions under which they were best retrieved. Although there might have been an element of reactivity, in that the process of generating a self-report actually influenced the content of the report (Nisbett & Wilson, 1977), strategies were employed to reduce the level of reactivity by choosing a time for reporting that did not conflict with other cognitive processing tasks (White, 1980).

Participants were asked to provide retrospective reports of both good days and near-miss events. Good days were to be selected based on the outcome and the overall challenge of the day. The preference was to gather reports from days that provided difficult decision-making and had good outcomes. The near-miss events were more obvious to report on. Participants were asked to complete the reports as soon as possible after the completion of the day to avoid the degradation of the perceptions of events over time. Memories of negative or painful events resulting from poor decisions are likely to diminish with the passage of time (Soman, 2003).

4.3.2.3.3 Questionnaires

The goal of this research was to capture reflective information as soon after an event as possible (Soman, 2003), however I could not be with every participant at the end of every day. This necessitated the use of a self-administered questionnaire to prompt the participants to reflect on critical areas of interest to the study. Palys (1997) suggested that direct contact between the researcher and the participant would positively affect response rates on questionnaires. The pre-season meeting with the participants allowed me to brief them on the process and collect feedback from them. The questionnaire facilitated the collection of information much like a diary, and formed the basis for an interview. Participants generated an entry at the end of each 'interesting' day, the criteria for which were: a challenging environment, with minimal or misleading feedback, and the potential for major consequences. These descriptions were given to the participants with the freedom to interpret them and choose the reporting days. As the predictability of the avalanche hazard was constantly changing, there were periods when few questionnaires were completed and periods when questionnaires were completed every day.

I maximized the advantages as described by Palys (Table 7) by providing a reporting structure that allowed the participants an element of privacy. I was the only person who was able to link a participant with a completed questionnaire, which was the basis for the interview process. This also helped to overcome some of the limitations by clarifying ambiguities and ensuring that questions were interpreted correctly.

Table 7 Advantages and disadvantages of questionnaires (Palys, 1997, p.148)

All Types of Questionnaires	Self-Administered Questionnaires
Advantages / Strengths	Advantages / Strengths
Good way to amass a lot of data quickly	If researcher is there, can respond to questions and clarify ambiguities
Relatively inexpensive	Respondent can answer in privacy
Structured questions make for easier data coding	Good for sensitive issues where anonymity is provided
Disadvantages / Limitations	Disadvantages / Limitations
Researcher's data are limited to what is on the paper	Researcher, if not present, cannot clarify ambiguities
Vocabulary must be appropriate	Misinterpreted questions and non-responses not caught until too late

The questionnaires were administered through the web-based survey tool SurveyMonkey. This tool allowed participants direct access to the survey instrument whenever they had web access. I was able to view the surveys as they were completed.

4.3.2.3.4 Interviews

Kvale described the interview process as a “construction site of knowledge” (1996, p. 2). He used the metaphor of the interviewer as a miner of information and knowledge and as a traveller through the experiences of the participants. He suggested that the research interview should be characterized by a methodological awareness of the formation of the questions, a focus on the dynamic interaction between the researcher and the participant, and detail-oriented, critical attention to

not only the words used, but also the message contained within the words.

Through the use of open-ended questions the researcher could adapt to the responses of the participants and elicit more in-depth answers while retaining control over the process (Creswell, 2003). However interviewers must be wary of the influence they exert, as there could be the potential to alter both the content and the context of the participant's input (Reed, Patton, & Gold, 1993). Although interviews can range from a highly structured series of questions, much like a verbal questionnaire, to a completely unstructured chat, it behoves the researcher to have a thread which binds the process together and creates a connection between what the participant says and what the researcher wants to learn (Long, 2007).

In my extensive experience conducting interviews and debriefing sessions initially as an Outward Bound Instructor and more recently as an examiner for the Association of Canadian Mountain Guides, capturing the subtlety of the message required intense concentration on the part of the interviewer. A recording of the interview, either video or audio, allowed the interviewer to review the interaction multiple times to ensure that nothing was missed.

Kvale (1996) described seven important stages in the design and implementation of the interview process. The first stage was the creation of a theme that the interview will follow. The rest of the process is hung on this framework. The second component was the design and was dependent on the intended knowledge gain. The amount of detail may vary, but some sort of schedule of key topics or issues was desirable (Long, 2007). The actual interview itself required the researcher to create an environment that encouraged the participant to become fully engaged. Formulations that describe the impact of the dialogue on either the participant or the researcher can be used to clarify statements that are cryptic or misunderstood (Patton, 1984). Once the interview was completed it needed to be transcribed, analysed, verified and reported. These steps have been discussed later in a larger context.

Kvale (1996) and Long (2007) suggested a number of strategies and examples for the types of questions to use at various points through an interview.

1. Introduce the topic and get started - "Can you tell me about...?"
2. Begin with description and build into reflection, introspection and analysis

3. Elicit a follow-up to a question – “Is there anything more...?”
4. Specify or probe – What did you think then? Why?
5. Lead from one question to the next – “OK let’s move on”.
6. The importance of silence – Give the participant sufficient wait time.
7. Interpret and reflect an understanding – “So you mean... What I hear you say...?”

While the self-report questionnaires formed the basis for the interview, it was the interview itself, which formed the mainstay of my research methods. It allowed me to clarify information from the questionnaires and brought together information from a number of daily reports. The synthesis of individual reports helped to generate a more complete understanding of how intuition was used.

4.3.2.3.5 Direct Observation

Observation is methods by which researchers can watch phenomena unfold. The researcher either acts as a participant within the study group, or as an outsider not fully engaged in the activity (Drew, Hardman, & Hosp, 2008).

The advantages of observation included:

1. Full immersion in the process increased the depth of understanding.
2. There was increased access to the cultural patterns that explained the participants’ sense of their own behaviours.
3. The observer also interviewed the participants.
4. Less time was needed to distinguish common events from unusual events.

The disadvantages of observation included:

1. There could have been a tendency to focus on frequently occurring events.
2. There was the potential for sampling bias.
3. There could have been some loss of objectivity.
4. There could have been a temptation to accept others’ explanations too readily.

(Drew, Hardman, & Hosp, 2008, p. 197)

Direct observation was one of the strategies that I used to overcome the limitations of self-reporting. This allowed me to actually be present as decisions unfolded and not be completely dependent on the participants’ interpretation of

events (Long, 2007). As mentioned in the self-reporting section, a participant's report could be coloured by their needs and wants, and when in doubt, could be used to portray them in a more favourable light. It was entirely possible that a participant was oblivious to the subtleties of their decision process. Although I was a participant observer my presence alone could have caused the participants to change their behaviour in some way (Veal, 2006). However, the participants were all somewhat familiar with having someone watching them. They had all completed multiple guiding exams in which an examiner was not only observing their behaviour, but also grading them on it. My presence was much less intrusive and intimidating. In the larger ski groups of twelve skiers, I could blend into the background and become just another guest. I had the benefit of not having to make the actual decision, but retained the luxury of second guessing it. It provided me with the opportunity to ask questions about the process of how the participant got there. I was more interested in the process than the actual decision. In the end however, direct observation was not extensively used due to time constraints.

4.3.2.3.6 Cognitive Task Analysis

Task analysis is defined as a study of what a person is meant to do (Schraagen, 2006). The follow-on question is how do they achieve the task they are meant to do. From a research perspective, task analysis is an applied strategy where real job tasks are investigated. With the advent of computer technology and a developing interest in expert systems, the focus became more on the cognitive aspect of task analysis. As such it can be used to help generate a more complete understanding of expert decision-making.

Cognitive Task Analysis (CTA) is an extension of task analysis, primarily focussed on the decision process that forms the basis for observable actions (Schraagen, Chipman, & Shalin, 2009). CTA attempts to capture how decisions are made in NDM settings (Gordon & Gill, 1997). The analysis is focussed on the knowledge and ways of processing that are used by experts. CTA goes beyond simple task analysis and is useful when complex problems push the decision maker.

Although CTA is not well defined (Gordon & Gill, 1997), many elements can be examined including: pattern recognition, mental models, challenges in the development of domain specific knowledge, and instructional methods in the transition from novice to expert. The intent is to use enough of the above strategies to form a theory or model of expert decision-making in a specific domain.

CTA takes a great deal of time and effort and is therefore expensive. It is most appropriate when the task is complex and not easy to learn, is dynamic with high levels of uncertainty, and requires the decision maker to multi-task. CTA includes a broad range of different techniques including: direct observation, interviews and reports. CTA is a cognitive analysis tool. The primary applications of CTA are as an instructional design tool, or in the design of an expert system. There are three key stages to CTA: extract the knowledge, analyse the knowledge for meaning, and finally communicate that meaning (Yates & Feldon, 2011).

Militello (Militello, Hutton, Pliske, Knight, & Klein, 1997; Militello & Hutton, 1998) suggested that CTA had become too sophisticated and consequently required tremendous resources, time in particular, so they developed a user-friendlier version of CTA. Termed Applied Cognitive Task Analysis (ACTA), it was designed as part of a US Navy project. There are three components to ACTA: the task diagram, a knowledge audit, and a simulation interview. The task diagram interview provides an overview of the task and illuminates the key cognitive challenges. The task is broken down into three to six smaller chunks or sections. The knowledge audit investigates the nature of the expertise need to solve the task, particularly diagnosis, situational awareness, improvisation, and recognition of anomalies. The simulation interview investigates the cognitive process of the expert. The primary focus is the identification of how to deal with high consequence environments.

1. Present a scenario (vignette). This can be picture, video, or diagram.

It may require a CTA to design a challenging scenario

2. Semi-structured interview questions. How would you think and act in this situation? Situation assessment, key indicators, actions, possible pitfalls.
3. Develop a cognitive demands table

No metric has been developed to assess the validity and reliability of ACTA

There are many different forms or methods of CTA, with over 100 variations identified in the literature (Yates & Feldon, 2011). There is little structure in the selection of any particular CTA method other than attempting to craft a good match between the method and the specific research environment. The top five most commonly used CTA elicitation techniques were: Think Aloud, Semi-structured Interview, Document Analysis, Structured Interview, and Critical Decision.

Klein et al. (1989) described the Critical Decision Method (CDM) as a way to model expert decision-making under conditions of high variability, time pressure and large volumes of information. The context of the CDM was from within Recognition-Primed decision-making (RPD). CDM operates under the assumption that a greater level of expertise is needed to solve non-routine challenges. The intent of the strategy was to extract information from the decision maker, particularly when the decision maker is cognitively unaware of all the elements that contributed to a decision. Klein et al. (1989) applied this strategy in an attempt to generate greater understanding of the content knowledge of experts and how that contributed to decisions. There are three key stages: extract the knowledge, analyse the knowledge for meaning, and finally communicate that meaning.

In the CDM, experts are asked to think of a critical event and how they managed it (Klein et al., 1989). The researcher facilitates the process by supplying probing questions that help the expert to explore the critical elements. The CDM is based on a retrospective interview of an expert on a specific incident. The expert is probed for retrospective thoughts on how the situation was addressed. Typically the incident involves non-routine events. Incidents are selected on the basis that the environment is challenging and the decisions are not simple. Near-misses provide fertile ground for CDM interviews. Semi-structured probing pushes the decision maker to reflect on the event while still allowing the participant to be engaged in a stimulating dialogue. The probing centres on the development of the decision point, specifically the elements of prior knowledge, situational awareness and pattern recognition. CDM has often been used as a way of extracting and analysing expert decision strategies with the intent of developing a way to train less skilled decision

makers. Although one of the limitations of this method is that with self-reports, participants can misrepresent their actions, CDM is one of the CTA techniques that has the greatest level of formal and specific methodology (Yates & Feldon, 2011).

4.3.2.4 Components of Data Collection

There were both concurrent and sequential elements to the data collection (Creswell, 2003). A quantitative analysis of the formation of intuition due to environmental factors as described by Hogarth (2008) ran concurrently with the largely qualitative analysis of the use of intuition (Figure 9). Each participant's expertise profile was established through a questionnaire at the beginning of the season when they committed to the contribution of field data.

There were four components to the qualitative data collection:

1. A good decision questionnaire
2. A near-miss questionnaire
3. An interview process, which allowed for the collation and summarization of the accumulated good decision questionnaires and near-miss questionnaires.
4. Direct observation

Weightings were allocated foremost to the interview data, as they were a summary of the questionnaire data. When the four components led in the same direction, the relative weightings were less critical. However anomalous indicators had great weight as they promoted further inquiry and were addressed in the final round of interviews.

Methods Summary

- 1) Expertise – Background experience profile
 - Web-based
 - Quantitative analysis
- 2) Decision-making – Event reports
 - Web-based
 - Good days and near miss
 - Quantitative and qualitative analysis
- 3) Decision-making event report interview
 - Face-to-face or phone

Semi-structured interview questions

4) Decision-making interview (post season)

Face-to-face

Vignette – based on Cognitive Task Analysis

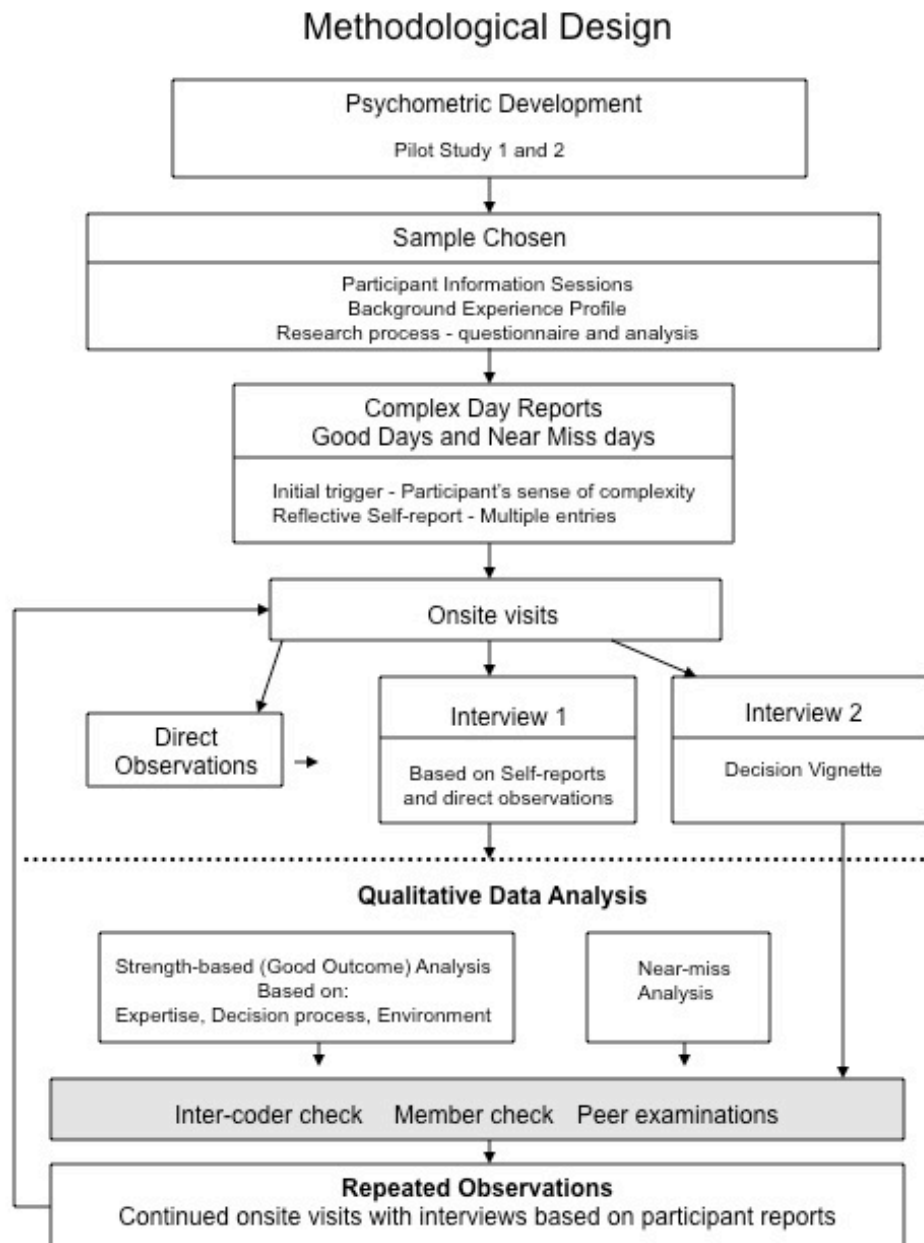
A variation of Critical Decision Method

Moved to semi-structured interview questions

I adapted the interview (to CDM)

Captured data in the form of stories

Figure 9 Methodological design used in the study



4.3.2.4.1 Formation of intuition data

The development of intuition has been characterized as a long term process dependent on accumulated individual days and seasons (Hogarth et al., 2008). The InfoEx database, as described in Chapter 2, was sufficiently well developed that I could extract the characteristics of the environment for any combination of time frame and geographic region. The data could also be linked over numerous seasons. This information was used to develop a picture of the nature of the environment in which the participants had developed their intuition (Appendix 2). The consequence and feedback received while operating in an immediate dynamic environment form the basis for the development of patterns (Einhorn & Hogarth, 1978; Hogarth et al., 1991, 2008; Hogarth, 2001). Patterns formed under wicked environments may produce suspect patterns. It is only when these patterns are recognized and acted upon in the future that the possible negative implications may play out. The decision process will be flawed due to the recognition of a flawed pattern formed under wicked conditions.

For the last 10 years, the InfoEx has recorded sufficient breadth and depth of data to generate a categorization of the nature of the environment. This included both the frequency and quality of the environmental feedback, and the consequences of potential errors. This was done for the two seasons of data collection and the preceding year.

Avalanche observations provided the greatest insight into the characteristics of the complexity of the decision environment. Both the quality of feedback and the consequence of errors were mined from this data. The quality of feedback data came from the frequency of avalanches observed, combined with the ease and type of triggering. The consequences of errors were detectable through the depth of the fracture plane and the size of the avalanche. The indication of the percentage of terrain observed contributed to a level of reliability. The comments section provided insight into the decision process. All of the above data was then linked to the Stability Assessment section, which provided a general assessment of the snowpack stability for three elevation bands (Alpine, Treeline, Below Treeline) using the terms: Very Good, Good, Fair, Poor, and Very Poor.

4.3.2.4.2 Expertise data

The data collection process for the establishment of expertise accommodated a description of the depth and breadth of the participants' experience and how that experience has led to the development of expertise. This was achieved initially through a questionnaire with follow-up questions in an interview. The data collection process was explained to the participants and base line information relating to expertise was collected. The questionnaires were piloted twice prior to implementation. The first pilot study was conducted in 2006-2007 with some of the instructional staff at Glenmore Lodge. The second pilot study was conducted in 2007-2008 with a small group of heli-ski guides.

Previous research studies have generated a variety of criteria to calculate or estimate expertise, with no definitive method gaining wide acceptance (Ericsson & Charness, 1994; Ericsson, 1996; Galloway, 2005a, 2007; Patel, Kaufman, Magder, & Ericsson, 1996; Starkes & Ericsson, 2003). The challenge has been to extract enough high quality parameters to generate a good picture of expertise. Most researchers of deliberate practice have depended on self-reported retrospective accounts of the frequency, type and duration of practice sessions. Even diaries have not proved to be accurate reflections of how practices have been structured.

A balance between simple and complex methods might provide a practical, yet relatively accurate solution. Adams (2007) used a simple measure of years of professional experience as her determinant of expertise. However, a simple inference from the years of experience might lead to a flawed assumption of expertise, as the years may be lacking in learning opportunities. An overly complex index may suffer from the introduction of more numerous small errors due to inadequate record keeping and flawed memories. In response to this challenge, I chose a relatively small number of factors, each of which had an increased likelihood of accuracy.

I employed both objective and subjective criteria to assess each participant's level of expertise. The key criteria were: certification level, years of work experience, breadth of work experience, time spent engaging in continued professional development (CPD), and a self-rating of expertise. The participants had recorded information on certification, years of work experience and participation in

CPD as a requirement of professional membership in the Canadian Avalanche Association. In contrast to Galloway's (2005) sample population of Outward Bound instructors, the sample population of ski guides was generally highly experienced with only two participants with less than ten years of experience in avalanche terrain. Galloway's group included the full range of experience levels from interns to course directors.

The number of different operations that the participant had worked at was easily calculated and gave an indication of the breadth of work experience. The questions, which asked the participants to rate themselves as to expertise, required an introspective analysis by the participants. These subjective measures of expertise provided additional insight into how and why expertise might influence decision-making. Although these factors were not all the factors that could and have been used to determine expertise, e.g. populations worked with and levels of education, they represented a grouping that provided a broad picture of the participants' levels of expertise.

4.3.2.4.3 Decision data

The collection of good decision and near-miss data was initiated with a questionnaire and followed by interviews. During the season, guides had access to a short questionnaire, which focused on generating a reflective analysis of the day's good decisions. The questionnaire was available on the web and in paper form. A sample has been included in Appendix 3. Participants were asked to fill out this form on the days when the decision-making was particularly challenging and yet the outcome was still good. The completion of the questionnaire on a particular day was like a diary entry.

Once per season, I visited each operation to collect and discuss completed questionnaires (diary entries). Some of the interviews were conducted by phone due to the logistical complexity of meeting face-to-face. I conducted interviews in an iterative process, each interview building on the last and the intervening events, as learning likely occurred for both the participant and the researcher as the season(s) progressed (Palys, 1997). Thus there was an opportunity to explore issues to a

greater depth later in the season and in the second season. I was able to expand upon the questions as a cycle of successive interviews took place.

The first interview (in Study 2) was based on CDM strategies, but was expanded to use both near-miss and good day reports as both were challenging decision environments. Sosniak (2006) describes this as tough, or challenging case analysis. Adams (2007) used the principles of CTA and CDM as the basis of her analysis of the 47 critical incident decision-making summaries (CIDS) described by her participants.

The web-based incident reports provided the starting point for the interviews. Participants were asked to describe the events in detail. The semi-structured questions provided a standardized set of probes and thus an increase in reliability. The probing focussed on how the participant's decision process evolved, with particular emphasis on situational awareness and pattern recognition.

The key questions that provided insight into the participants' decision processes were:

1. The Type of Decision Response
 - a. Did you go with your initial intuitive response or were you more analytical?
 - b. If there was an element of intuition in the decision, rate the intuition in terms of strength and whether it promoted feelings to do something (Positive or good feeling), or to avoid doing something (Negative or bad feeling).
2. Confidence
 - a. Describe how confident you were in your decision(s) prior to committing to a course of action and at the end of the day.
3. Feedback
 - a. Reflect on the quality and quantity of feedback you received about your decisions. Feedback could be from the environment, fellow guides, or guests.

The questions were tested in two pilot studies, during the winter of 2006-2007 with Glenmore Lodge staff and the winter of 2007-2008 with Canadian ski guides.

The web-based near-miss reporting questionnaire had similar questions to the good day questionnaire, relating to the use of intuition in the decision process. This questionnaire was of particular significance when guides had a near-miss that offered a good learning opportunity for other guides. The structure of the web-based reporting offered an opportunity to contribute while remaining anonymous.

The second interview (Study 3) was initiated with a decision vignette due to the time interval separation from the decision environment. The vignette proved to be unnecessary as participants were still cognitively engaged with the previous season's challenges. This is supported by Klein et al.'s (1989) suggestion that artificial vignettes take too long to prepare and do not provide a sufficiently sophisticated and rich description of the context.

Although the second round of interviews was designed using a CDM framework, the structured confines of the decision vignette limited the range of possible answers. The CDM framework was opened up to allow for a broader exploration of the participants' perceptions of events.

CTA and CDM help to capture the essence of the expert's knowledge. This can be difficult, as the expert often cannot articulate what is known. Methods include 'talk aloud' exercises that facilitate the expert's articulation of what is going on in his head. The reality of a true task environment can help the expert to articulate what is happening (Gordon & Gill, 1997). CTA may work to determine *what* is the expert's knowledge. Does it also help to describe *how* the expert is able to use previous knowledge in the solving of a new task?

Second Interview Scenarios

Rationale:

The intent of the second round of interviews was to clarify my understanding of the participants' use of the terms intuitive and analytical. Specifically, when they said that a decision response was a mix of intuitive and analytical, what did that

really mean? Were they using both strategies? If so were they using them sequentially or in parallel?

Horstmann, Hausmann and Ryf (2010) suggest that it is possible to elicit an intuitive or analytical response by manipulating the context of the scenario. A familiar setting, with minimal objective information, framed by directions to respond intuitively, might induce an intuitive process, while an unfamiliar setting, with significant amounts of objective information, framed by directions to respond analytically, might induce an analytical process.

The intent of the decision vignette was not to discover whether they decided to ski the slope, but rather to challenge them with a scenario and then query them on the process that they used to get there. The decision scenarios were used to initiate a discussion and investigate the use of intuitive and analytical strategies. The participants described what an intuitive response or an analytical response meant to them. Participants were given one of two possible scenarios; one had factors that might promote an intuitive response, while the other had factors that might promote an analytical response.

- The Intuitive scenario used a photo of familiar terrain supplemented by limited snowpack and weather data, with the intent of inducing some level of pattern recognition and thus an intuitive decision response.
- The Analytical scenario used a photo of unfamiliar terrain supplemented by extensive snowpack and weather data, with the intent of inducing an analytical decision response.
- The environmental conditions in both scenarios promoted a high degree of uncertainty, with neither an obvious 'go' response or 'no go' response.
- The key questions were at the end.

Questions

1. What is your initial impression?
2. What are the conditions under which you would ski it?

3. Talk aloud your decision process. Would you ski it? Yes / No
4. If yes, where would you go and how confident would you be?
 - a. Would there be any stop conditions?
5. If no, what additional information would you want?
6. Would it change if you knew
 - a. The HST interface produced a CTM on facets size 1 Yes / No
7. Would it change if you knew
 - a. There was a persistent weak layer down 120cm, facets on top of a crust, which produced an RB 5 Yes / No
8. Describe an intuitive response
 - a. What does it mean to you?
9. Describe an analytical response
 - a. What does it mean to you?
10. What caused you to be more or less confident in your decision?

4.3.2.4.4 Observation data

There were limited opportunities for field observation. Observation of ski guiding decision-making required participation in the enactment of the day's ski plan, as the logistical considerations required me to travel with a guided group. As a researcher, I travelled with a guide and a group of guests, but did not participate in the decision process as a guide, and only participated in the activity as a guest. It was clearly recognized that space availability for this field observation was dependent on guest registrations and operational logistics. I did not displace guests in the helicopter or snowcat, as any fiscally responsible operation would prefer to have a paying guest rather than a researcher occupying a \$1000/day seat. However there were occasional circumstances when seats were unoccupied and provided me with the opportunity to conduct direct observations. The benefit of direct

observation was to immerse the researcher in the complexities of the environment beyond what was expected because of discussions within the morning guide's meeting. As a fellow ski guide, it helped me gain a greater understanding of the specific challenges faced by the participant on that particular day and helped me to focus the interview questions. Due to the logistical considerations, I was only able to conduct one day of direct observation. I applied the lens of what I would do as a ski guide to analyse the actions of the participant.

4.3.2.5 Analysis

4.3.2.5.1 Introduction

Clancey (2006) suggests that the use of statistics to analyse data collected in an NDM setting may develop into an over-reliance on data that could be misleading. This could evolve into a tendency to quantify data merely for the sake of generating a statistical argument (Forsythe, 1999). Wright (2003) supports the use of descriptive statistics as the most useful tool for communicating to the reader. He supports the argument that null hypothesis significance testing (NHST) can be overused and that the reporting of *p* values may, at times be of limited worth. Hopkins (2001) adds to this by stressing the importance of considering the practical rather than the statistical significance of the outcomes of data analysis. He suggests that *p*-values should not be used to generalize from a sample to the general population within an NDM setting.

Merriam (1998) describes qualitative research data as being collected and analysed in a synchronic fashion, as insights which developed in one phase of the research would typically merge into the next phase of the investigation. "But the researcher does not know what will be discovered, what or whom to concentrate on, or what the final analysis will be" (Merriam, 1998, p. 162). Strauss and Corbin (1998) argue that the data has to undergo a microanalysis which involves a dynamic, semi-structured process, freely flowing between the raw data and the interpretations generated by the researcher and the participants. Miles and Huberman (1994, p. 10)

stressed the importance of “maintaining three concurrent flows of activity: data reduction, data display, and conclusion drawing / verification”.

4.3.2.5.2 Quantitative Analysis

4.3.2.5.2.1 Rating the Expertise

As described in the Literature Review, a mere calculation of hours of engagement was a crude and largely inadequate measure of expertise. The concept of dedicated practice as previously described in Chapter 3, gave additional credibility to the argument. The primary determinants that were gathered in the Background Experience Profile included: certification, work experience, continued professional development activities and self-rated expertise (Appendix 5). Certification was easy to measure, but represented only a few of the benchmarks in a guide’s career. It did not measure higher levels of expertise once the top level of certification had been achieved, or once a participant no longer trained toward a higher level of certification.

The specific participant variables within the reported experience category included:

- Total years of work experience (broken down into weeks of work)
- The number of different locations worked at (breadth of experience)
- The number of years at the current location (depth of experience)
- Engagement in Continued Profession Development (CPD) activities (dedicated practice)

The final measure was the self-reporting of expertise through three questions. These three questions asked the participants to rate themselves. The first two asked them to rate themselves relative to their peers, while the third used a more abstract arbitrary scale.

1. Compared to other guides or instructors in your primary activity, how do you rate your overall abilities as a decision maker? Note: This does not refer to your technical skill expertise.

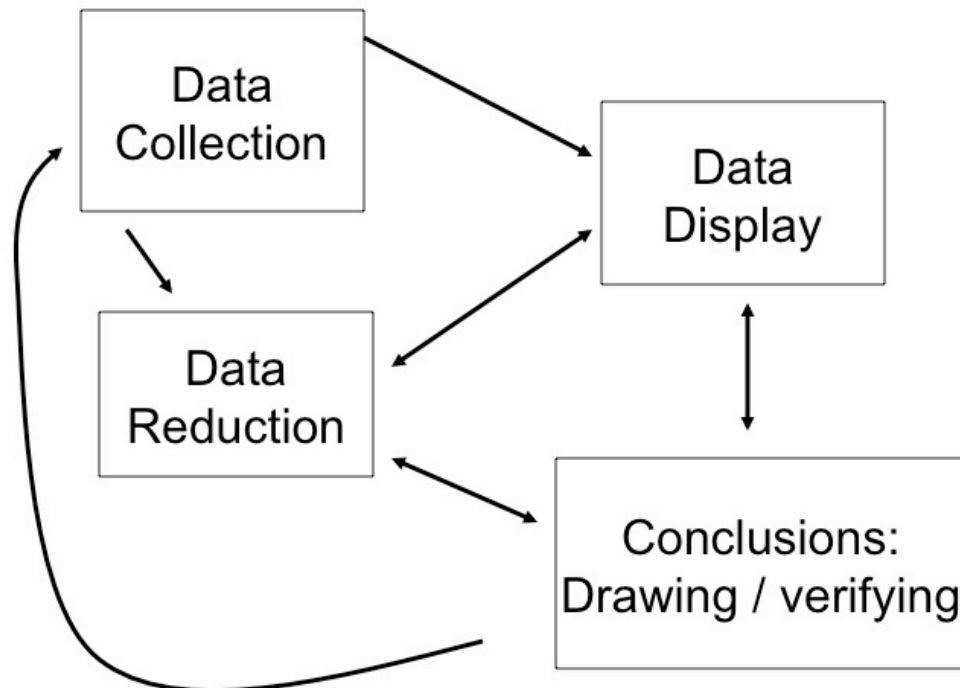
2. Compared to other guides or instructors in your primary activity, how refined are your abilities to balance risk with reward (i.e. your risk optimization skills)?
3. Categorize your guiding skill set in each of the following areas as to your level of expertise. (Expert, Proficient, Competent, Advanced Beginner, N/A)

Heli or Snowcat Skiing
Ski Touring
Avalanche Control
Waterfall Ice Climbing
Alpine Climbing
Rock Climbing
Other

4.3.2.5.3 Qualitative Analysis

Miles and Huberman (1994) suggested that qualitative data analysis was an interactive process, involving data collection, data display, data reduction and finally conclusions (Figure 10). Data reduction consisted of the continual process of extracting the essence of the contact. Strauss and Corbin (1998) recommended doing this through a line by line microscopic analysis. Described as ‘mining the data’ this detailed focus on every word was aided by the process of coding key data chunks and summarizing patterns, and has been described later. Data display involved the organizing of the reduced data into easily digestible texts, graphs or charts. Conclusion drawing was the process of distilling the meaning from the data (Miles & Huberman, 1994).

Figure 10 Components of data analysis: Interactive model (Miles & Huberman, 1994, p. 12)



Miles and Huberman (1994) suggested that the writing up of field contact data should be summarized in a contact summary sheet a day or two after the contact. This summary should include questions like: who was involved, what were the main themes, what aspect of the research question was addressed, did anything new come out of the contact and what are the implications for the next contact? This was to be followed by a process that looked for patterns in the data. From these patterns, generalizations could be formed which had the potential to contribute to the literature (Table 8).

Table 8 Common process of qualitative analysis (Miles & Huberman, 1994, p. 9)

1. Code field notes
2. Note personal reflections in the field notes
3. Sort materials with regards to similar phrases, relationships, patterns, themes and sequences
4. Isolate the patterns, commonalities and differences to integrate into the next iteration of field data collection
5. Begin to generate a set of generalizations from the patterns
6. Integrate the generalizations with the formal body of knowledge

4.3.2.5.3.1 Coding

The next step was the coding of information. Miles and Huberman (1994) stressed the importance of avoiding data overload and being able to access and retrieve the key components. The coding process involved the generation of descriptive labels, which were then attached to chunks of data. This helped to generate meaning for the researcher as segments were clustered together around the central research themes. Strauss and Corbin (1998, p. 103) described the process of coding as beginning with the “abstract representation of an event”, or conceptualization. Concepts were grouped together to form categories, with each categories then further developed through the description of its’ properties and dimensions. Miles and Huberman (1994) described the use of three types of codes: descriptive, interpretive and pattern. These codes were incremental in their complexity. Codes were created prior to the start of fieldwork based on the research question, and as a more inductive approach was also warranted, codes were generated after the first round of data collection. There was room in the middle for an approach that created codes for general themes and allowed for the addition of more specific codes as the data emerged. The themes listed below became apparent through relating my personal expertise in decision-making to my interpretation of the decision-making literature.

I took this middle ground using these central themes to generate the initial codes:

1. Expertise (Ericsson, 1996)
 - a. Depth
 - b. Breadth
 - c. Dedicated practice (Ericsson, Krampe, & Tesch-Romer, 1993)

2. Environment
 - a. Temporal
 - b. Geographic
 - c. Characteristics – Wicked or kind? (Hogarth, 2008)
 - d. Snow stability / hazard forecast
3. Decision Process
 - a. Familiarity with the terrain
 - b. Feedback (Hogarth, 1980; Soman, 2003)
 - c. Intuitive – analytical (Kahneman, 2003)
 - d. Intuitive confidence (Simmons & Nelson, 2006)

This qualitative data analysis process has been described as noticing, collecting and thinking about the data (Seidel, 1998). Although the context of data flow might imply the idea that these codes were sequential, this was just one way to construct meaning. Some of these themes and coded components described events or processes, which happened simultaneously. The decision process has been described as a cyclical and iterative process (Klein, 1998) and this analysis followed that model.

My first step was to allocate data codes to the subjective data from the questionnaires and the interviews, and then the data codes were formed into themes. The thematic grouping process was based on relationships amongst the codes and followed the iterative process typically used in qualitative data analysis (Seidel, 1998).

I used the meanings to generate a logical flow and pattern, which I formed into central themes. The frequency of occurrence of the codes was only one indicator of their significance to the participants. However it was likely a reasonable measure of the strength and weight attributed to these factors within the decision process, by the participants.

4.3.2.5.3.1.1 Inter-rater

An inter-rater, also termed a co-coder to aid in the reliable and consistent interpretation and analysis of the data, assisted me. Palys (1997, p. 416) described inter-rater reliability or inter-observer agreement as “the degree to which two or

more people, using the same coding scheme and observing the same people, produce essentially the same results". Miles and Huberman (1994) suggested that the initial set of field notes should be coded by both the researcher and the inter-coder. Using the formula:

Reliability = # of agreements / total # of agreements + disagreements,

Miles and Huberman (1994) suggested that it was rare to get better than 70% inter-rater reliability on the first round, and that it should increase to over 90% by the end of the process. I achieved an 80% level of reliability on the first round.

Drew, Hardman, and Hosp (2008) advised to re-check the coding a few days later to ensure a high level of code – re-code reliability. This data audit was a way to assess the logical process of the analysis. It was also suggested to check-coding, both for internal consistency, code-recode reliability, and inter-coder reliability (Miles & Huberman, 1994).

Pelham and Blanton (2007) suggested that the inter-rater needed to be independent from the project and yet trained in the coding method specific to the analysis. I used an inter-rater with those qualities. Dwayne Congdon, who had great interest in the research topic, agreed to assist in the project. Congdon brought an extensive knowledge and experience base in mountain guiding to the project, which he used to interpret, analyse and code the participant's responses. His personal practical experience included numerous first ascents of alpine routes in Canada and culminated with an ascent of Everest *via* a new route on the west ridge in 1986. He has worked extensively in the mechanized-ski industry and is currently the director of the Canadian Mountain and Ski Guide Program at Thompson Rivers University, which is responsible for the training and certification of mountain guides in Canada to the international standard, as set by the International Federation of Mountain Guides Associations (IFMGA).

4.4 Validity

4.4.1 Introduction

It was essential that this research be conducted in an ethical manner, which produced valid results that the researcher, participants, the guiding community and the general population beyond, considered credible, authentic and trustworthy. Reliability in terms of the consistency of responses and generalizability in terms of its applicability to new environments played much less of a role (Creswell, 2003). Odom and Morrow (2006, p. 138) defined reliability as the “consistency of measurements”. An example of a reliability coefficient based on Pearson’s r is the objectivity coefficient, measuring the consistency between the interrater scores (Interrater reliability). They defined validity as the truthfulness of the measurements. Criterion-related validity was generated using the Pearson r to evaluate the relationship between the objective calculation of expertise and the subjective estimation of expertise. However, neither objective, nor subjective scores can be considered absolute, or completely ‘truthful’.

This research has the potential to impact professional practice in the Canadian mountain guiding environment and beyond. Greater accuracy in the decision-making process will result in a decrease in the number of injuries and fatalities. There was a need for practical, action-oriented results that had been developed in a manner that inspired confidence. The key was to develop an understanding of the decision-making phenomenon from the perspective of the decision-maker and to interpret it within the context of the operational environment.

4.4.2 Issues concerning the validity of the research

As previously mentioned, I used a small, non-random sample. The invitation to participate initially went out to all companies that were members of HeliCat Canada. Seven companies responded positively to the proposal. I visited the participating companies during their pre-season training weeks in November and December 2007 and revisited the training weeks in 2008 and 2009. I solicited individuals to participate in the study and was open to the inclusion of more participants for the primary data collection period of November 2008 to April 2009

and November 2009 to April 2010. Inclusion in the study was based on voluntary participation.

This was a self-selecting sample and presented the challenge of accommodating an inherent level of selection bias. Titus (2007, p. 489) described self-selection bias occurring “when predictors of an out-come are themselves associated with other unobserved or observed variables”. The variable to address in this research was ‘why participate?’, which then produced the question of whether participation was in anyway related to the use of intuition within the decision-making process. Two principles had been suggested to alleviate selection bias concerns (Shadish, 2002). More data could be collected and, or more assumptions could be made about the data that were absent. Participation in this study should have appealed both to those who had a high level of expertise and considered themselves good decision makers, and to those who had a lower level of expertise with an interest in becoming better decision makers. This helped to differentiate the decision process based on levels of expertise. I was pleasantly surprised by how many of the long time guides became actively engaged in the discussions that I held at the various training sessions.

I was the primary investigator. I needed to account for my personal biases, values and interests in an open and honest manner that gave credibility to the process (Creswell, 2003). Strauss and Corbin (1998) argue strongly that the elimination of bias is impossible, but that there are strategies which can help to reduce its effects. Biases can creep into the data set from either the researcher or the participants. The terms ‘always’ and ‘never’ were potential red flags indicating the acceptance of statements at face value rather than being scrutinized by a deeper analytical process (Strauss & Corbin, 1998). I have been very clear about my tendency to be conservative in my risk management decisions. My presence might have caused participants to be on their ‘best behaviour’, or to modify their decisions in some way, perhaps to reflect more closely how they thought their employers would like them to act. They might also have modified their decisions based on participation in the study as they became more reflective of their practices. This increased sensitivity to the decision process was a potential follow-on benefit for participants.

4.4.3 Strategies to enhance validity

4.4.3.1 Triangulation

Bottorff (1997) described methodological triangulation as the integration of findings produced by using both qualitative and quantitative methods. This could be achieved through either simultaneous or sequential methodological triangulation. Creswell (2003) identified triangulation as an essential element of pragmatic research which built on the strength of this methodology.

I examined the decision-making phenomenon from two distinct perspectives of the decision – outcome interaction. The primary focus concentrated on good decision-making resulting in good outcomes and the secondary focus was on near-miss events, when a flawed decision process resulted in a good outcome. Studying both good and bad decisions is supported by Galloway's (2002) suggestion that a goal of leadership development programs should be to free learners from the cycle of only learning from bad experiences and poor decisions. Certainly the argument can be made that connections can be drawn between negative outcomes and the poor decisions that likely caused them. The reverse is not necessarily true. A good outcome can be considered likely to have evolved out of a good decision process, but there may be minimal direct evidence. However peer feedback and review is a potential source of validation. To achieve this result, in the questionnaire I asked the participants to comment on the quantity and quality of peer feedback they received on their decisions. This allowed me to integrate a quantitative analysis of the operational environment with a qualitative analysis of the decisions that took place within that environment. The importance of feedback to the determination of whether a good outcome can be attributed to good decision-making is discussed in Section 7.2.3 and Section 8.3.3.2. Once decisions have been identified as being of high quality, they can be used as the basis for learning. This has the potential to build high quality patterns for future intuitive recognition.

4.4.3.2 Member Checks

As knowledge was generated through the subjective interpretation of data, this information was fed back to the participants for validation. Termed interpretive

authority it is easier to trust the interpretations of the researcher when my tentative interpretations were relayed back to the participants and their responses were incorporated into the analysis (Thorne, 1997). These member checks occurred at each subsequent repeated observation.

4.4.3.3 Repeated Observations

I had participants from eight different operational areas and was able to gather data from them numerous times. I visited each operation once per season to conduct interviews with the participants.

4.4.3.4 Peer Examinations

I have a peer group within the Adventure Studies Department at Thompson Rivers University that represented a concentrated pool of expertise in the field of risk management. They were used as a sounding board. This was somewhat like the Delphi Panel as used by Davidson (2005). My analysis of the raw data was circulated, with the intent of tapping into their collective expertise and creating a broader interpretation. I was able to retain a broader perspective on the research problem.

4.4.3.5 Validity Check

A six-point validity check was completed to determine two key points. The first question was whether I was justified in combining the seasons. The second question was how I needed to accommodate for the range in the number of reported days as some participants reported only a single day, while the most prolific participant reported 19 events. This avoided a heavy reliance on a single participant's responses. Participant 103's responses were not leptokurtic. His responses were wide ranging. The quantitative data were averaged for all participants to avoid over-reliance on a single contributor.

1. All the reports from the 2008/2009 season were compared to the Individuals' averaged reports from that season. There were 33 good day reports from 14 individuals and 23 near-miss reports from 16 people.

2. All the reports the 2009/2010 season (29 good day reports from 17 people and nine near-miss reports from eight people) were compared to the Individuals' averaged reports from the 2008/2009 season.
3. Participant 103 contributed 21.3% of the total number of reports so it was necessary to assess whether this high level of participation would skew the data set.
 - a. For the 2009/2010 season, a comparison was made between: Participant 103 alone, the group including Participant 103, and the group without Participant 103.
 - b. A further comparison was made using all the reports for both seasons. Participant 103 alone was compared to the group including Participant 103.
 - c. A final comparison was completed using Participant 103's average over both seasons compared to Averaged Individuals (without Participant 103) over both seasons 08/09 and 09/10.
4. The individuals' averaged reports from the 2008/2009 season were compared to the individuals' averaged reports from the 2009/2010 season.
5. The final comparison was to look at an average of all the reports from both seasons as compared to an average of all the reports using averaged individuals.
 - a. This final comparison also allows for a comparison between averaged good day reports with averaged near-miss reports.

4.4.3.5.1 Validity Check Results

1. The questions 'Sources of Challenge' and 'Sources of Uncertainty' had the greatest degree of variability in all five of the above comparisons.
 - a. Within the 'Sources of Challenge' answers the ranking of the top three were consistent, however the percent weightings varied. The

answers ranked fourth and fifth varied in many of the above five comparisons.

- b. Within the ‘Sources of Uncertainty’ answers both the rankings and percent weightings varied.
2. Participant 103 was the most prolific contributor with 19 reports over the two seasons (14 good days, 5 near-misses).
 - a. Compared to the Averaged individuals, with the exception of the two above-mentioned questions, all good day parameters were within one standard deviation. As there were no extreme values, or outliers, in the data set, standard deviation was used to classify variance.
 - b. Compared to the Averaged individuals, in addition to the two above-mentioned questions, the near-miss parameters were within one standard deviation with the exception of The Intuitive-Analytical Mix and the Most Likely Consequence.
 - i. On the Intuitive-Analytical parameter, Participant 103 was within two standard deviations.
 - ii. On the Most Likely Consequence parameter, Participant 103 was within two standard deviations.
 - c. Compared to the Group without 103 (09/10)
 - i. Near-misses – The intuitive response was toward a positive action for both P103 and the Group without P103.
 1. The Group without P103 had a stronger positive response with a smaller standard deviation. P103 had a stronger intuitive response, but it was split between strong positive and strong negative responses, while the rest of the group tended toward moderate positives.

4.5 Ethics

This study adhered to The University of Edinburgh and Thompson Rivers University - Research on Human Subjects Ethics Policies, which identified several key issues for consideration. The primary issue was the confidentiality of participant contributions.

See Appendix 4 for the Informed Consent document.

4.5.1 Confidentiality

All potential participants were informed of the ethical principles of research on human subjects. As there was the potential for reputations to be impacted through contributions to the study, it was essential for the researcher to ensure complete confidentiality for all participants. To ensure the integrity of the data and to maintain confidentiality for the participants, the questionnaire webpage was password protected and required a user ID.

The names of the participants and the companies that they worked for have not been used in the document to protect the confidential nature of near-miss reporting. Individuals or companies that wished to be credited for their contributions to the research have been identified as such. No individuals or companies have been linked with any specific incidents in the published results. Identifying information such as locations, run names and group size were not included in the results. Information was stored in a password protected electronic file. Raw physical data (questionnaires) were kept in a locked file box, until they were incorporated into the analysis at which time they were shredded. Only the research team had access to the data.

Participation in this study was by invitation and was in no way linked to professional performance, conduct, or employment reviews. This study was completely independent of all job related formative feedback and summative evaluation.

4.6 Summary

This chapter described both the theoretical origins of the research methodology and placed the research problem within an appropriate research

paradigm. It has linked the problem with specific methods and justified those methods within the operational context of mechanized ski guiding. The importance of recognizing the role of the researcher within the research has also been addressed.

As described in the literature review, the characteristics of the decision-making environment played a key role both in the long-term development of intuition and the significance attributed to intuition in the solution of a current challenge. It was the intent of this research to generate greater understanding of this phenomenon. This was a pragmatic question, with not only the need to address the significant logistical complexities in the mechanized ski industry, but also the potential for lives to be saved. The specific mixed methods described in this chapter generated understanding through triangulation. This chapter set the foundation upon which the next chapters on analysis and discussion of results were based.

A testing out research strategy was used to find the limits of previous generalizations made in other fields. The Judgement and Decision-making literature, particularly the theories generated by the heuristics and biases researchers and the naturalistic decision-making researchers, was used to analyse whether the ski guiding environment was any different from other risk-based decision environments.

Mixed methods were used to analyse three data sources:

1. A web-based questionnaire on background experience, was completed by each participant,
2. A web-based questionnaire, which allowed for multiple event reports of both good days and near-miss days, and
3. Interviews and focus groups.

The data were contributed over two seasons, 2008/2009 and 2009/2010 by a self-selected group of 32 heli-ski and snowcat-ski guides working in British Columbia. A quantitative analysis of the participants' background experience and 89 event reports (57 good day reports and 32 near-miss reports) was used to provoke questions of the qualitative data from the interviews and the descriptive prose within the event reports. Some participants were more prolific in their event reporting than others. The highest number of reports from a single individual was nineteen and the lowest was one. The average of each individual's event report(s) created a single set

of data points. These averaged individuals were then combined to generate group averages and annual averages.

Although the quantitative data was generated from arguably a statistically marginal number of research participants and reports, its analysis provided cues from which to query the qualitative data. The intent of the experience profile was not to compare a range of expertise to decision responses. The intent of the study was to examine expert responses, thus the intent of the experience profile was to show that the participants were, by and large, experts. Valuable insight was gained through this two-stage analysis. A number of trends were evident within the quantitative data, which although not in themselves statistically significant, prompted further questions of the interview responses and descriptive questionnaire responses.

Chapter 5 Results: Expertise and the Link to Intuition

5.1 Introduction

As described in the methods chapter, the empirical basis of this thesis comprised three studies. However, rather than presenting findings and discussion of each study in its own chapter, the results of my data analysis are presented in a theme-based approach. By utilizing this approach to the presentation and subsequent analysis of the data, I illustrate the connections between the various data sources generated through mixed methods data collection. In this first results chapter, I describe the results of a quantitative analysis of the two questionnaires, with the analysis focusing primarily on the role of expertise in ski-guides' decision-making. In particular, I begin by evaluating and rating the participants' expertise based on responses to the Background Experience Questionnaire. After this I present the results from the good day and near-miss event reports. I conclude with an examination of if and how these reports differed as a function of expertise.

Although it might be intuitively gratifying to believe in the strength of an argument based on a small sample size, it would be no more than wishful thinking to believe that the power of the study would be sufficient to produce publishable results based on the quantitative results alone (Tversky & Kahneman, 1971). As my sample size was small, I generated a stronger argument by using descriptive statistics as a launching pad for the qualitative investigation. As the inherently low statistical power of my study would have needed to be compensated by a large effect size, basing my argument solely on the results of my statistical analysis lacked both strength and weight (Maxwell, Kelley, & Rausch, 2008).

5.2 Background Experience Questionnaire

5.2.1 Introduction

Thirty participants completed the Background Experience profile (Appendix 5). As described in the methodology chapter, the intent of the background experience questionnaire was to elicit information that could be used to generate an expression of each participant's degree of expertise. The elements considered in the

estimation of participant expertise included: level of certification, depth and breadth of professional practice, dedicated deliberate practice in the form of continued professional development, and subjective self-evaluations.

5.2.2 Objective Depth of Expertise

The certification process to become a ski guide is very rigorous. Extensive personal experience in the form of deliberate practice is needed to apply for entry into the guide training process. Success at both the aspirant and full guide exams demands considerable expertise and on-going deliberate practice. The Canadian Mountain and Ski Guide Program requirements for entry into the Ski Guide Training courses suggest that a minimum of five years of personal experience is needed prior to application. Applicants must provide evidence of experience through a ski resume. As entry to the program is competitive, the actual level of experience often far exceeds the listed criteria.

- 15 backcountry tours of 1-2 days in high alpine or glaciated terrain
- 2 backcountry tours of five-days or longer in remote, glaciated terrain (non-hut based)
- 5 backcountry tours of three to five-days or longer in remote glaciated terrain (may be hut based)
- 5 peaks requiring mountaineering skills, climbed during ski tours
- Notable backcountry descents
- Relevant summer mountaineering experience
- A total of 3 or more years of experience in a variety of snow climates
- References that can vouch for your backcountry experience resume

Participants were asked to estimate the number of weeks of work that they had completed over their guiding career. Three different areas of work were distinguished: heli-ski and snowcat guiding, ski tour guiding, and avalanche control. A 'week' of work is the standard unit of measurement for the commercial ski guiding industry, and it may range from five to seven days of actual guiding time with guests. The participants also listed the average number of days that they had participated in continued professional development (CPD) activities over each of the previous three each years.

In order to derive the final variables, I had to make certain assumptions; assumptions designed to generate a conservative estimation of the actual hours of

experience. This conservatism would serve to counteract potential self-enhancement biases in self-reported measures of expertise (Dunning, Heath, & Suls, 2004).

In particular, the assumption regarding work hours was that a guide would have worked eight hours per day and six days per week. Although it could be argued that a guide's work day begins at 0600 hours (e.g., weather observations) and extends past 2300 hours (e.g., guest socialization), the amount of time dedicated to guiding decisions could be considered to be eight to ten hours, based a 0700 morning guide's meeting and a 1630 evening guide's meeting. Workplace regulations in British Columbia state that workers cannot commit to excessive hours to the point that their health is compromised. Excessive, however, is not defined (Workrights.ca, 2011). So long guiding days are the norm in the industry.

The CPD hours were calculated based on the number of CPD days per season multiplied by the number of seasons. The assumption was that a CPD day would have been eight hours. The final number of CPD hours was less well defined as the calculation was based on an average number of reported CPD days per season, over the previous three years.

I based the final 'Depth of Expertise' variable on the sum of "work hours" and "CPD hours" where:

Work Hours = (Number of Seasons) x (Number of Weeks) x (6 Days) x (8 hours/day)

CPD Hours = (Number of Seasons) x (Number of Days) x (8 hours/day)

As discussed in the literature review, one of the underlying principles in the determination of expertise was the concept of deliberate practice (Ericsson et al., 1993). Although this may be easy to determine when evaluating musicians' expertise (e.g. the number of hours of preparation), it may be harder to do with guides. A recreational day of skiing in avalanche terrain may generate increased expertise in relation to terrain use and, as such, it might be considered deliberate practice; however it would not be a professional guiding day, with all of the additional considerations linked to conducting guests through the terrain.

The calculation of expertise did not include recreational hours spent in avalanche terrain. Participants were not asked to supply their number of recreational

days as typically these days may not be recorded and would be more difficult to document. However, it should be acknowledged that recreational ski days likely contribute to the generation of some elements of ski guiding expertise. As such, the ‘objective’ measure of expertise used in this study can only be used as a general guideline.

There were twenty-five profiles with sufficient information to generate the depth-of-experience calculation. The observed depth of expertise ranged from a low of 584 to a high of 23,600. The average was 8,956 hours ($SD = 5244$). Table 9 shows the calculation for a sample participant.

Table 9 Example of the depth of expertise calculation for Participant 714

	Heli	Touring	Total	Days	Hours	CPD	Total
# Years	# Weeks	# Weeks	# Weeks	Based on 6 days/week	Based on 8hrs/day	Days/year 26	Hours
12	20	2	264	1584	12672	Hours/year 208	
3	18	4	66	396	3168	# Years 20	
5	15	0	75	450	3600		
20 years total					Work Hours 19440	CPD Hours Total 4160	Work + CPD 23600

For 12 of his 20 years, the participant worked 20 weeks of heli-skiing and two weeks of ski touring. For three years he worked 18 weeks of heli-skiing and four weeks of ski touring, and for five years he worked 15 weeks of heli-skiing. This participant did not work in avalanche control separate from his work as a ski guide. The full spread sheet with the calculations for all participants is Appendix 7.

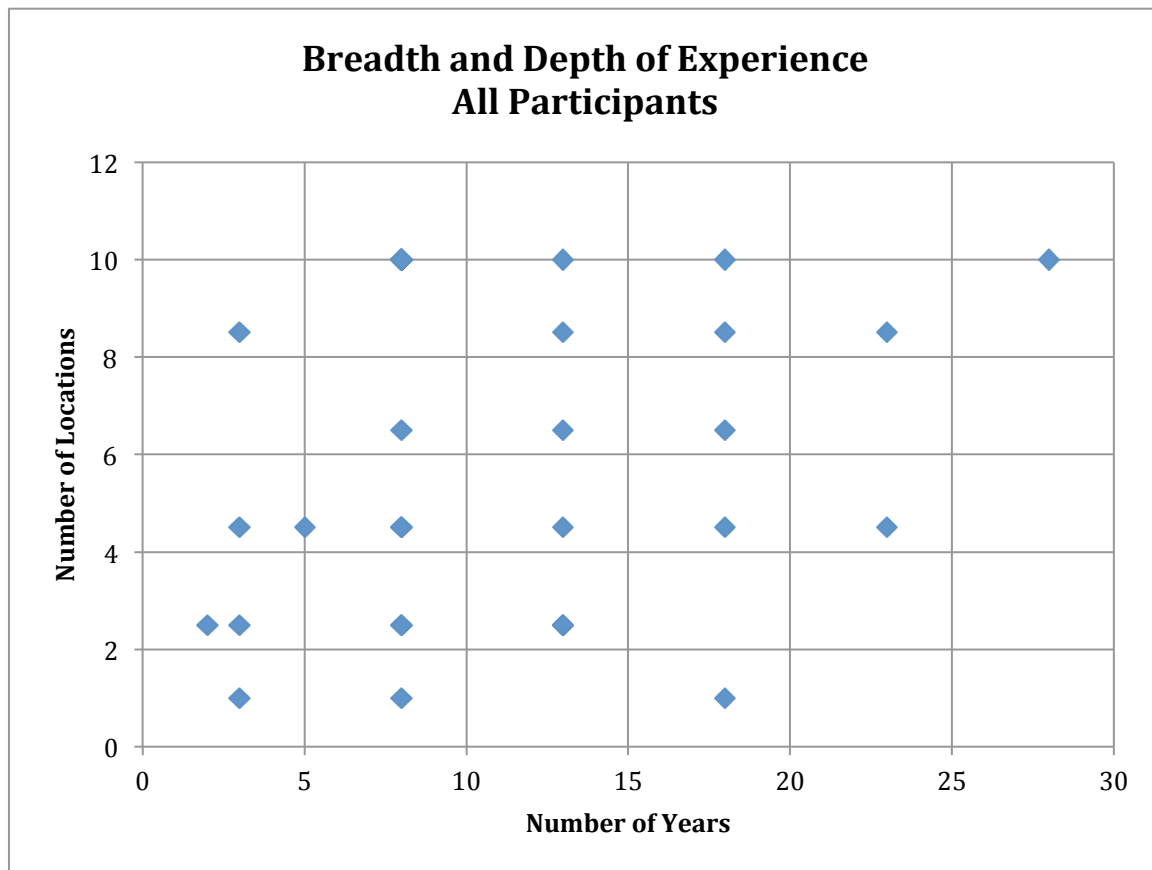
5.2.3 Objective Breadth of Expertise

Breadth of expertise comprised two criteria: the physical location and the operational context, the latter of which was a function of the dynamics of the ski program (e.g. physical scale of the operation) and the expertise of the guiding team. Of the two, the physical location was theoretically perhaps, the greater contributor to the development of expertise breadth, as all heli-ski and snowcat-ski companies have defined areas of operation or tenures. The operational context was discussed in Chapter Two. Given the spatial variation of snowpack characteristics, I am suggesting that each area of operation is unique. There are degrees of variation within this premise, however, as two neighbouring areas will be more alike than two distant operations (Hägeli, 2005).

5.2.4 Objective Integration of Breadth and Depth of Expertise

The intersection of the participants' depth and breadth of experience can be seen in a simple scatter chart (Figure 11). Although they were all certified guides and 'experts', this figure illustrates the variation in depth and breadth of experiences. For example, within the 16-20 years of experience group, the number of locations varied from one to ten. One might surmise that the participant with 18 years of experience in a single area would know that area very well. In contrast, the participant with 18 years of experience in ten different locations would likely not know any one area as richly, but may have developed decision expertise that was able to adapt to new challenges more easily (Tozer et al., 2007).

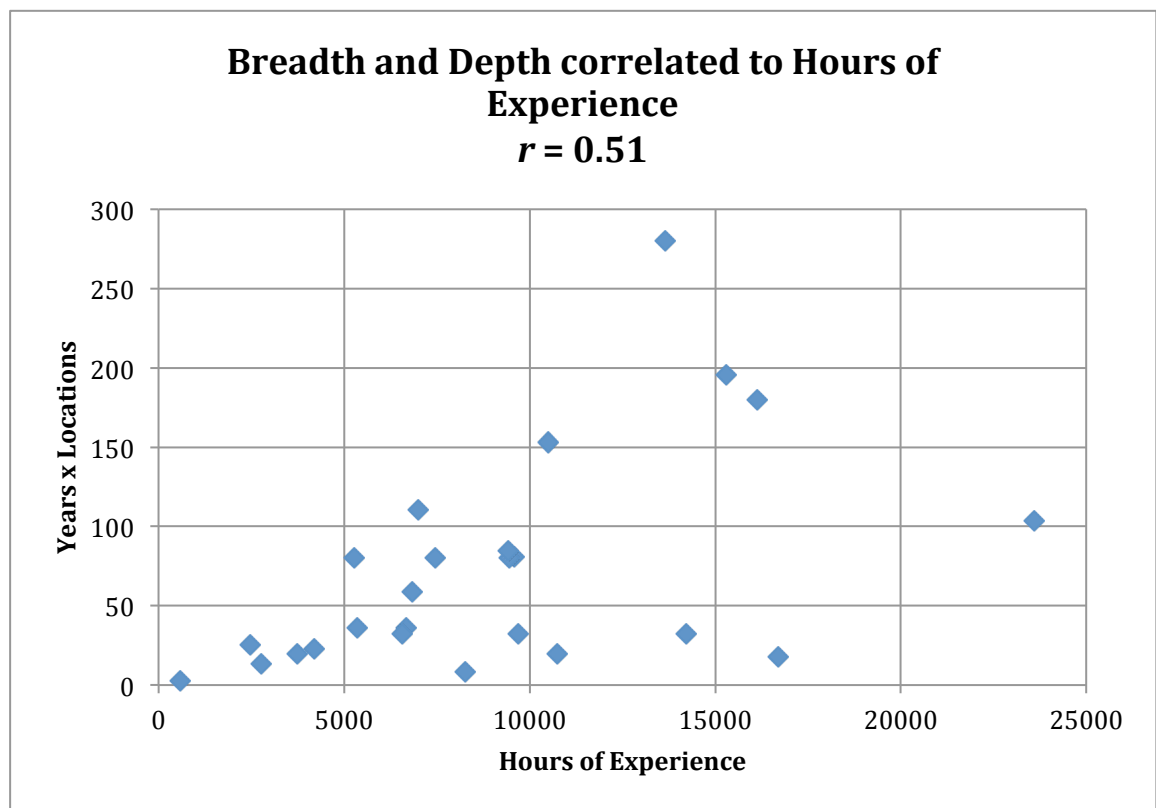
Figure 11 Experience - depth and breadth



5.2.5 Correlation between Depth and Breadth of Experience with Hours of Experience

Galloway (2007) used the interaction between depth and breadth as a subscale within his Outdoor Leader Experience Use History instrument in the determination of expertise. Multiplying years of experience by the number of locations generated an indication of depth and breadth. This was termed the Professional Environment. I used Pearson's correlation to see if there was a measure of association between this measure of expertise and the hours of experience calculation (Figure 12). As the Hours of Experience calculation used the number of years of experience as a primary factor, a positive correlation was expected. When all participants were included, there was indeed a positive correlation ($r=0.51$).

Figure 12 Breadth and depth of experience correlated to hours of experience - All participants



5.2.6 Subjective Expertise

The subjective measure of expertise gave an additional perspective on the participants' level of expertise. In the first self-rated question (i.e. "Compared to other guides, rate your overall abilities as a decision maker", where 1= very low and 9 = very high) the average rating of the participants was 6.61 ($SD = 1.16$). Nine participants rated themselves as Average-to-High (6) and thirteen rated themselves as High (7). The participants perceived themselves to be highly expert, even in comparison to other experts.

A similar pattern was seen in the Risk Optimization question: participants perceived themselves as being very adept at balancing risk with reward. Using the same scale of Very Low (1) to Very High (9), the average rating was 6.5 ($SD = 1.2$), with 15 participants rating themselves as High (7).

The third subjective-expertise question asked participants to rate themselves using four of Dreyfus's (2004) five-stage Expertise Scale (Novice, Advanced Beginner, Competent, Proficient, and Expert). The Novice stage was not included as

an option, as none of my participants would have fit this descriptor. Most of the participants believed themselves to be either Expert (47%) or Proficient (37%).

There were two potential explanations for the finding that participants, on average, rated themselves as having higher abilities than an average guide. The first was that this group of participants was not a random sample of the larger ski guide population and, given their positions within the industry and levels of expertise as described above, they indeed may have been better at decision-making and risk optimization. This explanation, however, was unlikely, as there was no evidence to suggest that the participants in the sample group were not typical of ski guides in the larger population. The more likely possibility was supported by research in other areas. Studies have demonstrated that people overestimate their skills in relation to others, such that more than 50% of a sample will report themselves as being 'above average' (Hoorens 1995). This of course is a statistical impossibility. It has been argued that this 'above-average effect' is largely due to a lack of information about how others perform, a lack of personal feedback and an element of motivational bias as the results consistently trend toward an overestimation of skills (Dunning et al., 2004).

5.2.7 Relationship between Objective and Subjective Measures of Expertise

To assess the degree to which the subjective measures revealed anything objective about participants' levels of expertise, I performed several bivariate (simple) correlations between the two classes of measures. With a sample size of 25 and using 0.05 alpha level, results for a one-tailed test were considered significant when $|r| > 0.337$ (Price, 2000).

Field and Gillett (2010) list the Pearson correlation coefficient, r as one of the most common measures of effect size. It can be used to express both the strength and direction of the relationship between two variables, as well as the strength of an experimental effect. Cohen (1992) suggests the following interpretation of effect sizes: a small effect is when $r=0.10$; a medium effect is when $r=0.30$; and a large effect is when $r=0.50$. Field and Gillett (2010) recommend using the Pearson correlation coefficient as it is generally well understood. My research was based on a small non-random sample. Similar to a case study, the effect size should only be

considered as an estimation when extrapolated to the larger population of ski guides (Field, 2005a, 2005b).

5.2.7.1 Relationship between Hours of Expertise and Self-reported Expertise

All three subjective measures of expertise (self-reported abilities as a decision maker, self-rated risk optimization skills and self-rated level of expertise) showed a significant, positive correlation with hours of expertise (Table 10). With increasing hours of expertise, participants perceived themselves to have enhanced decision-making abilities, better risk-optimization skills, and a higher level of expertise.

Table 10 Hours of expertise correlations with self-reported expertise

<i>r</i>	Hours of Expertise
Self-reported Decision-making	0.502
Self-reported Risk Optimization	0.456
Self-reported Proficiency	0.514

5.2.7.2 Relationship between Self-reported Expertise and CPD

The correlation between subjective expertise and participation in Continued Professional Development activities across the last three years was negative (Table 11). With increased self-perceived expertise, CPD went down. Once guides complete the certification process, there may be a reduced drive to engage in deliberate practice. Another possible explanation for this finding is that more experienced guides rate themselves higher in their decision-making and risk management abilities and feel less of a need to have recently engaged in professional development. Evidence in support of this interpretation is the finding that hours of expertise and CPD activities were also negatively correlated ($r = -0.393$); that is, the greater the number of hours, and the fewer the CPD activities.

Table 11 Continued Professional Development correlations with self-reported expertise

<i>r</i>	CPD
Self-reported Decision-making	-0.449
Self-reported Risk Optimization	-0.207
Self-reported Proficiency	-0.396

5.2.8 Summary

As noted earlier a common benchmark for defining an expert is 10,000 hours of deliberate practice (Ericsson, 1996). The 30 participants who contributed to this research had an average of 8,956 hours experience (work and CPD combined), which approached the 10,000-hour benchmark of practicing the profession of ski guiding. This would include avalanche hazard forecasting, risk assessment, terrain selection, guest management and emergency management. Again, the data set did not include the number of recreational hours spent in avalanche terrain. This would have added significantly to the participants' totals.

It is important to recognize, however, that 10,000 hours of experience by itself does not make an expert. When put on a continuum, experiences could be considered relatively empty to relatively full, with full experiences maximizing the learning potential inherent within a given situation. Top levels of performance have not been attributed only to years of experience, but also to years of deliberate and intense practice aimed at continual improvement (Ericsson et al., 1993; Starks et al., 1996). That is, the number of days or hours engaged in an activity cannot be used as the sole measure of expertise as many people will simply repeat the same mistakes with little effort towards improvement (Weick, 2001).

Similarly, Vick (2002) argued that expertise was dependent on two integral elements: the size of the knowledge base and the speed at which it can be accessed. These two elements have also been called pattern recognition (Kass, Herschler, & Companion, 1991). In the next section the participants' good day and near-miss decisions were recorded and analysed. The focus of this analysis was to link expertise with the use of intuition primarily through an examination of the role that pattern recognition played. Klein's (1998) research on fire-fighters supported the notion that the recognition of patterns would prime a decision response and form the basis for action.

5.3 Expertise and the Decision Process in Daily Event Reports

5.3.1 Introduction

Participants contributed event reports for both good days and near-misses over the 2008/2009 and 2009/2010 winter seasons. During this time, the 30 participants completed 89 useable reports, 57 of which were good day reports and 32 were near-miss reports. There were seven reports (all from the first season) excluded from data analysis, as these participants merely indicated whether it was a good day or near-miss report, but did not answer any of the subsequent questions about the event. I attribute these reports to a lack of participant familiarization with the web-based questionnaire format of SurveyMonkey, as they learned how to use the tool.

Twenty-two people contributed 32 near-miss reports and 21 people contributed 57 good day reports. The number of reports completed by a single participant varied from a high of 19 (14 good days and five near-misses), to a low of one (either a good day or a near-miss). To ensure that the results represent ‘participants in general’, rather than the perceptions of a single, frequently-reporting participant, all the reports from each participant were averaged within each of the good day and near-miss categories separately. This produced a singular set of values for each individual. For example, to reduce the reliance on the most prolific participant’s contributions, the results from his 14 good day reports were averaged, as were the results from his five near-miss reports. If there was a tendency for him to be more or less intuitive in his decision responses, the weight of his responses counted as only one response. This was done for all participants who contributed more than one good day or near-miss response.

5.3.2 Comparison between Near-miss and Good day Reports - Combined Seasons

I compared the near-miss data and the good day data, to see if there was a difference in how the decisions were enacted; in particular, the extent to which the decision process was influenced by intuition and analysis.

5.3.2.1 Challenge and Uncertainty

According to the participants, the greatest challenge for both good day and near-miss events was the forecasting of snowpack stability. This may have been due

to the uncertainty that often arises from conflicting alternatives (Table 12).

Answers to the open-ended question indicated that the most common conflicting alternatives were between a desire for good skiing and the avoidance of a severely negative outcome. The open-ended questions have been analysed in detail in the next chapter.

Table 12 Sources of challenge and uncertainty

	<i>Near-misses</i>	<i>Good Days</i>
What made the day challenging?		
Snowpack stability	75.2% (SD=0.40)	81.9% (SD=0.31)
Terrain variability	42.7% (SD=0.45)	56.5% (SD=0.44)
Flying weather	31.7% (SD=0.45)	22.2% (SD=0.36)
Changes through the day	28.6% (SD=0.42)	19.6% (SD=0.29)
Skiing conditions	24.1% (SD=0.40)	38.1% (SD=0.36)
Group dynamics-guests	24.1% (SD=0.37)	24.0% (SD=0.33)
Source of uncertainty?		
Conflicting alternatives	38.1% (SD=0.42)	53.8% (SD=0.43)
Not fully aware	32.8% (SD=0.41)	22.2% (SD=0.38)
Incomplete information	25.9% (SD=0.41)	20.8% (SD=0.34)
Other	19.1% (SD=0.34)	8.5% (SD=0.16)

Not surprisingly given the feedback inherent in a near-miss event, decision difficulty was perceived as being higher and decision quality perceived as lower, in the near-miss reports (Table 13).

Table 13 Decision difficulty and quality

	<i>Near-misses</i>	<i>Good Days</i>
Decision Difficulty (1=Very Easy, 7= Very Difficult)	M = 4.14 SD = 1.24	M = 3.65 SD = 1.17
Decision Quality (1=Not good enough, 4 = Excellent)	M = 2.28 SD = 0.97	M = 3.64 SD = 0.37

5.3.2.1.1 Snowpack Stability

According to the participants, completing the snow stability forecast was the greatest challenge of the day; for both seasons of data collection and regardless of whether the event was a near-miss or a good day. The stability evaluation process was a task that the participants completed at the end of every day based on their field observations gathered throughout the day. The evening evaluation formed the starting point for the stability forecasting process the following morning.

I was able to access the stability assessments generated by the participants and submitted to the InfoEx. These site-specific assessments were used to generate context for the event reports. An analysis of the outcome of the snow stability assessments showed that the average stability rating was in the 'Fair' range, or a three on a scale of 1-5, for both good days and near-misses (Table 15). This made for an easier comparison between good day events and near-miss events, as the snowpack stability is a major variable in the decision process. If the participants had contributed good day event reports on days when the stability had been good to very good and near-miss event reports when the stability had been poor to very poor, a comparison of the decision process would have been much more complicated. The participants had been asked to provide good day reports on days that they felt provided some level of challenge. The fact that the stability ratings were consistent between good days and near-miss events shows that this happened.

The Canadian stability rating scale was used with ratings for three elevation bands: Alpine, Treeline and Below Treeline (where 1 = Very Good and 5 = Very Poor). As the participants did not provide information as to the specific elevation

range where they had been for a particular event report, it was necessary to convert the three elevation band ratings to a single rating. (Appendix 8 – Calculation of Stability Number Based on Three Elevation Bands). Additional information that was available in most of the InfoEx reports, which provided further insight into the decision process, was the indication of whether a persistent weak layer (PWL) was a factor in the snowpack analysis and whether there had been any skier triggering of avalanches. The information in Table 14 came from the InfoEx and has been grouped based on the two data collection seasons and sub-divided based on good day and near-miss reports. It shows the average stability rating for each of the sub-groups. In addition, it shows how often persistent weak layers, skier accidental triggered avalanches and skier-controlled avalanches were reported in the InfoEx on days when participants reported good days or near-misses.

Table 14 InfoEx - stability, snowpack and skier triggerability

Season	Stability	Number of Reports	Reports w/ a PWL	Reports w/ Sa Sc
0809 GD	2.8	29	11	9
0809 NM	2.9	23	15	11
0910 GD	3.0	31	24	20
0910 NM	3.1	9	4	4
Totals		92	54	44

Note: PWL = persistent weak layer, Sa = avalanche triggered accidentally by a skier, Sc = avalanche triggered deliberately by a skier.

The presence of these two factors in the InfoEx reports was useful, because participants subjectively described them in the interviews (presented in the next two chapters). The presence of a persistent weak layer emerged as one of the qualitative data codes and contributed to the central theme – ‘Impact of the environment’. Skier triggering of an avalanche factored into the likelihood and consequence aspect of the decision and was discussed as part of a number of the qualitative data codes including ‘Terrain Selection’ and ‘Surprised by Events’. ‘Skier triggering’ was central to the two themes, Environment and Future Decisions, which provided the bookends, or the beginning and end of the decision process, for the qualitative analysis as described in the next chapter.

5.3.2.2 Intuitive Analytical Continuum

Participants rated their decisions on a continuum, with intuition at one end and analysis at the other. The scale midpoint (3) was labelled as representing an even mix of intuition and analysis. This allowed the participants to indicate a blend of decision response processes. The analysis showed that no decisions were rated as being fully analytical (5). The primary decisions involved some level of intuition, with four of the 89 rated as fully intuitive (1). The intuitive-analytical ratings for near-misses and for good days were slightly intuitive (Table 15). The participants rated their intuitive responses on a 7-point continuum in terms strength and direction, with strongly positive at one end (1) and strongly negative (7) at the other. The middle ground (4) was neutral. The mean for both good days and near-miss days was slightly positive. Taking this one step further, the strength of the intuitive response was isolated. The mean for both categories was about '2', or moderately strong.

Table 15 Near-miss and Good Day - Use of intuition

	<i>Near-misses</i>	<i>Good Days</i>
Decision Intuitive-Analytical mix (1 = Intuitive, 5 = Analytical)	M = 2.82 SD = 0.52	M = 2.85 SD = 0.66
Strength & direction of intuition (1 = Strong Positive, 7 = Strong Negative)	M = 3.77 SD = 1.99	M = 3.82 SD = 1.93
Strength of Intuition (1 = Weak, 3 = Strong)	M = 1.97 SD = 0.61	M = 2.03 SD = 0.51
If intuition-analysis conflict, how easy to choose which one? (1 = Very easy, 5 = Very hard)	M = 2.67 SD = 0.75	M = 2.43 SD = 0.67

5.3.2.3 Direction of Intuitive Response

The intuitive response was analysed with regard to whether it promoted feelings to do something (positive or good feeling), or to avoid doing something (negative or bad feeling). I did not use the averaged individual results in this situation. I treated every report as a data point, as the use of the averaged individual scores for this variable would mask the implications of the degree to which intuition was used. For example, Participant 103 provided 14 good day reports. He had an almost even balance of positive and negative responses. When comparing his reports of negative intuitive responses to his positive intuitive responses, he had two more negative responses than positive ones. His net score was -2.

Overall, participants reported more positive intuitive responses than negative responses by a 1.7:1 ratio on good days and a 1.6:1 ratio on near-miss days (Table 16). A positive intuitive response was given a weighting of +1 and a negative intuitive response was given a weighting of -1. The open-ended responses to this question have been analysed in detail in Chapter Seven. There was a noticeable difference between the pattern of results from the event reports and those obtained from the interviews (to anticipate: the interview participants described how the negative intuitive response was far more significant to them, yet in their quantitative ratings, they indicated that the positive intuitive responses occur more frequently).

Table 16 Good Day and Near-miss - positive and negative feelings

	Positive	Neutral	Negative	Ratio
Weighting	1	0	-1	
Number of Good Day Reports	32	2	19	1.7:1
Number of Near-miss Reports	16	3	10	1.6:1

5.3.2.4 Use of intuition on Good days compared to Near-miss Days

Thirteen participants provided both good days and near-miss reports and completed the experience questionnaire. There was a weak positive correlation between their use of intuition on good days and on near-miss days ($r = 0.32$). This

shows some degree of consistency in the use of intuition, regardless of the outcome of the decision.

5.3.2.5 Decision Confidence

The participants rated their decision confidence both pre and post-event. The average self-rated pre-event confidence for both near-miss and good day reports was in the 80-89% bracket (very confident) (Table 17). This appeared to conflict with the subjective comments from the questionnaires and the interviews where the participants described a decision environment fraught with variables that did not match previous patterns. As the reports were done retrospectively, the rating of pre-event confidence was likely influenced by the decision outcome. Confidence has been discussed further in relation to consequence and likelihood in Chapters Six and Eight.

Table 17 Decision confidence

	<i>Near-misses</i>	<i>Good Days</i>
Decision Confidence prior to decision 1 = 100% - Completely Sure 2 = 90-99% - Highly Confident 3 = 80-89% - Very Confident 4 = 65-79% - Moderately Confident 5 = 50-64% - Educated Guess 6 = 50/50 – Just Guessing	M = 3.29 SD = 0.93	M = 3.00 SD = 0.78
Decision Confidence at end of day (1 = 100% confident, 6 = 50/50 guess)	M = 3.97 SD = 1.40	M = 2.06 SD = 0.76

Not surprisingly, post-event confidence went up after a good day and down after a near-miss. Post-event confidence may have been influenced by the feedback inherent within the outcome. That is, the most obvious feedback was whether the participants perceived the event as a near-miss. The perception of the occurrence of a near-miss had an immediate effect on decision confidence. Confidence went down

when a decision event was perceived as a near-miss and went up when it was not perceived as a near-miss. A second level of feedback came from fellow guides. The average feedback received from others at the end of the day was ‘some moderate quality feedback’. The feedback quality was perceived to be slightly higher on good days (Table 18).

Table 18 Decision feedback

	<i>Near-misses</i>	<i>Good Days</i>
Quantity of feedback (1 = None, 3 = Some, 5 = Extensive)	M = 2.96 SD = 0.89	M = 3.19 SD = 0.69
Quality of feedback (1 = Low, 3 = Moderate, 5 = High)	M = 2.95 SD = 1.36	M = 3.42 SD = 0.81

5.3.3 The Relationship between Expertise and Decision-making

In this section I examined the relationship between expertise and decision responses in order to analyse the impact of five aspects of the participants’ decision strategies. Expertise was represented by 'hours of expertise' and the event reports provided the decision data. The primary focus was the impact that expertise had on the use of dual process decision-making, particularly the intuitive-analytical continuum. This was followed by an investigation of how expertise related to the strength and direction of the intuitive response expressed as feelings or somatic markers. I also examined how pre- and post-event confidence changed, based on the level of expertise. Lastly I analysed the role of expertise in perceptions of how consequence and luck influenced the decision process.

5.3.3.1 Correlation between Expertise and the Intuitive - Analytical Mix

Participants rated their relative use of intuition and analysis using Hammond and Summers’ cognitive continuum (1972). I used the Pearson correlation to measure the association between expertise and the intuitive-analytical continuum.

On good days, as expertise increased, so did the use of intuition ($r = -0.26$), albeit somewhat weakly. When near-misses were reported the correlation was slightly stronger ($r = -0.39$).

5.3.3.2 Correlation between Expertise and Strength and Direction of Intuition

A similar pattern was noted when the strength and direction of intuitive response was correlated to expertise. With increasing expertise, self-reported use of intuition became stronger and more positive (the feeling to do something). This correlation between expertise and strength/direction was somewhat stronger for near-miss days ($r = 0.38$) than good days ($r = 0.30$).

5.3.3.3 Correlation between Expertise and Confidence

Confidence was expressed on a scale from 100% (given a ranking of 1) to 50/50 (given a ranking of 6). There appeared to be a weak relationship between expertise and confidence *prior* to a good day and *after* a near-miss. Levels of confidence *prior* to a good day decision had a weak positive correlation to the measures of expertise (Table 19). After a near-miss there was a slightly stronger negative correlation.

Participants with lower levels of expertise had a greater drop in their confidence. The occurrence of a near-miss appeared to have less of an effect on the more experienced participants, perhaps because they have had a greater history of near-misses and subsequent opportunity to learn from those near-misses. This is consistent with Shanteau's findings (1992).

Table 19 Hours of expertise correlations with decision confidence

<i>r</i>	Hours of Expertise
Good Day Confidence – prior to event	0.252
Good Day Confidence – post event	-0.033
Near-miss Confidence – prior to event	0.117
Near-miss Confidence – post event	-0.321

5.3.3.4 Correlation between Expertise and Consequence

Participants typically viewed their decision environment as having the potential for serious and occasionally fatal consequences. On both good days and

near-miss days, the most likely consequence of a poor decision was an injury to a guest or guide (Table 20). The most likely consequence scale does not have equal severity increments between options. It reflects the reality of the possible consequences. There is no equal distance between dead and alive.

Table 20 Decision consequence and luck

	<i>Near-misses</i>	<i>Good Days</i>
Most likely consequence	M = 4.20	M = 3.89
1 = Loss of time	SD = 0.48	SD = 0.73
2 = Increased cost to the operation		
3 = Loss or damage to equipment		
4 = Injury		
5 = Fatality		
How lucky were you today?	M = 3.41	M = 1.93
1 = Not at all,	SD = 0.98	SD = 0.55
2 = A little,		
3 = Some,		
4 = Very,		
5 = Incredibly		

In contrast to the previous three correlations, multiple measures of expertise were used in the exploration of the measure of association between consequence and expertise. I found that the correlation between consequence and expertise was different when I used objective, as opposed to subjective measures of expertise. The objective (hours of expertise) measure showed a weak positive correlation with the perceived consequences on both good days and near-miss days (Table 21). However, subjective (self-rated) expertise, particularly self-perceived risk optimization skills, showed a negative correlation. Specifically on good days, participants who rated themselves as having had better risk optimization skills perceived lesser consequences.

Table 21 Good Day and Near-miss consequence correlations with expertise

<i>r</i>	Near-miss Consequence	Good Day Consequence
Hours of Experience	0.196	0.200
Self-rated Decision-making	-0.095	-0.048
Self-rated Risk Optimization	-0.102	-0.300
Self-rated Proficiency	-0.236	-0.198

5.3.3.5 Correlation between Expertise and Luck

On good days, more experienced participants were less inclined to attribute the outcome of the day to luck (Table 22). Level of expertise did not correlate however, with the degree to which luck was considered a factor when a near-miss occurred.

Table 22 Hours of expertise correlations with Good Day and Near-miss luck

<i>r</i>	Hours of Expertise
Good Day Luck and Hours of Expertise	-0.393
Near-miss Luck and Hours of Expertise	-0.066

5.4 Summary

In this chapter, I presented the quantitative data from the Background Experience Profile and the Event Report Questionnaires. I used the information provided in the Background Experience Profile to generate expertise profiles for the participants. I analysed the event reports with regard to differences between good days and near-miss days. In the final stage of my analysis, I examined how expertise related to the decisions made on both good and near-miss days. Expertise played a role in some, but not all of the decision parameters. Intuition was used to some extent in most decisions and was increasingly used by participants with higher levels of expertise. This relationship is analysed and discussed further in the next three chapters.

The quantitative analysis of my data provided clues for me to investigate through a more detailed qualitative investigation. The quantitative expertise data

merely suggests that the participants in my sample population have high levels of expertise. This was used as a starting point for the process of coding and the generation of themes. Drinkwater (2008) concludes that equating statistical significance with value or worth is not necessarily the only way that research can contribute to the development of knowledge.

The primary result of interest was how and when ski guides used their intuition. Avalanche professionals have been trained in the use of an analytical process in the forecasting of avalanche hazard. This process has been well defined and is widely used. Less well understood in the industry is the role that intuition plays. It was clear from the results that the participants usually used some element of intuition in their decision process. Based on the question format in the event report questionnaire, participants reported regular use of a 50/50 mix of intuition and analysis. The intuitive – analytical interaction is discussed further in the next three chapters. In Chapter Seven, it is analysed in relation to dual-process models rather than as a continuum. The analysis of how intuition was used prompted a question for future research, as the method of how intuition is fostered and developed has not clearly been addressed in the avalanche or mountain guide training programs.

Across a wide range of judgement and decision-making literature, there has been support for the notion that as expertise develops there is a corresponding increase in the ability to generate a more sophisticated and nuanced intuitive response (Benner, 1984; Dreyfus, 2004; Easen & Wilcockson, 1996; Hogarth, 2008; King, 2002). The pattern of self-reported, increased intuition use by the participants in this study had a weak positive correlation with an increased level of expertise. Minor variations were observed, which were likely due to the challenge of calculating expertise.

The general parameter that has been widely used in the calculation of expertise is a simple calculation of the number of years of experience. However Klein (1993) suggested the use of a more sophisticated analysis, so for this study on ski guides I used a more nuanced measurement to contribute to the explanation, which included a combination of years of experience, number of locations worked at, and engagement in continued professional development. I attempted to strike a balance between simplistic and complex methods of expertise calculation.

With 32 near-miss reports and 57 good day reports there were sufficient data to make a comparison between days when near-misses occurred and days when they did not. The evidence was strong enough to suggest differences between good days and near-misses and to provoke further questions of the qualitative data.

Three key results that emerged in this chapter related to the intuitive analytical mix, decision confidence and feedback. These issues have been addressed in the next three chapters, which focused on the analysis of the qualitative data and a discussion of the research question in relation to the literature. In other words, the event reports provided a springboard for further analysis and subsequent discussion with participants. It was an iterative process as the event reports triggered questions for the interviews: “what you mean by that and how does that actually play out”.

Chapter 6 Findings and Discussion - Qualitative analysis of decision-making filters using event report questionnaires

6.1 Introduction

A significant ontological shift occurred in Chapters Six, Seven and Eight, as I became the instrument of analysis. In Chapter Six and Seven, I used the lens of expertise to expand on the analysis of the decision process through a qualitative analysis of the questionnaires' open-ended responses and the first of two rounds of interviews. The critical theme in Chapter Six was the influence of a variety of filters on the decision process. The critical theme in Chapter Seven was the interaction between intuition and analysis, as described through actual decision events (good days and near-misses). I used the results from Chapter Five to provoke questions in Chapters Six and Seven, in which I used a qualitative data analysis process (Seidel, 1998) to generate a set of codes and themes based on the descriptive prose contained within the event reports and the first round of participant interviews. The interview protocol can be found in Section 4.3.2.4.3 on pages 120-124.

I used HyperRESEARCH software to aid me in the task of analysing the qualitative data from the interviews and prose embedded within the participants' event reports. As explained in Chapter Four - Methodology, this research used both an inductive and deductive approach to coding. Some of the codes were anticipated prior to the analysis while other codes emerged as data were analysed. The data codes are introduced as they fit within the thematic discussion.

One of my primary goals was to gain more information on the extent to which intuition played a role in the decision process, so I asked related questions both in the event questionnaire and the interviews. Generally the participants responded to this line of questioning, which allowed me to generate thick descriptions of the ski guide decision process (Denzin & Lincoln, 2003). My interpretation of what the participants said about their intuitive responses formed the basis for an in-depth understanding.

An example of the interaction between the inductive and deductive approach to coding was that I had expected the codes of Environment and Impact of

Environment to have a relatively high frequency, however during the analysis of the reports and interviews, it became apparent that the data codes Terrain Selection and Wicked Environment were more appropriate.

6.2 Discussion of Codes

I generated 41 codes. They are listed in Table 23 as per their frequency of use. The frequency of use was just one way to list the data codes and does not necessarily indicate their relative significance to the discussion. The significance of each code is discussed as it appears within the explanation of the themes.

Table 23 Code frequencies

Code Name	Frequency Number of Uses
Terrain selection	60
Expectations (Guests, self, peer, company)	53
Feedback (Environment, peers)	51
Intuitive response	41
Surprised by events	33
Near-miss	30
Analytical response	27
Wicked environment	24
Guests following directions (or not)	19
Margin for error	19
Intimate knowledge of the snowpack	15
Consequences	14
Uncertainty	14
Confidence	13
Different winter (abnormal conditions)	13
Teamwork	13
Terrain Choices	12
Intuitive confidence	11
Snow stability	11
Good Day	10
Persistent Weak Layer	8
Exploring new terrain	7
Reflection on the events	7
Analysis of data not enough	5
Experience (as a mitigating factor)	5
Avoid making hard decisions	4
Development of intuition	4
End of the day	4
Guest complaints	4
Age factor difference	3
Calibration of decisions	3
Committed to the line	3
Communication	3
False intuition	3
Human factors	2
Kind environment	2
Feedback on intuition	2
Familiarity	1
Open to new ideas	1
Environment	0
Impact of environment	0

Direct quotations from the qualitative data are used to illustrate the meaning of the codes. The codes are a distilled description of the participants' words. Collectively, these descriptions were interpreted to form meaning for the code. For example, 'Expectations' was one of the key codes that played into the participants' decision-making. Within this code, guest expectations figured prominently. The guests' expectations to ski more aggressive terrain were described by participants as difficult to deal with. Participants expressed their perception of the guests' aspirations for steep terrain in the following way. "We had a great day even though I was under pressure to give the people more challenging terrain" (Participant 305). The pressure from the guests to ski steeper terrain was so strong that one participant described how he went against his intuitive feeling. "My intuition was telling me to pick a mellower run, but due to the ability and keenness of the group I thought I would try to please them with a steeper, more extreme ski run" (Participant 106).

6.3 Themes

In the creation a narrative explanation of the ski guide's decision process, I formed the coded passages into six themes. The inter-rater provided feedback on the generation of the themes. These themes were: Environment, Complexities, Uncertainty, Process, Outcomes and Future Decisions. Table 24 displays the arrangement and interaction of the themes, codes and sub-codes. The Theme Map (Figure 13) provides a graphic representation of how the codes fit and link within the themes and how the themes link together within the decision-making process. Themes have been initially discussed in isolation. However each of these themes has a key connection with at least one of the other themes and this connection has been discussed. The initial three themes, Environment, Complexities and Uncertainty are grouped together as they represent filters through which the participants approached the decision process. They are discussed in this chapter and form the basis for the following chapter in which the decision process is analysed.

The three themes in the filter group represent the pre-conditions or modifying factors that influenced the decision process for the participants. The Environment theme created the context and formed the basis for a set of underlying principles that

the participants typically followed. The second theme included all the complexities that exacerbated the decision environment. The final filtering theme explored the degree to which uncertainty increased the degree of challenge. Incomplete knowledge within the decision environment forced participants to continually adapt.

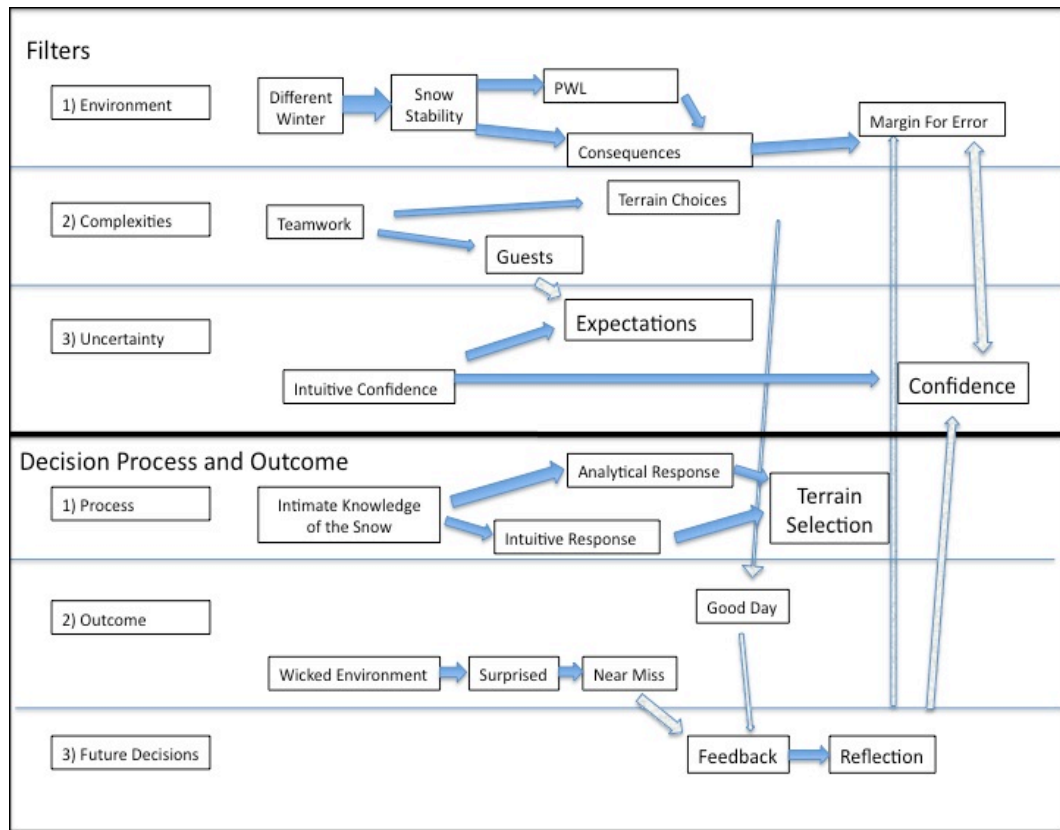
Teamwork (present/absent) and Guests (cooperative/uncooperative) are expressed as dichotomies as they are an ever-present aspect of the decision environment. For example some guests may be cooperative while at the same time others may not.

Although a conservative decision alternative should likely be the first choice, it is not necessarily always selected. Both guests and guides seek the thrill of adventure. It is an integral part of the heli and snowcat experience. With the higher than usual levels of uncertainty present during the 2008-2010 seasons, participants regularly expressed the desire to reduce exposure to avalanche hazard through conservative route selection.

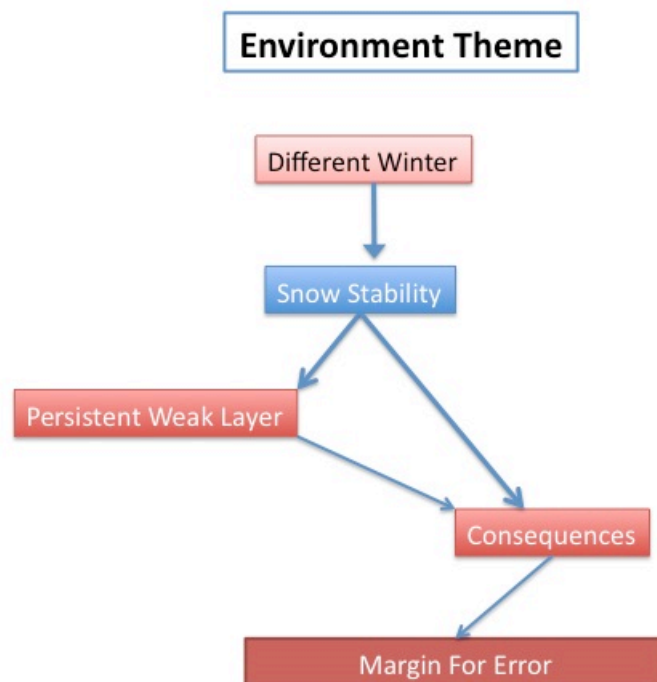
Table 24 Themes, codes and sub-codes

Theme	Code	Code	Code	Code	Code
Filters					
Environment	Different Winter	Snow Stability	Persistent Weak Layer	Consequence	Margin for Error
Complexities	Teamwork	Terrain Choices	Guests		
<i>Sub-codes</i>	<i>Present Absent</i>		<i>Cooperative Un-cooperative</i>		
Uncertainty	Intuitive Confidence		Expectations	Confidence	Margin for Error
<i>Sub-codes</i>			<i>Guests Self Employer Peers</i>		
Decision Process					
Process	Knowledge of snowpack	Intuitive	Analytical	Terrain	Margin for Error
<i>Sub-codes</i>		<i>IA Continuum Conservative choice</i>	<i>IA Continuum Conservative choice</i>	<i>Choices Stability Consequences New Terrain Guest Behaviour Guest Expectations</i>	
Outcome	Expertise	Near-miss	Surprise	Good Day	Feed back
<i>Sub-codes</i>		<i>Wicked Environment</i>	<i>Depth Layering</i>		
Future Decisions	Feedback	Reflection	Confidence		Margin for Error
<i>Sub-codes</i>	<i>Environment Skier Action Explosives Peers</i>				

Figure 13 Theme map



6.3.1 Environment Theme



I used the environment theme as a starting point for analysis, as it was foundational to all subsequent themes. It provided the context for both the decisions enacted and the analysis of those decisions. Five codes contributed to the environment theme. They included: the idea that the 2008-2009 and 2009-2010 winters were different from *normal* winters, the forecasting of snow stability, the existence of persistent weak layers, the potential consequences if caught in an avalanche, and the margin for error, or safety factor needed to maintain a prescribed risk envelope.

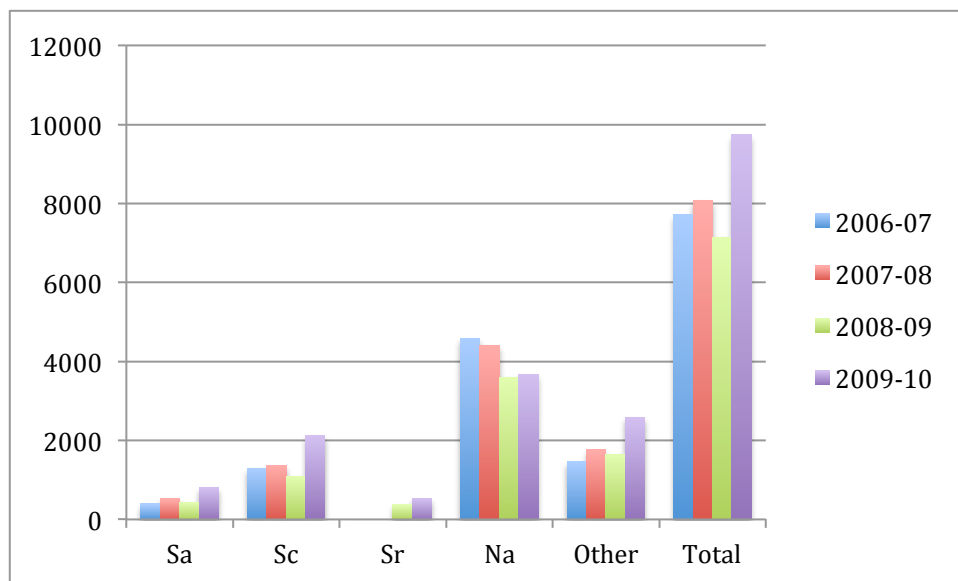
6.3.1.1 Different Winter

The winter prior to the start of this study (2007/2008) was described as a very difficult winter for commercial ski guiding operations in British Columbia. Persistent instabilities forced guides into rethinking the decision processes as to how this challenge was managed (Piché, 2008). However it paled in comparison to the following two winters, the winters of this study. The acknowledgement that all three

of these winters were ‘different’ was an ever-present component of the participants’ decision processes. The winters of 08-09 and 09-10 were different from ‘normal’ winters and yet similar to each other in that they were both plagued by persistence deep weak layers. However they were also different in that persistent weak layers formed by facet/crust combinations characterized the 08/09 season, whereas persistent weak layers formed by buried surface hoar characterized the 09/10 season. These two snowpack weaknesses are both notoriously hard to predict, but perform differently.

The forecasting team at the Canadian Avalanche Centre used the term “the new normal” (Klassen, 2010, p. 176) and summed up a mid-season warning with the suggestion that the avalanches that were occurring only happened once every 100 years. As such, no current avalanche practitioner had experienced the combination of snowpack and weather factors that were causing these events.

The number of skier triggered and the number of observed, naturally triggered avalanches from 2006 to 2010 within the InfoEx database provided an indicator of the challenge (Figure 14). During the 2009-2010 season, skier-triggered avalanches (S_a – accidental, and S_c – controlled) were more than one standard deviation higher than the four-year average; whereas the number of observed natural avalanches (N_a) during that season were almost one standard deviation below the four-year average ($N=3680$, $Ave=4066$, $SD=433$). This is an indicator of the difficulty of the decision environment in 2009-2010. InfoEx subscribers tended to get less environmental feedback in the form of natural avalanche activity and while at the same time more were caught in accidentally triggered avalanches ($N=807$, $Ave=540$, $SD=161$).

Figure 14 Number of avalanches reported in the InfoEx 2006-2010

(Sa - skier accidental, SC - skier controlled, Sr - skier remote, Na – natural)

6.3.1.2 Snow Stability

The assessment and forecasting of snow stability is central to the occupation of ski guiding (Bruns, 1996). Participants, as professional ski guides, had developed these skills over their careers, becoming highly proficient. This competence is demonstrated through the relatively few avalanche fatalities experienced in the heli-ski and snowcat-ski guiding industry as compared to recreational skiers and snowmobilers (Grissom, 2011).

Participant 311 described a typical guiding challenge as “To bring day skiing groups out in poor stability with limited terrain available after big storm”. Research indicates that ski guides are highly skilled when it comes to forecasting storm snow instabilities, but have greater troubles when it comes to forecasting the stability of persistent weak layers (Jamieson & Geldsetzer, 1999). The challenge as described by Participant 103, came from trying to determine whether “...a deep instability was ripe for triggering”. Atkins (2004), found that given the same stability rating, ski guides selected more conservative terrain when a PWL was present, compared to when a PWL was not present.

Research in other areas provides possible answers as to why. In a study of optimal decision choice (Schul & Mayo, 2003), it was found that study participants consistently tried to outperform a simple rule-based decision process. Even when

they knew that the decision rule worked, they thought they could do better by combining the access to more information and a greater use of intuitive thinking. Even though intuition might have been less trustworthy in an environment filled with uncertainty, copious amounts of information could be used to augment the analytical process.

Participant 104 stated, “The most important decision of the day was to open up a number of ski runs for guiding which had been closed to guiding for some time due to persistent instabilities”. The difficulty in forecasting these instabilities over these two seasons was illustrated by the frequency that participants who were surprised by the extent of propagation of avalanches on persistent weak layers (PWL).

6.3.1.3 Consequences

Consequences were directly related to the depth of a potential failure plane and the terrain into which the avalanche could run, with potential fatalities attributed to both asphyxiation and trauma (Boyd, Hägeli, Abu-Laban, Shuster, & Butt, 2009). Grímsdóttir and McClung (2004) found that ski guides considered potential consequences as the primary factor when selecting terrain. The vulnerability of the element at risk also played a role. For example a skier standing above a large cliff can be swept off the cliff by a relatively small avalanche, whereas a group of guests riding uphill in a snow cat may be unaffected by a larger avalanche. Participant 103 described being hit by a small avalanche that might not have caught him had he been moving. “It was a small slope and a small slide. If I were carrying speed instead of standing sideways when the avalanche triggered, I likely would have skied off it with no consequence.”

The most likely consequence reported in most of the near-miss events and many of the good day reports was injury to a guest or the guide. Consequences with this level of severity were regularly accepted as a trade-off in the quest for better skiing. “[I] chose to ski the untracked snow with my group, which is the line, exposed to the most overhead hazard” (Participant 404). This was likely motivated by the risk – reward conundrum. Participants had to decide whether the likelihood of a negative consequence was balanced by the possibility of better skiing.

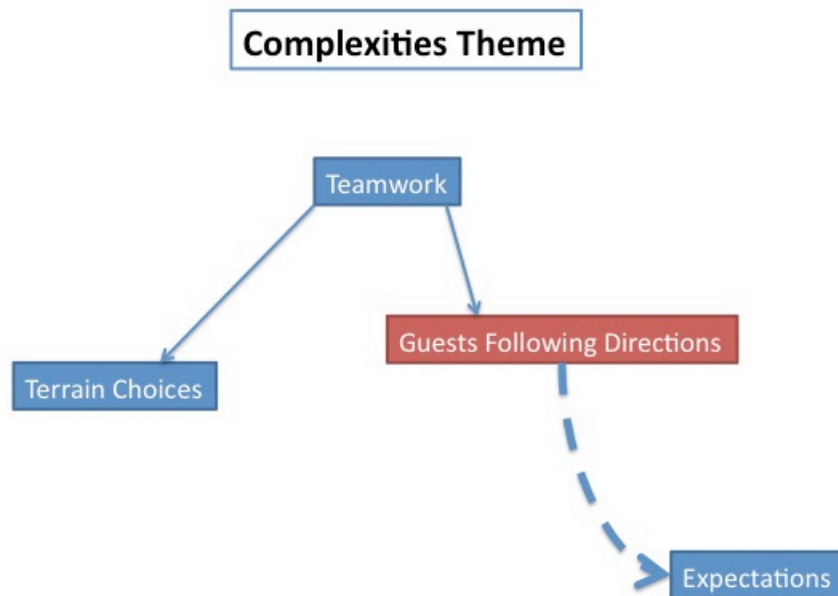
One member of guiding team wanted to ski a particular run with unlikely, but potential overhead consequence (rated yellow). Other group experienced a skier remote release on a different slope. My role (decision) was to argue against the choice to ski under the potential risk (remote triggering). We skied a different option. Participant 103

6.3.1.4 Margin for Error

The consequences of a release on a deep PWL were much more severe and played a direct role in the determination of how large a buffer was needed to avoid catastrophe. In practice, participants anticipated that if they made a poor decision, it had a high likelihood of a severe injury, a fatality, or even multiple fatalities. Elements of the environment theme, specifically the snow stability and the presence of a PWL provided the initial indicators of how large the margin, or safety factor might need to be when terrain was chosen. However this was modified by four codes contained within other themes. Two codes within the Uncertainty theme, Expectations and Confidence, were consistently linked to the concept of the need to maintain an adequate safety margin. Two codes within the Future Decisions theme, Reflection and Feedback, were also connected to the Margin for Error code.

The difficulty experienced by participants in the forecasting of the triggerability of persistent weak layers may have been exacerbated by a number of issues. Participants might have been reluctant to acknowledge that their apparent command of large volumes of data did not provide a complete answer to the PWL question. There were also questions as to the reliability of their intuitive response in this wicked environment. The decision process is the focus of a theme in the next chapter and explores the intuitive – analytical interaction in the terrain selection process.

6.3.2 Complexities Theme



The complexities theme is a collection of codes that describe the need for a subtle and nuanced response to decision-making. These complexities are partially to blame for reasons why expert decision-making in avalanche terrain has not been managed by rule-based protocols (Hägeli et al., 2006). It also helps to explain why principle-based decision-making can accommodate this large range of contingencies. These complexities come from interactions with fellow guides, guests and the environment.

Teamwork was an important support structure that helped the participants to make better decisions and learn from those decisions. Poor teamwork, or the absence of teamwork reduced feedback opportunities. The implications of this are explored in the Future Decisions theme in the next chapter.

The guest interactions posed a complex human dynamic. The participants expended considerable energy in the management of these dynamics. Guests had expectations that may or may not have been realistic given the conditions. Participants described how they were careful in their communication strategies to

ensure that safety was not compromised. Piché (2008) described how during the 2007-2008 season guides gave up on trying to find fresh snow and ensured that they communicated the difficulty of finding safe terrain, let alone safe untracked terrain.

The final code within the complexities theme was linked to terrain choices. Participants described how they avoided some difficult decisions by choosing simpler terrain. They recognized that they just did not need to go there. At the other end of the terrain scale, some participants were working in terrain new to them and took on an exploratory approach to terrain decisions.

6.3.2.1 Teamwork

The participants worked in a team environment for most if not all of the time. Virtually all mechanized ski companies operate with a minimum of two guides and can have up to twenty-five guides working together. As described in Chapter Two, these guiding teams typically use a consensus style of group decision-making. Participants described events that were affected by both good teamwork and poor, or absence teamwork. Good communication and shared common values amongst team members created a supportive group decision-making environment. Correspondingly, a lack of these characteristics has the potential to add considerable complexity to the decision process (Surowiecki, 2004).

6.3.2.1.1 Good Teamwork

The synergy of effort in good teamwork contributed to a safe, efficient operation. Participant 404 described her comfort level with a particular ski run because of the “confidence from the guide’s team about stability and little potential for remote triggering”. Within the team setting, the participants’ abilities to give and receive feedback were highly valued. “[I have] excellent trust in the human side of the boys I work with” (Participant 502).

Open discussions amongst the guiding team during the day provided the basis for collaborative decision-making efforts. “Discussed run with junior guides at lunch and thought I’d go ahead and take a look, but decided to leave it alone today” (Participant 708). “We did discuss it at our lunch guide meeting, seems a reasonable choice” (Participant 708).

6.3.2.1.2 Poor or Missing Teamwork

At times, teamwork was low quality or missing completely. Participant 708 described the team culture as playing a role. “No implication to safety for the day so who really cares, implication only relates to the work place culture that may have long-term cultural implications” (Participant 708). Participant 104 described in a near-miss report, how the absence of teamwork was a contributing factor. “Lack of organization the day of [the event]. Lack of control over public/off duty staff on the mountain”.

Participant 106 described a near-miss event that occurred when a group of independent guides were working at a popular backcountry ski touring destination. These guides were not working together *per se*. They had their own groups of guests and did not have a common company that they were all working for.

Complete "brainfart" regarding working as a guiding team while working as an independent guide among them. One group was triggering avalanches below Bow Hut. Myself and a Mountain Guide thought, "wow" look at the natural activity going on across the valley near the moraines. In actual fact, the group leaving the hut was triggering the slides at/or near the group. If we were more on it, we would have raced down below the hut to see if the guide/group were OK, rather than dismissing it as "natural" activity and continuing on with our routes and plans.

The operational context was missing. Had they been working together for the same company, they would have likely benefited from increased communication and expectations of teamwork.

6.3.2.2 Guests following directions

The degree to which guests followed the directions, which the participating guides thought they had given, played a significant role in the complexity of the decision scenario. A guest's failure to follow the guide's directions can be caused by poor communication or wilful disobedience. Grímsdóttir and McClung (2004) reported three possible explanations for guests not doing what the guide expected them to do: intentional disobedience, a lack of ability, and an inappropriate response to a warning. Participant 103 described how a group of guests forgot or were unable to maintain the spacing that he had asked of them, with a near fatal consequence. “It was decided to ski a run at wide spacing. Group control was lost and skiers were

close together and on top of each other. There were 2 simultaneous Sa [Accidental, skier triggered avalanche] 1.5 and 2.0 with one ride and partial burial”.

6.3.2.2.1 Cooperative Guests

The importance of the guests being given clear directions, understanding those directions and following the directions was a critical element that linked to terrain choices. This was particularly important when the safe terrain option was a narrow strip that threaded between potential trigger spots. Participant 101 described the need for good “group management, and how they skied through tricky pieces of terrain”. These guide – guest interactions were categorized as positive, promoting good cooperation, or negative, promoting a lack of cooperation. The efficiency of the day was affected by the quality of communication between the guide and guests. Good communication led to cooperative guests and more skiing.

I stopped early to tell them to stay on the ridge and not in the gully (gully feature is small and insignificant looking until it releases). We skied the ridge and coming down to the bottom I looked over and saw 2m of debris beside me spilling out of the gully. Participant 702

6.3.2.2.2 Un-cooperative Guests

When the participants did not trust the guests to follow their directions, a more conservative line of descent was often the only recourse. “In hindsight [I] remember questioning the ability of my group to maintain ‘the line’ as they were a weak group. Don’t take it for granted that the group will do what I expect them to” (Participant 404).

A more conservative line often only served to make the situation worse when dealing with a guest who wanted to ski more aggressively. “[There were a] few aggressive individuals who liked to push the limits of any restrictive instructions on how we planned to ski a run” (Participant 103). Wilful disobedience can often be blamed on a lack of trust between the guide and guest. A guest who sees a potentially enjoyable ski line outside of the guide’s safety parameter, may choose to ski that line if he feels that the guide is being too conservative.

The guests were not completely cooperative in heeding the warnings to ski cautiously in shallow snow areas. I was not fully certain that the message to ski slowly and under control in an area with near surface hazards was fully

comprehended by all. There was some reckless, fast skiing and several crashes. Participant 103

Miscommunication can be attributed to either the guide issuing poorly worded directions, or the guest failing to understand the directions. Although none of the participants in my study expressed a concern with language skills, many guests do not speak English as their primary language and many guides do not speak a second language, so the interpretation of body language may be an important method of communication. Participant 103 summed up his methods of managing guest behaviour, suggesting that “if there are difficult skiers to control, address the issue early by talking privately with the individual(s) or the group as a whole. I will deal with skier behaviour issues early and as they are presented”.

6.3.2.3 Terrain Choices

Many companies are fortunate to have tenures with a large enough variety of terrain to provide a high quality experience, even when the avalanche hazard is high or there has been a lack of new snow for an extended period. “I try to make guiding as easy as possible. Do I really have to go there when I have all these other options that are easier and simpler?” (Participant 106). Many of the participants expressed relief in not having to make difficult stability decisions by having the option to move to less hazardous terrain. They choose to avoid difficult decisions when faced with high levels of uncertainty. “We have so much terrain. We are only running one group. It’s pretty easy we can just avoid terrain... It will be there tomorrow. There is nothing that so important that we need to ski it today” (Participant 201).

When the number of untracked, high quality, safe ski runs became limited due to extensive skier traffic, participants were tempted to explore terrain that was steeper or more hazardous. “[I chose] to ski a short pitch in a cutblock where snow pack was shallow and near surface hazards existed; as opposed to skiing on the snowcat road where those hazards would be avoided” (Participant 103). Participant 503 summed up the Terrain Avoidance code by saying “a lot of it is having that self-composure to say we don’t need to be here. Let’s just go somewhere else, where it is unicorns and rainbows”.

From my personal experience, exploring new terrain can be an exciting part of the ski-guiding job. Known as on-sight guiding, it is a significant component of

the ACMG examination process. Aspirant guides are assessed as to their competence in selecting safe options when in terrain they have not seen before. This ability to apply previous knowledge and pattern recognition to new terrain is a key guiding skill (Association of Canadian Mountain Guides, 1999) and is likely influenced by the concepts of adaptive expertise (Tozer et al., 2007).

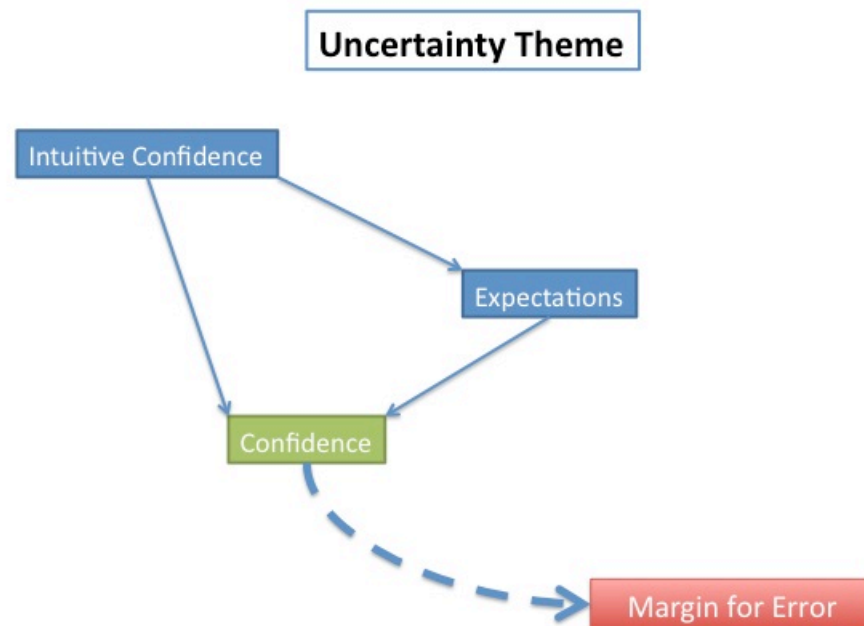
Participants who worked for new companies, or companies that added new terrain to their commercial tenures had the opportunity to evaluate terrain in terms of its potential for new runs. New guides to a company are in a similar scenario as they generally lack familiarity with the company's existing terrain. Some of the necessary exploration and terrain familiarization will happen during training and operational set-up weeks, however guides will end up entering terrain that they have not skied before, accompanied by guests. In the Process Theme described in the next chapter, the participants explain how an intimate knowledge of the snowpack and how that snowpack varies across the terrain is important. A lack of intimate terrain knowledge can be a limiting factor. Entering unknown terrain with guests typically required an adjustment to the desired margin for error.

Knowing this place so well, we have a better historical overview and feel for how the snow lays on there and how you ski it. When we go out into the new terrain that hasn't been skied so much and we don't know the history, we just need to pull in the reins and dig a lot more profiles and get some data. Just not knowing the terrain so well, you just have to take it conservatively. We are still exploring terrain. New runs every time we go out. Participant 101

6.3.2.4 Summary

The primary sources that made decision-making more complex were: the fellow guides, the guests, and the terrain. These fluctuating elements forced the participants to continually adapt and modify their decision process. Strategies that provided successful resolutions included: beginning with a strong sense of team effort, moving into a recognition of when terrain can and cannot be avoided and finishing with clear and on-going communication with the guests.

6.3.3 Uncertainty Theme



The uncertainty theme formed the core of what generated stress and made decision-making hard for ski guides. Uncertainty may have had a cumulative effect for the participants, as it was attributed to a variety of sources. In this study, as part of the event questionnaire, participants were asked to ascribe the source of the uncertainty to three categories: conflicting alternatives, low situational awareness, or incomplete information (Lipshitz & Strauss, 1997). These initial conditions of uncertainty were modified by the decision makers' initial level of confidence prompted by the immediate intuitive response and then further modified by the conditions or the expectations placed on the decision maker. Levels of confidence were expressed both before the decision event and afterwards.

6.3.3.1 Sources of Uncertainty

The physical environment was dynamic, as the snowpack stability was constantly being modified by the weather. The distribution of the snowpack across the terrain, the changes occurring within the snowpack and changing weather

conditions served to create an environment plagued with uncertainty. The most significant source of uncertainty expressed in the questionnaire was dealing with conflicting alternatives. This revolved around expectations placed on the participants by guests, other guides and the company.

The challenge for the participants was to provide a high quality experience that met the preconceived expectations of the guests within a context of weather and snowpack characteristics that were not necessarily conducive to achieving that goal. The most common conflicting alternative was that the guests want to ski steeper terrain, but the guiding team's assessment of the stability suggested a more cautious approach. During times of poor stability, participants described the struggle to find good quality skiing and avoid avalanches. "We had seen very poor stability. Na [natural] avalanches and skier triggered avalanches in low angle and surprising places. Snow conditions were poor. [We were] trying to find the best snow but "safe" terrain" (Participant 708).

Poor weather conditions also served to add uncertainty and significantly constrain terrain options but were likely more easily understood by the guests. "[I was] not certain of the terrain due to limited visibility" (Participant 310). "We were a 'heli-assisted' ski touring group, so because we had only had one lift in the morning we did not have a good sense of what the winds were doing and how bad they were" (Participant 404). Both heli-ski and snowcat groups were negatively affected by poor visibility on the ground. However, heli-ski guides were further constrained by poor flying weather. "Due to weather we were only able to ski the same 2 short runs all day" (Participant 608). Heli-ski research participants recognized that pushing the pilots to get to places was counterproductive, as it increased the likelihood of a crash.

The weather was threatening mid-day and even though the guests were anxious for more skiing after a difficult wx [weather] week, I flew closer to base to assess the approaching storm. Skied two more runs close to home and then the weather pushed us home for the afternoon. . . Potential for a helicopter incident if the decision was to "push" for skiing by flying in poor wx. Participant 703

The most prevalent factors that led to a reduced situational awareness, or provided incomplete information, were knowledge of what was happening in the

snowpack and how that snowpack varied over the terrain. “There was some uncertainty with the reaction to the four layers of SH [surface hoar]. The temps were playing a roll with ski penetration and reactivity” (Participant 101).

[I] wasn't comfortable with skiing more aggressive terrain, with limited knowledge of the terrain and poor confidence in the snowpack, too [sic] much SH [surface hoar]! A bit uncertain on my decision not to ski the headwall because of my lack of knowledge of the terrain, except that there was a skier accidental size 2 the week before. Participant 202

6.3.3.2 Intuitive confidence

The literature suggests that confidence based on an immediate or growing intuitive response has a strong influence on the decision process (Simmons & Nelson, 2006b). It was not unusual for the participants to have an increased feeling of confidence based on an absence of class one stability factors (McClung & Schaerer, 2006). These class one factors of natural and skier-triggered avalanches provided immediate and tangible feedback to the on-going decision process during the day. A lack of analytical data related to the probability and consequence of avalanches supported a greater reliance on intuitive responses. In the absence of direct environmental feedback, intuitive confidence may have increased, prompting the participants to seek out more aggressive terrain, even though the hazard still existed.

I was kind of wondering at the time if we would get that awful surprise. We weren't seeing anything... For a long time we were worried about remotely triggering things. We were avoiding that kind of terrain for so long. We kept saying “caution shallow areas”, but we were not seeing it. We were building confidence on that. Maybe it's not as bad as we think. I was wondering are we going to get caught with our pants down. Participant 404

At times, the perception of improved stability grew based on a lack of direct evidence; there were no avalanches occurring. This perception of reduced avalanche hazard permitted an adaptation to the use of terrain. Guides began to venture into terrain, which was capable of producing avalanches, or bigger avalanches. “It really settled things out. You start to build up your confidence. You start going bigger, bigger, bolder” (Participant 503).

Obviously as we're watching that facet layer develop in December, everybody was thinking... we thought we had trickiest winter over with last year. And now all of a sudden we are starting the same pattern. Then in

January we didn't have that much snow, and so all of a sudden, the stability [got better]. We were getting pretty confident. Participant 404

Participants had to constantly remind themselves that the absence of negative feedback was not the same as the presence of positive feedback.

Just because it's good doesn't mean it's good. Just because that was good today doesn't mean it will be good tomorrow.... It's been good for three weeks. Doesn't mean it's not going to get enough weight and finally crack the eggshell tomorrow. Participant 201

A lot of it is having that self-composure to say we don't need to be here. Let's just go somewhere else, where it is unicorns and rainbows. I know it is going to be good. Lets go with the sure thing instead of the maybe. Maybe is not good enough in this business. Last year it felt like maybe was not a good idea. Participant 503

6.3.3.3 Expectations

There were many expectations placed on the participants. The primary source of these expectations was the guests, but participants described additional pressure from other sources including, fellow guides and company management. Due to the high profile and high cost of mechanized skiing, the participants considered guest satisfaction a high priority. Heli-ski and snowcat skiing not only attracts an affluent clientele, but also one that is highly skilled in downhill skiing or snowboarding (Harley, 2002). The expectations and pressure expressed by the guests, typically to ski more technically challenging terrain, had the potential to exert an influence on the decision process.

However, the degree to which guest expectations exerted an influence on the decision process was determined by the decision maker's adaptation to these perceived and perhaps self-generated expectations. "My intuition was telling me to pick a mellower run, but due to the ability and keenness of the group I thought I would try to please them with a steeper, more extreme ski run" (Participant 106). "[I was] feeling pushed to ski a yellow run but decided not to get pushed" (Participant 311).

When an incident occurred, it was easy to place blame on the negative effects generated by the guests' expectations. However it was the guide's perception and response to these expectations that had placed people at risk.

[I] felt very confident in the snow stability and the fairly confident in the families ability, good skiers, but my decision to ski it as the 1st main run of the day, with an easier option to warm up on that I passed by, was a poor guiding decision on my behalf. I think my motivation to impress the youth (considering it was the owners family) and challenge them affected my guiding program. Participant 202

When the ski program was limited by avalanche hazard or poor weather conditions to conservative and or tracked out terrain, the participants felt pressure through guest comments to deliver a better product. “[The] decision was to continue with skiing mellow, skied terrain and not being tempted to venture out of our skied, lower angle terrain. The terrain was very much skied out” (Participant 104).

6.3.3.3.1 Guests

Guest expectations were divided into two categories based on the skiing ability of the guests. Advanced skiers wanted advanced terrain to match their skills. “[I had] aggressive guests who want to ski steep” (Participant 404). A question that this research has not addressed, but is likely a factor, is the origin of the expectations, as the promotional material of most if not all operators have candid explanations of the need to balance ‘steep and deep’ with safety (Canadian Mountain Holidays, 2007). Yet over the two years of the study, guides expressed their feelings of regularly being pushed by the guests to take them into more aggressive terrain. With technical skills honed by the steep terrain available at many ski hills, many guests had the ability to ski steep (in excess of 38 degrees) terrain. As the likelihood of triggering an avalanche increases as the slope angle approaches 45 degrees, the desire to ski steep was not always a good match with the desire to stay alive.

However, not all guests were expert skiers. Some companies cater to first-time heli-skiers. These skiers did not have the technical skills or fitness to exceed the safety-related terrain limitations, but created other decision-making challenges.

6.3.3.3.1.1 Aggressive – high ability guests

Participants described being caught between the guests’ expectations of skiing aggressive steep terrain and the need to manage the avalanche hazard. “It was a fine line between providing them with exciting runs and scaring them in a near-miss avalanche” (Participant 106). “Based on slope history and current snow pack

decisions, [I] avoided a very tempting ski line much to the dismay of [the] guests” (Participant 715). Guests frequently expressed their desire for steeper skiing. “They had a specific idea of what they wanted and were critical of every element from small to big” (Participant 501). Even when guests did not explicitly express their concerns, participants were aware of the issue. “German guests were not happy with the skiing. They were only talking in German. I felt pressure to give them more” (Participant 304).

The pressure to ski was compounded by poor weather. Both daily operations and weekly operations had times when they were challenged by poor weather and had difficulty providing a quality experience. “The guests were anxious for more skiing after a difficult wx [weather] week” (Participant 703).

Less experienced guides might have felt the pressure more than the seasoned veterans, as the coded responses included fewer responses from the most experienced guides. Solutions to the issue were described in the following ways. “I have re-emphasized good dialogue with clients” (Participant 501). “Focus less on providing quality over safe skiing” (Participant 404).

6.3.3.3.1.2 Low ability guests

Occasionally, participants were dealing with guest abilities at the other end of the spectrum. Participant 103 described the need to select easier ski conditions for one of his guests, however it necessitated accepting an elevated level of risk. “We decided to ski the most dry and soft snow especially to suit the needs of one special guest skier (quite lame in the legs), which meant northerly slopes (and PWL's)”.

When there are three or four groups sharing one helicopter, it is possible for fast groups to pass slow groups. “[We stopped] intentionally to let [an] other group lap us while I was giving one guest in my group a chance to catch her breath” (Participant 304). A group with one or two weaker skiers can be more difficult to manage than a group, in which all the skiers have weaker ski skills, as a ski group tends to move through the terrain at the speed of the slowest skier.

6.3.3.3.2 Self

Perhaps the greatest pressure came from within the guide, in his or her desire to do well and provide high quality service. “[I was] feeling pressure to “turn it up” from the guests and from myself” (Participant 311). Participants expressed a desire to please the guests by providing them with an exceptional experience. “Part of me wanted to send them home with a great and exciting last run, when they probably would have been happy with another, less committing line” (Participant 106). Often what was perceived, as pressure from the guests was just an inaccurate reading of their needs or desires. “[I] felt pressure from the guests. In retrospect, there was absolutely no pressure from the guests” (Participant 304). “I think my motivation to impress the youth (considering it was the owners family) and challenge them, affected my guiding program” (Participant 202).

At times, a competitive element may have played a role. If one guide skis a bigger, bolder line, another guide’s group may express the desire to do the same. “The challenge was that the group sees the other line, why aren’t we skiing there etc., Personal feelings of not giving my group the same level, but good feeling that for me it was the right thing to do come home!” (Participant 708).

Personal motivation also played into the decision. Guides are skiers too, so when the skiing was good they wanted to push it a little. “The snow pack was bomb proof and I wanted to ski the line. The lead guide already skied a great run that we could see” (Participant 202). “I decided to ski a run that I am not very familiar with in the quest for good skiing” (Participant 508).

Participants recognized the pressure to go against their better judgement and made conscious decisions not to give in to it. “Yes, I want to follow the program more and not step out of it to please guests. Quite often, I think I pressure myself more than they actually pressure me into doing certain things” (Participant 304). Participant 304 summed it up with: “The guests get what they get. I should never pressure myself in skiing certain slopes just to please them”.

As a service industry, the ability to provide high quality service is often rewarded financially through tips. The effect of tipping was not included as part of this research primarily because participants were reluctant to talk about it, even though an argument could be generated that tipping has a potential influence on

terrain selection. This would be a significant research project in its own right, so it is outside the scope of this research.

6.3.3.3 Employer and Peers

Employers and peers had expectations of performance. Participants recognized that the logistics of running a heli-skiing program are considerable, as they are heavily dependent on equipment for transportation. The breakdown or inefficient use of this equipment had the potential to turn a profitable day into a significant loss. Participants expressed feelings of stress when they used excessive flight time, as at \$0.50 to \$1.00 per second, it did not take long for indecision to become a financial burden. “[I] had to pick a run to ski after twelve minutes in the air flying around and not going anywhere” (Participant 304). This was \$720 worth of indecision. “[I] felt guilty flying around and not able to find a landing with good snow” (Participant 602).

6.3.3.4 Confidence and the Link to Margin for Error

Within a theme of uncertainty, confidence went up or down depending on the above described factors. As explained in Chapter 5, the feedback implicit within an outcome had a moderating effect on confidence. Confidence went up at the end of a good day and went down after a near-miss. The uncertainty within the decision challenge was likely magnified by the pressure exerted through expectations, be they guest, peer, or self-generated. The final level of decision confidence prior to the enactment of a decision created the desired margin for error.

Strong-willed guides were able to resist the perceived demands placed on them and focus on the challenge of selecting appropriate terrain, with the goal of optimizing the quality of skiing in relation to the level of risk. One participant described how he had the confidence to resist both a personal and guest expressed expectation to ski a particular run. He and another guide were fortunate enough to get direct feedback on the sensitivity of triggering an avalanche big enough to kill someone, but with no negative consequence, as their margin for error was just big enough.

Based on slope history and current snow pack decisions, [I] avoid very tempting ski line much to the dismay of guest. Two runs later, a group skiing

within 10m of the slope remotely triggered the slope resulting in a size 2.5 avalanche. Participant 715

6.3.4 Summary

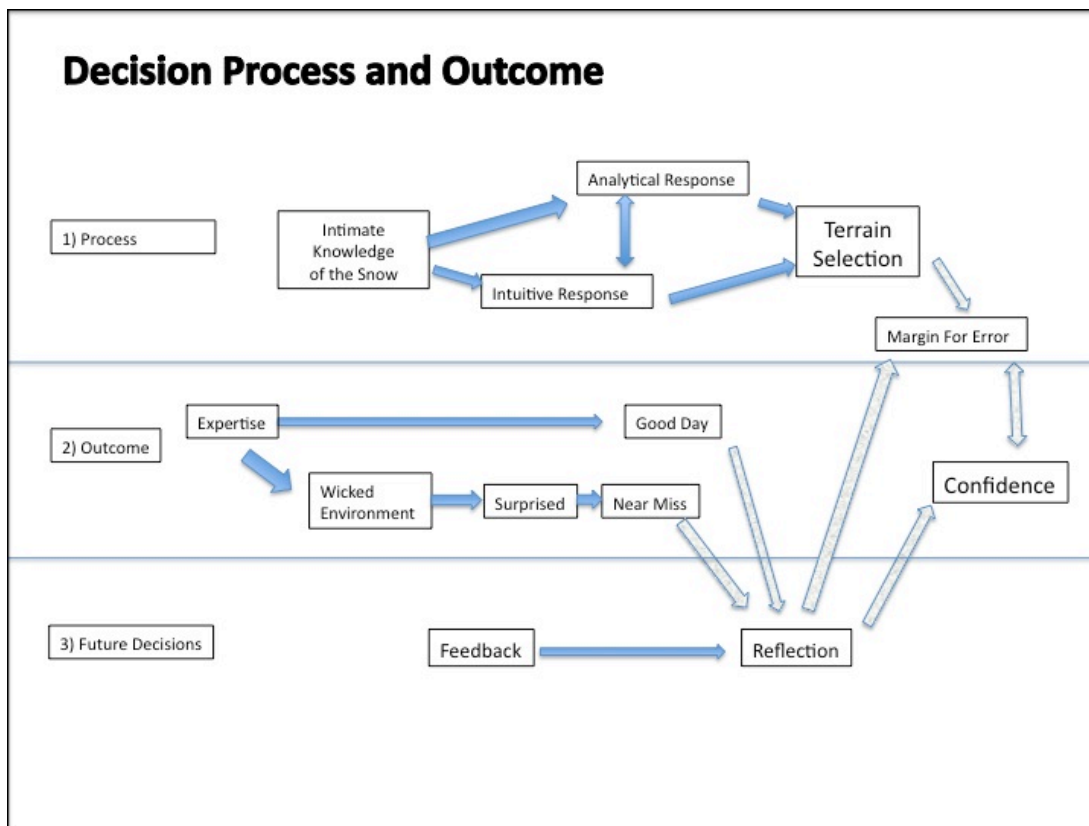
The Environment, Uncertainty and Complexities themes formed the fundamental challenges for the participants. It was incumbent upon the participants to view the decision environment through the lens of these challenges. They needed to interpret the baseline environment, accommodate the various complexities and assess the degree of uncertainty. The nature of the environment during the winters of 2008 to 2010 was so complex that it forced the participants to adapt. Some participants may not have had sufficiently rich repertoires of pattern memories to accommodate the full breath of challenges. These three themes form the basis for the following chapter, in which the decision process is analysed. The sequential and iterative process of decision – outcome – decision forms the framework for Chapter Seven.

Chapter 7 Findings and Discussion - Qualitative analysis of the decision-making process and outcome using event report questionnaires

7.1 Introduction

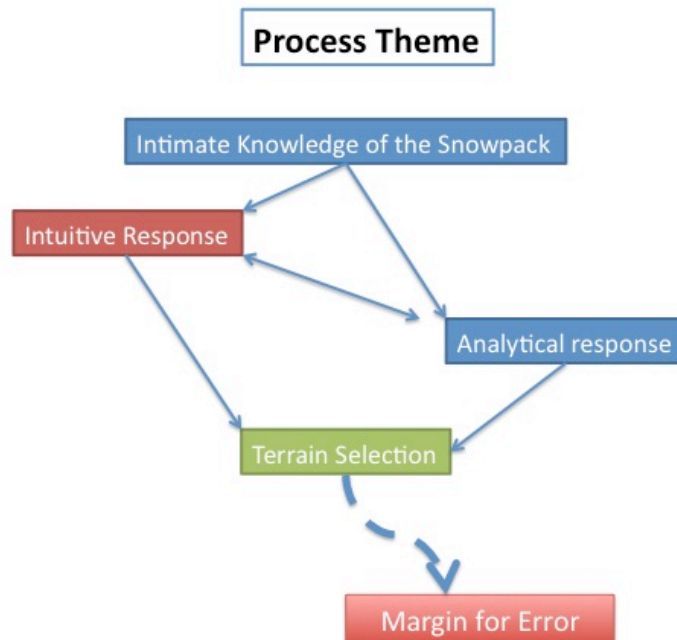
The cyclical nature of the decision process, as displayed in Figure 15, was central to the three themes presented in this chapter: Process, Outcome and Future Decisions. The filters presented in the previous chapter framed the challenges within the decision environment and formed the basis for a discussion of the findings presented in this chapter. The primary theme presented in this chapter is the interaction between intuition and analysis within the decision process. This interaction between the intuitive and analytical responses was bracketed by the participants' depth of knowledge of both the snowpack and the terrain. Although there were rarely precursors to indicate whether a day would end up poorly, reflection on the day's outcome helped the participants to anticipate future decision challenges. The participants' reflection on the feedback that they received was instrumental in shaping future decisions.

Figure 15 Themes map - decision process and outcome



7.2 Themes

7.2.1 Process Theme



The analysis of the process theme centred on a blending of possible decision responses generated through intuition and analysis as described by Evans (2010, 2011). An intimate knowledge of the qualities of the snowpack and the intricacies of the terrain were intertwined throughout the participants' application of intuitive and analytical responses. Safe skiing terrain was chosen based not only on the shape of the terrain, but also the participants' understanding of how the snowpack had developed on the terrain over the season. Numerous localized variables within the snowpack had to be interpreted by the participants.

I felt that I was on a safe terrain feature and there was little risk for me to investigate the ski line. I miss-judged the spatial variability of the SH [surface hoar] layer thinking it was not in this wind exposed location, and in any case did not think the bench I was on was steep enough to slide.

Participant 608

7.2.1.1 Intimate Knowledge of the Snowpack

The guide's knowledge of the snowpack as it evolves over the winter is one of the cornerstones of commercial ski guiding risk management (Association of Canadian Mountain Guides, 1999). Watching weak layers develop and change over time is key in the interpretation of snowpack stability. Atkins (2004) created an avalanche characterization checklist to aid in the assessment of potential avalanche character. The intent was to strengthen the connection between stability assessments based on knowledge of the snowpack and risk management choices in the selection of terrain.

Participants made it their job to be familiar with what was going on within the snowpack. “[I] got in and made an assessment that we were not affecting the layer of concern. And surface instabilities were not yet a problem” (Participant 101). They maintained an awareness of the history of the season. During times of changing conditions this was a challenge. “We did not have a good sense of what the winds were doing and how bad they were” (Participant 404).

The participants' knowledge of the terrain and the history of the season's snowpack on the terrain aided the decision process. “Based on slope history and current snow pack decisions, avoid very tempting ski line much to the dismay of guest [sic]” (Participant 715). The knowledge that certain layers were weak or poorly bonded provided a starting point, or anchor and allowed the participants to seek out information, which would fill any potential gaps in their knowledge. “[We were concerned about] 2 buried SH layers and a weak FC CR [facet crust] basal layer, [and the] critical threshold load on these layers after large storm with wind [sic]” (Participant 605). Although the on-going familiarity with the intricacies of the snowpack provided an anchor from which to generate a stability forecast, it was a self-generated anchor and thus susceptible to insufficient adjustment (Epley & Gilovich, 2001). To avoid this trap, participants had to be cognizant of the uncertainty in their original forecast. “There was some uncertainty with the reaction to the four layers of SH. The temps were playing a role with ski pen and reactivity” (Participant 101). In this way they were able to make adequate adjustments to their stability assessment when conditions changed.

7.2.1.2 Intuitive Response and Analytical Response

In my initial analysis and coding process, I created separate codes for the intuitive responses and the analytical responses. I have grouped them together to facilitate analysis in terms of Dual Process theories (Evans, 2008). Within these responses there are specific intuitive references, specific analytical responses and dual process responses. One additional aspect that stood out within the intuitive responses was a large number of conservative choices.

The way in which the intuitive and analytical processes interacted was central to the decision process used by the participants. Rule-based decision-making, such as that advocated for novice avalanche decision makers is not widely used within the professional guiding community (Hägeli et al., 2006). An overriding trend from the data was the intermingling of the intuition and analysis. Occasionally a decision was attributed to a fully intuitive process and more rarely, a decision was attributed solely to a fully analytical process. The majority of the time the two processes were used together.

Participants described a give and take between intuitive and analytical modes. “[I] listen to my intuitive sense more, and weigh it against my analytical decision-making” (Participant 202). There was regular discussion of the interaction between the two processes. “My intuition was saying, ‘maybe this could slide’ but logic said, it is a planar 25-degree slope, it's OK” (Participant 708). This is in harmony with the quantitative data as described in Chapter Five, suggesting that both processes are used in most decisions. “My intuition said the bench was safe terrain, and upon investigation my analytical decision was not to ski the line but return to the group and ski on the ridge” (Participant 608).

7.2.1.2.1 Intuitive Response

Participants had a variety of ways of describing the intuitive response, but generally it came down to a feeling. This feeling was expressed both positively and negatively, either as good feelings or bad feelings and was generally related to risk management. The good feelings promoted an inclination toward entering more aggressive terrain, while bad feelings inhibited that tendency.

Participant 305 described an intuitive feeling that avalanche conditions were better than the analytical decision that had been formed earlier, during the morning guide's meeting. "The group wanted steeper terrain but I stayed on my program even though things felt better than they really were". The analytical process engaged in during the morning guide's meeting would have formed a self-generated 'plan' or initial decision. The initial anchoring heuristic was challenged by an intuitive desire for adjustment. Previous research suggests that these adjustments from self-generated initial anchors may be insufficient (Epley & Gilovich, 2001).

The negative feelings were oriented toward moving away from steeper terrain, or the realization that the terrain the group was in, was already too aggressive. "As I ski down I feel increasingly uncomfortable" (Participant 708). These conservative or negative intuitive feelings often clashed with one of the other codes, that of guest expectations. This link was explored further in the previous chapter through the Uncertainty theme. "My intuition was telling me to pick a mellower run, but due to the ability and keenness of the group I thought I would try to please them with a steeper, more extreme ski run" (Participant 106).

The intuitive feeling of caution was also challenged when operational considerations pushed risk management thresholds. This happened when weather restricted access to good ski terrain. "Skiing in poor weather, confined to one very mellow and short run, we finally get a slight break to move to a new run, and as we ski the last pitch, intuition says to me, we should not be skiing this line" (Participant 708).

Reflection on the use of an intuitive response was a common practice. "In hindsight [I] remember questioning the ability of my group to maintain "the line" as they were a weak group. Should have stopped and listened to my intuition which was suggesting I give them more 'direction'" (Participant 404). When combined with feedback from peers, this reflection had the potential to change how future decisions were made. "In the current environment seeing avalanche events occurring in unexpected places, these events have made me more attuned to my intuition" (Participant 708). Reflection is explored further as its own code, later in the chapter as part of the Future Decisions theme.

One of the by-products of asking the participants to reflect on their decision process was that they reflected on their intuitive responses. There is very little in the JDM literature specific to the role that reflection on intuitive responses can play in the development of decision-making. Hogarth et al (1991) argued for the ‘learning of intuition’ but did not expand on the learning that could occur through the reflective process. Their focus was on the environment in which the intuitive responses took place, with descriptions of the attributes of kind and wicked learning environments. There is some support for the use of a reflective practice in the development of intuitive responses in a therapeutic relationship (Bove & Rizzi, 2009), but this does not necessarily transfer over to the ski guide’s reflection on the use of intuition in avalanche terrain.

7.2.1.2.2 Analytical Response

Based on the emphasis placed on the analytical decision-making process delivered in the CAA and ACMG certification programs (Association of Canadian Mountain Guides, 1999; Canadian Avalanche Association, 2011), it would be reasonable to assume that these models form a core element of professional practice. An analytical response might be expected to be the mainstay of the participants’ decision response process (Bruns, 1996). However, one of the challenges expressed by participants over the two seasons of the study was a frustration with the results of their analytical efforts in avalanche hazard forecasting, as the reality of where avalanches were occurring was frequently not consistent with their forecast. The participants’ analysis of the current snowpack conditions, grounded in the theories of where and when avalanches should occur, did not match up with what was actually happening.

Participants had been trained to gather and analyse information as an integral part of the avalanche forecasting process. Participant 602 described this data gathering process. “[I] found SH [surface hoar] down 45cm, I had heard about it but not seen it all week.” Some level of uncertainty was a common thread through the participants’ event reports and typically prompted further data gathering and analysis. “I went in with the intention of skiing the line but held the group back so as to do some of my own analysis” (Participant 508). Slope angle was the most

commonly used indicator of safe terrain. “Analysis said this is too low an angle to slide. . . I measured the slope angle, it was 24 degrees, in a "normal" winter we would ski this slope in poor stability” (Participant 708).

Gathering additional information was not always easily achieved, as even the decision of where to dig a snow profile was compromised by the shortcomings of the analytical process. Participant 104 described his challenge as “needing more snowpack information, but [I was] very hesitant and had very low confidence in the snowpack. Biggest decision was where to dig (snow safety) to obtain pertinent information, with out endangering the snow safety team”.

In a similar study of avalanche professionals, Adams (2005) found that only 17% of her participants used analysis as their primary mode of cognitive function within their field-based decision-making. However analysis was used largely when decisions were made in the office. This is consistent with my participants’ description of their use of analysis in the morning guide’s meeting. This is also consistent with findings in the Naturalistic Decision-making literature, that in high stress time-limited scenarios, intuition prevailed as the predominant decision process (Kahneman & Klein, 2009; Klein, 1993; Lipshitz, Klein, Orasanu, & Salas, 2001; Zsombok & Klein, 1997).

Participants had lost confidence in their ability to analyse snowpack and weather data in the application of the avalanche forecasting process. They struggled with an analytical process that did not provide the level of accuracy that they were accustomed to. After repeatedly seeing avalanches on terrain features that they had deemed ‘safe’, they questioned their ability and began to build in larger safety margins by making more conservative terrain choices.

7.2.1.2.3 Conservative Choice

When faced with a conflict between an analytical response and an intuitive one, participants regularly expressed the desire to go with the more conservative choice. Although this may be viewed as the more correct response from a risk manager’s perspective, the nature of the environment that these decisions were taking place in, would be considered ‘wicked’ (Hogarth, Plessner, Betsch, & Betsch, 2008). With massive consequences and intermittent feedback, participants

were feeling pushed to act more conservatively. “[I] discussed [the] run with junior guides at lunch and thought I'd go ahead and take a look, but decided to leave it alone today. As I flew over the run, the "little guy" said this is too hard and "has potential, so I flew back to the short, mellow lines” (Participant 708). The impact of a wicked environment is discussed further as an element within the Outcome theme.

When faced with the cumulative results of low confidence in their analytical process and an intuitive response that was often a ‘bad feeling’, participants were defaulting to the conservative intuitive choice.

In the current environment seeing avalanche events occurring in unexpected places, these events have made me more attuned to my intuition. If I have any slight reservation or "little voice" telling me not to go to a run ski a line or similar I'm pretty much listening to that completely and going with that.
Participant 708

Participant 708 described the lesson learned from working in this wicked environment as “Listen to intuition, [and] question "seniority/experience" especially in times of uncertainty and unusual events”.

7.2.1.2.4 Summary

Participants described how they used both intuition and analysis in their daily decision-making process, which is consistent with Adams’ findings (2005). She described how her participants used either intuition or analysis, as their primary decision mode, and the other as a quality control check. This does not fit well with the Cognitive Continuum (Hammond & Klein, 1993), which suggests that as the use of intuition increases there is a corresponding decrease in analytical processing, and vice versa. Participants described times when they used large amounts of both processes for the same decision and other times when they used neither. More recently Hammond (2010) has argued for the use of ‘quasirationality’, which he defines as a dynamic balance between analysis and intuition. He suggests that very few decisions can be fully analytical because information is incomplete and yet the temptation to *surrender* to intuition should be avoided.

My participants’ inability to find and assimilate snowpack data that was representative of the terrain and conditions that they would like to ski, compromised the analytical process and resulted in surprises; avalanches occurring in unexpected

times and places. The resultant loss of confidence combined with the massive, negative, potential consequences promoted a more conservative theme to the decision process. Participants used an analytical process of stability evaluation as a starting point, and then mapped out a plan onto the terrain using intuition. This intuitive process drove the terrain selection procedure and formed the basis for the terrain selection code.

7.2.1.3 Terrain Selection Code

Terrain selection was the most frequent code in the participants' responses. This was entirely understandable and expected as the choice of location is generally agreed to be the most important aspect of managing risk exposure for ski guides (Cardon, 2004). It is consistent with the findings of Grímsdóttir and McClung (2004) who found that the general shape of the terrain was the prime consideration in the selection of safe skiing terrain. Atkins (2004) suggested that guides are also much more capable of communicating terrain choices than they are capable of communicating stability evaluations. The guides use careful terrain selection to manage the amount of danger that the group is exposed to and for how long the party is exposed to it (Bruns, 1996). The terrain code was divided up into six sub-codes: Decision Timing, Stability, Consequences, New Terrain, Guest Behaviour, and Guest Expectations, with the latter five linked to other codes.

7.2.1.3.1 Decision Timing

The primary sub-code within terrain selection was the timing of the choices made by guides in their quest for challenging, yet safe ski routes. Decisions were made prior to skiing during the morning guides meeting, and during the ski programme. The structure for the morning guides meeting decision process was described in Chapter Two. Key decisions made during the morning meetings centred on the selection of ski terrain; "It is a reasonable choice for the first run" (Participant 601), and the designation of terrain to be avoided; "[The] decision [was made] to not ski steeper slopes" (Participant 311).

Although the determination of snowpack stability and the associated avalanche risk was largely an analytical process, the application of this knowledge to the terrain became much more intuitive at times. "The most important decision of

today was terrain avoidance. Convex lee loaded features @ tree-line looked fat and we knew the surface hoar was in there” (Participant 703). Slope angle is considered one of the best objective measures of avalanche likelihood, with few slab avalanches triggered on slopes with an incline of less than 25 degrees and 38 degrees being the average angle at which slab avalanches occur (Jamieson & Geldsetzer, 1996). However, avalanche triggering during the period of the study did not correlate well with previously observed norms.

Hogarth (2010) suggests that analysis can work well when the task is simple, but can falter as task complexity rises. Intuition has the potential to be more accurate in this complex environment, but only if the ‘cultural capital of patterns’ has been generated under ideal ‘kind’ conditions. Participant 708 described this interaction between the analytical and intuitive process the following way.

Intuition (the little guy inside your head) was making some thought about "given what we are seeing today and with the anomalies of the season, is this the best choice, but [the analytical process of] terrain selection said a mid 20 degree slope with no steep associated slope it should be OK.

This fits with earlier findings (Jamieson & Geldsetzer, 1999), which suggest that 70% of unexpected skier-triggered avalanches occurred on slopes which were less than 35 degrees.

Typically the participants left the morning meeting with certain terrain management principles to govern their decision-making during the day, such as: “Keep to moderate angle, higher elevation” (Participant 201), and “stay on fully supported ridges instead of [in] the gullies where the snow was better” (Participant 714).

Once the participants got out into the terrain, those governing principles were typically modified by current observations. This process may have been compromised by the heuristic biases of anchoring and adjustment (Kahneman, Slovic, & Tversky, 1999). Although the initial anchor of stability assessment was self-generated and thus potentially susceptible to insufficient adjustments during the day’s ski operations (Epley & Gilovich, 2001), the on-going process of stability forecasting and evaluation was modified each evening by access to other operations’ interpretations of stability through the daily information exchange (InfoEx).

The initial stability forecast anchor generated in the morning meeting by the previous day's observations, the overnight changes and the forecasted weather for the day was not necessarily well reflected in the current conditions, thus requiring some level of adjustment during the day. Additional insight may be contributed by examining the role that another heuristic might play, that of a confirmation bias.

Mercier and Sperber (2011) argued that the function of an analytical reasoning process was fundamentally argumentative. Reasoning through human communication has the potential to be side-tracked by personal agendas and deliberate misinformation. I observed debates during the participants' morning meetings as evidence of the argumentative nature of analysis and reasoning. The interpretation of hard data, such as wind, precipitation amounts and temperature, from remote sensing stations can be compromised by a confirmation bias. There can be a tendency to see what one wants to see, and to seek out data that confirms a hypothesis (Lehner et al., 2009).

Once out in the field, participants described both aggressive and conservative adjustments based on observed conditions. "But my decision to ski it as the first main run of the day, with an easier option to warm up on that I passed by, was a poor guiding decision on my behalf" (Participant 202).

The weather was an additional complicating factor, which regularly dictated changes to the terrain selection. There were two types of weather-related circumstances that mandated a modification of the ski plan: weather that was significantly different from the forecast, "[We had to pick] up high on [the] last run as the pick up is threatened by steep west facing slopes and [the] sun was out in [the] PM" (Participant 304), and poor visibility which reduced the participants' abilities to assess conditions. "The decision was made to stay on conservative terrain and avoid wide-open areas due to poor light" (Participant 103).

Good visibility allowed the guides to continue to monitor changing conditions, while poor visibility created a higher level of uncertainty. "[I was] not certain of the terrain due to limited visibility" (Participant 310). With higher levels of uncertainty linked to a lack of environmental feedback, there was a tendency to be more conservative, which is congruent with research conducted on gamblers and the disjunction effect (Bagassi & Macchi, 2006).

7.2.1.3.2 Stability

The participants' selection of ski terrain varied tremendously depending on the assessment and forecasting of the snowpack stability (Cardon, 2004) and the potential avalanche characteristics (Atkins, 2004). The difficulty in accurately forecasting the sensitivity and reactivity of the persistent weak layers (PWL) during the 2008-2009 and 2009-2010 seasons led some participants to be more reliant on their ability to pick safe terrain than their ability to forecast the snow stability. Participant 605 described how he choose more conservative terrain based on the presence of a persistent weak layer. "We have a current stability rating of G-G-G [Good-Good-Good], caution windslab & PWL's (persistent weak layers). Some runs that we typically ski during G stability are being avoided, and some runs skied very conservatively". For example, Participant 101 provided a more simplified description of his most important decision on one of his Good day reports as, "Terrain selection: choosing the terrain vs. [having to assess] the snow/stability".

Participants were challenged to rationalize the incongruence between the results of their decision process, including both analytical and intuitive responses, with the reality of when and where they were seeing or triggering avalanches. Their comments included: "[I] was aware of [the] layer but was on 25 deg terrain which [I] thought was safe" (Participant 311), "[I decided] to stick with the terrain choice even though I have never seen avalanches on this run" (Participant 714), and "it changes my view on what avalanche terrain is" (Participant 311).

On the other end of the scale, when weather and snowpack conditions became more stable, participants were able to choose more aggressive terrain. "[We] skied fairly aggressively today. Big open slopes in ALP [alpine] to 38 degrees" (Participant 304). For example, the best decision on one good day report was "skiing a bigger slope on a run we had greened that morning, but with caution on certain features, including loaded ridge top features, such as that slope" (Participant 304).

7.2.1.3.3 Consequences

One of the challenges in the selection of terrain was the need to find a balance between risk and reward. The key elements of this balance were: the quality of the skiing, the likelihood of triggering an avalanche and the consequence if an

avalanche were to be released. Most often this was expressed as a choice between steeper and more challenging skiing with higher consequences, and lower angled, less challenging skiing with lower consequences, but it was also expressed as a choice between a high consequence event with a low likelihood of occurrence compared to a low consequence event with a higher likelihood of occurrence.

Making a decision between skiing a line that was likely more stable but had higher consequences if anything released, or skiing a steeper more challenging line that offered more options of safety while exposing ourselves to a higher likelihood of releasing something smaller with likely smaller consequences. Participant 605

Generalized utility theories (Camerer & Kunreuther, 1989; Camerer, 1989) suggest that there would be an optimum balance between ski quality and the possibility of a negative event, however the balance would likely be different between the guides and the guests depending on the level of risk aversion. The participants tended to be more risk averse than their guests. This is consistent with research conducted on medical decision-making. Garcia-Retamero and Galesic (2011) found that doctors chose more conservative options than their patients. There is a significant difference with ski guiding as the ski guides were committed to the same level of risk exposure as their guests, whereas in medical decision-making it was only the patient that was at risk. Participant 311 “decided not to ski a more committing slope and limited exposure to a smaller feature”, whereas Participant 404 “chose to ski the untracked snow with my group, which is the line, exposed to the most overhead hazard”. One participant described the lessons learned as: “to never underestimate terrain and what can occur on what kind of terrain” (Participant 604).

7.2.1.3.4 Guest Behaviour

In addition to being a sub-code within the terrain selection code, guest behaviour was a code all to itself and will be discussed further later in this section. I have defined guest behaviour as the guests’ ability and willingness to follow the guide’s directions (Hersey, Blanchard, & Johnson, 1996). There was a critical link between guest behaviour and terrain selection. There were times when the participants chose terrain close to places where avalanches could have been triggered. The guides needed to carefully conduct the guests through these narrow

strips of safe terrain. If the guests were unable or unwilling to follow the guide's directions, it would only take a few turns in the wrong direction to trigger an avalanche. The standard strategy used by guides is to create a defining boundary with their ski tracks. The guests are managed with words like "Stay in my tracks", or "Ski to the right/left of my tracks". Participant 103 described an event with guests who failed to heed his directions.

[I] located the controlling left ski line too close to a steep unsupported feature. [I] stopped on a bench to move right (30 metres) and keep skiers off the slope. Two aggressive skiers came in fast and the slope triggered below.

The following is an example from my own guiding to illustrate this point. In the photo below (Figure 16), I put in a defining track and told my guests to ski to the right of my tracks, one at a time. This particular slope is considered an indicator slope as it frequently avalanches naturally, or can be deliberately triggered. I wanted to test the stability of the slope so I jumped on the convex rollover at the entrance to the slope in an attempt to ski trigger the slope, but was unsuccessful. The first guest (seen just left of the avalanche, in the red circle) crossed his ski tips at the convex rollover and fell head first into the snow. He was two meters to skier's-right of my track, but the additional weight that he was able to generate in his fall was sufficient to cause an avalanche.

Figure 16 Avalanche on indicator slope

The influence of guest behaviour on the selection of terrain is likely grounded in the nature of the relationship between the guide and the guests. Guides who know their guests well may be able to conduct them through more complex terrain that requires the guests to follow a precise ski line. This level of familiarity could come from time spent together in challenging terrain.

7.2.1.3.5 Guest Expectations

This sub-code is also linked to its own code and represented a significant contributing factor to terrain selection. Although participants were frequently able to select terrain that exceeded their guests' expectations, the challenging avalanche conditions of 2008-2009 and 2009-2010 made this much more difficult to achieve. The difficulty in predicting the reactivity of the persistent weak layers forced participants to choose more low-angled terrain. Often this did not meet their guests' expectations.

[My] decision was to continue with skiing mellow, skied terrain and not being tempted to venture out of our skied, lower angle terrain. The terrain was very much skied out and the guests were only marginally challenged/satisfied. (Participant 104)

The participants were also affected by the desire to increase the level of challenge and ski more challenging terrain. However, the participants' desires, whether internally or externally generated was modified by the reality of the snowpack. "Based on slope history and current snow pack decisions, [I made the decision to] avoid a very tempting ski line, much to the dismay of the guests" (Participant 715). This did not mean that participants were always disappointing their guests or that guests stopped exerting pressure to ski steeper terrain. "We had a great day even though I was under pressure to give the people more challenging terrain" (Participant 305).

7.2.1.3.6 Summary

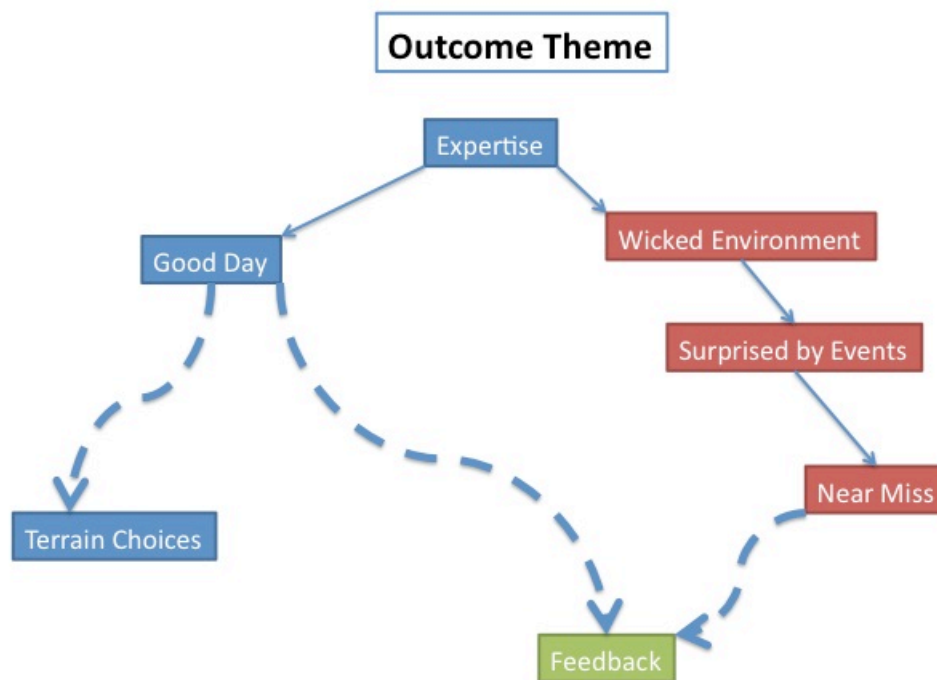
Terrain selection is at the core of the decision process for ski guides. The intuitive-analytical discourse within the stability/consequence evaluation process may be the means by which terrain is selected, however there are many mitigating factors. The key factor is the role that guest satisfaction plays. Ski guiding is a service industry, thus guest expectations of the product must be accounted for in its delivery. Guest expectations and subsequent guest behaviours combined with corporate, peer and self-expectations modified, and in many ways exacerbated, the complexity of the decision environment.

The decision process matched knowledge of snowpack and terrain with the selection of safe skiing options. These skiing options were constrained by a context specific margin for error. The margin for error was modified by elements within the Filter themes, Environment and Uncertainty. Participant 702 summed it up with a comment from a near-miss report; "This was so great because I actually got an answer to the safety margin / decision-making process we do everyday". The ultimate goal of the decision process was the selection of technically challenging, yet safe terrain. Striving to achieve an optimal balance between maximum challenge and acceptable risk was a constant battle.

The likelihood and potential consequence of an occurrence played a huge role in the determination of margins. A high likelihood of being caught in a small avalanche with minimal consequences may have been entirely acceptable, while the potential for dying in a low-likelihood, large avalanche event may not. Somewhere

between the extremes of no hazard and probable death, was a place that divided acceptable loss from unacceptable loss. The ability to forecast avalanche occurrence, let alone avalanche size is insufficiently developed to have a definitive line in the snow (Atkins, 2004; McClung & Schaerer, 2006). This precipitates the need to gather as much information as possible without actually generating more risk for the data gatherer. Participant 104 described the challenge of balancing information gathering with risk acceptance. “[It] just wasn't worth putting everything on the line to gather a bit more information, knowing full well that the existing conditions were tricky”.

7.2.2 Outcomes Theme



Participants described how they used their expertise as a cornerstone on which to base their decision-making within this challenging environment. An analysis of the decision environment provided clues as to whether implicit feedback was present and to its validity. A wicked environment, with low quality feedback and severe potential consequences, had the potential to deceive the participants (Hogarth et al., 1991). The likelihood of being surprised by events and having a near-miss went up when the environment provided imprecise feedback. Having a good day was linked to the concept of not making snow stability decisions and instead choosing terrain that was less likely to produce an avalanche.

7.2.2.1 Expertise

The ability to use and trust decisions based on expertise was linked to the environment in which the expertise was built (Camerer, Johnson, Goldstein, & Hogarth, 1997; Hogarth et al., 1991). One of the most experienced participants recognized that even with all the good decisions that he had made over a 20-plus

year career as a heli-ski guide, the most powerful learning came from his poor decisions. He recognized that misleading feedback could come from what was thought to be a good decision. However, a bad decision with a negative outcome could not be ignored and a bad decision with a near-miss outcome should be embraced.

I hate to say it, but its a good thing for a guide to experience having somebody in their group buried or caught in an avalanche because all of a sudden it changes your reality. Now I know what its like to have one of my clients caught in an avalanche and be swept away and hopefully they're just sitting there on the surface when you get over the edge and look. Participant 714

7.2.2.2 Wicked environment

The wicked environment has two components: quality of feedback and severity of consequences (Hogarth et al., 2008). The two winters of the study had highly variable feedback in both quality and quantity, and were characterized by massive consequences.

Just this year because of the anomalies and not having a good handle on it, things are surprising people all year.... A lot of the terrain we have a known history of, but its been showing us differently this year. We've had avalanches go through roads that we didn't expect. Participant 104

Participants received environmental feedback, however it was often outside of what they expected. "Mother nature just defined the new run out zones for a few select locations. Knowing the potential of the type of snowpack we have this year" (Participant 104). Feedback was not missing in this wicked environment. It was just unexpected in its timing, location and magnitude. At times there was a lack of negative environmental feedback, which prompted the participants to be more aggressive in their terrain selection. "The long dry spell may have lured many into skiing like it is a normal snowpack" (Participant 608). "After 2-3 weeks of good stability, maybe we forgot that there were still weak layers buried deeply within the snowpack" (Participant 605).

It was hard for the participants to learn from the feedback, as it did not make for easy pattern recognition. This could have produced a false context for future pattern recognition and subsequent faulty intuitive responses, however participants described how they learned to deal with the challenge.

Wow, how do I feel about this slope, with the facet layer compared to how do I feel about it with the surface hoar layer. I think going into it, having been there last year in a weird year, really prepared me well for it. If I hadn't been there last year with a weird persistent weak layer, then I might have just gone into it being influenced by what I had been observing in the Bugaboos. Participant 404

Decision-making in this wicked environment, with significant and possible, negative consequences, was characterized by low confidence and conservative choices. Participant 605 stated, “[my] risk tolerance has not changed, but guiding during times of prolonged PWL's has me choosing as conservative lines as needed”. “[The decision was] to stick with the terrain choice even though I have never seen avalanches on this run” (Participant 714). This may be analogous to decision-making when competing against a stronger opponent. In a study of chess players, a slower, more conservative strategy was employed when facing opponents of greater skill (Slezak & Sigman, 2011).

7.2.2.3 Surprised by events

Inherent within the nature of a near-miss event is an element of surprise. The element of surprising environmental feedback, an avalanche occurrence, was associated with 24 of the 31 near-miss events that included feedback information.

For example, last week we had a skier accidental and it was the snow safety guide while they were going to dig a pit. They took off their skis then they had a size 3 ripped out under their feet, which sympathetically released six other avalanches all in the same zone. Participant 404

The primary source of surprise was how low the slope angle was. Additional factors were the depth of the failure plane and number of layers involved. “I have never seen that slope avalanche like that before” (Participant 601). All of the responses could be linked to the existence of persistent weak layers. “It really surprised me. Did we make a mistake when we decided in the morning guides meeting that the run should be green?” (Participant 604).

7.2.2.3.1 Slope angle

Slope angle is one of the benchmark measurements used in avalanche forecasting. On slopes of less than 25° the potential for slab avalanche failure is minimal (McClung & Schaerer, 2006), yet participants reported avalanches

occurring on terrain as low as 20°. “I did not think I was in a spot that would slide” (Participant 608). Participant 311 was not surprised by the release of a weak layer, just the angle of the location where it released. “Was aware of layer but was on 25 deg terrain which thought was safe [sic]. Do not trust unskied terrain and [it] changes my view on what avalanche terrain is”. An additional surprise was the distance that some avalanches travelled into what had been considered safe terrain.

It's south facing. I land on top and see a huge (size 4) avalanche on a run across the valley, running to the valley floor, starting on steep terrain, but propagating into shallow angle what we have historically called "safe" i.e. 20 degree terrain. Participant 708

7.2.2.3.2 Layering, depth and extent of propagation

The number of reactive layers, the depth of those layers and the extent to which they propagated over large distances took some participants by surprise. To have numerous reactive layers all producing anomalous avalanches was outside the pattern recognition of many participants. “Experienced practitioners with 30+ years of experience have never seen anything like the layering in this year's snowpack and many of us are waiting for the other (next?) shoe to drop” (Participant 810).

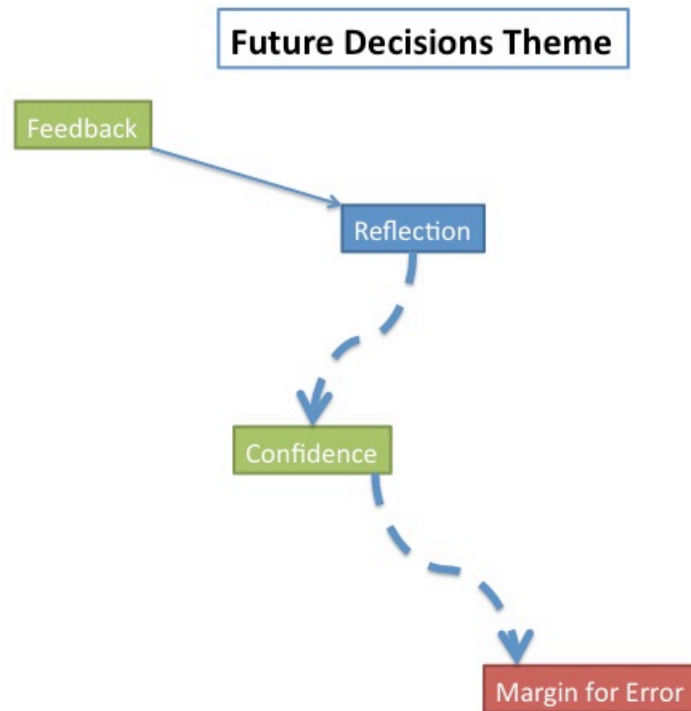
Avalanches released on weak layers much deeper in the pack than were thought possible. “The slide released on SH [surface hoar] and went deeper than I would have expected with only 10 cm HN [height of new snow]” (Participant 608). Larger avalanches were produced by this combination of deep weak layers and extensive propagation. “[I was] surprised with the extent of propagation and fracture depth” (Participant 601). “We were all surprised by the magnitude and depth of the release” (Participant 604).

7.2.2.4 Outcomes - link to feedback and reflection

The outcomes from the event reports produced feedback and a stimulus for reflection, which had the potential to alter future decisions. The nature and variability of this feedback produced uncertainty even for the participants with very high levels of expertise. Avalanches were surprising everyone. Numerous incidents were attributed to the difficulty of dealing with a wicked environment, as both analytical and intuitive responses had failed to predict these events. This failure promoted deeper reflection and a default to more conservative choices.

I have gone over that so many times in my head. Could we have seen this? Could we have forecasted this? Could we have seen that coming? If you look at just the data, no, in a sense. Are things touchy after a cycle? Yeah but that big, it was amazing. Participant 104

7.2.3 Future Decisions Theme



Decision-making in this environment occurred in a context of repeated opportunity. The opportunity to improve decision-making came from feedback and reflection. Some of the feedback came from the environment, but many of the participants reported high levels of peer feedback. Hammond and Summers (1972) suggest that learning in a complex environment with high levels of uncertainty is best accomplished by incorporating feedback which addresses the *why* question and not just the *what* question. Feedback that helps the recipient understand not just that their decision solution was right or wrong, but also the reasons why, will help to accelerate the learning process.

The most potent opportunity for learning came from reflection on peer feedback. The reflection likely increased the acquisition of potential patterns that could be used as the basis for future intuitive responses. This rapid pattern recognition has also been credited with generating an increase in decision confidence (Simmons & Nelson, 2006b). A higher level of confidence allowed the participants to adjust the margin for error.

7.2.3.1 Feedback

Feedback came from three sources and played a role in the on-going, iterative decision process of the participants. The mountain environment contributed some of the feedback; unfortunately it was often incomplete or misleading. Additional feedback came from the actions of the ski group as they travelled through the terrain and from other guides in the field. Participant 101 described the challenge of working independently. “I’m pretty hard on myself when it comes to my own business...Its pretty hard to bounce things off yourself. Its easier to talk to someone about it and sort of calibrate or figure out how it went when you have some other people”.

7.2.3.1.1 Environmental feedback

Natural and skier triggered avalanche activity observed by the participants was taken as a strong and reliable indicator of weaknesses within the snowpack (McClung & Schaerer, 2006). “Whenever the mountain ‘talks’ like that it gives strong feedback” (Participant 608). As described in Chapter Two, someone from within the ski group triggers the majority of avalanches that catch skiers. Far fewer skiers are involved in natural avalanches. The environmental feedback most frequently discussed by the participants centred on their ability to directly impact the snowpack through skier or explosive initiation.

7.2.3.1.2 Skier initiated feedback

Skier triggered avalanches were one the best sources of information and feedback for the participants, as they were a direct measure of a skier’s potential to trigger an avalanche. Participants or their guests triggered slopes in a number of ways: deliberately by choosing a potential weak area, accidentally by skiing through that weak area inadvertently, and remotely from a distance (either deliberately or accidentally). Some of the participants also attempted to trigger avalanches with explosives. Participant 708 described the dilemma of wanting feedback on the sensitivity to triggering, but not the potential negative consequence. “Feedback on terrain choices, if you make a decision not to go somewhere there is little feedback,

but if you go and something happens, then it's easier but tough because of consequence”.

7.2.3.1.2.1 Deliberately triggered or controlled while skiing

Ski cutting was routinely used to test the stability of the snowpack. Small slopes with minimal consequence that were similar in nature to the intended ski lines were tested. “Ski cutting produced 10 cm loose sluffing. Guide cut most starts” (Participant 103). Although it was an excellent source of feedback, the lack of a result was less definitive. “I suspected a windslab and ski cut the slope with no results, I was still suspicious of the slope and therefore had the group ski a less steep line” (Participant 404).

7.2.3.1.2.2 Accidentally triggered

Accidentally triggered avalanches were an excellent source of direct feedback on the decision process. “As soon as the guest entered the chute, the slope released (30 cm crown) and zippered around into a steep rocky area next to the chute” (Participant 106). Testing the slope through ski cutting may not always be possible and can result in accidental avalanches. “Skied a lower TL [treeline] NE aspect in previously skied area without ski cutting, resulting in 2 Sa's [skier triggered accidental avalanches] to size 1.5 and scaring one guest” (Participant 103). Non-fatal and non-injurious skier involvements in avalanches may be a regular and acceptable risk within a commercial ski operation, however great effort is put into avoiding them, as there can be a very small margin between a fatal and a non-fatal outcome.

See it and feel it be part of it for it to actually sink in and be part of you from then on. And particularly if you've been part of the decision. It's that negative feedback, I made a decision and it was wrong, way wrong because somebody got caught. Those are the decisions that sink in. Participant 714

7.2.3.1.2.3 Remotely triggered

Remotely triggered avalanches that do not entrain a skier are arguably a better form of feedback, as they give a good indicator of the sensitivity of the snowpack while providing a larger safety margin. “[I] went to the fracture line of the

skier remote to get a feeling of the avalanche size and consequence” (Participant 714).

Participant 608 described feedback he received just after he made the decision not to ski a slope. The slope released remotely and the avalanche was big enough to bury and kill someone. “I decided it was not viable to ski the group down this line and was sidestepping back up when the flank of the ridge release Sr size 2 [skier remote size 2]”. Participant 702 welcomed the feedback when the group triggered an avalanche large enough to fully bury the entire group.

[An] expert group on mellow terrain - wanted to ski non stop [I] but was concerned with Jan 30 SH triggering on gully walls, so I stopped early to tell them to stay on the ridge and not in the gully (gully feature is small and insignificant looking until it releases). We skied the ridge and coming down to the bottom, I looked over and saw 2m of debris beside me spilling out of the gully. It has triggered remotely from less than 10m away and fractured the whole gully wall! This was so great because I actually got an answer to the "safety margin / decision-making process" we do everyday. Participant 702

7.2.3.1.3 Explosive triggered

Some participants used explosives to test slopes without placing a skier in potential harm. This provided feedback from a larger trigger than a skier. “[We decided] to ski a supported feature adjacent to a size 2 Xe [explosive triggered avalanche] from a week ago” (Participant 103). However the lack of result did not necessarily mean that the slope or similar slopes were safe to ski. Participant 810 described a near-miss event that occurred after explosive testing. “[An] explosive charge [was] placed in [the] slope and [the] run was skied prior to the [near-miss]”.

Avalanches resulting from explosive testing helped with decision-making, however non-results were less definitive and needed to be interpreted within the context of the terrain and snowpack. “[We decided] to have explosive testing done on a main ski line. A size 2 avalanche resulted and we skied an alternate route in white out conditions, mostly along a cat road” (Participant 103).

7.2.3.1.4 Peer feedback

Participants faced a dilemma in that conservative terrain choices typically resulted in a lack of environmental feedback, whereas aggressive choices potentially

led to accidents or near-misses. Participants were dependent on peer feedback to calibrate their confidence and margin for error. “Guide team agreed I made a good decision not to ski the slope, and the clients were in a safe spot. Discussed the variability of SH [surface hoar] and the SSL [soft slab] which was deeper than expected and triggered remotely” (Participant 608). Peer feedback was a powerful tool available to guiding teams, but appeared to be under reported and perhaps under utilized. This area has great potential for the development of decision-making expertise and is further discussed later in this chapter and in the next chapter.

If I have had what I feel is a challenging day, irrespective of what those challenges have been, I bring it up with the rest of the guiding team and say how did it go for you because I need to get some more tangible feedback. I felt like the day sucked and I want to know how it went for you. And then you can have some learning out of that. Participant 508

7.2.3.2 Reflection

The ability to reflect on decisions and the feedback generated either from the environment or from peers was key to the development of more sophisticated decision responses. Participants described how reflection modified their future decisions.

I decided to ski it but at the end of the day was disappointed with myself that I let myself be exposed like that when it wasn't necessary at all - lots of good snow around. I hadn't switched my mind from Good stability yet even though we had a couple of warning days leading up to today that the layers were waking up. Nothing happened but I feel stupid for letting myself be exposed like that - I had a contingency plan but the guilt of skiing it afterwards leads me to believe I really shouldn't have been there. Participant 702

7.3 Summary

I used the Background Experience Profile to form the foundation for the analysis of the event reports. It was from within this view of expertise that I was able to put the event reports into perspective. Although not all the participants were ‘experts’ as per the strictest definitions from the literature (Ericsson, 1996; Ericsson & Charness, 1994), the ‘average’ participant could be considered an expert. This allowed me to move the analysis forward on the basis of expert performance and delve into the role of recognition-primed decision-making (Klein, 1998).

The codes that were assigned to the descriptive responses from the event reports and the first round of interviews had both inductive and deductive origins. The participant responses spoke strongly about the processes that were used to make decisions. I analysed the participant responses and allocated them into coded groups to generate a number of themes. These themes described the decision process used by this group of expert ski guides. The most frequently mentioned and eloquently described codes were terrain, expectations and feedback. These three codes were central my discussion of the decision process of the participants.

Although the twenty-four primary codes were grouped into six themes, there was considerable overlap that tied the themes together. Each theme was connected to its neighbour by at least one code, while the confidence and margin for error codes straddled all six themes. These six themes described the decision processes used by ski guides to navigate the challenges of conducting guests through potentially hazardous terrain. Both intuition and analysis were embraced as integral components of the decision process.

Although the word 'terrain' was used as a code, the meaning of this code included the snowpack as it lay on that terrain. Thus the code can be taken to include the concept of environment. The terrain and snowpack environment provided the initial challenge for the participants, but also proved to be a source of feedback, although the frequency was sometimes lacking and the meaning masked. The sombre undertone of the feedback included the potential for fatal or exacting consequences as per Hogarth et al. (1991). Fortunately my research participants experienced no fatalities, however there were injuries to both guests and guides.

Exacting feedback from the terrain was powerful on a visceral level and had the potential to degrade decision performance (Hogarth et al., 1991), however peer feedback provided the opportunity for cognitive learning when it included an analysis of the *why* question (Hammond & Summers, 1972).

The participants clearly described the difficulties that they faced and the ways in which they used both intuition and analysis to solve problems. Hammond (2010) argued that intuition should not be used in isolation and should be paired with analytical strategies. A concern expressed by participants was that intuitive responses generated through pattern recognition were not able to account for the

current conditions. Uncertainty was high and confidence low as intuitive responses did not easily come to mind as the literature suggests (Simmons & Nelson, 2006b). In addition to this, analytical strategies were also unable to account for the anomalies. Participants felt abandoned by intuitive and analytical strategies that had worked in the past. Koole and Jostmann (2004) suggest that action-oriented individuals, like these participants should be able to control intuitive emotions and not let their emotions hijack their decision process.

The primary strategy used by the participants to manage uncertainty was a prudent risk management process. This was due to the anomalous events observed during the winters of the study. Guides described how they were reluctant to 'step it up' and take their guests into more complex and potentially hazardous terrain. Although there was considerable pressure from guests to use more aggressive terrain, the decision process was tempered by the possibility of a low frequency, high consequence event. The nature of the deeply buried, persistent weak layers was that it was difficult to forecast the likelihood of triggering. Yet the information exchange within the industry, facilitated primarily by the InfoEx, produced a steady flow of reports of large catastrophic, yet anomalous events. A majority of the fatal avalanches that occurred during this time frame were attributed to persistent weak layers (Klassen, 2008, 2010b). The fact that there were very few avalanche fatalities within professionally guided groups is testament to the effectiveness of this cautious strategy.

Despite the expertise within the participant group, many were surprised when anomalous events occurred that did not fall within previously recognizable patterns. This is not surprising as Canadian Avalanche Centre forecasters described these as one-in-thirty year patterns (Klassen, 2010a). Some participants felt that they had learned how to make better decision in spite of the wicked, unfavourable learning environment. The literature suggests that wicked and exacting environments will produce minimal learning and that any learning that occurs may be compromised and lead to future poor performances (Einhorn & Hogarth, 1978; Hogarth et al., 1991; Simandan, 2011).

One outcome, measured by the number of commercial fatalities, suggests that this is not true. After three increasingly difficult winters the fatality rate was

unchanged. Decision performances did not get worse. There is no doubt that the environment was exacting; poor decisions had the potential to be punished with severe consequences. These conditions increased the likelihood of numerous commercial fatalities. Yet that did not happen. I suggest that this was due to increasingly conservative decision-making. The only other possible answer is that the entire mechanized ski industry was incredibly lucky for two years. Given the roughly 90,000 commercial skier days each season, it would be hard to attribute the success to just blind luck. I suggest that this was highly unlikely. The analysis of the second round of interviews has been used in the next chapter to connect the results from this chapter to a broader discussion of the topic.

Chapter 8 Findings and Discussion: Study Three – A holistic interpretation of dual process

8.1 Introduction

In Chapter Eight, I used the participants' words and descriptions generated through the final round of interviews to develop a more holistic perspective of dual process decision-making. This chapter provided my findings and analysis of how intuition fits into the broader context of the Dual Process Theories (Evans, 2010; Glöckner & Witteman, 2010). I used the final interview responses to look at intuition as a parallel partner to analysis rather than an either/or comparison. It is a more global perspective compared to the findings and results in chapters five to seven. Chapter Nine, the conclusions and recommendations, is used to draw the findings and results together from all four chapters and to clarify the contribution to the literature.

Chapter Eight provides the findings and discussion from the third and final study. As discussed in the methods chapter, the intent of this third study was to distil a richer understanding of the decision process. Findings from the first two studies used expertise and event reports as the data source. The third study was narrower in scope, using nine participants; however these nine participants provided great depth of perspective for analysis.

The interviews were conducted in October and December just prior to the start of the 2010-2011 ski season. As the participants were not actively guiding at the time of the interviews, a scenario or a vignette based on the Critical Decision Method (Klein et al., 1989) was used to get the participants thinking about ski guide decision-making again. These vignettes consisted of a photograph of a ski run and a set of facts about the snowpack. See Appendix 9 for the vignettes and the interview questions. Once I felt that the participants were sufficiently primed to make guiding decisions, I moved to the primary questions as listed below. This took longer for the interviews conducted in October, likely because the December interviews were conducted during the pre-season training week and the participants had spent one or more days back in the wilderness skiing environment. The interviews took from 45

minutes to two hours. I did not limit my questions or the participants' answers to the impact of the 2008-2010 seasons and opened up the interview to be inclusive of all previous experiences. As with Study 2, the interviews were initially coded as digital audio files using HyperResearch. The coded sections were then transcribed using MacSpeech Dictate and inserted back into HyperResearch for the thematic analysis.

8.2 Study 3 - Final Interviews

The central premise that emerged from the final interview data was that guiding decisions were co-generated by both intuitive responses and analytical results. This fits within the dual process theories as supported by a growing body of literature (Thompson, Prose Turner, & Pennycook, 2011). I asked the participants three key questions in this third study.

1. *What is an intuitive response?*
2. *What is an analytical response?*
3. *How do they relate?*

In Study 2, using the Event Report Questionnaire and follow-up interview, participants were asked the extent to which their decision was based on an intuitive response, an analytical response, or a mix. In this final interview, participants were asked a broader series of questions focused on the nature of the intuitive-analytical relationship. Within this broader context, it became apparent that participants were using intuition and analysis at the same time. Rather than being an either-or answer, participants described a more nuanced approach that integrated the two systems. This fits with the dual process models of decision-making described by Evans (2007, 2008), as opposed to the dual system theories described by Kruglanski and Gigerenzer (2011).

8.3 Themes

I developed the coded responses into four central themes: the challenge, the response, mitigating factors and outcomes. Although this Study 3 has fewer themes, there is consistency between it and Study 2. Study 3 has a more streamlined set of themes compared to Study 2, but they follow a similar progression.

8.3.1 The Challenge

As described in previous chapters the winters of 2008-2009 and 2009-2010 presented a number of cumulative long-term challenges for ski guides in British Columbia. For long periods, guides had difficulty providing consistent, high quality ski days for their guests. The complexity of the environment had a direct impact on the decision process. Both intuitive responses and analytical processes were negatively affected by what was termed by the participants as *different winters*. Participants described elevated levels of stress, because both their intuitive responses and their analyses were failing them. Participants described their stress in the following way:

Difficult, very difficult. Because I saw terrain avalanche that I hadn't seen avalanche in twelve seasons of being here. I had a guest with a small involvement... in terrain that I'd never seen avalanche before, [terrain] that I didn't think anything about. Participant 106

We had two winters before last. They had their issues. They were a piece of cake compared last winter. The difference was last year took what was normally a safe piece of terrain and totally threw it out the window. Participant 702

The timing of the interviews generated distance from the day-to-day stress of ski guiding, with six to eight months of separation from the enactment of guiding decisions. During this time, the participants had the opportunity to reflect. This reflection likely formed an integral part of the learning process for the participants (Boud & Walker, 1991; Dewey, 1938; Korthagen, 2005; Schön, 1990). After three difficult winters in a row, the accumulated level of stress surprised me.

We have a lot of safe terrain. It should not have been that hard. But to be out there day in and day out and have to deal with that...It really upset me. I think because it seemed like I couldn't get away from avalanches. They were everywhere. No matter how hard you tried to ski as mellow as possible and they were still there... I was just mad. I had a lot of anger. Participant 702

8.3.2 The Response

Participants were asked to describe in detail how they used intuition and analysis. They described what each process meant to them and how they thought the two processes interacted for them. Participants rarely described using intuition or analysis in isolation. More frequently, the two decision processes were described as complementary elements of the final decision. This confirmed what might have been

expected and is consistent with Kruglanski and Gigerenzer's (2011) unified theory of judgement. They suggest that intuition and analysis share a common set of rules or inferential processes. The use of heuristics provides a possible clue as to how intuition and analysis can be linked. Kruglanski and Gigerenzer (2011, p. 100) defined a heuristic as "a rule that ignored part of the information and did not attempt to calculate the maximum or minimum of a function".

My participants termed the decision process easy when the two processes suggested the same course of action, and difficult when different courses of action were indicated.

So I think its always subtly going back and forth between the two. I think as time goes on, as I skied this terrain here, I probably rely a bit more on intuition and when I ski terrain where I'm less familiar with pieces of the puzzle, I rely on data a lot more. Participant 101

The dynamic interaction between intuition and analysis also caused stress. This occurred when the two response processes were at odds. This interaction of intuition and analysis described by the participants fits what is described in the literature as a Dual Process Theory (Evans, 2008; Hogarth, 2005; Pretz, 2008). In this chapter, as I analysed the participant responses, I used the context of intuition and analysis as separate entities operating concurrently.

8.3.2.1 Analysis

Participants learned through their guide training and avalanche training programs to use an analytical process in their determination of safe travel choices (Association of Canadian Mountain Guides, 1999; McClung & Schaerer, 2006). This analytical process is sophisticated and well defined. Considerable global expertise has continually improved snow science as evidenced by the preponderance of hard science or engineering-based research presentations at the biennial International Snow Science Workshop. The analytical process anchored the decision process for the participants.

It is definitely there. Absolutely, because it's part of our job. It's part of learning what's going on in the snowpack and following it through the winter. It's what gives you your foundation to know what's there in the snow and what to watch for, where things will move and if they step down. It's like your baseline vitals. Participant 604

Participants acknowledge that this analytical process did not occur in isolation, that most often it was the basis for a group decision process during the morning guides meeting. “An analytical response is often a group response; all of the information that we gather, the formal process that we operate under as guides, the training system that we have, [and] the decision-making process that we’ve been taught” (Participant 608). For many of the participants the analytical process was anchored by the physical act of digging into the snow to see what was there.

The actual studying of what’s going on. So digging. Most of the digging that I might do would be surface or what we might call hasty pits, but there is always weekly full profiles done. We look at, as a group and discuss. That to me is analytical. Participant 103

However, participants described how their use of the well-defined analytical path changed as they gained expertise. “Earlier in my career, I would put more confidence in the information that was gathered. More trust in that. I do that less now” (Participant 608).

Extensive use of the analytical, data-intensive process exposed deficiencies or shortcomings, resulting in the feeling that at times, data analysis was not enough.

What makes me not trust it is I think an analytical response can’t, just by the very nature of its limited ability to assess everything. It’s not possible to do that. If we had superpowers to see into the snow and see everything there, and way faster brains to process more information, maybe I would trust it a lot more. Participant 608

Participants felt most reluctant to trust the data when they were dealing with persistent weak layers. Participant 714 described the problem. “But on the persistent weak layers, I don’t think we’re getting nearly the quality of result to base a decision ‘to ski or not to ski’, a based on a profile”. They had good reason to feel this way, as many unexpected skier triggered avalanches have been linked to the presence of persistent weak layers (Jamieson & Geldsetzer, 1999). As a result, this area has been the target of extensive research since 2005, with new diagnostic tools developed such as the Propagation Saw Test and the Extended Column Test (Gautier 2007). These new tools may allow participants (guides) to change from their current default strategy of using extra caution when they know that there is a persistent weak layer.

Dial it back a step when you've got a persistent weak layer in the snowpack. Even when it's not performing, dial it back a step. Don't worry about your test results. You can throw most of your test results out.
Participant 714

Avalanche forecasting has not been skipped by the current age of technology. With increased access to information about snowpack and weather conditions, participants described how it has become more challenging to make efficient use of the wealth of data. "When I'm in the zone, [I] can't process this information because I've got enough coming in already. But at the same time... it just starts to become overwhelming at times" (Participant 106). There is a growing perception that although abundant information is good, less, but enhanced or more targeted information is better.

In the early days I was trying to look at it all and try to analyse it. And just finding it was too overwhelming to take in that much information. In the last couple of years... okay let's bring it closer to home and look at these operations that are close to me and see if they're seen similar things in the snowpack or not and why or why not. Participant 106

8.3.2.2 Intuition

I separated the role that intuition played in the dual process into three parts for analysis. The first step was to use the participants' words to simply describe an intuitive response. The second step was to analyse the different ways in which participants used intuition. The final stage was to analyse possible differences between positive and negative intuitive responses.

8.3.2.2.1 Description

Intuition is a concept that is difficult to describe. As described in the literature review chapter, there are many, varied descriptions ranging from: "heuristic and error prone" (Kruglanski & Gigerenzer, 2011 p. 97), to "contrastive of reasoning" (Evans, 2010, p. 313) and simply, pattern recognition (Kahneman & Klein, 2009; Klein, 1998). Not surprisingly, participants also explained it in a variety of ways. The predominant description included a sense of feeling. These feelings were described as either positive, the need to do something, or negative, the need to avoid something.

For Participant 702, it was associated with sound and feel. “Intuition comes in when you’re standing there and you can feel the snow and listen to the sounds it makes and how it feels when your skis are going through it.” The feeling of the snow likely elicits a somatic response (Brown & Reid, 2006; Damasio, 1996). There is emotion associated with the feeling of the skis cutting through the snow. It may be a good feeling associated with memories of high quality skiing. Alternately, it could be a bad feeling associated with a negative event, anything from poor skiing quality to an avalanche involvement. “It is the feeling that you get based on your senses, your observations visually and sensory-wise, feeling the snow and knowing the history of what happened in the days leading up to it” (Participant 604). These somatic markers are thought to exert a powerful influence on the decision process (Brown & Reid, 2006).

Participants linked intuition with pattern recognition; the sense that they had seen it before and recognized what had worked, or not, in the past. “Intuition, in my mind, comes from something that just wasn’t conscious: pattern recognition. I use intuition in my guiding all the time, not necessarily just for go or no go decisions, but where to ski a line” (Participant 714).

Participant 702 described intuition as starting with a feeling, but then becoming a voice to listen to. This inner dialogue may be a form of constructive intuition that begins to link retrieved patterns with mental representations of possible solutions (Glöckner & Wittman, 2010).

To me it’s a feeling that I get. I get butterflies in my stomach. I get that voice in my head that starts talking about the “what ifs”, or “what about this” or “are you sure about this”. The voice that starts talking to me, asking me, it’s like a checklist in my head. Have you really considered all this, or are you just pushing it aside because you really want to ski that? Participant 702

Participant 106 summarized his description of intuition by linking his feelings with his experience base, acknowledging that his cumulative cultural capital was a source of information that could be linked with his analytical reasoning. Hogarth (2010) supports this notion, but cautions that the cultural capital of previous patterns has the potential to lead the decision maker astray, if the patterns were learned in wicked environments.

Intuition is like a sixth sense when I'm out there... the ability to make good decisions based on experience with decisions and bad decision-making and using that collective knowledge to reinforce the ideas or thoughts that I'm having going through my head along with factual evidence as well.
Participant 106

8.3.2.2.2 Use of Intuition

Intuition was used in a variety of ways. For many of the participants, the use of intuition did not just happen. There was a conscious use of intuition. Morsella and Bargh (2010) suggest that an initial intuitive response promotes action; however conscious processing of that intuitive response serves to constrain action. Participants recognized that the presence of an intuitive response often triggered an element of deliberation, which in turn led to an analysis of that response. This process is supported by the notion of constructive intuition (Glöckner & Witteman, 2010). Participant 106 described the process when he recognized that his intuitive pattern recognition was flawed. His conscious processing or deliberations may not only have changed the output of his decision, but also impacted future intuitive responses.

So the pattern has changed. So when it comes back to intuition, is intuition correct here or not? It wasn't in that situation. So then I start to guess the intuition. How much should I be basing my decision off intuition? It starts to get all messy when I start to break it down and try to figure it out. Participant 106

This integration of intuition into a deliberate process was described as being integral to the task of terrain selection. The task began during the morning guides meeting and extended out into the field. Participants felt that intuition helped them select terrain on both a macro and micro scale. In the morning meeting, Participant 101 suggested that the integration of intuition and analysis occurred when the run list was generated. "Certainly during the run list. You're talking about different runs, the characteristics of the runs, you have the feeling of how the snow, how the stability has laid up. What you can get away with?"

Hogarth (2010) suggests that the question should not be whether intuition or analysis is superior, but how to use both process in a synergistic effort, with intuitive responses treated as data and analytical responses passed through the intuitive filter of "*How does it feel?*".

8.3.2.2.3 Positive and Negative Intuitive Responses

Intuitive responses played a greater role for participants when they evoked stronger feelings. This included both positive and negative feelings. “Intuition tends to be more site-specific. I feel good here. I don’t feel good over there. And often if you move to the next site, it’s not there any more” (Participant 714). These somatic markers functioned as alarm bells, alerting the participants to existence of previously experienced positive or negative events (Carter & Pasqualini, 2004; Damasio, 1996). “It’s like a thing within your body that is just sort of an alert. It’s almost like a siren goes off on in your body” (Participant 604).

Many participants reported experiencing negative intuitive responses. These negative intuitive responses had a strong influence on the decision process and triggered further analytical processing. “I learned that it was good to listen to all the time was the [sic] nagging voice that was saying: ‘No don’t do that. This might happen. Remember this’” (Participant 702).

It just means that there is [sic] enough factors in the back of my mind that are telling me that there is something that’s not right. It’s a warning bell that you’ve got to weigh against other things, but it is a warning bell, that over the years I’ve been involved in skiing in the winter, it has been a warning bell that has been good for me. Participant 601

The negative intuitive response seemed to speak more strongly to the participants. “I try not to make *go* decisions based on intuition but I do make lots of *no-go* decisions based on intuition” (Participant 714). Although the negative intuitive responses were valued as alerts to possible dangers, participants described a preference to operating in the absence of these bad feelings.

To me the best way is to not let it get to the point where you have a bad feeling about something. If it’s gotten to that point it’s almost like I haven’t been using the intuitive process early enough. I’ve already gotten to the point where it’s a critical enough decision or situations that I’m actually getting a bad feeling about something. I would rather be operating where I having a good feeling about what’s going on. I found listening to intuition early; I’m much more in that place of feeling good about what is going on in the process and the decisions that are being made. Participant 608

The positive intuitive response was only mentioned twice in total by the nine participants, but may represent the tip of the iceberg.

Sometimes you definitely do go for it... it's not a standstill think about it, think about it. You just go. If you have that feeling you just go. It's a split [second] decision...I've had situations where I went for it and I've been lucky. Participant 604

It is possible that this type of response occurs more frequently during winters when persistent weak layers are less of a concern.

8.3.2.3 Dual Process

The dual process models suggest that intuition and analysis are complementary and parallel processes (Sloman, 1996; Stanovich et al., 2011), however given the immediacy of the intuitive response to a sudden stimulus; it may frequently occur prior to the development of an analytical response. The default-interventionist theory suggests that decisions could be made solely based on the intuitive response, if it were strong enough (Gillard et al., 2009). Hausmann and Läge (2008) described this as the process of accumulating enough evidence to attain a desired level of confidence. It would likely take a conscious decision to extend beyond the stop conditions, if the threshold for certainty was reached within the intuitive response. Feduzi (2010) argued that the issue of the 'stopping problem' hinged on the degree of completeness within the weighted evidence. Taken one step further, there were times when the strength of the intuitive response provided adequate stop conditions for my research participants. However, participants described that this was not a frequent occurrence and that more often, they relied on both intuitive and analytical responses as a series of checks and balances. This may be due to some of the elements of analytical pre-planning that occurred on a daily basis. The morning guides meeting set the stage for an intuitive – analytical dialogue.

The initial framework decisions are based on analytical [analysis]. That's in the office before you're on your skis. If you made an analytical decision to ski slope "A" and you get there and things are not exactly as you discussed them, that's when intuition kicks in. Participant 103

I use my intuition a lot. It's a dual process for me. I don't go hundred percent analytical. You always have a feeling about something as well. You get out of the machine and step into the snow; right away you get a feeling. Participant 604

Participants displayed reluctance to be entirely dependent on either process, preferring instead a blend of processes. “Make sure you have data and intuition every single time. Not just intuition” (Participant 101). “Gut feeling? I don’t think I solely use intuition. I also use our team’s analysis our discussions in the morning” (Participant 103). However when intuition and analysis clashed, participants indicated a preference for intuition.

Intuition plays a big role for me. I can look at statistics or facts on a piece of paper and it plays a role, but intuition for me over the years, you can’t quantify it, but it has played a reasonably high role. If something doesn’t feel right, if the paperwork is indicating it is right, I may not do it... The final decision comes out of an intuitive process. Participant 601

Defaulting to intuition did not always work well for the participants, as their intuitive responses could have been swayed by the use of a representative heuristic that failed to account for base rate neglect (Kahneman & Tversky, 1973).

Participants described how their decision confidence suffered and stress increased when they had to choose between intuitive and analytical conflicting alternatives.

If I’ve overridden the analytical, I would probably have very low confidence in it. I know that that happens to me. So I do it much less. When I was a younger guide I made that decision more and more and you skied the whole run with your hair standing up. At your regroup spot, yelling, “come on, come on, come on, oh man, I can’t believe he fell there” by the end of the run you feel shitty and stressed. Participant 714

This is consistent with studies conducted using an fMRI to detect areas of brain activation. De Neys, Vartanian and Goel (2008) monitored frontal brain areas thought to be responsible for conflict detection and response inhibition. They found that the conflict detection area was activated in most cases. They suggest that although the intuitive process may provide a rapid solution; as long as it is not immediately acted upon, the analytical process has the opportunity to provide an alternate and potentially conflicting alternative. They suggest that heuristic biases may occur, not from a failure to detect a conflict, but from a failure to inhibit the intuitive response.

My participants showed that they were able to detect conflicts between intuition and analysis and regularly used both processes in a series of checks and balances.

It [intuition] plays a huge role for sure. I think of it as 50/50, when I am feeling comfortable on the slope. When I have less history, less analytics, I kind of lean towards more data, but there's always that touching base with how you're feeling. Participant 101

As the human brain has finite cognitive capacity, and in the environment of my research participants, limited time, the primary task of the participants was to decide when to trust an intuitive response and when to apply more in-depth processing. Evans (2010) argues for the use of intuition as the basis for analysis and this was the strategy used by many of my participants.

8.3.3 Mitigating Factors

The participants described how the duality of the decision process was dependent on, or varied, based on two key factors; the range of possible consequences of a particular action and the feeling of confidence generated by the decision process. Participant 101 described how he used two questions. "Does it feel good? and Is it worth it? Not only the consequence, but touching base with the risk and reward."

Consequence also played into the conflicting outcome scenario when intuition suggested one course of action and analysis another. Galloway (2005) stressed the importance of assessing the potential outcomes of a decision. If the decision was wrong, and the worst possible outcome were to occur, would this be acceptable?

You know what I think it boils down to for me is consequence. If analysis says don't go and intuition says go, then I take the next step. If I go what's to happen? Am I going to get wrenched through trees for 500 vertical feet? Well no I probably won't go. Participant 103

Even when nothing went wrong, there were times when participants felt that they had made poor decisions. These were taken as opportunities to modify future decisions.

When I feel that something really could've gone wrong, and it didn't, that really hits home hard. And I can't really explain it. It's pucker factor. It is gut feeling. Something was wrong there. And you just know. At least you think you know. Participant 103

8.3.3.1 Confidence

Participants described confidence as a feeling that permeated the entire decision process, but was most acutely felt at a few key points. Their initial level of intuitive confidence would likely have been generated as the result of previously enacted decisions and resulting feedback. Whether or not participant confidence was tainted by an illusion of validity would have depended on how the participant had learned from those previous experiences (Einhorn & Hogarth, 1978). “I try to relate it to past events, past history, past build-up of snowpack, past types of terrain, what has and hasn’t happened on things. My level of confidence is pretty high in my decision-making” (Participant 601). However the assumption that confidence is increased through additional time spent in the environment may be flawed. The absence of reflection on non-event days may lull the unsuspecting decision maker into a state of overconfidence (Fischhoff et al., 1977).

I think the more time you’re at it, experience longevity. You can’t help but to build your confidence in your decision-making skills, the more time you put into it, and the more that you’re exposed to and the more that you see.
Participant 604

The environment experienced by the participants during the winters of 2008-2010 was not conducive to the development of confidence. Some participants described having a low level of confidence due to the presence of persistent weak layers. They could not use their level of confidence as a stopping rule as suggested by Hausmann and Läge (2008).

For me personally it is harder to feel confident about what is going on with that [PWL] when it is that deep in the snow pack. And you know that it’s lingering and you know that it’s going to be variable. Participant 608

Other participants described a process to reduce the level of uncertainty, by being less dependent on the analysis of snowpack stability. They created larger margins for error through conservative terrain choices. “I make those kinds of decisions less and less. I seldom ski runs that I don’t have high confidence in” (Participant 714).

8.3.3.1.1 Increased confidence and subsequent terrain use

One of the challenges expressed by participants was the scenario when snowpack stability was improving. Typical indicators of improving stability are a reduction in negative indicators, such as natural avalanche activity and the likelihood of skier triggering an avalanche (McClung & Schaerer, 2006). The validity of these two indicators is dependent on sample size. The amount of terrain observed and the volume and type of terrain skied are necessary components of the decision process. Along with other stability factors, if no avalanches are observed or triggered, the guides may decide that snowpack stability is improving and that it may be possible to begin to use more aggressive terrain. Participants described using small incremental steps as they began to use more aggressive terrain.

I think you build confidence and don't know if you build any knowledge. But you do build confidence as you step a little further. As we step out, we do continue to analyse and if we're not seeing a reaction on a layer or an interface of concern and we're not getting it in our analysis and we're not getting it in our skiing, then it tends to get stepped up a little further. As you step out further you may need to choose terrain that has more support or low consequence. Participant 103

8.3.3.2 Feedback

Participants perceived feedback on their decisions coming through human interaction and from the physical environment. This equates to behavioural and outcome feedback as described by Brown (2006). The limitation on peer feedback received by the participants within a small circle of influence was that the peer group might have also misperceived the environmental context, due to a similar set of misleading factors. The group decision process may have been distracted. However, it was the environmental feedback during the 2008 / 2009 and 2009/10 seasons that forced participants to step back and re-evaluate their decision process; in particular the faith that they put in both the intuitive and the analytical processes.

It was a progression and a learning to listen to that voice last year. Because in so many other years I might have had the voice and I might have listened and probably other times I didn't listen to it and I didn't have that direct feedback and what was so neat about last year was I had that direct feedback a lot of times. Participant 702

Participant 106 described the importance of receiving environmental feedback on the use of well-known terrain. "I think being complacent, skiing the

terrain for the last 12 years and never seeing anything happen on it. Thinking ‘ahh’ it will be fine. And then something pulling out and getting slapped”.

Finding the balance between caution and recklessness was a constant battle for the participants. Direct environmental feedback provided a calibration opportunity. The repeated negative feedback from the environment could be summed up with; *no you cannot go there*. This contributed to the participants’ penchant for conservative decision-making and is consistent with other research findings (Brown, 2006).

I was really lucky to get that direct feedback that is what I needed. You can talk about avalanches until you’re blue in the face, but if you never see one and you never see one happen where you don’t expect it. Or you think it might happen, but then it doesn’t. You start to question am I being overly cautious? Am I just getting away with stuff? Participant 702

8.3.3.3 Reflections

Reflection was different from feedback, but served a similar role. Participants described how they reflected on their performances, particularly in the absence of direct feedback. The trigger of the reflective process was attributed to a direct evidence event such as a near-miss, or to forward thinking of the “what if...” scenario building process. Much of the reflection centred on a self-critique of possible negative outcomes that could have occurred, but did not. Harteis, Bauer and Gruber (2008) found that there were constraints on near-miss reflections if at the organizational level, there was a culture of blaming. Participants in my study reported corporate cultures that supported near-miss reporting.

Participants described that reflective episodes within their practice surfaced after both good days and on days when near-misses occurred. Near-misses frequently triggered extensive reflection. Some of these near-misses were avalanche events that occurred either just before or just after the participants were exposed to the hazard.

For the past nine years it has worked. I’ve had no issues. The last three seasons it’s kind of slapped me around. It’s made me re-evaluate the situation with intuition and my own perception off collecting data and analysing data. Participant 106

Reflection was also triggered in the absence of a near-miss. This raises the question of why participants felt that they had made a poor decision, even though an analysis of the decision provided no concrete evidence to support that. There

appeared to be post-event, reflective episodes that pointed to an error in the decision response. “I’ve never had the same gut wrenching feeling as when I made a mistake and nothing happened. Never...I get to the bottom and everybody’s happy, but I’m pissed off because I think I’ve killed everyone” (Participant 103).

The need to justify one’s actions to the guests and the company hierarchy provided additional impetus for reflection. Knowing that others would judge the quality of decision outcomes contributed to a more conservative range of risk acceptance.

There have been a lot of times when I felt like an idiot, for skiing what I skied and taking people down it, because of the potential strictly for avalanches. I get to the bottom of a run and my group is behind me. Nothing happened and I felt like an idiot. Participant 103

Participant 714 described the self-questioning process that he used. “How would I justify this decision, and if I can’t justify it then I don’t do it. That’s my acid test, how would I explain this and how I explain that if something went wrong?”

8.3.4 Outcomes

As described above, the conservative choice became a theme in the participants’ decision processes. This pattern of behaviour was influenced by the nature of the environment. The environment experienced during the winters of 2008-2009 and 2009-2010 was not a fully wicked environment as described by Hogarth, et al (1991) and Pretz (2008). The consequences were severe, however the quantity and quality of feedback were mixed. The challenge for the participants was a conflict that emerged between perceived feedback and previously observed patterns. The feedback provided by observed natural and skier triggered avalanches did not match with expectations. This created a sense of doubt, which mandated larger margins for error. A kinder environment, one with less severe consequences, might have allowed for more aggressive decision choices. However, the more wicked environment experienced over the two seasons and in particular the 2009-1010 season, emphasized the need for a conservative approach.

The long term effect of this somewhat wicked environment was a trend toward more conservative decision choices. “That’s what the last three years have done is added doubt to my ability to predict avalanches, persistent weak layer

avalanches and how long that they can stick around” (Participant 714). “I tend to err on the safer side, regardless of whether it’s an intuitive feeling or an analytical situation. Today I will go with the conservative decision” (Participant 604).

When balancing their intuitive feelings with the results of analytical processing, participants described a conservative, hedging process as they adopted a wait and see attitude.

I would rather wait an extra day or two even though all of the analytical information is pointing in that direction. And even intuitively you feel that the stability is pretty good, but I still would rather be a bit more conservative. There’s no hurry. Participant 608

The existence of a persistent weak layer in the snowpack, regardless of whether it was performing, was enough to question analytical test results and to embrace conservative intuitive responses.

8.3.4.1 Changes over time

Participants described how their decision-making had changed over time as they gained expertise in dealing with the challenges of snowpacks with persistent weak layers.

Five years ago I might have given you a different answer. Five years ago I don’t think I was so defined in my decision processors. But the last three years of persistent weak layers causing all kinds of issues, to me has solidified that thought that: no, “if it is there its there” and don’t try to second-guess if it’s there. Participant 714

8.3.4.2 All the answers

The complexity of the ski guiding decision environment has led some participants to question their understanding of the avalanche phenomenon. Although they had built expertise through years of deliberate practice, they felt that their ability to make good decisions was compromised.

It’s interesting, I find the more and more I get into this, the less and less I feel like I know what’s going on. The last couple of seasons it feels like my confidence has dropped. It feels like I keep asking bigger and bigger questions about what’s going on there.... I don’t have any answers yet. It seems like there will be a pattern growing where I will start to build confidence and then it just seems like I get slapped down and then it’s right back to the bottom again.... I’m just getting more confused. Participant 106

8.4 Summary

There has been considerable discussion as to the nature of, and even the existence of dual processing in decision-making (Barrouillet, 2011a). Single process theories have been argued by Keren and Schul (2009) and Kruglanski and Gigerenzer (2011), however they do not address the evidence provided by the research that has used fMRIs to demonstrate a link between brain activation and dual process (Lieberman et al., 2004).

The common ground between the single and dual process camps is the acknowledgement there are two components or parts at work. Researchers have used a variety of names for these components from System 1 and System 2 (Kahneman & Tversky, 1973; Simon, 1987), Type 1 and Type 2 (Evans, 2011), and more simply intuition and analysis (Hammond & Summers, 1972). The argument as to how these two components integrate, ranges from the Cognitive Continuum Theory (Hammond & Summers, 1972; Hammond, 2010), to the fMRI studies conducted by De Neys et al. (2008), and Fuzzy Trace theory (Reyna & Brainerd, 2011).

Within this matrix of conflicting and often overlapping research, the data from Study 3 suggest that participants used both intuition and analysis, but not as a cognitive continuum as explored in Study 2. Participants described using intuition and analysis as distinct and separate continuums. They used these two continuums in a series of comparisons, one to the other. At times, they experienced high levels of both intuition and analysis, while at other times they experienced low levels of each. There were times when intuition and analysis were congruent and times when they suggested different courses of action. The greatest challenges were experienced during these moments of cognitive discord, well thought out analysis suggesting one course of action and the intuitive response the opposite. There is very little in the literature that explores the nature of intuitive feelings, be they good feelings or bad feelings. Participants described how they were more motivated to action by bad feelings than good ones. Participants responded to this challenge by defaulting to the conservative choice, perhaps exacerbated by the exacting and 'wicked' nature of the operational environment experienced during the two research seasons. The avoidance of low likelihood, yet extreme negative consequence was the overriding theme expressed by the participants.

Participants indicated that they were conscious of their processing of intuitive responses (Morsella & Bargh, 2010). Rather than letting an immediate action prompted by an intuitive response that seemed to satisfice the decision environment become action, participants described how they often used analytical processing to constrain action. Although there were likely times when Recognition-primed decisions that satisficed the operational environment occurred as per Klein's (1993) and Simon's (1979) descriptions, participants reported regular use of intuition as a check, or constraint on analytical responses and vice versa.

Participants used feedback and reflection to learn from their experiences. This learning was likely powerful enough to impact their future intuitive responses. Hodgkinson, Langan-Fox and Sadler-Smith (2008) summarize that intuition is typically slow to change. I suggest that three winters in a row of dealing with the possibility of low probability, high consequence events may have been enough to modify the participants' intuitive processes. Hogarth (1980) suggests that learning in this type of environment is difficult. However, given the strength of the potential negative consequence and the occasional near-miss occurrence, ski guides who participated in the study were able to integrate learning into their practices, facilitated by reflection and peer feedback.

Last winter I felt like hanging up my skis and walking away. Because it didn't seem worth it. I was trying so hard to be out there in a beautiful environment, that is supposed to be fun, but it seemed like I was working so hard just to make it through the day without having anybody killed.

Participant 702

Chapter 9 Conclusions and Recommendations

Standing at the top of the first run of the day, everything seems to be coming together. The storm is over. There is plenty of fresh powder snow. The sun is poking through the clouds. The guiding team has selected a range of conservative terrain for the run list, with a low angle north-facing slope chosen for the first run. It is the first week of March and the only avalanche concern is an instability with the recent storm snow; temperatures are relatively mild and the snow is settling and bonding rapidly. The guiding team feels confident with their terrain selection in relation to the snow stability and their forecast of considerable avalanche hazard. Figure 17 shows the slope and the ski line in red (Google Earth, 2010).

Figure 17 Buster's Run - ski line



The first guide and his group enter the slope and ski to the pick-up point. The second group is flown up from the valley and skis the slope. The third group is flown up and enters the slope. By this time, the helicopter has picked up the first

group and the second group has made it to the pick-up and taken their skis off. One of the guests in the third group skis slightly away from the line designated by the guide and stops on a convex roll. A fracture occurs and an avalanche initiates in the storm snow five metres away from the guest. The avalanche, more than big enough to bury and kill a person, rumbles down the slope below the group. Nobody is caught in the slide.

Midway down the slope, the avalanche triggers two more avalanches, one from each side of the valley (Figure 18). As the three avalanches gather momentum and race down the slope, the guide thinks of the second group, still at the bottom of the slope and waiting for a pick-up. He radios a warning, but there is nothing they can do. Their skis are off. There is nowhere to run, nowhere to hide.

Figure 18 Buster's Run - Three avalanches



I was a participant-observer for this event. I participated in the morning guide's meeting and contributed to the stability assessment, hazard forecast and run selection. I did not observe the event occur, but I interviewed the guides at the end of the day. How did this happen? How did we get it so wrong? Six guides with

over 100 years of combined guiding experience made the decision to ski the slope. The knowledge of the snowpack development over the season, the analysis of the weather and snowpack observations over the previous few days, the comparison with the nearest neighbours' observations and stability assessments, the knowledge of the terrain, and intuitive confidence generated through pattern recognition contributed to the decision.

The first avalanche failed at the interface between the recent storm snow and the older snow. The second avalanche also failed at the storm snow interface. It was the third avalanche that was anomalous. Although it initially failed at the storm snow interface, it stepped down to a depth of 265 centimetres and an old weak layer that had formed and been buried in early December (Figure 19). This was highly unusual for the area. Weak layers in the upper snowpack are typically the major concern in a coastal snowpack. It was rare for a weak layer formed in the early season to remain weak right through until March. However, this event was not the only deep avalanche reported that day as two other deep avalanches with skier involvements were reported in the region.

Figure 19 Fracture Line – maximum depth 265 cm



So what happened? The analytical and intuitive processes were in harmony and indicated the same action. The weather and snowpack data seemed to match up with previous patterns. The answer may be that this winter was different. This early-March event was the first indicator that the environment was not providing consistent high quality feedback and that the negative consequences of making a poor decision could be catastrophic. The Mountain Conditions Report produced by the Association of Canadian Mountain Guides posted an analysis the following day.

If anything, this year is weirder and more complex than last.... Usually, avalanches in the Coast Ranges or the Rockies have little or no relevance to the interior ranges. This year, however, I think the recent incidents reported on the Coast and in the Rockies are directly relevant to what we might expect here in the interior.... In my opinion, in a winter like this, it's wise to keep an eye on conditions farther afield than you might normally--my nearest neighbour in a PWL winter may not be geographically close by--it could be a place hundreds of kilometres away where the snowpack is similar (Klassen, 2009).

This near-miss event was similar to many other near-miss events reported by participants over the two years of the study. Nobody was hurt, but the consequences were potentially catastrophic.

9.1 Introduction

Results and findings from chapters Five through Eight have been interpreted in light of the previous literature. The discussions of expertise, and dual process decision-making as it occurred in the wilderness ski-guiding environment of Western Canada have been made clear and have the potential to contribute to the literature. I have also discussed the study's limitations, the implications for ski guide practice and training, and implications for future research.

This chapter connects discussions of the findings from three studies together and places my research within the broader discussions that have taken place in the literature. As there have been a variety of discussions or arguments within the decision-making literature, I needed to be selective in choosing which discussions to join and how to contribute to them. My research has the most direct connection with the snow sciences discussion, so the contribution to this domain is most germane. Connections have also been made to the context of the adventure literature and the judgement and decision-making literature.

Although the methods included both qualitative and quantitative components, the research questions were framed in a qualitative perspective of the role that intuition played in the decision process of ski guides. The quantitative results were used as a springboard for further exploration of the qualitative data.

Within the JDM literature, the heuristics and biases research studies have investigated the negative side of intuition (Kahneman & Tversky, 1973). While the recognition-primed research (RPD) studies have investigated the positive side of intuition (Klein, 1993; Zsombok & Klein, 1997). Although Kahneman and Klein (2009) acknowledged the value of each other's work, there was still much to be done to assimilate the results from each area into some common language. A fragmented discussion of the decision-making process also exists within the dual process research (Evans, 2007, 2008).

The snow science literature lacked clarity and depth in the discussion of expert decision-making. It is important to understand how ski guides actually make decisions, in particular how they blend analytical and intuitive responses together. The ability to dissect the decision process has led to a maturation of understanding within the JDM literature, so these JDM theories have been applied in the snow science context. This has led to the development of strategies for decision success, which are explored later in the chapter (Hogarth, 2010).

9.2 The Research Questions

The primary question queried why guides relied on their intuition when they had been taught to use analysis. My investigation sought to clarify the degree and the method in which ski guides with a range of expertise, used intuition to solve decision challenges within a culture that favoured analytical decision-making. An additional question examined why somatic markers, or good and bad feelings had such an impact on ski guides' decision processes. The final question assessed the influence of feedback. The literature suggests that the development of intuition is dependent on the presence of high quality environmental and peer-based feedback. The following questions were prompted. What did ski guides do to integrate variable quality feedback into the formation of patterns for future recognition? How did the uncertainty presented by the mere existence of persistent weak layers affect the decision response? How was decision confidence influenced by the strength of intuitive response?

9.3 The Problem - Expertise and Intuition

The challenge experienced by the research participants was the need to digest a wealth of data. Sort them. Sift them. Arrange them. Use them to generate a logical risk assessment. This was no easy task, as along with other sources of information, the InfoEx alone provided over 10,000 data points per day (Tomm, 2008, personal communication). The potential for information overload was significant, even for these expert ski guides. Davis (2011) described information overload as the result of having an overabundance of information and faulty or

inefficient filters. Participants needed some way to filter, or reduce the amount of data that they needed to process.

One method of filtering that has been regularly used in the industry is the idea of only using information from the nearest neighbours. Nearest neighbours have typically been considered to range from the same valley to the same mountain range. Under conditions of increased uncertainty, such as dealing with a persistent weak layer Klassen (2010) proposed that the nearest neighbour concept might need to be geographically expanded. The conditions experienced hundreds of kilometres away in the next mountain range, rather than just five to ten kilometres away in the next valley, might provide valuable indicators of changing conditions. This was the case with the vignette presented at the beginning of the chapter.

However, expanding the range of the nearest neighbour network does not ease the challenge of data filtering. On the contrary, it makes it worse. Computer-based filtering using nearest neighbour models was proposed and tested, but has not received wide acceptance (Cordy, McClung, Hawkins, Tweedy, & Weick, 2009; Purves, Morrison, Moss, & Wright, 2003). This may be an area for future research.

Over the two winters of the study, participants regularly described a lack of faith in the standard analytical process that they had learned in their training courses. Many decisions produced through this process were found to be inadequate for the complexity of the challenges presented during the winters of 2008-2010. Participants described how they began to rely more on their intuitive feelings. Many of these intuitive feelings were negative in that they promoted feelings of caution. Terrain was avoided based on these conservative thoughts. They felt the need to rely on their intuitive feelings to fill the void left by the inaccuracies of their analytical decision process.

However I question the accuracy of the participants' intuitive responses, as they were potentially the result of a wicked and exacting environment. Hogarth (2005) cautioned against relying on intuition when the initial patterns were learned in an environment which gave contradictory feedback. Although participants may not have been able to overcome all the challenges of the wicked environment, they generally choose a conservative line of reasoning which blended their intuitive feelings and their analytical assessments.

9.4 Primary Research Findings

The key variables that were examined in this study included expertise and how it could be estimated, or calculated, the interaction between intuitive and analytical responses in the decision process, and the influence of somatic markers both positive and negative. These variables were examined in relation to how they influenced the development and use of intuition

The primary findings centred on how intuition and analysis should be viewed as concurrent and separate processes rather than sequential and mutually exclusive and thus rejecting the cognitive continuum concept (Hammond & Summers, 1972; Hammond, 2010). In the development of a decision response, intuition and analysis were not weighted relative to each other. The weight of the intuitive response did not need to change based on the weight of the analytical response. Decisions were made across a spectrum of possibilities, with some decisions involving high levels of both intuition and analysis and others involving low levels of each. These findings support Evans' (2010) definition of dual process, but conflict with the argument proposed by Hammond (2010), who suggests that intuition is over-valued and should not be trusted. The challenge for my participants occurred when the weight of the two responses were equal, but indicated opposite actions. In this situation, the strength of each response was then factored into the decision, with conservative intuitive responses the dominant force.

The environment, or setting in which these variables were examined was unique, both professionally and physically, each providing opportunities for decision feedback and subsequent learning. The physical environment was at times wickered in that it provided variable quality and quantity of feedback in the face of exacting consequences (Hogarth et al., 1991). The professional environment had the ability to generate high quality feedback, but was dependent on the quality of interactions within the guiding group. Feedback and reflection that occurred within these peer groups created opportunities to build strong intuitive responses through the establishment of peer-validated patterns.

Faced with an environment over the winters of 2008-2010 that hindered both analytical and intuitive processes, how were guiding teams able to produce high quality and safe experiences for their guests? An exploration of how and when

intuition was used, particularly the importance of somatic markers expressed as *bad feelings* has provided a possible explanation. The quantitative data suggested that participants used positive or good feelings as the basis for many decisions. However the interview data suggested that participants defaulted to the conservative option when intuition and analysis clashed, with generally the intuitive response indicating the need for additional caution.

9.4.1 Study 1 – The Calculation of Expertise

Relationships were explored between expertise and the use of intuition, and expertise and confidence. These relationships were analysed based on good day and near-miss reports. The intuitive-analytical continuum (Hammond & Summers, 1972) was used to examine the relative use of intuition within the good day and near-miss reports. Although the ratings indicated that the participants typically blended their use of both intuition and analysis, there was a trend toward the use of intuition. Further examination indicated that when intuition was used, there were slightly more positive intuitive responses than negative ones. The intuitive response was rated as positive more often than negative. This conflicted with the findings in study 2.

As expertise cannot be directly measured, it must be calculated based on a variety of measurements. The accuracy of the calculation is dependent on the selection of the variables and the accuracy in the measurement of those variables. Galloway (2002, 2003, 2005, 2007) used multiple measures of experience in the Outdoor Leader Experience Use History Instrument (OLEUH) to generate an expertise profile. The OLEUH is a sophisticated tool that has the potential to generate a precise portrayal of expertise, but is dependent on accurate recordkeeping for a wide range of activities. Ollis, MacPherson and Collins (2006) suggested using a longitudinal research design and the inclusion of a field study component to generate greater accuracy. Although this was not a ski-guiding context, they used an 18-month period in a study of rugby officiating. I was able to interact with my participants over an extended period (two seasons).

The selection of appropriate measures for calculating ski guide expertise was one of the challenges that I faced. I used a more limited range of measures than were used in the OLEUH, as my participants did not have accurate records for all of the

measures. I was concerned with the accuracy of the individual elements, so I used the most accurate measurements available. The participants had recorded some of these measures as part of the Canadian Avalanche Association's template for the documentation of continued professional development (CPD).

A simple summation of each participant's years of experience was not rigorous enough, as it did not accommodate the range of experiences captured within a year, or give any indication of what might have been learned during that year. So in addition to an hours of professional, field-based experience calculation, I generated an hours of experience calculation for continued professional development. I took these CPD markers as being indicative of reflective learning, as many of the CPD days were training events, which connected new learning to field experiences. The opportunity to question what could be learned from previous events potentially prompted new learning. The integration of CPD events helped me to distil the participants' expertise out from their experiences. The ability to learn from experiences was considered indicative of the development of expertise.

A subjective assessment of expertise was also conducted. Participants were asked to reflect on their expertise and rank themselves relative to their peers. Although the literature suggested that there could be major inaccuracies in the self-assessment of expertise (Dunning et al., 2004), the three subjective measures were only slightly higher than the objective measures. It is likely that the regular feedback received by the participants from the environment and their peer group helped them retain a balanced perspective.

The acceleration of expertise

Endsley (1997, 2006) concludes that experts generally have more refined situational awareness. Fadde (2007) adds the suggestion that situational awareness could be trained through dedicated practice with an increase in repetitions. These repetitions could be attained directly, or by watching others. A less experienced ski guide could build situational awareness by anticipating the lead guide's decisions. Personal reflection in conjunction with a feedback session facilitated by the lead guide would complete the process. Whether through direct or indirect repetitions,

timely feedback is likely best when focussed on the decision process rather than the outcome.

The standard method of developing expertise consists of performance preparation, performance and debriefing (Fadde, 2007). The preparation and debriefing phases are the key to the eventual development of expertise. However to accelerate the development of expertise, targeted instructional settings can be constructed that focus on the development of the recognition component of the decision process. For ski guides, the ten years or 10,000 hours of dedicated practice is achieved through three somewhat discreet segments of development: preparation for certification, formal training and certification, and professional practice.

The training of recognition skills has a potential benefit in the acceleration of decision expertise, as it is the first step in the RPD process. Quicker recognition provides a more rapid priming of the decision process. Fadde (2007) identifies three critical issues: why train recognition, how can recognition best be trained, and will improved recognition lead to better decision-making? Fadde (2007) suggests that it is possible to use instructional design to hasten the development of expertise through the improvement of training that targets pattern recognition. This combination of prescriptive instructional design with descriptive expertise research may offer a way to accelerate the transition from competent practitioner to expert and as such is not appropriate for teaching novices.

The ski guide needs well-defined reaction skills; these abilities are based on recognition, decision and action. For example: the ski guide needs to correctly identify the reaction component of the feel of the skis in the snow. When a pattern of skier-triggerable windslab is felt and recognized, there is a priming of the diagnostic action. The appropriate response is to traverse off to the side around the windslab. Delayed recognition may result in the guide travelling further onto the windslab, triggering an avalanche.

As the ski guiding decision context varies considerably, multiple opportunities exist to explore new techniques. Developing experts can choose to make the task progressively more difficult. The recognition training approach is

anchored in direct instruction, which has been largely remiss in addressing the developmental needs of RPD. The instructional elements are immediate feedback and incremental difficulty.

9.4.2 Study 2 – Intuition

A qualitative analysis of the event reports and interviews produced insight into the filters that were present in the decision environment. In Chapter 7, the cyclical nature of the decision process was analysed. The filters formed the groundwork for the enactment of decisions. The participants were able to improve the quality their decisions through reflection on their decisions and feedback from both the environment and their peers.

The greatest challenge in the use of intuitive responses has been identified as knowing whether the response is valid and correct, or the product of an imperfect heuristic bias (Kahneman & Klein, 2009). They suggested that an intuitive response would come to mind whether the decision maker had underlying expertise and skill or not. Although intuitive responses may generate strong feelings of confidence, confidence alone has not been found to be a quality indicator of a correct intuitive response (Einhorn & Hogarth, 1978).

Over the two years of the study, the general theme expressed by participants was a lack of trust in their analytical process and a questioning of their intuitive responses. They described a wicked decision environment that did not match previous patterns. Kahneman and Klein (2009) suggested that intuitive responses should be evaluated through effortful analysis, but that this regularly did not happen, either through inability, or lack of effort. Even though the participants described how they reflected upon their intuitive responses, it did not generate a sense of confidence as the results of their analytical decision processes were also suspect.

Although the consequences were exacting, often the feedback timing allowed participants the opportunity to make decisions that were subsequently proven wrong. Fortunately the catastrophic consequences occurred prior to participants exposing themselves and their groups to the suspect slopes. After experiencing events such as this, participants described how they began to trust their negative intuitive responses more than their positive ones. A tendency to rely more on negative intuitive

responses developed. Participants turned to more conservative choices when they experienced general feelings of uncertainty and low levels of confidence.

9.4.3 Study 3 – Dual Process Interpretation

The findings from Study 3 were presented in Chapter 8. They resulted from a qualitative analysis of interviews conducted with nine of the participants. These interviews asked the participants to describe their global perspective of decision-making and reflect on their practices based on an analysis of critical decisions.

9.4.3.1 Dual Process

Data suggest that participants used a dual process in their decision strategies as opposed to using intuition and analysis on a continuum. Participants described how they varied their use of intuition and analysis. At times the two decision processes were used in isolation from each other and at other times, used together as a series of checks and balances. This is particularly interesting, as they had received considerable training in their use of the analytical process, but little to no training in the use of intuition. The striking imbalance in training was perhaps offset by the depth of the expertise that had developed over their careers.

What is running through the mind of the ski-guide at different stages of guiding?

The default-interventionist theories suggest that the decision-making default response is based on intuition or heuristics and requires the decision maker to consciously make an intervention to change the initial response (Alter et al., 2007; Evans, 2011; Sinclair, 2010). Hogarth (2005) suggests that conscious processing is a limited resource. As such, it must be conserved whenever possible, allowing the unconscious, or intuitive process to solve as many challenges as possible. Thus the intuitive response, or heuristic processing happens first. Pattern matching may provide an answer that appears to satisfice the problem. An adequate solution that satisfices the decision challenge can provide a stop condition, negating the need for further searching. This becomes the default. Although analytical reasoning may provide an opportunity for a solution check, previous experience might suggest that the time and effort needed to go down the analytic route is not worth it, as the

intuitive response has usually been correct. This makes for a faster, but more error prone decision strategy (Gillard, Van Dooren, & Verschaffel, 2009). In addition, any departure from the default may produce regret (Kahneman, 2011).

The prescribed ski-guiding industry decision process followed in the morning Guides Meeting is anchored in analysis. Most operations use some iteration of the Canadian Avalanche Association A.M. Avalanche Hazard and Risk Analysis Worksheet (Appendix 1). It is a largely analytical process, however there is a significant turning point when the data analysis demands an intuitive response. The form begins with an analysis of the weather observations and forecast. This is followed by an analysis of the impact of the weather changes on what has been observed in the snowpack. Class One stability factors (McClung & Schaerer, 2006) provide the evidence considered to hold the greatest strength and weight, as avalanche activity and snowpack tests are the best indicators of the likelihood and severity of the avalanche hazard. In an effort to gain greater weight of evidence, reports of avalanches from nearest neighbours are a vital part of the analysis. This helps the guiding team to create a detailed description of the avalanche problem. Weak layers and interfaces are named and dated along with the character and destructive potential when avalanches occur. The sensitivity to triggering is described as: unreactive, stubborn, touchy, or very touchy. Finally, the potential locations where these avalanches could be triggered are described. This includes both the spatial distribution and the specific terrain features.

The weather, snowpack and description of the avalanche problem contribute to a hazard forecast rating of both the stability of the snowpack and danger posed by a potential avalanche. Hazard ratings are made for three elevation zones: Alpine, Treeline and Below Treeline. A confidence bracket is also included.

The transition to an operational plan demands a combination of both analytical and intuitive processes. Although based in an analytical framework, the questions of “Where should we go?” and “How will we manage our exposure to the hazards?” benefit from intuitive responses based on pattern recognition. Interpretation and extrapolation from the data analysis is aided by intuitive responses. “Have we seen this before? If so, what did we do?” The analytical plan

formed during the guide's meeting likely forms an anchor for the field decisions. Adjustments to this anchor will depend on the strength of intuitive responses to field conditions (Epley & Gilovich, 2001).

9.4.3.2 The Training of Intuition

The enhancement of existing reflective components and peer feedback elements had the potential to further increase the quality of the intuitive responses. Participants expanded their pattern recognition with the inclusion of reflective learning over the two wicked winters of the study. Hogarth et al. (1991) suggested that positive feedback, which reinforced the strategies that were used, occurred more often in lenient environments. While exacting environments were more likely to produce negative feedback and thus a motivation to search for a better strategy.

Groups of guides working together and using guide's meetings, such as the ones that are an integral part of the heli-ski and snowcat-ski guiding landscape in Western Canada, are only just beginning to occur outside of the Canada. Although guide's meetings have been the industry norm for many years in Canada, a culture of decision support within the meetings could accelerate the development of intuition, but it is currently under utilized (Piché, personal communication, 2008). Piché reported that guiding teams at Canadian Mountain Holidays' Bugaboo Lodge had initiated a peer feedback process for the end of each day. This template has tremendous potential given the theoretical underpinnings and the empirical results from my research. The ability of a guiding team to make a collective decision, enact that decision individually, and then reflect on the decision outcomes as a group has the potential to accelerate the development of decision expertise.

Four-step recognition training

The training of intuition is likely dependent on the development of recognition skills. Fadde (2007, pp. 369-370) recommends using a four-step process to build recognition skills that is regular and progressive (incrementally challenging), rather than stand alone discreet sessions.

- Identify the key recognition component of a reaction-generated skill
- Create a task that will train the recognition skill

- Conduct a training program
- Assess the transfer of training through performance-oriented tasks

The ability to recognize evolving patterns and anticipate future events is a benchmark of highly defined situational awareness. It has been referred to as ‘flying in front of the plane’. This early recognition can be trained. Truck drivers are trained to maintain a 7 second following distance, but to look 15 seconds down the road. Typical tasks that are used to assess recognition skills have been identified as recall, detection, categorization and prediction (Ericsson et al., 1993).

Scenarios or vignettes have been proposed as a method of enhancing deliberate practice (Ross et al., 2006). A deliberate practice session would ideally include a learning objective and timely, focussed feedback. Scenarios need to be constructed with the intent of accelerating the recognition phase, which in turn primes the decision process. Is this typical and or similar? Is this atypical and or dissimilar? These scenarios can be based on real events and may use a cognitive task analysis to ensure authenticity. Decisions are made and a mentor provides feedback. The vignettes may lack the physical integrity of the decision environment, but they should encompass a high degree of cognitive authenticity (Chauvin, Clostermann, & Hoc, 2009).

The transfer of training to the real world is a consideration. Regular and frequent use of low cost and low fidelity training modules is likely more beneficial than infrequent use of high fidelity training (Fadde, 2007). For example, in avalanche rescue, a transceiver basin (numerous pre-buried transceivers, with the potential to activate varying combinations of transmitting units) provides an excellent practice field. Although real avalanche rescue is far more complex, a high fidelity simulation once per year is perhaps less effective than more regular low fidelity sessions. A combination of regular training in low fidelity settings interspersed with less frequent high fidelity settings might hold promise. As helicopter time is expensive, a low fidelity alternative is needed. Trainings of this sort will benefit competent performers who are ready to transition to experts. The transition can be accelerated through improvements in pattern recognition.

Fadde and Klein (2010) propose five strategies to enhance and accelerate the development of intuitive decision-making: estimation, experimentation, extrapolation, explanation, and coaching. Estimation requires the decision maker to make a prediction and then measure the outcome. For example, an avalanche forecaster might estimate whether any avalanches will be seen in the forecast region over the next 24-hours. This can be expanded to include both the number and destructive potential. (Moore, personal communication, 2003).

Experimentation requires the decision maker to try something new. This might include reflection-in-action experiments. An estimation of a possible avalanche trigger location can be translated into a commitment to action to produce a change. This could include ski cutting and explosive control.

Extrapolation pushes the decision maker to recycle prior events and extract significant lessons. Failures, near misses and surprises provide potent learning opportunities. The opportunity for learning often occurs in fleeting moments. Weick (2001) describes these as 'moments of the unexpected'. Extrapolation requires an understanding of the causal relationship. Imagine failure. What would it look like? Where will we be most at risk today? If our routine, standard operating procedure will lead to failure, how will we change our routine? One of the more difficult aspects is learning to recognize when to break the rules in ambiguous, challenging environments (Chauvin et al., 2009). Although not all decisions will result in good outcomes, decision makers need to be aware of and able to counteract the effects of bad outcomes when making future decisions (Ratner & Herbst, 2005).

Explanation creates opportunities for reflective explanation. The desire for improvement and the quest for excellence is the key to the development of mastery through feedback, which can sometimes be hidden, or missing. Allowing the vagaries of ambiguous feedback to limit the development of decision expertise is only an excuse for mediocrity.

An on-going dialogue between an emerging expert and an established one will benefit from coaching. Predicting a senior lead guide's decisions creates an opportunity for reflection and discussion at the end of the day. Maximum benefit

can be attained through the development of specific questions prior to the PM guide's meeting. Macpherson and Collins (2009) stress the importance of learning from optimal performances and going beyond an analysis of the corrective actions generated by poor performances.

Fadde and Klein's five strategies have many similarities to the four processes of Kolb's (1973) experiential learning model. These processes: concrete experience, reflective observation, abstract conceptualization and active experimentation form the building blocks, which can accelerate development of expertise. Deliberate performances integrating all four of Kolb's processes can quicken the development of decision expertise and can be accomplished during regular work activities.

9.5 Conclusions

9.5.1 Role of Feedback

9.5.1.1 Near-miss Reflections

Accuracy in decision-making is thought to benefit from the feedback received through making errors and recognizing that these errors have occurred (Cure, Zayas-Castro, & Fabri, 2011). Near-miss events have been considered excellent opportunities to learn from the decision environment, as they are believed to share a pattern of causal factors that would be seen in an accident. Weick (2001) suggested that when the number of perceived errors was low, there was minimal opportunity to learn. It was only once the errors had been detected that feedback could be elicited. Errors, which were not perceived or recognized as such, could actually lead to a 'false positive'. For example, the decision to ski a particular slope could be considered appropriate when the result has not included a negative result such as an avalanche (Gonzales, 2008). The adjustment to detected errors could potentially increase the quality of the decision-making. Participants described the benefits of learning from mistakes. This implies that although making mistakes should not be encouraged, they will happen and should be embraced for their learning potential (Lipshitz, Klein, Orasanu, & Salas, 2001). Working towards an error-free performance in a highly complex unstable environment may in the end be detrimental to the learning process.

Near-miss experiences can have two very different effects on future decision strategies. Bird and Germain's (1966) landmark research on industrial accident rates suggested that the collection of near-miss reports and their subsequent analysis might help the avoidance of future accidents. Learning can occur through an understanding of the near-miss event sequence. However this is contradicted by Dillon, Tinsley and Cronin's (2011) suggestion that people who experience a near-miss may perceive a future similar scenario as being less risky and subsequently reduce their risk mitigation efforts. With the potential fatal consequences of being wrong, ski guide participants made the most out of the learning available through the near-miss events. They described becoming more risk averse following a near-miss.

Reflections on near-miss events by my research participants indicated that they recognized how lucky they had been and made conservative adjustments to their subsequent decisions, so as not to be dependent on what Cure et al. (2011, p. 738) termed "a convenient evolution of the circumstances". This supports Weick's (2001) premise that high reliability organizations should take advantage of near-miss occurrences with the intent of reducing future accident rates.

9.5.2 Feelings of Confidence

9.5.2.1 Confidence in the Analytical Process

Moxley, Ericsson, Charness and Krampe (2012) found that additional time spent on the analytical process was beneficial for experts when they were dealing with complex problems. This conflicts with Gigerenzer and Goldstein's (1996) assertion that in environments with high levels of uncertainty, the analysis of too much information may lead to less accurate predictions than a Take-the-Best (TTB) approach that focuses on two or three key indicators. Gigerenzer and Goldstein argued that small errors in multiple cues could generate an inflated error in the final decision and that small levels of uncertainty in only two or three cues could be more accurate. The experiences of my research participants suggests that even with an extensive analytical morning guide's meetings, they were not always successful in their selection of safe skiing terrain. There was a resulting reduction of confidence when the decision outcomes were wrong even though they had been generated through an extensive analytical process. This suggests that there may be benefit in

the development of decision filters that would reduce the available information to some select indicators.

9.5.2.2 Confidence in the Intuitive Process

The participants described a change over the two years of the study in the confidence that they had in their intuitive responses. Early in the study they had a mix of positive and negative intuitive responses, with slightly more positive feelings generating motivation to choose certain travel routes. This changed over the two seasons, as often the terrain selection proved more hazardous than expected. The participants learned despite the limitations of the wicked environment. They became more cautious and developed a growing confidence in their negative intuitive responses. Their feelings of ‘do not go there’ were strong and immediate and generated confidence in their decisions.

I had this feeling that wasn't so good, I overrode that for various reasons, and then it didn't turn out well. So after going through that experience a number of times, I've really realized that it's incredibly important to listen to that. That intuitive feeling is generally the better way to go. It seems to me in almost every situation that I've been in; it's been a more reliable gauge of the best decision to make. Participant 608

9.5.2.2.1 Persistent Weak Layers and Decision Confidence

Comments from the participants included statements about the surprise they experienced when avalanches occurred on low angle terrain and or initiated deeper in the snowpack than they had expected. This fits with Hogarth's (2008) description of the ‘wicked’ environment. The initial effect of the existence of a persistent weak layer in the snowpack was a reduction of decision confidence. The level of uncertainty and the consequence of releasing a deep avalanche contributed to a reduction in decision confidence. As the difficulty of predicting the sensitivity of a persistent weak layer may have caused higher levels of anxiety and stress, what is remarkable is the safety record of the mechanized ski industry. One of the reasons that decision confidence dropped was likely that their intuitive responses were unable to account for the variables in the environment. They did not experience what Thompson, Prowse Turner and Pennycook (2011) termed the ‘feeling of rightness’.

Dillon et al. (2011) suggested that experts placed more emphasis on the probability of an event as opposed to the consequence of the event. This contradicts my results, which suggest that expert participants were greatly influenced by the series of low probability, high consequence potential failure layers within the snowpack. Even though very few ski guides were caught in persistent weak layer avalanches, near-misses were common. The participants displayed a reluctance to expose their guests and themselves to these hazards.

9.5.2.2.2 Somatic Markers

Experience-based affective cues generated by previous similar situations may trigger a pattern recognition that can be used as the basis for a decision (Glöckner & Hochman, 2011). The power of these positive or negative feelings can be very convincing (Damasio, 1996). Participants described the importance of following their feelings, particularly when the feelings promoted a conservative action.

9.6 Summary

The expertise literature crosses many fields and areas of study. It is well developed, with studies ranging from doctors (Patel et al., 1996), to sports (Ollis et al., 2006; Starkes & Ericsson, 2003), to nursing (Benner, 1984; Rolfe, 1997), and even fire-fighters and guided missile ship commanders (Klein, 1993). Data from the ski guide participants were analysed in light of the suggestions from Galloway's Outdoor Leader Experience Use History Inventory (OLEUH). The results produced a more definitive definition of ski guide expertise than was used by Grímsdóttir (2004), or Adams (2005). The greatest contribution was the use of continued professional development data as a measure of expertise. I considered these data the most robust indicator of dedicated practice, as participants had documented their professional development activities, one of the requirements for professional membership in the Canadian Avalanche Association.

My findings support greater understanding of expert ski guide decision-making and fill the gap between three previous studies (Adams, 2005; Grímsdóttir, 2004; Hägeli & Atkins, 2010). The two seasons of data collection (2008/2009 and 2009/2010) were beset with snowpacks characterized by persistent weak layers. This

presented more complex decision-making challenges than what might be considered in 'normal' winters. Most of the participants would have experienced three seasons in a row of making decisions regarding persistent weak layers, as 2007/2008 was of a similar nature. Based on the evidence provided by the participants, they may have developed an increased level of pattern recognition regarding this phenomenon. These findings provoke further research to investigate whether other practitioners within the Canadian ski guiding and avalanche industries have also learned to recognize these patterns.

Evans (2011) acknowledged that there was a wide ranging discussion within the dual process theories debate. Evans' (2011) dual process argument is supported by neuroscience research (De Neys et al., 2008; Huettel, Song, & McCarthy, 2005; Lieberman et al., 2004), which shows that different parts of the brain are activated depending on whether intuitive or analytical processing has been stimulated. There are no clear, easy answers. Stanovich et al. (2011) cautioned that the transition from decision theory to empirical testing, to practical application will not easily be solved. The findings in my research lend support to Evans' argument that two processes are actively used in the pursuit of decision excellence.

My research participants described how they were conscious of their intuitive feelings or somatic markers, even though they were unable to identify the source of their feelings. This does not fit with Dijksterhuis' (2004) argument that intuitive responses, which included periods of unconscious thought could be used to increase decision accuracy.

The findings from my research are not entirely in agreement with Kruglanski and Gigerenzer's (2011) description of heuristics. They considered heuristics to be rule-based strategies that ignored information and could form the basis for both analytical and intuitive judgements. These heuristics could be used in a satisficing role and were not used as part of an optimizing strategy. Although they suggested that both analytical and intuitive processes were rule-based, they had a very broad interpretation of what constituted a rule. Rules needed to be based in an if-then relationship. They suggested that rules could be consciously or unconsciously applied, with the implication that this replaced the analytical - intuitive dichotomy. The part of their argument that does fit with my findings is their descriptions of how

new skills become learned skills. They suggested that tasks that initially required analytical thought, after extensive practice resulted in intuitive responses.

Hammond (2010) argued for the replacement of intuition with the notion of quasi-rationality. He labelled intuition as unjustifiable. He argued that all decisions should include some element of analytical thought. Pure intuition, residing at one end of his cognitive continuum should not be depended on. Findings from my research do not support this argument. Participants described blending intuition and analysis, but certainly did not refrain from purely intuitive responses. The opposite was true, with none of the participants describing their use of a purely analytical response. This discussion warrants further study, as the implications are significant. Should intuition always be subjected to the scrutiny of analysis? Are there times when intuition alone can be depended on?

My research fills a void in the Adventure literature. It goes beyond the classic risk management behaviour and outdoor leadership decision-making paradigm described by Meyer and Williamson (1998). It complements the theoretical contributions of Watters (2005) and Cook (1996) by adding empirical, field-based research to the discussion. Boyes and O'Hare (2011) used computer simulations to study naturalistic decision-making in an outdoor context. Their findings that experts spent more time and accessed more information for their analytical decision process was consistent with Hägeli and Atkins (2010) research on ski guides. However the context of the computer simulation, as used by both Boyes and O'Hare, and Hägeli and Atkins, allowed participants to be more reflective and analytical. This was counter to the expectation that experts would use rapid intuitive responses. This demonstrates a critical difference between research that uses simulations or vignettes and research that observes or measures real decision situations. My field-based research was situated in an environmental context that followed ski guides as they made real decisions. This also adds a dimension to causal factor accident analysis, supporting the work of Davidson (2005).

The level of engagement of the participants can be seen in the degree of openness and honesty in the answers to both the questionnaires and the interviews. Participants expressed their thought processes with an openness that might concern corporate marketing managers. Discussions of the level of confidence they had prior

to committing to a ski line and the potential role that luck played in the outcome revealed much about the professional ski guide decision process. Participants accepted that they did not always have a good answer. There was a willingness to say, “sometimes I just do not know”. In their acknowledgement of this void, they were willing to be more prudent and simply avoid some terrain features.

A theme that emerged from the two sets of interviews focused on decision avoidance through the management of terrain and the avoidance of certain areas. Rather than feeling forced into making a decision about what was safe to ski, terrain was chosen to avoid the hazard. The decision was avoided completely by choosing alternate terrain. Participants made life easier for themselves in terms of the decision process by choosing to not use certain terrain.

Ski guides have been trained in an analytical decision process at each step in the certification process. With three levels of avalanche training and four levels of guide training and certification representing a total of 50-60 days, there would appear to be many opportunities to foster the development of a quality decision process. However when approached from the perspective of dual process, intuitive-analytical decision-making, more emphasis has been placed on the development of analytical decision-making within the training courses curricula. A possible reason for this is that the analytical process is easier to teach. The results from this study suggest that intuition plays a role in most decisions, so it may be beneficial to expand the training opportunities in this area.

Participants described the important role that peer feedback played in the development of their decision process. The classic mechanized guiding team approach has the opportunity to excel in this area. A small group of guides can help each other become better decision makers by improving the quality and quantity of feedback, particularly when it comes to the role that intuition plays.

9.7 Limitations

Limitations were discussed in the introductory chapter and the methods chapter. Limitations discovered during the collection of the data have been summarized here. As previously mentioned this was a study of ski guide decision-making in a real world setting, while the participants were leading guests down

potentially hazardous slopes. The risk of accidents was real, so confidentiality was of utmost importance, as it allowed the participants to engage freely with the researcher.

Guest interactions were not considered as part of this study. Although the expressed desires of the guests had the potential to influence the participants' decision-making, an assessment of guest motivation was not part of this study.

This was a self-selected participant group. The limitations of this method of participant selection were discussed in the methods chapter. There was a range in level of participation within the participant group. Not all the participants completed all the aspects of the study. Some participants were more highly engaged in the research process, while others needed frequent prompts from the researcher to complete event reports. The number of event reports from each participant ranged from one to nineteen.

Perhaps the most significant limitations were the characteristics of the two study winters. Participants described the winters of 2008-2009 and 2009-2010 as being novel and unique. They were different from 'average' winters and demanded much more from the participants. The decision-making was much more complex.

The final limitation was my bias as a researcher. This was largely a qualitative analysis based on my interpretation of the data. I used an inter-rater to help me overcome my inherent biases. Other tools that I used to overcome my inherent biases were to discuss my interpretations with the participants and to engage in regular peer review of my progress. During the course of the study, I presented twice to the International Snow Science Workshop. Feedback from this group was instrumental in the on-going shaping of the study.

9.8 Recommendations

So what would a model for the development of expert decision-making look like? As described in Chapter 3, the literature supports the notion that the development of expertise is dependent on dedicated practice and the ability to learn from experiences. Also foundational to the argument is the acknowledgement of two decision processes, intuition and analysis. The development of expert decision-

making thus needs to apply the concepts of dedicated practice to both intuitive and analytical processes.

The analytical decision framework for ski guides is largely in place, but is missing a process for data filtering based on context specific challenges. The analytical process can easily be overwhelmed by access to data, if the decision maker is no longer able to make sense of it. Research on information filters needs to be conducted. These filters would likely need to be adapted to each operational context. An example of this would be to create a filter that would limit the runs discussed in the morning guide's meeting, based on hazard forecast rating.

The training of the intuitive response needs to be grounded in reflective analysis and peer feedback. Tools for both reflection and feedback need to be developed for the ski-guiding context. A relatively simple set of questions could facilitate reflective analysis. A process for peer feedback needs to take into consideration both the size of the operation and the existing communication pathways. The culture within the team environment would need to be conducive to open and honest feedback. This could be challenging based on the diverse cultural backgrounds of ski guides in Western Canada.

Key to the development of a decision-making model is an analysis and subsequent thorough understanding of the context. Just looking at the possible diversity within the ski-guiding context, the analytical filters and the intuitive patterns will be different based on geographic differences. However the underlying process for decision capacity building would remain the same. The development of the intuitive context will be dependent on establishing filters that identify good and bad patterns. The criteria for identifying the quality of the patterns are based on Hogarth et al.'s (2008) concept of wicked and kind environments.

Although there may be situations that are predisposed to resolution through one process or the other, decision-making for ski guides would appear to benefit from a strategy that combines the strengths of both intuition and analysis. There is room for improvement in the development of both intuitive and analytical response training. The following recommendations highlight the implications for both practical application and theoretical investigation.

9.8.1 Recommendations for Practice and Training

There are two major implications for the ski guiding industry and the ski guide training and certification providers. Intuition and analysis form two sides of the decision process and both should be used. At this point, analysis is over-taxed and intuition is under-used. However intuition may also be under-trained. There needs to be complimentary development of an integrated decision matrix. This would be a two-stage process for improvement. A filtering process for analytical decision process and a training tool for intuition need to be designed. Heuristics, using only information that addresses the most important aspect of the decision environment should be considered, as this may straddle the two problems. Heuristics can be used as a filtering process for an excess of analytical data. This would simplify the search for a solution that works (Gigerenzer & Goldstein, 1996).

When intuitive responses degenerate into lazy heuristic shortcutting, the decision process can be derailed, become less accurate and suffer from biases. However, intuitive responses that are grounded in pattern recognition and learning generated through experiences, the decision process can be remarkably accurate (Kahneman & Klein, 2009). The ability to differentiate between skill-based intuition and heuristic-based intuition is key.

9.8.1.1 Integration of newly available data sources into the decision process

The first stage of information filtering is complicated by easier access to information. New data sources have become increasingly accessible and available. Smartphone technology and Internet access have made it easier to access volumes of information. More information has the potential to reduce uncertainty, but it also has the potential to overwhelm the decision maker. It is important to avoid information overload, which occurs when information is plentiful and filters fail to reduce the flow (Davis, 2011). New research by Hägeli and Atkins (2010) has the potential to help determine which decision filters are most appropriate.

9.8.1.2 Change within the intuitive response.

The second stage is to improve the accuracy and consistency of the intuitive process through reflection and feedback. Betsch and Glöckner (2010) suggested that intuition was capable of handling large volumes of complex information. This

would necessitate an assessment of what an optimal level of information would be for a ski guide. One participant described a method that resulted in an improvement in the intuitive response.

It is good to get a client caught in an avalanche because it brings back the reality of the consequences. A stronger intuitive response is built as a result. See it feel it and be part of it. Particularly if you have been part of the decision involved in that happening. It's that negative feedback – I made a decision and it was wrong, way wrong because somebody got caught, those decisions really sink in. Participant 714

However, although burying a guest may be a powerful learning opportunity, there are obvious potential negative consequences.

Hogarth et al. (2008) suggested that intuition was slow to learn, but quick to react. Learning or change does happen within the intuitive response, but it takes a while. It is likely that over the two seasons of the study, the participants grew their intuitive ability. The winters were hard on participants forcing them out of their comfort zones and into new learning situations. The ability to learn from experiences was dependent on three elements: disconfirming evidence, awareness of environmental effect on the outcome and the use of memory aids to record events (Einhorn & Hogarth, 1978).

Teaching intuition. Being able to have some kind of mentorship programme in the guiding operation. To have debriefs. You have your afternoon debriefs with a chance to talk with the guiding team. And talk about the day and have the opportunity to ask questions and to have an open learning environment where it's okay to ask questions. I know it used to be the "shut up and listen". I hope, I think, that it has changed. Participant 702

9.8.2 Recommendations for Future Research

Numerous related research questions were not addressed in this study. Some were anticipated prior to the commencement of this study, such as the culture of group decision-making in this environment and the influence of guest expectations on the decision process. Other questions became clarified as the study progressed, such as the use of filters to screen information and whether certain decision challenges are more conducive toward being solved through intuition or analysis.

A logical next step beyond this study would be to examine what filters could be generated for use as decision support tools by expert decision makers. The results

and findings of this thesis suggest that ski guides can become overwhelmed by conditions of uncertainty even though they have access to a wealth of information. More information does not necessarily make the decision process easier. Some method of filtering and sorting information may produce greater efficiency and result in better decisions. Filters have been produced for recreational decision makers in avalanche terrain. Although the success of these filters has been challenged, consensus amongst users has been positive (McCammon & Hägeli, 2006).

Some tasks may be better solved through an intuitive process, while others are better solved through an analytical process. Are there times when the conditions are more conducive to successful decision-making via intuitive methods and other conditions that favour analytical processing? Can flags be generated to help guides know when to favour an intuitive or analytical response?

The organizational culture of the heli-ski and snowcat industry has evolved over the last 40 years. Many cultural aspects warrant study. They include a study of the multi-national aspect of the guiding culture. Does a Canadian guide make decisions differently from an Austrian guide, or a French guide? What role does corporate culture play in decision-making? How are guest expectations manifested? Are they a result of marketing? How do these expectations play out when the avalanche hazard precludes skiing steep slopes?

The area of group decision-making within the guide's meeting has not been addressed. Is there a difference in decision-making based on the size of the group or number of people in a guides meeting? In the evolution of a group, is there an optimal point of maturity? Is a long-standing group a good thing or a bad thing?

The measurement of expertise has been the subject of considerable research. However there is still some discussion over how to objectively rank expertise. Although many criteria have been proposed, the accuracy of each individual element may be questionable. The assessment of what has been learned from experience is still highly subjective.

9.10 Final Words

Kahneman and Klein (2009) suggested that the best way to evaluate the quality of a decision was to look at the underlying conditions of the environment and

the decision maker's level of mastery within that environment. Shanteau (1992) examined the development of expertise and related use of intuitive responses. He suggested that the predictability of the environment and the degree to which an individual had learned from that environment were key considerations in the development of decision expertise. He noted that some areas of expertise development produced higher reliability in decision outcomes.

Of particular significance to this discussion is the notion that expertise regularly becomes 'fractionated' (Kahneman & Klein, 2009). In this situation, an expert's decision process works well for some circumstances, but not all. Decision confidence generated under optimal conditions may spill over into non-optimal ones. The mark of true expert would be the ability to recognize when a situation poses novel challenges and is outside of the decision maker's pattern recognition. These anomalous conditions were an ever-present part of the decision environment for ski guides over the winters of 2008 to 2010.

The participants described how they used a combination of intuition and analysis to solve the decision challenges of managing guests in hazardous conditions. The analytical process that they used was well documented and supported through their previous training. Their intuitive responses were the product of a more haphazard developmental process. With no formal training in the use of intuition, research participants became more aware of their responses through participation in this study, which may have provoked an increased introspective analysis of what their intuition was telling them and what they should do about it.

There is a great opportunity for ski guides to learn how to develop their intuitive responses into a much more potent tool. The optimal conditions, under which intuition will be more accurate, include an environment that provides relatively consistent indicators as to its true nature. The second and perhaps more important aspect is whether the decision maker has had the opportunity to learn the meaning of these indicators. The absence of quality environmental cues, or a decision maker that has not learned the meaning of the cues may lead to confidence in an intuitive response that lacks underpinning. This confidence has been termed the 'illusion of validity' (Einhorn & Hogarth, 1978). A good outcome based on the illusion of validity can only be attributed to luck. In the words of one participant,

“Intuition is based on a series of events. Intuition has to be based on experience, if it is not it is luck.”

Klein (1993) suggested that overconfidence was typically reduced in environments, which placed the decision maker at risk. Direct personal hazard had the modifying effect of reducing the likelihood of overconfidence. It is incumbent on ski guides to have an acute sense of the limits of their expertise as overstepping their decision resources has the potential for catastrophic events and multiple fatalities.

In the words of one of the participants reflecting on a near-miss...

The event occurred towards the end of the day and, in hindsight, I should have picked a mellower run. It was a fine line between providing them with exciting runs and scaring them in a near-miss avalanche. I think I'd rather ride the side of keeping it mellow and bringing everyone home, even if they feel that the runs were too mellow. Most guest over estimate their abilities and energy levels (especially at the end of the day). Part of me wanted to send them home with a great and exciting last run, when they probably would have been happy with another, less committing line.

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Appendix 1 – Hazard and Risk Worksheet

Date: _____ Time: _____ Valid Until: _____

Location: _____ Spatial Scale: _____

Analysts: _____

Meteorological Factors

Forecast Weather

Weather Systems & 500 mb flow

(describe Highs, Lows, fronts, timing, duration, freezing level, cloud cover etc.)

Freezing Level: _____

Actuals at:	Wind Direction	Wind Speed	Temperature	Dew Point
850 mb				
700 mb				

Local Weather Forecast Precipitation Wind Temperature

Local Weather Observations

Location			
Time			
Sky			
Precipitation Type/Rate			
Temperature Max			
Temperature Min			
Temperature Present			
Temperature (-10 cm)			
Relative Humidity			
Foot Penetration			
Surface Form			

H2D			
HNW			
HN24			
HST			
HS			
Settlement			
Wind Low			
Wind Ridge/Blowing Snow			
Barometric Pressure Trend			

SNOWPACK FACTORS

Significant Changes since last analysis: (precip, temps, wind, no change etc.)

InfoEx Reports:(include relevant avalanche activity or test results of nearby operations)

Avalanche Activity, Snowpack tests or important observations: (include your avalanche activity, snowpack tests or useful observations)

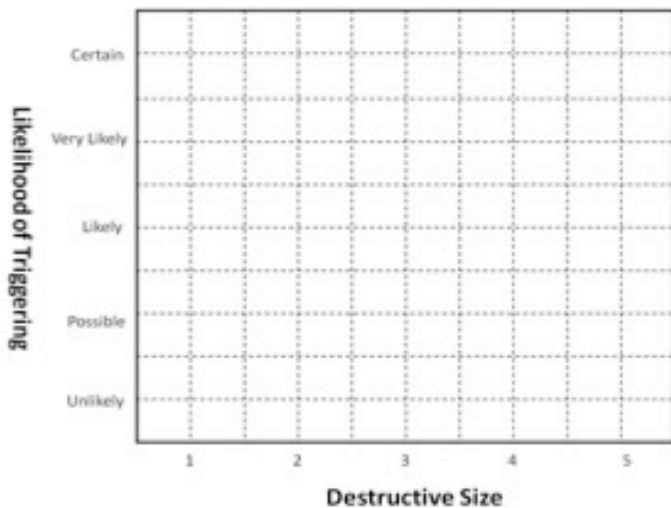
Avalanche Character

Triggering

Terrain

Layer	Avalanche	Forecast	Sensitivity	Spatial	Terrain Feature
Depth/ Name Persistence	Type Slab, loose, wet, dry, cornice etc.	Size -Destructive Potential -Relative to Path	Unreactive, Stubborn, Touchy, Very Touchy	Distribution Isolated, Specific, Widespread	Run name/ Location Feature/Elev./Start zone shape/Angle Exposure to Wind/Sun
Surface					
Ground					

Avalanche Hazard Summary Chart



Avalanche Hazard Forecast Rating - Consider Trends, Intuition,

Zone	Stability Rating	Danger Rating	Comments	Confidence
Alpine				
Treeline				
Below Treeline				

Operational Plans

Trip or destination: (where do you plan to go? Timing?)

Risk Treatment: (describe the risk control to manage exposure to hazards)

Field work objectives: (what knowledge gaps will you fill?)

Appendix 2 – InfoEx Sample

Location	Date	Num	Size	Trg	Type	Depth	Width	Length	Failure Plane
Joe's Perch	13-Mar	Sev	3	Na	S	20-60	100-200	800-1000	O: SH/CR (02-26)
Started in 20cm storm snow and quickly stepped down.									
Amazon	13-Mar	1	1	Sa	S	40	15	10	S: SH/~ (02-26)
Triggered by guide regrouping on the edge of a wind-loaded gully in a cut block with the start zone being 10 degrees only!									
Armstrong	13-Mar	1	1	Sa	S	35	25	10	S: SH/~ (03-10)
Windslab on steep roll Mar 10 SH									
Dog Bone	13-Mar	Iso	2.5	Na	~				
Steep non-skiable hanging serac									
Tums	13-Mar	Num	1.5-3	Na	~	30-100	20-300	50-200	O: SH (02-26)
In Southern Monashees terrain, esp Born Creek and south, in Alp & TL 24 hour +									
3.2 Slidepath	13-Mar	5	2-2.5	X	~	15-35	20-30	200-300	S: DF/DF (03-08)
Heli-bombing; 12.5 kg ANFO. Soft slab. No sign of SH at fracture lines.									
Monashees	13-Mar	1	2	Ni	S	50	30		
Baldy Bowl	13-Mar	1	2	Sa	S	20-50	40	170	O: SH/SH (03-08)
9th skier on slope, partial burial head above, one ski released and found									
Chicken Little	13-Mar	1	1.5	Sa	S	30	25	30	O: SH/SH (03-08)
Benign glade, no involvement – triggered when skier entered slope									
Baldhead	13-Mar	2	0.5-1	Sc	S	20	10	20	S: SH/SH (03-08)
Convex rolls in glades									

Appendix 3 – Event Report Questionnaire

Intuition in Decision-Making Survey

Please use this form to report good days, or near misses once you have completed the Background Experience Profile.

1. Please enter your User ID

Definition of Terms

- 1) Uncertainty – The decision maker may be faced with uncertainty due to:
 - a) Ill structured problems. Example: Snowpack stability will vary considerably from place to place
 - b) Uncertain dynamic environments. Example: Weather conditions can change rapidly.
 - c) Shifting, ill-defined, or competing goals. Example: Guest expectations may clash with safety parameters
 - d) Action / feedback loops. Example: There may be minimal feedback on good decisions

2) Intuition

There are a variety of terms used interchangeably with intuition including: gut feeling, hunch, knowhow, and tacit knowledge

3) Intuitive – analytical continuum

The intuitive end of the continuum is characterized by easily accessible thoughts that do not require much in the way of reflection. Intuitive responses are: fast, effortless, can be impacted by emotions, governed by habit and can be difficult to control. Analytical responses use reasoning and are: slower, require effort, are potentially rule-based, and are consciously controlled.

4) Confidence

Confidence is easily affected by the feedback from recent events. In situations with minimal feedback, over or under-confidence may result from an inability or unwillingness to adjust one's confidence far enough, as the task difficulty changes.

5) Feedback

The type, quality and quantity of feedback will be dependent on the characteristics of the operational environment. The ski guide faces the challenge of interpreting numerous, possibly conflicting environmental feedback clues. High quality feedback can also come from other experts, so teams of guides such as those used by most mechanized ski operations will likely benefit from some form of decision analysis during the traditional evening guides meeting.

6) Consequences

There are two elements to the evaluation of potential consequences: the magnitude of the event and the potential or likelihood of it occurring. The estimation of the magnitude may include a range of values but should focus on the most likely size.

7) Luck

This refers to a very qualitative interpretation of events. The tendency within the guiding community may be a preference to attribute outcomes to good decision making, rather than luck, however an open and honest appraisal of each situation may be warranted.

2. This was a (n)

Good Day - The decision-making was challenging and the outcome was good

Near Miss or Incident - In a near miss there was the potential for serious consequences, but no first aid was required and no equipment was damaged or lost. OR an Incident, which is described as Minor first aid, was required or equipment lost, or damaged, or the program was delayed or interrupted.

3. When did the event occur?

4. Location - Mountain Range

Southern Rockies

Northern Rockies

Purcells

Selkirks

Southern Monashees

Northern Monashees

Cariboos

South Coast

North Coast

Other

5. What made today challenging (if anything)? (Check all that apply)

- Snowpack stability
- Forecast
- Variability over the terrain
- Changes through the day
- Skiing conditions (finding good snow)
- Flying Weather
- Weather on the ground
- Group dynamics within the guiding team
- Group dynamics with the guests
- Other (please specify)

6. When making the day's decisions, did you ever feel uncertain? If so, tick the boxes below (as many as apply) that represented the source(s) of this uncertainty.

I was not fully aware of some significant events or components that were happening

The available information was incomplete, ambiguous, or unreliable

There were conflicting alternatives (e.g. the guests wanted to ski some steeper terrain, but your assessment of the stability suggested a more cautious approach.)

Other (please specify)

Good Day Report

This questionnaire is for challenging days that ended well. Choose the days that are challenging for you and complete the questionnaire on those days. Ideally pick at least one day per week. The intent of the questionnaire is to capture the immediacy of your thoughts shortly after the completion of the day. There will be room to describe the three most important decisions of the day.

7. Brief Description of the most important decision of the day (What happened?)

8. Rate the difficulty of the most important decision of the day.

- Very easy
- Easy
- Moderately easy
- Moderate
- Moderately difficult
- Difficult
- Very Difficult
- Other (please specify)

9. Rate the quality of the most important decision

After reflection and/or discussion with the rest of the team on each decision, how well did you do?

- Not good enough
- Just barely good enough to get home safely
- Good, but could have been better
- Excellent, could not have done much more
- Other (please specify)

10. Brief Description of the second most important decision of the day (What happened?)

11. Rate the difficulty of the second most important decision of the day.

12. Rate the quality of the second most important decision

After reflection and/or discussion with the rest of the team on each decision, how well did you do?

13. Brief Description of the third most important decision of the day (What happened?)

14. Rate the difficulty of the third most important decision of the day.

15. Rate the quality of the third most important decision

After reflection and/or discussion with the rest of the team on each decision, how well did you do?

16. Intuitive Analytical

Describe the role that intuition played in each of the three decisions you described above. Remember that intuitive responses are typically fast, effortless, can be emotionally charged, governed by habit and difficult to control, while analytical responses use reasoning and are: slower, serial, effortful, potentially rule-based, and are consciously controlled.

Did you go with your initial intuitive response or were you more analytical?

- Fully intuitive
- Mostly intuitive
- Mix
- Mostly analytical
- Fully analytical

17. If there was an element of intuition in the decision, rate the intuition in terms of strength and whether it promoted feelings to DO something (Positive or good feeling), or to AVOID doing something (Negative or bad feeling)

- Strong positive
- Moderate positive

Weak positive
 Neutral
 Weak negative
 Moderate negative
 Strong negative

18. If intuition suggested one course of action and analysis another, was it easy to decide which one to go with? (if the question does not apply to a given decision, you may leave the item blank)

Very easy
 Easy
 Moderate
 Hard
 Very hard

19. Describe how confident you were in your decision(s) prior to committing to a course of action.

100% Completely sure
 90-99% Highly confident
 80-89% Very confident
 65-79% Moderately confident
 50-64% Educated guess
 50/50 Just guessing

20. Describe how confident you were in your decision(s) at the end of the day.

100% Completely sure
 90-99% Highly confident
 80-89% Very confident
 65-79% Moderately confident
 50-64% Educated guess
 50/50 Just guessing

21. At the end of the day, did you do anything to check whether you were over or under-confident in relation to the quality of your decisions such as talk it over with another guide?

Yes
 No

22. If "yes" what did you do?

Discussions with my peer group
 A personal retrospective analysis (20/20 hindsight, second guess)
 Other (please specify)

23. Reflect on the quantity of feedback you received about each of your 3 decisions by the end of the day. Feedback could be from the environment, fellow guides, or guests.

None

- Little
- Some
- Large amount
- Extensive

24. Reflect on the quality of feedback you received about each of your 3 decisions by the end of the day. Feedback could be from the environment, fellow guides, or guests.

- Low
- Low to moderate
- Moderate
- Moderate to high
- High

25. Most likely consequence if the decision had resulted in a poor outcome

- Loss of time
- Loss of money
- Loss or damage to equipment
- Injury to guest or guide
- Fatality
- Other

26. Reflecting on the day as a whole, in terms of outcomes as a result of your decisions, how lucky do you think you were today?

- Not at all
- A little
- Some
- Very
- Incredibly Lucky

27. When did the event occur?

28. Location

- Southern Rockies
- Northern Rockies
- Purcells
- Selkirks
- Southern Monashees
- Northern Monashees
- Cariboos
- South Coast
- North Coast
- Other

29. What made today challenging (if anything)? (Check all that apply)

- Snowpack stability
- Forecast
- Variability over the terrain
- Changes through the day

Skiing conditions (finding good snow)
 Flying Weather
 Weather on the ground
 Group dynamics within the guiding team
 Group dynamics with the guests
 Other (please specify)

30. When making the day's decisions, did you ever feel uncertain? If so, tick the boxes

I was not fully aware of some significant events or components that were happening
 The available information was incomplete, ambiguous, or unreliable
 There were conflicting alternatives (e.g. the guests wanted to ski some steeper terrain, but your assessment of the stability suggested a more cautious approach.)
 Other (please specify)

31. Did you make a decision potentially relevant to managing the event before the near miss? (If no, please skip to question #27)

32. Brief Description of the most important decision that contributed to the near miss or incident (What happened?)

33. Rate the difficulty of the most important decision of the day.

Very easy
 Easy
 Moderately easy
 Moderate
 Moderately difficult
 Difficult
 Very Difficult
 Other (please specify)

34. Rate the quality of the most important decision

After reflection and/or discussion with the rest of the team on each decision, how well did you do?

Not good enough
 Just barely good enough to get home safely
 Good, but could have been better
 Excellent, could not have done much more
 Other (please specify)

Describe the role that intuition played in the decision you described above.

Remember that intuitive responses are typically fast, effortless, can be emotionally charged, governed by habit and difficult to control, while analytical responses use reasoning and are: slower, serial, effortful, potentially rule-based, and are consciously controlled.

35. Intuitive Analytical

Did you go with your initial intuitive response or were you more analytical?

- Fully intuitive
- Mostly intuitive
- Mix
- Mostly analytical
- Fully analytical

36. If there was an element of intuition in the decision, rate the intuition in terms of strength and whether it promoted feelings to DO something (Positive or good feeling), or to AVOID doing something (Negative or bad feeling)

- Strong positive
- Moderate positive
- Weak positive
- Neutral
- Weak negative
- Moderate negative
- Strong negative

37. If intuition suggested one course of action and analysis another, was it easy to decide which one to go with? (if the question does not apply to a given decision, you may leave the item blank)

- Very easy
- Easy
- Moderate
- Hard
- Very hard

38. Describe how confident you were in your decision(s) prior to committing to a course of action.

- 100% Completely sure
- 90-99% Highly confident
- 80-89% Very confident
- 65-79% Moderately confident
- 50-64% Educated guess
- 50/50 Just guessing

39. Describe how confident you were in your decision(s) at the end of the day.

- 100% Completely sure
- 90-99% Highly confident
- 80-89% Very confident
- 65-79% Moderately confident
- 50-64% Educated guess
- 50/50 Just guessing

40. At the end of the day, did you do anything to check whether you were over or under-confident in relation to the quality of your decisions such as talk it over with another guide?

Yes

No

41. If "yes" what did you do?

Discussions with my peer group

A personal retrospective analysis (20/20 hindsight, second guess)

Other (please specify)

42. Reflect on the quantity of feedback you received about your decision by the end of the day. Feedback could be from the environment, fellow guides, or guests.

None

Little

Some

Large amount

Extensive

43. Reflect on the quality of feedback you received about your decision by the end of the day. Feedback could be from the environment, fellow guides, or guests.

Low

Low to moderate

Moderate

Moderate to high

High

44. Most likely consequence if the decision had resulted in a poor outcome

Loss of time

Loss of money

Loss or damage to equipment

Injury to guest or guide

Fatality

Other

45. What was the worst possible outcome for this incident? In other words, where does it sit on the potential severity scale?

No injury

Minor injury

Major injury

Death

46. Reflecting on the day as a whole, in terms of outcomes as a result of your decisions, how lucky do you think you were today?

Not at all

A little

Some

Very
Incredibly

47. Were there any additional factors that contributed to the occurrence of the event?
48. What if anything, could be learned from the event?
49. Any additional comments?

Concluding Remarks

If you have had a chance to reflect on this event, please complete the following questions.

50. As a result, of this incident has your risk tolerance changed? Do you do things differently now?
51. Has it influenced your work situation and changed how other people do things?
52. Did the lessons learned have a short-term impact, long-term impact, or permanent impact?

Appendix 4 – Consent Form

THE
UNIVERSITY
OF EDINBURGH

Informed Consent by Subjects to Participate In a Research Project or Experiment



Note: The University of Edinburgh and those conducting this project subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects. This form and the information it contains are given to you for your own protection and full understanding of the procedures, risks and benefits.

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more details, feel free to ask at anytime. Please take the time to read this carefully and to understand the accompanying information.

I have been asked by Iain Stewart-Patterson of the Outdoor Education Department of The University of Edinburgh, telephone number (250) 828-5184, email: spatterson@tru.ca to participate in a research project entitled: Expertise, Intuition and Confidence in the Decision Process of Ski Guides.

This encompasses the following:

The purpose of this research is to create a structure for the strength-based analysis of good decisions and to analyse near miss data. Questions will be asked relating to previous experience, description of the setting, and the challenges of the decision making process

- The procedure will involve: completing a questionnaire at the beginning of the guiding season related to their level of expertise, followed by the reporting of good decision days and near misses as they happen through the season by filling out two different questionnaires. The development of a strength based reporting scheme for good day reporting will occur through these questionnaires, field observations and participation in a short, interview once per month. During these field observations, the researcher will travel with a guide and a group of guests, taking the role of a guest. For each guide that is participating in a field observation day, there will be a short interview at the end of the day.
- In an effort to be more proactive in the understanding of near misses, my intent is to

develop a 'blameless reporting scheme' that will allow the sharing and pooling of near miss and incident information in particular. Through the analysis of this data, it is hoped, that serious accidents can be further minimized, as a seemingly insignificant near miss or incident may be an indicator of a larger problem when put in the context of other near misses and incidents.

- Avalanche workers including ski guides, instructors, ski patrollers and avalanche technicians are invited to participate in this study. Participation in this study is in no way linked, to professional performance, conduct, or employment reviews. This study is completely independent of all job related formative feedback and / or summative evaluation.
- The research will be submitted for publication in a peer-reviewed journal, a consumer magazine and in IFMGA newsletters. Papers will be presented at the International Snow Science Workshop, The Association for Experiential Education Northwest Conference and others.
- It is unlikely that there will be any discomfort or inconvenience associated with participation in the study. No individuals or companies will be named in any of the published results other than individuals or companies that wish to be credited with contributing to the research will be identified as such. Identifying information such as locations, run names and group size will not be included in the results. Information will be stored in a password protected electronic file. Raw data (questionnaires) will be kept in a locked file box, until such a time, as they will be shredded. Only the research team will have access to the data.
- Confidentiality of participants will be protected.
- Participants will receive updated information during the course of the research via e-mail through each agency's program coordinator, or directly through a personal email account.
- There will be no financial costs, or remuneration to the participants as a result of participation in the research.
- Copies of the results of this study, upon its completion, may be obtained by sending an e-mail request to Iain Stewart-Patterson <spatterson@tru.ca>

My signature on this form indicates that I understand the information regarding this research project including all procedures and the personal risks involved and that I voluntarily agree to participate in this project as a subject by type here

I understand that my identity and any identifying information obtained will be kept confidential.

I understand that I may refuse to participate or withdraw my participation in this project at any time without consequence. My involvement or non-involvement in this project is in no way related to my current employment status.

I understand that I may ask any questions or register any complaint I might have about the project with either the chief researcher named above, or with Dr. Peter Allison, Outdoor Education Department, The University of Edinburgh. Telephone number 44 (0)131 651 6001. Email: Peter.Allison@education.ed.ac.uk

I have received a copy of this consent form.

Name: (Please Print) _____

Address: _____

Participant's signature _____ Date _____

Investigator and/or Delegate's signature _____ Date _____

Appendix 5 – Background Experience Questionnaire

Background Experience

You have been invited to participate in a research project investigating the role of intuition in the decision process of ski guides. Participation in this project is entirely voluntary, however the entire guiding community will benefit from the quality of your input. Ultimately the results from this project may influence the way guides make decisions and help generate a safer work environment for both guides and guests.

Please read over the attached informed consent form. If you have any questions please be sure to direct them to me or to my supervisor Dr. Pete Allison.

Adventure guides operate in a dynamic wilderness environment, and our activities have an element of risk. Through diligent risk optimization we do our best to maintain high quality programs with relatively few accidents. The majority of the time we experience high quality days with minimal disruptions. There is much to be learned from these "good" days.

Despite these efforts however, we will all experience 'near misses', incidents and, perhaps, even accidents. In an effort to be more proactive in the understanding of such events, my intent is to make available a 'blameless reporting scheme' that will allow the sharing and pooling of near miss and incident information. A seemingly insignificant near miss or incident may be an indicator of a larger problem when put in the context of other near misses and incidents and so through the analysis of data, it is hoped that serious accidents can be further minimized.

Because I am seeking to understand the role of intuition in these events regardless of their outcomes, all information will be treated with strict confidentiality. In other words, all names and references to operations will be edited out of the final documents. Only the anonymous pooled results will be shared, again, with the aim of being used as a risk management tool.

In addition to helping generate an understanding of how we make decisions and potentially preventing future accidents, participation in this research is an opportunity for personal reflection. Thus, when thinking about a series of good decisions, or a near miss, try to be analytical about your actions without being critical. In all likelihood, you did the best job possible at the time, given the information that you had. Think about what happened and whether or not the situation was resolved in the manner in which you had anticipated. By including a reflective element, the information that you provide can contribute to a greater understanding of how guiding decisions are made and help you learn to become a better decision maker. Participating in the study can also help others learn from your experiences, and you from the other respondents.

This research is conducted by Iain Stewart-Patterson in partial fulfilment of the requirements for a PhD at the University of Edinburgh. Dr. Pete Higgins, Dr Pete Allison and Dr. Alison Lenton supervise the work

Contact Information

Iain Stewart-Patterson BPE, MEd, UIAGM

Outdoor Education Department, Edinburgh University

email: spatterson_at_tru.ca, Phone: (250) 3749474, Cell: (250) 3188811

Please complete this description of your background experience prior to contributing decision-making reports.

1. Please enter your User ID. If you do not have a User ID, please contact spatterson_at_tru.ca

2. Certification (Only mark the highest level attained)

For example an ACMG Mountain Guide would only tick two boxes, mountain guide and CAA level 2

Ski Guide	Assistant Ski Guide
Alpine Guide	Assistant Alpine Guide
Rock Guide	Assistant Rock Guide
CSGA 1	CSGA 2 CSGA 3

Avalanche Level 1

Avalanche Level 2

3. Number of seasons of professional work, either full-time or part-time over the last 15 years. If possible, indicate how many weeks you worked for each year in mechanized or ski touring operations. If you cannot recall the number of weeks, use fulltime or part-time.

Consider full-time as 7 weeks or more and part-time as 6 weeks or less.

Heli or Snowcat Skiing

Ski Touring

Avalanche Control

Waterfall Ice Climbing

Alpine Climbing

Other

4. Indicate the total number of seasons you have worked in each activity.

Heli or Snowcat Skiing

Ski Touring

Avalanche Control

Waterfall Ice Climbing

Alpine Climbing

Other

5. Name of primary activity for the current (0809) season (over 50% of your time).

6. Number of seasons of full-time paid work experience in this primary activity, at your current location.

3-5, 6-10, 11-15, 16-20, 21-25, 26-30, >30

7. Number of different locations or operations you have worked at during your career as a ski guide? Omit this question if you are responding solely as a climbing guide.

8. Which Continued Professional Development (CPD) activities, if any, have you engaged in over the last three years as per the CAA descriptions? Tick all that apply.

Professional Practice

Formal Learning Activities

Informal Learning Activities

Participation in Committee

Service

Presentations

Contributions to Knowledge

How often do you engage in CPD activities in a given year?

Weekly

Biweekly

Monthly

Seasonally

Annually

9. On average, how many days per year, over the last three years have you engaged in specific training towards the development of your professional guiding role?

Informal training in preparation for an exam
 Company organized formal training days
 Non-job related trips in terrain that challenges your abilities and focus on personal skill development in the winter environment

10. Compared to other guides or instructors in your primary activity, how do you rate your overall abilities as a decision maker? Note: This does not refer to your technical skill expertise.

Very Low, Low, Average, High, Very High

11. Compared to other guides or instructors in your primary activity, how refined are your abilities to balance risk with reward (i.e. your risk optimization skills)?

Very Low, Low, Average, High, Very High

12. Categorize your guiding skill set in each of the following areas as to your level of expertise.

Heli or Snowcat Skiing
 Ski Touring
 Avalanche Control
 Waterfall Ice Climbing
 Alpine Climbing
 Rock Climbing
 Other

13. Gender

Female, Male

14. Age?

< 25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, >65

Thank you for completing the background experience profile. You only need to do this once. Please use the event reporting survey to enter the details of your good days and near misses.

The Event Survey can be found at

http://www.surveymonkey.com/s.aspx?sm=dYh1lw_2fF1_2bKqnAxOhjEwEw_3d

Appendix 6 - First Interview Questions

Interview Script

Participant: _____

Date: _____ Location: _____

The intent of the interview is to talk about the days when you completed questionnaires (both regular and near miss).

1. How many times did you complete the questionnaire?
 - i. Did you have any near misses? *(Description)*
2. Describe the days that you chose. What was significant about those days?
 - Tell me about your most challenging day. *(Description)*
3. Now let's talk about the decisions that you made, in particular the difficulty and quality.
 - Describe the toughest decision. *(Description)*
 - i. From your questionnaire, you called it (easy-moderate-hard)
 - ii. What made it hard? *(Analysis)*
 - iii. Thinking back on it, how good was it? *(Reflection)*
 - a. What could you have done to make it better?
 - Describe the next toughest decision.
 - Describe the third decision.
4. You operate in a team environment. Describe your teams' decision process.

(Description)

 - i. How did your decisions fit in with the team's decision-making?

(Analysis)
5. I want you to think about the role that intuition plays in your decisions. Let us look at all your report days.

(Description)

 - i. How often were your decisions based more on intuition?
 - ii. Is there a common theme to the days? *(Reflection)*

1. How strong was your intuitive response?
- iii. When your intuitive response conflicted with your analytical response, what did you do? *(Description)*
6. How did your confidence relate to the quality of your decisions? *(Description)*
7. Did you find that your confidence changed during the day (either up or down)?
 - i. If so, what caused it to change? *(Analysis)*
 - ii. If not, what contributed to it staying the same? *(Analysis)*
8. Reflect on the feedback you received during the day.
 - i. Did you get much? *(Reflection)*
 - ii. Was it very useful? *(Reflection)*
9. How severe were potential consequences of a poor decision? *(Description)*
 - i. Did this impact your decision process? If so how? *(Analysis)*
10. Lets finish up with the luck question. Were you lucky to get away with what you did? *(Reflection Analysis)*
11. Is there anything more you would like to add?

Appendix 7 – Hours of Experience

		Heli	Touring	Total			CPD	
Participant	# Seasons	# Weeks	# Weeks	Weeks	6/7 Days	8hrs /day	Days	8hrs/day
714	12	20	2	264	1584	12672	21	
	3	18	4	66	396	3168	5	
	5	15	0	75	450	3600	26	4160
Totals	20	53	6	405	2430	19440	520	23600
703	18	18	0	324	1944	15552	8	
							144	
Totals							1152	16704
101	18	16	1	306	1836	14688	8	
							2	
							180	
Totals							1440	16128
402	11	14	0	154	924	7392	11	
	2	6	8	28	168	1344	165	
	2	0	14	28	168	1344	1320	
Totals	15	20	22	210	1260	10080		11400
	Seasons	Weeks	Weeks	Weeks	Days	Hours	Days	Hours
702	7	20	0	140	840	6720	21	288
	2	18	0	36	216	1728	11	2304
Totals	9	38	0	176	1056	8448	32	10752
605	1	10	1	11	66	528	18	
	1	12	0	12	72	576	5	
	1	12	1	13	78	624	11	
	1	11	0	11	66	528	34	
	1	12	0	12	72	576	544	
	1	11	0	11	66	528	4352	
	1	11	2	13	78	624		
	9	5	0	45	270	2160		
Totals	16	84	4	128	768	6144		10496
311	1	8	0	8	48	384	2	
	4	8	2	40	240	1920	11	
	1	8	3	11	66	528	11	
	2	8	4	24	144	1152	24	
	1	8	5	13	78	624	312	
	2	8	6	28	168	1344	2496	
	1	4	10	14	84	672		

	1	4	8	12	72	576		
Totals	13					7200		9696
	Seasons	Weeks	Weeks	Weeks	Days	Hours	Days	Hours
508	1	10	3	13	78	624	21	
	1	10	4	14	84	672	18	
	1	8	4	12	72	576	21	
	1	8	5	13	78	624	60	
	1	8	4	12	72	576	600	
	1	8	5	13	78	624	4800	
	1	8	2	10	60	480		
	1	2	6	8	48	384		
	1	0	1	1	6	48		
	1	0	1	1	6	48		
Totals	10	62	35	97	582	4656		9456
503	3	8	4	36	216	1728	35	
	8	4	8	96	576	4608	385	
Totals	11					6336	3080	9416
708	2	15	1	32	192	1536	11	
	6	17	0	102	612	4896	121	
	1	16	0	16	96	768	968	
	2	0	1	2	12	96		
Totals	11	48	2	152	912	7296		8264
	Seasons	Weeks	Weeks	Weeks	Days	Hours	Days	Hours
404	1	9	5	14	84	672	21	
	1	7	6	13	78	624	14	
	1	7	6	13	78	624	11	
	1	6	6	12	72	576	46	
	1	6	6	12	72	576	368	
	1	8	4	12	72	576	2944	
	1	5	4	9	54	432		
	1	5	4	9	54	432		
Totals	8	53	41	94	564	4512		7456
104	6	8	0	48	288	2304	11	
	1	8	4	12	72	576	8	
	2	8	2	20	120	960	8	
	1	8	1	9	54	432	27	
	1	4	0	4	24	192	297	
Totals	11			93	558	4464	2376	6840

Appendix 8 – Calculation of the Stability

Calculation of Stability Number based on Three Elevation Bands

Rating	Alpine	Treeline	Below Treeline	Average
Very Poor/Very Poor/Very Poor	5	5	5	5
Very Poor/Very Poor/Poor	5	5	4	4.7
Very Poor/Poor/Poor	5	4	4	4.3
Poor/Poor/Poor	4	4	4	4.0
Poor/Poor/Fair	4	4	3	3.7
Poor/Fair/Fair	2	3	3	2.7
Fair/Fair/Fair	3	3	3	3.0
Fair/Fair/Good	3	3	2	2.7
Fair/Good/Good	3	2	2	2.3
Good/Good/Good	2	2	2	2.0
Good/Good/Very Good	1	2	1	1.3
Good/Very Good/Very Good	2	1	1	1.3
Very Good/Very Good/Very Good	1	1	1	1.0

Appendix 9 – CDM Vignette and Interview Two

Interview Scenarios

Rationale: (from Horstmann et al 2010, Methods for inducing intuitive and deliberate processing modes)

1. The intent of the second round of interviews is to clarify my understanding of the participants' use of the terms intuitive and analytical. Specifically...
 - a. When they say that a decision response was a mix of intuitive and analytical, what does that really mean? Are they using both strategies? If so are they using them sequentially or in parallel?
 - b. Can I elicit an intuitive or analytical response by manipulating the context of the scenario?
 - i. Will a familiar setting, with minimal objective information, framed by directions to respond intuitively, induce an intuitive process?
 - ii. Will an unfamiliar setting, with significant amounts of objective information, framed by directions to respond analytically, induce an analytical process?
 - c. I am not interested in whether they decide to ski the slope or not. I want to challenge them with a scenario and then query them on the process that they used to get there.
2. I will use decision scenarios to initiate a discussion and investigate the intuitive-analytical continuum.
 - a. The participants will describe what an intuitive response or an analytical response means to them.

Methodology

Participants will do two scenarios; one will have factors that will promote an intuitive response, while the other will have factors that will promote an analytical response

- The Intuitive scenario will use a photo of familiar terrain supplemented by limited snowpack and weather data, with the intent of inducing some level of pattern recognition and thus an intuitive decision response.
- The Analytical scenario will use a photo of unfamiliar terrain supplemented by extensive snowpack and weather data, with the intent of inducing an analytical decision response.
- The environmental conditions in both scenarios will promote a high degree of uncertainty, with neither an obvious "go" response or "no go" response.
- The key questions come right at the end.

1. Scenario 1 – Intuitive/Familiar Terrain - Young's Peak photo and video

<http://www.youtube.com/watch?v=zWKqyWiU0VI&feature=related>

Start at 2:13

Here is a picture and a video of the slope you would like to ski with a group of 4 guests.

- A. What is your initial impression?
- B. What are the conditions under which you would ski it?
- C. This is what you know about the slope.
 - a. HS: 350cm
 - b. HST: 20cm
 - c. Air temperature: -6 deg C
 - d. Stability: F/F/G
- D. Talk aloud your decision process. Would you ski it? **Yes / No**
- E. If yes, where would you go and how confident would you be?
 - a. Would there be any stop conditions?
- F. If no, what additional information would you want?
- G. Would it change if you knew
 - a. The HST interface produced a CTM on facets size 1 **Yes / No**
- H. Would it change if you knew
 - a. There was a persistent weak layer down 120cm, facets on top of a crust, which produced an RB 5 **Yes / No**

2. Scenario 1 – Intuitive/Familiar Terrain - Young’s Peak photo and video

1. Describe your decision response.
 - a. How did you come to your decision?
 - b. Can you articulate the elements that most greatly influenced your decision?
2. How difficult was this decision?

Very easy Easy Mod easy Mod Mod difficult Difficult V
Diff
3. Was your response Intuitive or Analytical?

Fully intuitive Mostly intuitive Mix Mostly analytical Fully
analytical
4. Rate the intuition

Strong positive
 Moderate positive
 Weak positive
 Neutral
 Weak negative
 Moderate negative
 Strong negative
5. **Describe an intuitive response**
 - a. **What does it mean to you?**
6. **Describe an analytical response**
 - a. **What does it mean to you?**
7. How confident are you?

100% - Completely sure
 90-99% Highly confident
 80-89% Very confident
 65-79% Moderately confident
 50-64% Educated guess
 50/50 Just guessing
8. **What caused you to be more or less confident in your decision?**

3. Scenario 2 - Analytical/ Unfamiliar Terrain - Line King photo

Here is a picture of the slope you would like to ski with a group of 4 guests.

- A. What is your initial impression?
- B. What are the conditions under which you would ski it?
- C. If you knew these things about the slope, would you ski it?
 - a. HS – 350cm
 - b. HST – 20cm
 - c. Air temperature -6 deg C
 - d. The HST interface produced a CTM on DF size 1.5
 - e. There is a persistent weak layer down 120cm, facets on top of a crust, which produced an RB 5
 - f. There was an accidentally, skier-triggered avalanche (size 2.5) on a slope nearby with similar aspect and elevation, 3 days ago, prior to the storm snow. The depth (100 cm) and propagation (300m) surprised you.
 - g. There was minimal wind associated with the storm snow.
 - h. The slope has been skied on a regular basis though the winter.
 - i. There has been no avalanche activity over the last 48 hours
 - j. Stability: F/F/G
- D. Talk aloud your decision process. Would you ski it? **Yes / No**
- E. If yes, where would you go and how confident would you be?
- F. If no, is there any additional information that would prompt you to change your mind?

4. Scenario 2 - Analytical/ Unfamiliar Terrain - Line King photo

1. Describe your decision response.
 - a. How did you come to your decision?
 - b. Can you articulate the elements that most greatly influenced your decision?

2. How difficult was this decision?

Very easy Easy Mod easy Mod Mod difficult Difficult V
Diff

3. Was your response Intuitive or Analytical?

Fully intuitive Mostly intuitive Mix Mostly analytical Fully
analytical

4. Rate the intuition

- Strong positive
- Moderate positive
- Weak positive
- Neutral
- Weak negative
- Moderate negative
- Strong negative

5. Describe an intuitive response

a. What does it mean to you?

6. Describe an analytical response

a. What does it mean to you?

7. How confident are you?

- 100% - Completely sure
- 90-99% Highly confident
- 80-89% Very confident
- 65-79% Moderately confident
- 50-64% Educated guess
- 50/50 Just guessing

8. What caused you to be more or less confident in your decision?

1. This is what you know about the slope.
 - a. HS: 350cm
 - b. HST: 20cm
 - c. Air temperature: -6 deg C
 - d. Stability: F/F/G
 - e. If you knew these things about the slope, would you ski it?
 - a. HS – 350cm
 - b. HST – 20cm
 - c. Air temperature -6 deg C
 - d. The HST interface produced a CTM on DF size 1.5
 - e. There is a persistent weak layer down 120cm, facets on top of a crust, which produced an RB 5
 - f. There was an accidentally, skier-triggered avalanche (size 2.5) on a slope nearby with similar aspect and elevation, 3 days ago, prior to the storm snow. The depth (100 cm) and propagation (300m) surprised you.
 - g. There was minimal wind associated with the storm snow.
 - h. The slope has been skied on a regular basis though the winter.
 - i. There has been no avalanche activity over the last 48 hours
 - j. Stability: F/F/G

Appendix 10 - Reflective Practice - What did I learn from undertaking the thesis?

Reflection is an important component of the learning process. Schön (1983) describes it as a way of acquiring knowledge and a greater understanding based on previous actions and experiences. It has also been considered a way of entrenching the learning from fleeting opportunities into one's personal practical knowledge (Connelly & Clandinin, 1988). Reflection facilitates the transition and transfer from theory to practice and back again (Walker, 1996)

Dewey (1938) suggests a number of important qualities that would increase the value of reflection. These include: taking responsibility for what occurred, being open to all aspects of the situation, and taking responsibility for learning from the events that occurred. Hubbs (2010) proposes using reflection as a means of assessing learning by reflecting on both the process and content. The most potent learning comes from process oriented, analytical reflection, which generates self-awareness and insight. The implementation of a quality reflection should include aspects of both "what" occurred and "why" it occurred the way it did (Martindale & Collins, 2012).

Reflecting on my journey of discovery and learning through the PhD process led me to Csikszentmihalyi's (1990) concept of "loving wisdom". He suggests that by taking control of the direction of the learning process, learning becomes less effortful and more enjoyable. Although I managed the primary direction of the research I was coached and supported in my quest by my supervisors. Schön (1983, 1990) stresses the importance of introspection as a necessary aspect of reflection, but balanced by the support from a coach. I was fortunate to have three supportive and engaged supervisors. The increased value of having three supervisors came from their different points of view and areas of expertise. Feedback and debriefing generated frequent discussions. Often my many questions were not directly answered, but instead I was pointed in the direction of the answers. Although this was sometimes frustrating at the time, it ultimately led to greater learning.

The literature review was the most immediate and tangible learning opportunity. Exploring the depth and breadth of the literature, particularly the JDM

literature, was both rewarding and intimidating in its vastness. Learning to discern good research from bad was a slow process. Initially all the articles seemed irrefutable and convincing, but as I gained perspective, I began to be able to detect holes. Methods were flawed. Results and findings were overstated. I became an educated consumer of research. For example, I used Hammond's Cognitive Continuum as a starting point for the collection of intuition and analysis data from the participants. As my research progressed and as the literature evolved, it became apparent that the Dual-Process model was a better way of contextualizing the interaction between the two processes. As such, I used the Dual-Process model as the basis for the qualitative data analysis.

The methodology was the source of my greatest challenges. I felt fairly comfortable with the qualitative process. As I learned more about qualitative data analysis, I relished the challenge of teasing out the subtleties of meaning from within the data. I also wanted to become better at conducting quantitative research. I quickly learned that statistical analysis was an incredibly powerful and complex tool. The more I learned, the more I realised how little I knew. I truly appreciate the skills of researchers who have become masters at quantitative analysis. My next challenge beyond the thesis will be to become a better quantitative researcher. I need to become better friends with my quantitative data and learn to appreciate it like a fine wine (Wright, 2003).

Data collection, particularly conducting interviews was tremendously rewarding. Not only did I learn to refine my interviewing strategies, but I was also able to increase my comprehension of the ski guiding mosaic. The opportunity to engage with some of the finest ski guides in the world and to pick their brains was tremendous.

Making sense of the mountain of data required a structured and regimented work flow on my computer. I used HyperResearch to conduct the qualitative data analysis. It allowed me to code the digital audio files. Once coded, I transcribed the sections using MacSpeech Dictate. Taking the time to learn the computer programs was well worth the effort. I utilized the software program Mendeley to keep track of my 853 references. Although I did not use all the potential sources in the thesis, Mendeley made it easy to review, search, sort and cite them.

The final synthesis of my data analysis back into the surrounding literature gave a sense of completion and contribution. This final step was challenging and rewarding. I have gained a voice in the discussion. I have something to say.

While training for and being examined to become a full certified mountain guide, I often felt that once I achieved the certification, I would have arrived. As I was finishing my last exam, I was consumed with the realization that the end of the certification process was only the start of a new beginning. Now as a budding researcher, I am fully aware of how little I know and how much there still is to learn.

Reflective Questions (ISW, 2006)

Did it go according to plan? No

What would I do differently next time? Do it full-time

What was the biggest surprise? How long it took

What are the implications for the future? Use the skills I have learned to do more research

What do I do well? Persevere

What can I improve on? Everything

Is this enough for a PhD?

The research draws on JDM theories and applies them in a new context. It is an important topic that has not been covered, with the potential to reduce fatalities.

The research has been conducted effectively, with a clear pragmatic methodology using mixed methods and triangulation

The research contributes to knowledge. In Snow Science, it firmly establishes the legitimacy of using dual process theory to expand the understanding of ski guide decision-making. In the JDM literature, it contributes to the implications of Hogarth's work on the education of intuition in relation to decision consequences and feedback (Hogarth, 2001). It clarifies the need for an increase in peer-based feedback to compensate for when there is a lack of environmental feedback.

The research provides future direction, illuminating the need for research on peer-based feedback on good day decisions, and on ski guide group decision-making.

Appendix 11 – CAA Continuing Professional Development

Guidelines for Professional and Active Members

Preamble

Amendments to the Canadian Avalanche Association (CAA) bylaws in 2006 created a new type of membership, the Active Member. The 2006 bylaws state that CAA Professional and Active Members will undertake a program for Continuing Professional Development (CPD) as requirement of membership.

The CAA's Code of Ethics is amended to contain the following statement: Professional and Active Members accept responsibility to undertake continuing professional development to ensure the currency of their knowledge, skills and technical competencies within their areas of practice, to meet society and industry expectations.

Intent Of The CPD Program

The CAA's CPD program is intended to encourage, support and assist Professional and Active Members to continuously upgrade their knowledge, training, qualifications and credentials and thereby maintain a high level of competence throughout their careers. This policy serves as guidance for documenting and administering CPD program compliance.

Authority

This document contains all current terms and conditions of the CAA's CPD program in the attached Appendix 1, and serves as standing guidance for CAA Professional and Active Members, Directors and staff. The CAA's Board of Directors (Board) authorizes and requires the Director, Membership Committee to randomly select a prescribed number of Professional and Active Members annually, and audit their documentation for CPD program compliance.

Under the CAA's bylaws a Professional or Active Member unable to demonstrate compliance with the terms and conditions for CPD as contained in this document, and upon written notification from the Director, Membership Committee, shall have their CAA membership changed to a type of membership that is commensurate with their CPD activities, as determined by the Membership Committee audit process findings.

CPD Audit Process

Members deemed by the Membership Committee to be in compliance with the terms and conditions of the CPD program will have all documentation returned, accompanied by a letter from the Director, Membership Committee confirming CPD compliance.

Members deemed by the Membership Committee to be not in compliance with the terms and conditions of the CPD program will have all documentation copied and kept on file with the Director, Membership Committee for a period of three (3) years. All original documentation will be returned to the Member, accompanied by a letter from the Director, Membership Committee stating the reasons for the determination that they are not in compliance with the terms and conditions of the CPD program. All documentation or other information collected by the CAA for a Member's CPD compliance audit is confidential, and will not be released to any third party without the Member's written consent.

Appeal Process

A Member may appeal the Membership Committee's determination that they are not in compliance with the terms and conditions of the CPD program, to the Board. An appeal must be in writing, sent by registered mail to the Executive Director at the CAA's head office, and be received within 90 days from the date of the Member's written notification from the Director, Membership Committee.

The Board may request or collect additional information, consult, deliberate or do any other thing they deem necessary, and will deliver a binding decision regarding the Member's CPD compliance within 90 days from the date that the appeal was received at the CAA's head office.

Approved: June 10, 2006

Reviewed: insert date

Attachments: Appendix 1. Terms and Conditions for Continuing Professional Development (CPD).

Appendix 1

Terms and Conditions for Continuing Professional Development (CPD)

These terms and conditions apply to all Practicing Professional, Non-practicing Professional and Active Members (Members) of the Canadian Avalanche Association. Members will maintain records of their CPD activities for the past three (3) calendar years, or since their acceptance as a Member, whichever period of time is the lesser.

Required CPD Points

Members must earn CPD points from at least three out of the six CPD point categories during any three year period.

- Practicing Professional Members are encouraged to earn at least 80 points per year and must accumulate at least 240 CPD points over three years.
- Non-practicing Professional Members are encouraged to earn at least 50 points per year and must accumulate at least 150 CPD points over three years.
- Active Members are encouraged to earn at least 60 points per year and must accumulate at least 180 CPD points over three years.

Members in the third or subsequent years of their CPD program must maintain a three year rolling average of at least the minimum number of CPD points required for their type of membership. CPD points earned above the maximum allowed per category per year may be carried forward for a maximum of two years from the date those points were earned.

Eligible CPD Activities & Points

The CAA has defined six general categories for earning CPD points (listed below) showing annual maximum eligible points per category per year, by membership type.

CPD point categories by membership type Maximum eligible CPD points per year

	Practicing Professional	Non-practicing Profession	
Active Member	Member	Member	
1. Professional practice	50	30	30
2. Formal learning activities	30	30	30
3. Informal learning activities	20	20	20
4. Participation	20	20	20
• Committee service	20	20	20
• Other activities (specify)	10	10	10
5. Presentations	20	20	20
6. Contributions to knowledge	30	30	30
• Develop published codes, standards	10	10	10
• Peer reviewed publications	15	15	15
• Non-reviewed articles	10	10	10
• Reviewing articles for publication	10	10	10
Total CPD points recommended / year	80	50	60
Total CPD points required over 3 years	240	150	180

Definitions For Determining CPD Points

1. Professional Practice

A CAA Member's professional practice is deemed to be all "avalanche related activities" as defined in the CAA's Bylaws, as may be amended from time to time.

The professional practice year is January 1 to December 31

One CPD point is earned for each day of professional practice, to a maximum of 50 points per year for Practicing Professional Members and 30 points per year for Non-practicing Professional and Active Members.

2. Formal Learning Activities

Formal learning activities are avalanche related educational or training programs such as:

- University, technical institute and college courses
- Industry sponsored courses, programs and seminars
- Structured employer-sponsored training programs
- Short courses sponsored by technical societies, industry or educational institutions
- CAATS courses and other CAA sponsored programs

One CPD point is earned for every hour in attendance at the course or program.

For courses offering Continuing Education Units (CEUs), each CEU will be worth 10 CPD points. A maximum of 30 CPD points per year may be earned for formal learning activities.

3. Informal Learning Activities

These are learning activities which expand avalanche knowledge, skills or judgment, but which are not normally offered as structured educational or training programs.

Examples include:

- Attendance at conferences, technical sessions, seminars, workshops and industry trade shows.
- Attendance at meetings of technical, professional or managerial associations or societies.
- Self directed study.

One CPD point is earned for each hour of informal learning activity, to a maximum of 20 CPD points per year.

4. Participation

These activities enhance professional development by promoting peer interaction and providing exposure to new ideas and technologies. Examples include:

- Acting as a mentor to a less experienced member or to a member-in-training
- Service on public bodies that draw on a member's professional expertise (for example, planning boards, review panels, investigative commissions, coroners' inquiries, etc.)
- Service on standing or ad hoc committees of technical, professional or managerial associations or societies

One CPD point is earned for each hour of participation, to a maximum of 10 CPD points per year, except for committee service, where a maximum of 20 CPD points per year may be earned.

5. Presentations

Activities in this category include formal avalanche related presentations that members make, requiring preparation and presentation of original material. They may occur:

- At a conference or meeting
- At a course, workshop or seminar
- Within an organization/company
- At an event sponsored by a technical or professional organization

One CPD point is earned for each hour for preparation and delivery of presentations, to a maximum of 20 CPD points per year.

6. Contributions to Knowledge

Activities in this category include expanding the knowledge base of science, technical knowledge or best practice relating to avalanche safety. Activities may include:

- Development of published codes and standards.

One CPD point is earned for each hour of committee work developing published codes and standards to a maximum of 10 points per year.

- Publication of papers in a peer-reviewed scientific or technical journal.

Fifteen CPD points are earned for each peer reviewed paper published.

- Publication of articles in a non-reviewed journal

Ten CPD points are earned for each non-reviewed article published.

- Reviewing articles for publication

One CPD point is earned for each hour spent reviewing articles for publication. A maximum of 10 CPD points may be claimed for this activity per year.

- Editing papers for publication

One CPD point is earned for each hour spent editing papers for publication. A maximum of 10 CPD points may be claimed for this activity per year.

* A maximum of 30 CPD points per year may be claimed for contributions to knowledge.

Practicing and Non-practicing Professional Members

A Member that has been a Practising Professional Member in good standing for at least five (5) years, shall be eligible to be a Non-practising Professional Member if the Member's occupation has altered so that he is no longer directly engaged in avalanche-related activities, or is not sufficiently engaged to be able to comply with the terms and conditions for Continuing Professional Development for Practising Professional Membership, provided that the Member is able to comply with the terms and conditions for Continuing Professional Development for Non-practising Professional Members as stated in this policy document.

Members Declaration of CPD Category

As part of their annual membership renewal, Practicing Professional, Non-practicing Professional and Active members will declare the membership category for which they are earning CPD points at the start of each calendar (membership) year.

“Career Recess” Status

A Professional or Active Member who is currently not engaged in avalanche related activities as defined in the bylaws, is registered as a full-time student, on extended jury duty, or on medical or parental leave may declare themselves to be in career recess.

A Member who has declared themselves to be in career recess is not be required to comply with the terms and conditions for CPD, is exempt from Membership Committee audit for CPD compliance, and remains a Member in good standing of the Canadian Avalanche Association as long as they maintain all other requirements of membership.

When a Member declares to have resumed avalanche related activities the Member will be required to comply fully with the CPD program, and the time that they declared themselves to be in career recess will be exempted from consideration in any subsequent audit for CPD program compliance.

A Member who has declared career recess status for a consecutive period of time greater than two years or has been in career recess status for more than two of the past six years is deemed to have failed to comply with the CAA's CPD program, and may become a Member in good standing of the CAA at a reduced level of membership as defined in the bylaws.