ABSTRACT

Title of Dissertation: EXECUTIVE INFORMATION SEARCH WITHIN TOP MANAGEMENT TEAMS AND ITS IMPACT ON ORGANIZATIONAL INNOVATION

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The focus of this dissertation is an examination of an important yet understudied managerial activity – that of information search. Information is an essential component to the functions of managers, and the way in which information is gathered should therefore be of concern. Given a limited amount of research in this area, two major questions are addressed: What is the relationship between information search activities in top management teams and organizational innovation? To what extent is such a relationship affected by the capability of the top management team to integrate the information gathered through search?

In this dissertation, I deal specifically with the search activities of top management teams, differentiating this research from the exclusively organizational focus on search that is present in the innovation literature. Executive information search

is thus proposed as a relatively new concept for which I explore a more comprehensive and fine-grained characterization of search than has been attempted before. As a fundamentally individual-level behavior, the characteristics of search are poorly understood. This dissertation develops a model of search that makes the distinction between where search is conducted (terrain) and how search is carried out (process). Further, drawing on ideas from economics, decision-making, and innovation literatures, a set of key search characteristics are developed within the dimensions of both the search terrain and the search process.

The findings of this study are in line with previous research that highlights the importance of search. Search that is more effortful, more adaptive, or which draws upon a mix of resource and market information, has a significant impact on organizational innovation. Other characteristics of search are also important, but must be considered in terms of the interaction between how the search is conducted and where the search is conducted. These findings support the view of search as a multi-dimensional construct with several important characteristics that have an impact on organizational innovation.

EXECUTIVE INFORMATION SEARCH WITHIN TOP MANAGEMENT TEAMS AND ITS IMPACT ON ORGANIZATIONAL INNOVATION

by

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PREFACE

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DEDICATION

To my wife, Marilyn, and my children, Zoë and Kiran: without you, this journey would not have been possible - or meaningful.

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CHAPTER 1: INTRODUCTION

Research into the nature of managerial work emphasizes the importance of information to the many roles of managers, with estimates of the proportion of managerial time devoted to imparting or receiving information placed at between two-thirds and four-fifths (Hales, 1986; Kotter, 1982; Mintzberg, 1973; Stewart, 1976). Information is viewed as a necessity to effective management as it enables executives to deal with uncertainty, make effective strategic decisions, and guide the actions of specialist employees within the organization (Kotter, 1982; Mintzberg, 1973). Managers therefore act as 'nerve centers', functioning as 'input-output systems' for which information is their key resource (Mintzberg, 1973).

While various characterizations of managers' work roles exist, Mintzberg's (1973) classification of the 'monitoring' and 'disseminator' informational roles can be found in much of this research (Hales, 1986). As monitors, managers seek information "in order to detect changes, to identify problems and opportunities, to build up knowledge about [their] milieu, to be informed when information must be disseminated and decisions made" (Mintzberg, 1973: 67). As disseminators, managers send external information into their organizations, transmit information between subordinates, and transmit information reflecting organizational goals that guide subordinates in making decisions. These roles fit well with Barnard's (1938) assertion that the key function of executives is to serve as channels of communication, enabling the coordination of all aspects of organizations.

Thompson's (1967) concept of co-alignment as the basic administrative function also implies the importance of information to managers. Co-alignment involves keeping

an organization at the "*nexus* of several streams of action" (1967: 148, italics in the original) balancing the demands of the external environment and that of the 'technical core' of the organization. Doing this involves a paradox: managers must both seek to reduce uncertainty, but at the same time search for flexibility. Thompson highlighted Cyert and March's (1963) concept of problemistic search as an uncertainty reducing mechanism focused especially around the organization's technical core. On the other hand, 'opportunistic surveillance' (i.e. formal scanning) was argued to allow organizations to remain flexible by anticipating environmental trends rather than waiting for problems to arise.

Here, both search and scanning are forms of information acquisition (Huber, 1991). Search is the purposeful gathering of information within a relatively narrow segment of a manager's environment. Scanning is less purposeful, and involves a relatively wide-ranging sensing of a manager's environment. However, early work into the information gathering activities of managers often grouped these two concepts together (e.g. Aguilar, 1967) or focused more heavily on scanning (e.g. Hambrick, 1981, 1982).

Unfortunately, this ignores search as a complementary and purposeful information gathering activity. Certainly, search as focused information gathering is referenced as a function of managers (e.g. March & Simon, 1958; Cyert & March, 1963; Thompson, 1967), but the importance ascribed to this executive activity is not reflected in extant empirical research. Garg, Walters, and Priem (2003) implicitly highlight this fact in their review of the executive scanning literature. Boyd and Fulk's (1996) study of executive information search under conditions of uncertainty focused exclusively on scanning.

Further, empirical research into search has typically focused on an organizational level of analysis with particular reference to lower organizational levels (Huber, 1991; Greve, 2003). Given the importance ascribed to the informational roles of executives, it is therefore surprising that very little is known about what actions and behaviors of executives are most conducive to effective information gathering through search – a key part of the strategic decision making process (Mintzberg, Raisinghani & Théorêt, 1976).

These limitations are of concern as research has demonstrated empirical support for a positive relationship between information acquisition by top managers and organizational innovation and performance (e.g. Daft, Sormunen, & Parks, 1988; Garg, *et al.*, 2003; Tushman, 1977). The primary reason for this relationship has been argued to stem from the ability of top managers to recognize opportunities and threats in their environment through the gathering of information. However, this research has mostly been concerned with broad, undirected efforts of executives to obtain information (i.e. executive scanning), which may be argued as leading to the identification of strategic opportunities primarily due to luck (cf. Denrell, Fang & Winter, 2003).

In contrast to broad, undirected information gathering through scanning processes, the decision-making literature has highlighted the importance of more focused search as an important managerial behavior for generating ideas or solution alternatives that have an impact on organizational outcomes such as innovation (Alexander, 1979; Mintzberg, *et al.*, 1976; Nutt, 1993). Top managers may therefore be the source of the ideas that initiate the innovation process in an organization (Blau & McKinley, 1979), or the individuals that recognize the innovative potential of insights by specialist workers within the firm (Rice, Kelley, Peters, & O'Connor, 2001). However, relatively little

empirical research has addressed the specific search activities and behaviors that top managers engage in to acquire information and how these activities impact on organizational innovation (cf. Garg, *et al.*, 2003; Nutt, 1993).

An important gap in the literature therefore exists which necessitates further examination of search as a more focused form of information gathering and knowledge acquisition that has the potential to impact organizational innovation. Quantitative analyses of search activities have for the most part been limited to an organizational level of analysis, focusing on R&D expenditure, inter-firm alliances, patent citations and the like (e.g. Greve, 2003; Rosenkopf & Almeida, 2003; Katila, 2002). However, these are all processes and activities that are one-step removed from the actual activities that result in innovation. Further, little is known about the search activities of top managers, and how these activities impact on organizational innovation (cf. Nutt, 1993). The influence of top management teams on organizational innovation has been found to be more important than organizational or environmental factors, but studies of this relationship have tended to be from a demography perspective and therefore lacking in their examination of the impact of managerial activities (e.g. Bantel & Jackson, 1989; Hambrick & Mason, 1984; Hoffman & Hegarty, 1993).

This dissertation will address some of these shortcomings by investigating the relationship between search and innovation. In particular, search is viewed from the perspective of the activities and behaviors of members of a firm's top management team. The concept of executive information search is therefore developed to specifically highlight the search activity of top managers as it relates to their roles in maintaining the operation of an organization (Barnard, 1938). As a means to acquiring new knowledge,

search behavior by top managers is argued to contribute to their ability to generate new ideas and solution alternatives, and to recognize the potential of innovation opportunities arising either from outside or within the organization (Alexander, 1979; Nutt, 1993). Generating idiosyncratic knowledge through search may therefore be a key mechanism that allows a top management team to be alert to strategic opportunities and to lead their firm to superior profitability (cf. Denrell *et al.*, 2003).

In this dissertation, I argue that organizational innovation is influenced both by the acquisition and assimilation of information within top management teams. The search activities of top-managers are examined as a key factor influencing information acquisition that impacts the generation of creative ideas or solutions to organizational problems, or management's awareness of new innovations to be adopted. However, the impact of search activities on organizational innovation requires that the information acquired by top-managers is properly assimilated within the top management team. The process of assimilating new information is important for several reasons. First, the integration of specialist knowledge of individual top management team members influences the value-creating capability of the top management team (cf. Grant, 1996; Carlile & Rebentisch, 2003). Second, creative ideas for innovation may be fostered and developed by interaction processes among these members (cf. Mumford & Gustafson, 1988; Taggar, 2002). Third, to the extent that this interaction creates support for an innovation, there is a stronger likelihood that the top-management will have higher levels of commitment to implementing an innovation in their organization (e.g. West & Anderson, 1996). Finally, while not every innovation is immediately implemented due to market and/or technological considerations, assimilation of information on an innovation

increases the availability of ideas and insights when future conditions are ripe for their implementation (Garud & Nayyar, 1994; Carlile & Rebentisch, 2003; Greve, 2003).

The following chapter outlines my theoretical framework for an examination of search activities in top management teams. I deal specifically with the importance of search in various manifestations of individual and organizational activities and develop several key characteristics of search behaviors as suggested by past research in several different literatures. Building on this review, chapter 3 then outlines my model of executive information search. Assimilation of information acquired through search is examined in the form of the search integration capability of the top management team – a concept suggested as important by research into the information processing structure of top management teams (e.g. Thomas & McDaniel, 1990). This chapter also provides an overview of the expected relationships between executive information search, search integration capability, and organizational innovation. This theoretical framework lays the groundwork for several hypotheses linking search to organizational innovation in chapter 4, followed by the research method chosen to empirically investigate these relationships in chapter 5. Chapter 6 presents the results of the analysis, and a discussion of these results is presented in Chapter 7.

CHAPTER 2: REVIEW OF SEARCH THEORY

Search is generally viewed as an information gathering process through which a searcher can solve problems or experiment with new ideas such that a new innovation results (Nelson & Winter, 1982). Search can also be viewed as an important component of the decision-making process, contributing to the generation of solution ideas and alternatives to a given problem and aiding evaluation of the solution to pursue (Alexander, 1979; Cyert & March, 1963; Mintzberg *et al.*, 1976). Search should therefore be an important managerial activity given that the majority of managers' daily routines involve information processing and decision-making (Mintzberg, 1973).

As a theoretical concept, search has been explored in various literatures as an important component of the decision making process, and a significant determinant of organizational performance outcomes such as profitability, innovation, and survival. However, management research has not explored a full characterization of search, and more importantly, has not demonstrated how various aspects of executives' search behaviors influence organizational performance. In this chapter, I draw upon established research in economics, decision-making, and innovation in order to develop the concept of search more expansively than has been done before.

Economic Theories of Search

Economic theories of search have by far the longest history of research. This work has focused heavily on problems such as consumers search for low prices and workers search for the highest wages (e.g. Kohn & Shavell, 1974). The emphasis of economic theories of search is on the application of optimal stopping rules to decision-

making under uncertainty. It has thus dealt with issues such as bounded rationality[1] and the marginal costs and benefits of successive rounds of search.

Lippman and McCall (1976) provide an early review of the job search literature, examining several models of search for both employees and employers. Each of these models focused on a particular set of assumptions under which search may occur. For instance, degree of uncertainty, search under conditions of both finite and infinite time horizons, risk aversion, systematic search, adaptive search, and search with variable intensity of effort. The basic underlying assumptions to all of these models are that searchers are boundedly rational, and that each round of search entails some cost (e.g. advertising a job, transportation to/from interviews, etc.). From these basic models, more recent studies have developed models with greater complexity in assumptions and combinations of earlier models (e.g. Adam, 2001; Moon, 1996; Rauh, 1997). These models are all concerned with the extent to which search should continue in order to arrive at an optimal choice while minimizing costs. The basic argument of these models is that search will continue until the marginal cost of searching one more observation equals the marginal benefit from that additional observation. The different contextual factors and assumptions are shown to have varying impacts on marginal costs and benefits of search.

Economic research has also applied search theory within the context of firm R&D strategy (e.g. Reinganum, 1982; Kauffman, Lobo & Macready, 2000). Reinganum (1982) extended search theory within a game-theoretic framework to demonstrate the

[1] Simon (1957b) postulated that individual judgment is bounded in its rationality to the extent that while the individual attempts to make a rational decision, time and cost constraints limit the quantity and quality of available information. Individuals therefore forego the best solution in favor of one that is acceptable or reasonable – i.e. they satisfice.

existence of Nash equilibria in stopping rules for the new product development spending of rival firms. Kauffman *et al.* (2000) modeled firms' search activities as movement on a 'technology landscape'. Each location on the technology landscape refers to a configuration of engineering operations, with greater 'distance' implying the utilization of configurations further and further from the current expertise of the firm. The main argument of this work is that in seeking technological improvements, the distance that a firm traverses on its technological landscape should be greater the poorer it's initial position. When a firm achieves success in technological improvement, it should constrain its search within a local region of the technology landscape.

Decision-Making Theories of Search

While both the decision-making literature and the innovation literature build on the seminal work of March and Simon (1958) in their focus on aspiration levels as a driver of search, the emphasis of these two literatures is different. The decision-making literature is concerned with describing and evaluating the overall decision-making process, of which search is a part (e.g. Mintzberg *et al.*, 1976). This literature has investigated search as a part of the strategic decision making process in which search is a key activity for the identification of solutions to a given problem (e.g. Cyert & March, 1963; Mintzberg *et al.*, 1976; Alexander, 1979).

Cyert and March's (1963) theory of search focused on search as a behavior stimulated by a problem, where a problem is generally defined as a shortfall between the level of achievement and a stated goal (aspiration target). This theory of problem-oriented (problemistic) search is based on three assumptions: search is motivated; search is simple-minded; and search is biased.

Search is motivated to the extent that a goal is not met or there is anticipation that the goal will not be met in the future. This stimulates search until either a solution is discovered that satisfies the problem or the goal is revised to make current alternatives acceptable. The greater the difference between achievement and goals, the greater the motivation to search.

The assumption of simple-minded search affects the direction and objective of search. First-order response to a stimulus is to search in the region of the problem symptom or current alternatives ('local'). If a solution is not found, search behavior adapts, becoming increasingly complex ('distant'). This second-order response involves changes in goals, as well as greater consideration of technological opportunities. This distinction has been described in terms of refinement (efficiency-oriented) search and innovation search (Levinthal & March, 1981) and relates to March's (1991) distinction between exploitation and exploration. Search may therefore be focused on refining (exploiting) current technology or finding (exploring) a new improved technology. The ability of a searcher to increase the complexity of search, changing from an efficiency orientation to an innovation orientation, will therefore be a function of their ability to adapt to previous experience and changing conditions.

The bias of searchers arises primarily from differences in training or experience of searchers or differences in the goals and expectations among searchers. Specialization within different parts of an organization typically influences the emphasis of the search and the type of information most readily noticed by the searchers. This form of bias is reflected in the early work of Dearborn and Simon (1958) who found that managers faced with a particular problem would interpret the problem based on their experience and

background – a phenomenon that they labeled as 'selective perception'. Arguments for selective perception are related to the notion that managers have limited information processing capacity (Simon, 1957), and must therefore base selection on learned rules and prior experience (Kiesler & Sproull, 1982). The existence of selective perception suggests that managers will search for solutions from a biased perspective.

As an alternative to problemistic search, Carter (1971) has suggested that opportunity-oriented search may also occur. This form of search arises when an alert manager recognizes an opportunity that appears within the context of a firm's market. Carter also recognized that search may be driven by 'strong-willed' executives whose goals differ from that of the firm. This form of search is likely to arise when the availability of slack resources facilitates search processes arising from managerial decisions related to personal interests, differing interpretations of organizational goals, or of a desire for strategic change. Slack may therefore foster a lack in discipline in which managers may pursue pet projects with dubious organizational benefit – essentially solutions are created which are 'searching' for problems (Cyert & March, 1963; Cohen, March, & Olsen, 1972).

Cyert and March (1963) recognized that search might arise in the absence of a problem, in situations where slack resources enabled the pursuit of projects with uncertain short-run returns that would not necessarily be approved under tight budget conditions. This type of search is referred to as slack search (Cyert & March, 1963; Levinthal & March, 1981). The existence of slack may also be agued to affect the orientation with which an organization conducts search. Mone, McKinley and Barker (1998) argued that the absence of slack may encourage a conservative reaction to

organizational decline (a problem situation) that leads to a lower emphasis on innovation. Therefore, in instances of no slack, refinement search is more likely than innovation search.

Mintzberg and colleagues (1976) used case studies to describe in detail the role that search plays in the decision-making process. Primarily, these authors asserted that search can be viewed as a continuum varying by the extent to which the searcher exerts his/her own effort versus depending upon the effort of others (active search vs. passive search). Further, this research focused on describing how search is conducted under different environmental and problem significance conditions and its impact on effective decision-making (see also: Alexander, 1979; Nutt, 1984, 1993).

Alexander (1979) provides another of the few decision making studies that investigates the impact of search on the alternatives-generation process. The alternatives-generation process is one stage in decision-making, and is concerned with development of solutions or alternatives to a problem situation. This process is viewed as potentially consisting of two parts: the search for solutions that already exist, and the design or creation of a solution to a significant extent *ex nihilo*. Alexander's examination of alternatives generation in three case studies suggested the predominance of search over creativity. Search was shown to generate a wider range of opportunities – with ideas or options being found or recalled rather than formed or created. Not to suggest that creativity was unimportant, Alexander offered the view that creativity could be an effective part of alternative generation when used in conjunction with 'heuristic' search – search that involves less direct effort and follows simple intuitive rules (Cyert & March,

1963). However, with these arguments based only on three case studies primarily in an institutional context, more research is needed to expand on these findings.

Building on Mintzberg and colleagues (1976) work, Nutt (1984) attempted to provide a more detailed description of decision processes used by managers. With regards to search, active search was further broken down into extended search and truncated search, the distinction being the extent to which the search process attempted to identify numerous ideas. Passive search was further broken down into sequestered search and open search, the distinction relating to the degree to which subordinates were brought in to help with the search (i.e. open search). The difference in the utilization of either active or passive search was shown to stem from the degree to which the decision maker had an understanding of the needs of the organization resulting from a perceived problem situation. While more active forms of search were predominant in the case studies analyzed, Nutt (1984) further suggests that this form of search combined with other tactics used by managers were intended to reduce causal uncertainty in the decision-making process.

Expanding on this work, Nutt (1993) contrasted the use of solution identification tactics, finding results similar to that of Alexander (1979). Idea tactics (those that searched for solutions previously developed by the organization), template tactics (those that searched for solutions being utilized by similar organizations) and search tactics (those that searched for solutions in the marketplace) were used roughly 82% of the time. Design tactics – those in which custom made solutions were developed without reference to available ideas, the practices of others, or provided by vendors – were used only 18% of the time. In terms of the success of each of the four tactics, search tactics had the

second best success record (as measured by initial and sustained adoption of ideas), with template tactics coming out on top. When a distinction was made between single searches (i.e. the selection of a best response to a single proposal request) and cyclical searches (i.e. multiple waves of proposal requests, with each wave being refined to exploit knowledge acquired in the previous step), cyclical searches had comparable success to the template tactic. However, cyclical searches were relatively infrequent, and the results that were produced were situationally dependent – working best in low importance and low urgency situations, and when the best staff support was available.

Finally, Fredrickson's work on decision comprehensiveness (e.g. Fredrickson, 1984; Fredrickson & Mitchell, 1984) partly reflected the extent to which the information gathering activities of managers attempt to be exhaustive as part of the process of making and integrating strategic decisions. This research found that comprehensiveness was positively related to organizational performance in stable industries, and negatively related to performance in unstable industries.

Innovation Theories of Search

While related to the decision-making literature in its view of search as a means by which firms solve problems (Cyert & March, 1963; Nelson & Winter, 1982), the innovation literature has been more concerned with search as a means of organizational adaptation through innovation. Of predominance in this literature has been the extent to which search can be considered 'local' or 'distant' (e.g. Helfat, 1994; Martin & Mitchell, 1998; Stuart & Podolny, 1996). For the most part, this research has been guided by the work on evolutionary theory by Nelson and Winter (1982).

Nelson and Winter (1982) provided an evolutionary theory that viewed search as a mechanism that influences organizational adaptation and survival. Search, in the form of 'doing research', 'testing', or 'making a study', may result in the adoption of new routines – regular and predictable behavior patterns of the firm. Search is differentiated from routinized responses to stimuli in three respects. First, search is intrinsically irreversible as it involves the acquisition of information. Second, search involves uncertainty, where exploring perceived decision alternatives may bring to light other alternatives not originally contemplated. Finally, there is a degree of path-dependence in search, where previous history provides a context that influences search. This final characteristic leads to the assertion that search tends to be 'local', where search often takes place in the neighborhood of an organization's existing routines.

Several studies have demonstrated that firms search locally in the region of existing knowledge. For example, Martin and Mitchell (1998) examined the introduction of variations in designs of magnetic resonance imaging devices and found that incumbent firms tended to introduce new designs that were similar to their existing designs. In support of March and Simon's (1958) notion that aspiration gaps spur action, it was also found that declining market share prompted firms to introduce products that were already in their development pipeline (see also Greve, 2003). Rosenkopf and Almeida's (2003) examination of how semiconductor firms draw on the knowledge stock of other firms also found that technological similarity and geographic proximity between firms lead to a greater likelihood of the focal firm drawing upon the knowledge stock of the other firm – implying that search that was locally constrained. Overcoming local search was facilitated by the hiring of inventors previously employed by other firms and through

alliances. Both mechanisms for stimulating knowledge transfers increased in effectiveness the greater the technological distance that the organization was attempting to span. These authors further argue that individuals' mobility had a more pervasive effect on knowledge flows than alliances.

In contrast to these studies, Rosenkopf and Nerkar's (2001) investigation of boundary-spanning search suggested that the extent of the impact of a firm's innovation depended upon the 'location' of the information sources utilized in search. Search that was conducted outside of the boundary of the organization or even the boundary of the technology common to the firm's industry tended to have a greater impact on the radicality of the resulting innovation. Distance implied that more dissimilar (or novel) information was being utilized as compared to what was present within the firm or within the firm's industry. Utilizing novel information increased the degree to which the resulting innovation was different from the technological regime within which the firm was operating.

Katila (2002) examined new product development in the robotics industry to show how the age of the knowledge that firms searched affected innovation. Search age was measured using patent references in a focal firm's patents, where age depended on the elapsed time since the issue of cited patents for previous company patents (internal search age), competitor patents (competitor search age), as well as patents of firms external to the industry (external search age). Results of this study showed several interesting findings. Searching older knowledge only boosted product innovation when this knowledge came from external sources, and hurt innovation when it came from competitor knowledge. Searching internal knowledge first promoted and then harmed

innovation, suggesting that while older knowledge is more reliable, better established, and better understood, depending on this knowledge may lead to competency traps and reduced applicability of this older knowledge to innovation (Levitt & March, 1988; Sorenson & Stuart, 2000).

Katila and Ahuja (2002) further investigated search in terms of depth (frequency of reuse of existing knowledge) and scope (how widely the firm explores new knowledge). Measuring these types of search through patent citations, positive relationships were found between search depth and search scope with new product introduction, both directly and in interaction. Excessive search depth was shown to have a negative effect on innovation, supporting the argument that the exploitation of older, existing knowledge has an initial positive effect on innovation which becomes negative when used in excess (Katila, 2002). However, a combination of depth and scope facilitated the absorption and further development of new knowledge that led to unique combinations that could be commercialized. These results contrast somewhat with Fleming (2001), who found that inventors that experiment with combinations of new components and new configurations of previously combined components had less success on average, but increased the variability that lead to breakthrough inventions.

Other Literature on Search

While related to the decision-making literature, a few studies have focused more heavily on cognition as it relates to search. This perspective emphasizes the role that the cognitive representations of a searcher's environment plays on how search is conducted. Gavetti and Levinthal (2000) make the distinction between experiential search and cognitive search. Experiential search is guided by prior learning and is more akin to

routines in the sense that search behaviors with positive outcomes are reinforced and repeated as necessary. This type of search involves 'on-line' evaluation of alternatives, were actions are tried and subsequent revisions to these actions may occur. In contrast, cognitive search is 'forward-looking', based upon the searchers beliefs about action-outcome linkages. This type of search occurs 'off-line' as the searcher does not engage in an activity to evaluate a given alternative. Gavetti and Levinthal (2000) offer a simulation model that concluded that both cognitive and experiential search are important for performance outcomes. Cognitive search is useful for determining a starting point for experiential search and also for constraining experiential search within an area more likely to yield an optimal alternative. The importance and costs of changing cognitive representations of a searcher's environment was also highlighted as a mechanism that allows organizations to adapt. This occurs in two ways: First, new representations may result in changes to mental models that reflect a better understanding of the environment and the weaknesses of the prior representation. Second, a shift in representations may result in attention being paid to a different aspect of the environment. Over time, such shifts in attention lead to a better understanding of the searchers overall environment and thus the ability to identify optimal alternatives. The danger of shifting cognitive representations stems from the loss of tacit knowledge related with the prior representation, which could have a negative impact on performance.

This idea of the impact of cognitive representations on search behavior is also explored by Greve and Taylor (2000). These authors demonstrated that innovation events in a searcher's environment provide information that can lead to shifts in managerial cognitions on the types and benefits of actions that are possible. For instance,

innovations in large or nearby markets were shown to have a greater effect on an organization introducing a similar innovation, while an innovation by a larger organization has less of an effect. Their basic argument is that innovations by others encourage change and the pursuit of new opportunities by stimulating search to gain feedback and information on the changing external environment. Salience of external innovations, as well as the potential threat, therefore have varying effects on managerial cognitions, either by changing managerial schema directly or by stimulating search that causes the update of these schema.

In the entrepreneurship literature, several studies have also drawn upon search theory – primarily to contrast the differences between managers and entrepreneurs in their exposure to, and use of information (e.g. Kaish & Gilad, 1991; Cooper, Folta & Woo, 1995; Johnson & Kuehn, 1987; Pineda *et al.*, 1998). The primary findings of these studies have been that entrepreneurs tend to place greater emphasis on search than managers. Further, the choice of an information source is influenced by the type of decision facing the entrepreneur (e.g. external sources are more heavily utilized when making product-related decisions). This has been argued to be due both to the experience and ability of entrepreneurs in identifying opportunities, but also to the fact that entrepreneurs often do not have the same extent of information systems as managers in established businesses.

The preceding discussion has provided a review of some of the key research as relating to the concept of search and outlined the wide variety of search characteristics that have been defined and utilized in past studies. Additional discussion of several concepts that are related to search can also be found in Appendix I. It should be clear at

this point that the literatures outlined above utilize slightly different conceptualizations of search. Differences exist in terms of the objective of search, the level of analysis, the measurement of search, and the type of individuals that are doing the searching. Research in the economics literature and the innovation literature tend to focus on search at the organization level of analysis, with R&D spending as a common measure of search – whether measured or mathematically modeled (e.g. Greve, 2003; Reinganum, 1982). With reference to the specific types of employees that conduct search within the organization, these sets of literature typically refer to scientists, technologist, and other knowledge workers. The decision-making literature on the other hand focuses more on an individual level of analysis, and in particular, on the search activities of managers. The objective of search in this literature is mainly to assist in effective decision making through alternatives generation (e.g. Nutt, 1993). A summary of these observations can be found in Table 1. These differences aside, there is a certain degree of commonality across the above mentioned studies. The following discussion pulls together several common threads from previous research in order to describe the key characteristics of search.

Characteristics of Search

Given the different objectives and outcomes of search in the various literatures outlined above, previous research has not detailed the characteristics of search behavior – especially as it relates to managers and their role in influencing organizational performance. This dissertation attempts to rectify this shortcoming by focusing on the key set of characteristics for search based on the literature outlined above. To do this, the search behaviors of managers were first categorized into two choice sets – terrain and

process. Search terrain is the domain of knowledge sources that may provide the information (e.g. solution alternatives) that may satisfy the reason for the search. Search process is concerned with the use of the terrain and the way in which the search is conducted.

The distinction between terrain and process is implicit in the literature relating to information acquisition. Dollinger points to the importance of "the manner in which the individual processes information and the choice of which information to process" (1984: 353). Fredrickson and Mitchell (1984) examine comprehensiveness as a construct in decision making that is comprised both of the range of alternatives considered and the intensity with which these alternatives are sought out and evaluated. Barringer and Bluedorn's (1999) scanning intensity scale was comprised of two parts – the first assessed scanning effort, the second assessed the range of areas in which scanning occurred. Nelson and Winter's (1982) examination of organizational search distinguishes between the "topography over which search proceeds and the decision rules guiding the level and direction of search", also known as search strategy (Nelson & Winter, 1982: 247). These examples notwithstanding, it should be intuitively obvious that any information gathering process is comprised both of where you look and how you look.

Search Terrain

Terrain choices include the *scope* of sources in the search space, the relative *distance* between the searcher and the targeted information, the *familiarity* of the targeted information to the searcher, and the emphasis placed on *market vs. resource* information.

Scope. The scope of the search terrain is characterized by the range of information sources that may be utilized by a searcher. Research in decision making (e.g.

O'Reilly, 1982), boundary spanning (e.g. Dollinger, 1984), and entrepreneurship (e.g. Kaish & Gilad, 1991) suggest a wide variety of information sources of potential importance to a searcher. From this literature, a set of sub-categories of information sources was developed: sources within the organization (top-manager, managers, non-managers, consultants); sources outside the organization but within the industry (suppliers, customers, alliance partners, competitors); and sources outside the industry (government contacts, university contacts, investors, others). Encompassed within this classification is the notion that information sources may be either personal/verbal or impersonal/non-verbal (Aguilar, 1967; Kaish & Gilad, 1991).

Distance. The distance in the search terrain refers to the relative location of information sources utilized as compared to the location of the searcher. The underlying assumption is that more 'distant' information sources contain novel information not presently contained in the searcher's mental models (Gavetti & Levinthal, 2000; Katila, 2002; Rosenkopf & Nerkar, 2001). An increase in distance is therefore signified by the use of sources first outside of the organization's boundary, and then going outside of the industry boundary.

Familiarity. Familiarity in the search terrain refers to the degree to which information sources have been previously utilized before the current search, or the degree to which an information source can be considered as an 'old' versus a 'new' source. The characteristic of familiarity in search is suggested by innovation research that has looked at the differing effects of old versus new knowledge on firm innovation (e.g. Katila, 2002; Katila & Ahuja, 2002). This distinction is also reflective of March's (1991) exploration versus exploitation, where there are both positive and negative effects of

using familiar and unfamiliar information, and the challenge of balancing an appropriate mix of the two. Use of old/familiar information is less risky and more reliable, but can lead to rigidity or limits to improvement along a given developmental trajectory. Use of new/unfamiliar information can enrich knowledge and lead to new useful combinations of knowledge. However, this brings with it the cost of integrating different knowledge, which may not be reliably and effectively used for innovative outcomes. Research has also suggested that the previous use of an information source increases the perception of the sources availability, thereby leading to increased use of the source independent of the appropriateness of the source (March & Simon, 1958; O'Reilly, 1982).

Market/Resource. Although the scanning literature has to a limited extent investigated the importance of internal scanning and external scanning (e.g. Garg *et al.*, 2003), this examination has highlighted the importance of two different types of information – market versus resource information. Garg *et al.* (2003) specifically focused on CEO attention to task sectors in the external environment, those that relate to customers, competitors, and technology (see also Daft *et al.*, 1988). Internal scanning was argued to focus on innovation capabilities within the organization, those that relate to product R&D, market research, and basic engineering. This distinction between market and resource knowledge was also described in Abernathy and Clark's (1985) 'transilience' map, which specified the different market versus resource competencies that are the 'competitive ingredients' for determining features of an innovation and thus its appeal in the marketplace. Both market and resource knowledge are therefore required for a firm to pursue innovation (cf. Ardichvili, Cordozo, & Ray, 2003). Market knowledge enables a firm to better assess the commercial potential of its innovative

actions; resource knowledge (sometimes referred to as technological knowledge) enables a firm to respond to market demand, determine the optimal design of an innovation, and optimize its functionality, cost, and reliability (Wiklund & Shepherd, 2003). Both market and resource knowledge are therefore important knowledge-based resources that allow firms to discover and exploit opportunities (Ardichvili *et al.*, 2003; Wiklund & Shepherd, 2003).

Search Process

Characteristics of the search process relate to the intensity of *effort* and the *persistence* with which search is conducted, and the degree to which search is either *adaptive* or *formal* in its examination of the search terrain.

Effort. The degree of effort exhibited by a searcher reflects the time and energy devoted to search versus other activities that demand the searcher's attention, and stems from the extent to which aspirations are not being met (March & Simon, 1958; Cyert & March, 1963). The greater the shortfall between current or projected outcomes and the aspirations of the searcher, the more they are assumed to exert effort in the search process.

Persistence. While related to effort in the sense that it is reflective of a searcher's motivation to search, persistence refers to the degree to which a searcher continues to gather information despite the number of alternatives that have been found, in order to be exhaustive in determining the optimal alternative. Persistence is therefore affected by the extent to which a searcher will satisfice with a limited set of alternatives. In the economics literature, the issue of bounded rationality is argued to affect search. For instance, Kohn and Shavell (1974) argue for the existence of a 'switchpoint' where once

the utility of the best option discovered exceeds the expected utility of the searcher, the search will end. The existence of other options is of no concern, in that the costs of persisting with the search increases dramatically once the searcher reaches some level of satisfaction with what has been found. These arguments are supported by empirical research that has shown that individuals search only for sufficient information to allow them to deal with a problem as opposed to as much information as possible (e.g. Dukerich & Nichols, 1991).

Adaptive. Adaptation in the search process refers to the extent to which a searcher revisits past information sources (i.e. iterative) or changes direction on the search terrain based upon reflection or what has been learnt as the search continues. This builds upon the notion that search can switch from a first-order response to a second-order response as a searcher learns what is reasonable to expect by observing what has been achieved (Levinthal & March, 1981). Cyert and March (1963) postulate that adaptation in search rules will occur when a solution cannot be found by searching in manner that was successful in the past. This is similar to Nutt's (1993) observation that search can be cyclical – an initial search identifies available ideas, and subsequent searches are carried out to expand on this knowledge. The importance of rapid iteration for building understanding and creating multiple options in fast product development was also highlighted by Eisenhardt and Tabrizi (1995) in their examination of adaptive processes in the global computer industry.

Formal. Formal search processes are those that are more sequential, following set protocols or routines. The notion of formality in a search process is reflective of Cyert and March's (1963) conceptualization of search as being simple-minded and biased.

When searching in a particular way leads to the successful discovery of a solution, this method of search is likely to be used again in future circumstances. While formality in the search process may reflect the reuse of a past successful search process (cf. Nutt's [1993] template tactics), formality may also be viewed as a more rigid response to a situation in which the searcher is not knowledgeable with respect to the terrain that is being searched (Barrick & Spilker, 2003).

As demonstrated above, the characteristics of search have been examined in some form throughout search literature. However, there has been no explicit discussion of these characteristics or their use within a single framework. Table 1 provides a summary of search characteristics throughout this literature as a foundation for the development of a model of executive information search in the following chapter.

Table 1: Search in Various Literatures

	Economics	Decision-Making	Innovation	Entrepreneurship	Cognition
Objective	Optimal search strategy	Effective decisions	New Products; Knowledge Acquisition	Information on opportunities, effective decision-making	Effective decisions; Innovation adoption
Characteristics	**Persistence; Adaptive; Distance;** systematic search **(related to Formality)**	**Scope** of sources; Intensity of **Effort; Adaptive; Formality**	Local search (related to **Distance**), search depth (related to **Familiarity**), search scope	Breadth (**Scope**) of sources; Intensity of **Effort**	'on-line' vs. 'off-line' (related to **Adaptive**)
Research Methodology	Mathematical Models; Simulations	Case Studies	Archival (e.g. patent filings & citations)	Surveys	Simulations; Archival
Level of Analysis	Organization, Individual	Top Managers (Individuals)	Organization	Entrepreneurs (Individuals)	Organization

Note: Search characteristics emphasized in this dissertation are in bold.

CHAPTER 3: A MODEL OF EXECUTIVE INFORMATION SEARCH

This chapter draws upon the previous review of the search literature to develop one plausible model of search as it pertains to managerial information gathering activities and innovation. As an investigation of search at the level of detail proposed in this research has not been attempted before, this model should be viewed as a preliminary investigation into the importance and characteristics of search from a managerial perspective.

Executive Information Search

In order to highlight the importance of search activities to the top managers of an organization, I define executive information search as a focused information gathering activity that allows a manager to identify novel ideas and generate solutions to problems in order to ensure the successful operation of the organization. Referring to this concept as 'executive' implies that the function of such search activities is for the maintenance of the organization as described by Barnard (1938) and thus excludes search that may occur as part of the interpersonal activities of managers as outlined by Mintzberg (1973).

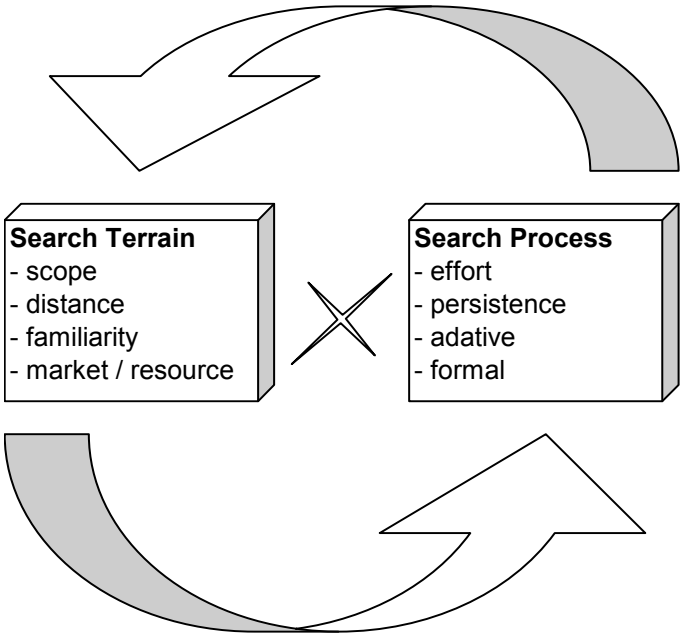
Defining executive information search in this way also provides an indication of the level of analysis in question. In contrast to research that has investigated search at an organizational level of analysis, it is important to recognize that search as an information gathering activity is fundamentally an individual level phenomenon. Information is not useful unless it leads to the creation of new knowledge (e.g. Kogut & Zander, 1992; Nonaka, 1994). The creation of knowledge out of information is dependent upon the commitments and beliefs of the individual receiving the information (Nonaka, 1994). For a manager to acquire knowledge through search, he/she must be exposed to information

assessed as being valuable and which can inform future actions. This is essentially a learning process in which a manager's capacity to take effective future action is enhanced. As such, executive information search is viewed as an individual level construct in which managers place themselves in a flow of information that is anticipated to have an impact on their stock of knowledge (Nonaka, 1994).

It is also noted that executive information search includes both notions of problemistic search (which focuses on search as a response to problem stimulus - Cyert & March, 1963, see Mintzberg's [1973] disturbance handler role) and opportunistic search (which focuses on seeking out new opportunities and executing a controlled organizational change – Carter, 1971 see Mintzberg's [1973] entrepreneurial role).

Based on the review of the search literature outlined in the previous chapter, I develop the concept of executive information search to specifically reference the search behaviors of managers. This level of specificity is useful for distinguishing the objective of this research from the various other ways in which search has been conceptualized and measured. However, the basic activity of search should be the same, and therefore the characteristics of search developed previously are just as applicable when dealing with the search activities of managers. I therefore propose the following model of executive information search that depicts the relationship of the terrain and process dimensions of search and their characteristics (see Figure 1).

Figure 1: Model of Executive Information Search



The basic message of this model is that the dimensions of search terrain and process are intricately interrelated. The dimensions of search form a *gestalt* – an integrated whole which can be used to describe any search process as it varies along the key characteristics of search. Furthermore, both prior and present search experiences of managers are likely to reinforce (or diminish) behavior along either dimension, making it difficult to distinguish the interrelationships between characteristics (cf. Gavetti & Levinthal, 2000). Such a model naturally lends itself to any number of conceptualizations in terms of interactions between the variables. For simplicity however, each characteristic will be dealt with individually in Chapter 4 in order to provide some indication of the relative importance of these variables.

Top Management Team Search Integration Capability

While I argue that executive information search is fundamentally an individual-level activity, there are several reasons why this dissertation examines search at the level

of the top management team. First, research suggests that there is specialization in information gathering roles given that different task requirements and information needs necessitate specialization (Hambrick, 1981; Tushman, 1977). Individuals are subject to cognitive limitations that cause them to selectively attend to information related to their prior knowledge and experience (e.g. Cyert & March, 1963; Dearborn & Simon, 1958; Simon, 1957). It therefore follows that specialization in information search will also occur due to differences between the backgrounds and experiences of members of top management teams.

Second, beginning with search as an individual-level activity follows from the assumption that the innovation process begins with individuals, but is fostered through interaction processes in teams (Mumford & Gustafson, 1988). If search is an individual activity, and is a contributor to the knowledge that allows top managers to identify and evaluate innovation opportunities, then it should contribute to the cognitive diversity of a top management team. Such diversity is likely to translate into "a greater variety of perspectives being brought to bear on decisions and, thereby, increases the likelihood of creative and innovative solutions to problems" (Milliken & Martins, 1996: 412). Additionally, the search activities of individual managers may yield information that complements or even compensates for information (or lack thereof) brought by another top management team member. It is the sharing of this knowledge that allows the top management team as a whole to make decisions that affect organizational outcomes (cf. LePine, 2003).

Finally, the objective of this dissertation is to examine the link between search and organizational innovation. An examination of search in top management teams is

therefore appropriate given that such teams influence organizational outcomes through strategic decision making (Hambrick & Mason, 1984). Executive information search within a top management team allows for the generation of ideas and alternatives to problems facing the organization, or may cause the recognition of strategic opportunities which the organization can pursue (Nutt, 1993; Denrell, *et al.*, 2003).

When viewed at the level of the top management team, search has the potential to lead to new knowledge to the extent that information is assimilated within the team. The ability to discern and use new knowledge for innovative purposes may be affected by an individual's cognitive biases, limited perspectives, and perhaps faulty thinking patterns (Pinchot, 1985). However, assimilating multiple insights and ideas from individual search processes may allow a top management team to recognize the value of information gathered through search. Building on research on knowledge transfer and information processing, I argue that one requirement for successful innovative action based on the creation of new knowledge through search concerns the extent to which top managers can overcome the fragmentation of knowledge introduced through their individual search behavior, i.e. their search integration capability.

The importance of search integration capability was alluded to as early as Aguilar's (1967) seminal work on executive scanning. Aguilar noted that a major problem of information gathering activities was 'fractionalization'. This problem was manifested in two ways:

> (1) in the failure of individuals and units to gather reasonably accessible information that was important for others in their organization; and (2) in the failure of decision-makers to receive relevant information *already* residing in the company. (1967: 184, italics in the original)

Several other researchers have since investigated this problem. As an organizational level capability, Grant (1996) outlined the importance of knowledge integration for establishing competitive advantage in dynamic markets. Arguments to this effect were built on the underlying assumption that efficient knowledge acquisition requires that individuals specialize in specific areas of knowledge, while the application of this knowledge to innovation requires the combination of many areas of specialized knowledge. These arguments were echoed by Carlile and Rebentisch (2003) who expanded on the notion of the dependence among members of an organization in utilizing knowledge – especially in novel circumstances. While primarily examined at an organizational level (e.g. Grant, 1996; Zahra, Ireland, & Hitt, 2000), knowledge integration can also be applied at the group level (e.g. Okhuysen & Eisenhardt, 2002). Top management teams are a particularly salient group for knowledge integration concerns given that such groups represent different business functions and who must make collective choices concerning the strategic direction of their business (Eisenhardt, 1989).

Several studies have also pointed to the importance of knowledge integration as a key capability in top management teams. McGrath, Macmillan and Venkataraman (1995) argue that one antecedent to competence development is deftness. Deftness is defined as a "joint activity in which organizational members know what action a situation requires, can anticipate what parts of that action can be done by others and trust them to do it, and are willing to do their part" (McGrath, 2001: 123). Deftness relates more to a group process characterized by 'heedful relating' (Weick & Roberts, 1993) that allows individuals to act interdependently and heedfully to produce reliable results.

Thomas and McDaniel (1990) demonstrated empirical support for a positive relationship between information processing capacity in top management teams and data search. Teams with high levels of participation, interaction, and flexibility were more active or mindful in information processing and were less likely to succumb to cognitive simplification and less vulnerable to information overload (Mintzberg, 1983). Further, of particular importance to the boundary spanning-performance relationship is the information processing capability of managers. As boundary spanning intensity increases, so too must information processing capability for there to be a positive impact on organizational performance (Dollinger, 1984). With respect to team innovation, several studies have argued that high levels of team interaction and participation leads to a cross-fertilization of perspectives that can lead to creativity and innovation (e.g. Mumford & Gustafson, 1988; West & Anderson, 1996).

Characteristics such as high levels of participation and interaction contribute to the information processing ability of a top management team and help to foster extensive use of information (Daft & Lengel, 1986). Similarly, the extent to which individuals can act interdependently within an innovation context has been shown to have a strong association with group performance outcomes (McGrath, MacMillan, & Venkataraman, 1995; McGrath, Tsai, Venkataraman, & MacMillan, 1996). Search integration, in which members of the top management team interact with one another to discuss individual search activities, participate in reflective thinking about search outcomes, or utilize feedback to guide search efforts should enable TMT members to draw upon the search activities of one another, process the variety of information being collected within the group, and better enable the TMT to apply search activities towards an innovative

outcome. The search integration capability of a top management team is therefore conceptualized as a group-level construct that is a key component of the group process involved in drawing upon the individual knowledge and experiences of individual TMT members in order to result in an organizational innovation.

Organizational Innovation

Executive information search can be viewed as a mechanism through which managers can progressively eliminate or absorb uncertainty resulting from environmental uncertainty (cf. March & Simon, 1958; Thompson, 1967). Information gathered through search can be utilized to foster the certainty that facilities efficiency or 'technical rationality' at the technical core of an organization (Thompson, 1967). Essentially, once a manager recognizes a problem (or an opportunity) in the environment, the importance of the event is assessed, alternatives are generated and a solution is selected for implementation (Lyles & Schwenk, 1992; Mintzberg *et al.*, 1973; Nutt, 1984; 1993). Managers then communicate this decision to others in the organization, thus influencing changes in organizational knowledge and the pursuit of innovation (Lyles & Schwenk, 1992; Lenox & King, 2004).

Innovation is defined as the successful production or adoption of useful ideas and idea implementation, where ideas can relate to products, processes, or administrative systems that are new to the adopting organization (Amabile, 1988, 1997; Damanpour, 1991; Kanter, 1988; Van de Ven, 1986). Innovation provides an important means by which firms diversify, adapt, and renew themselves to fit with changing environmental conditions (Schoonhoven, Eisenhardt & Lyman, 1990). Innovation is also an essential ingredient in a firm's ability to differentiate its product(s), and thus a potential source of

competitive advantage (Brown & Eisenhardt, 1995). As such, an organization's innovative capabilities have been linked to organizational effectiveness, profitability, and long-term survival (e.g. Ancona & Caldwell, 1987; Banbury & Mitchell, 1995; Woodman, Sawyer & Griffin, 1993). The effect that top management teams have on stimulating organizational innovation is therefore of great concern.

Top Management Influence on Organizational Innovation

There have been a number of studies that have demonstrated the impact of top managers on organizational innovation, some of which highlight the importance of the TMT above both organizational and environmental factors (e.g. Hoffman & Hegarty, 1993). There has also been some indication that top management team characteristics have greater predictive power over CEO characteristics alone (e.g. Bantel & Jackson, 1989). This section provides an overview of some of this work, differentiating the impact that top managers may have on innovation in terms of two general stages of the innovation process within organizations.

While the process of innovation is complex, and has been viewed as either non-linear (Schroeder, Van de Ven, Scudder, & Polley, 1989), random (Mezias & Glynn, 1993), or chaotic (Koput, 1997), a common, simplistic view of the innovation process identifies two distinct stages – initiation and implementation (Damanpour, 1991). The initiation stage is concerned with "all activities pertaining to problem perception, *information gathering*, attitude formation and evaluation, and resource attainment leading to the decision to adopt [an innovation]" (Damanpour, 1991: 562, italics added). In the initiation stage, research has demonstrated the importance of management's decisions to promote innovation and to direct attention and behavior in the innovation process (e.g.

Daft, 1978; McGrath, 2001; Van de Ven, 1986). For example, management sets the technology policy (i.e. the degree to which the firm aggressively pursues innovation) which has important implications for organizational innovation (Ettlie & Bridges, 1987; Lefebvre, Mason, & Lefebvre, 1997). Research has also shown that the ideas expressed by organizational leaders have a significant effect on organizational innovation. Blau and McKinley's (1979) examination of innovation in architectural firms showed that ideas expressed by management in the form of 'work motifs' had a significant impact on fostering innovation.

The implementation stage is concerned with the commitment of resources to an innovation, modifications to the organization, and the use of an innovation. In the implementation stage, management has a significant impact on organizational innovation through decisions relating to their commitment to innovation. Commitment to innovation may be defined as "managerial willingness to allocate resources and champion activities that lead to the development of new products, technologies, and processes consistent with marketplace opportunities" (Hitt, Hoskisson & Ireland, 1990: 29). Research has shown that while the allocation of resources to an innovation project is important, the championing of an innovation improves the performance of the project, facilitating navigation of the political forces within an organization (e.g. Howell & Higgins, 1990; Kessler & Chakrabarti, 1996).

Additionally, research has looked at how the composition of a top management team has an effect on organizational innovation. Hoffman and Hegarty (1993) showed that executives' externally-oriented expertise (marketing and R&D) as well as scanning behavior had a positive impact on product/market innovations ($\Delta R^2 = 0.23$, $p < 0.001$).

In relation to administrative innovations, top managers' general management expertise was the primary top management characteristic to impact this type of innovation. Bantel and Jackson (1989) showed that after controlling for the effects of other predictors of organizational innovation, TMT composition variables such as average educational level and heterogeneity of functional backgrounds had significant positive effects on organizational innovation ($\Delta R^2 = 0.09$, $p < 0.05$). Average education level had a greater impact on technical innovations, while functional heterogeneity had a greater impact on administrative innovations. West and Anderson (1996) also found evidence that the proportion of innovative individuals on a top management team (as measured by self-reports) positively predicted innovation radicalness, and that the larger the team, the more radical the innovations introduced. Taken together, these results indicate that the characteristics of top management teams have a significant impact on organizational innovation, and may further have differing impacts on the type and quality of innovations introduced.

Incremental vs. Radical Innovation

A basic distinction is often made between innovations that are incremental versus innovations that are radical. Radical innovations are those that are new and significant to the focal industry, and which often utilize knowledge or principles that are uncommon in the industry. Radical innovations therefore "advance the price/performance frontier by much more than the existing rate of progress" (Gatignon, Tushman, Smith & Anderson, 2002: 1107). Incremental innovations are those that involve marginal improvements and which typically build upon existing knowledge. Incremental innovations therefore "improve price performance advance at a rate consistent with the existing technical

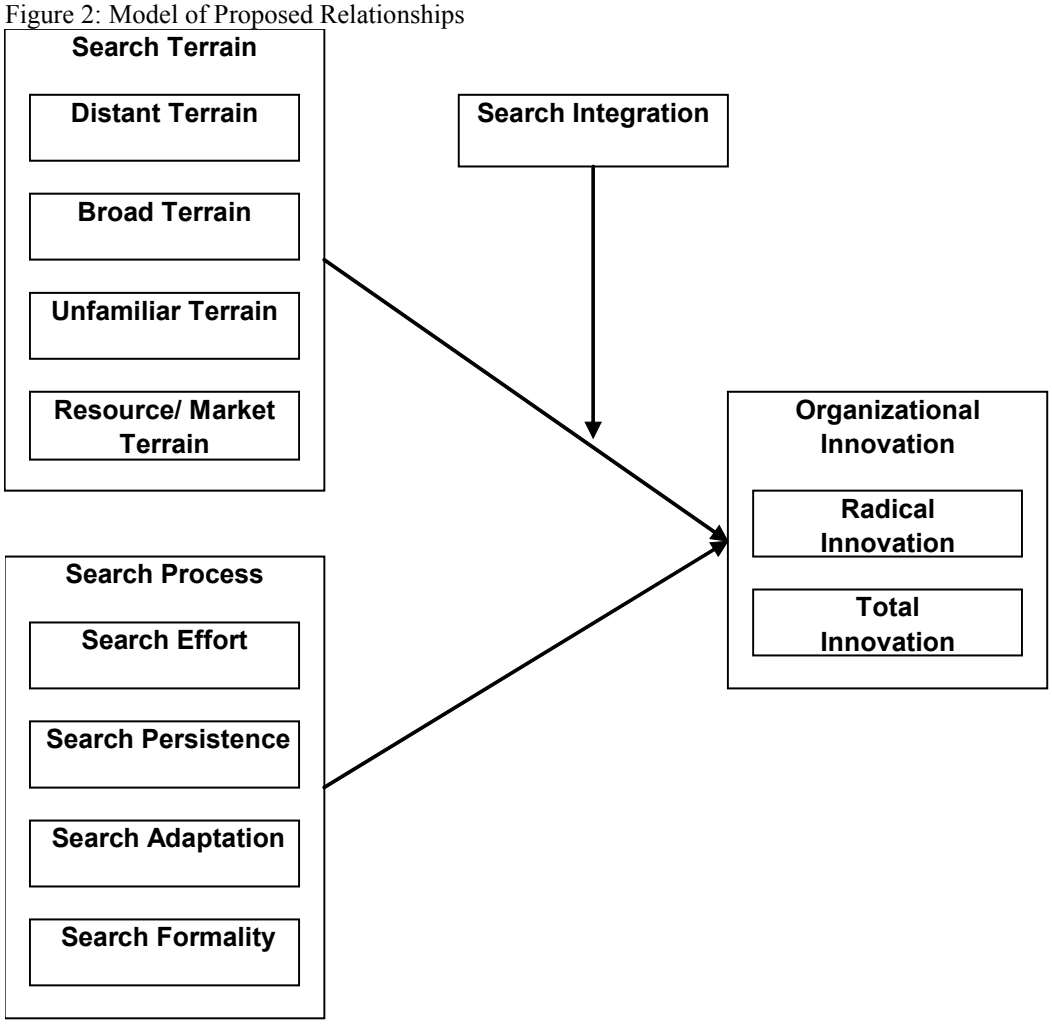
trajectory" (Gatignon *et al.*, 2002: 1107). As discussed by Henderson and Clark (1990), the differences between incremental and radical innovations are quite significant for a firm given that both depend on different organizational capabilities. Further, research has shown that radical innovations enhance market share, market value, and the survival of firms more so than incremental innovations (Gatignon *et al.*, 2002; Mitchell, 1989).

As reviewed previously, search has been shown to have an impact on organizational innovation, both in terms of the total number of innovations and the type of these innovations. The following chapter develops hypotheses that argue for a relationship between executive information search, TMT search integration capability, and innovation.

CHAPTER 4: HYPOTHESIS GENERATION

In this chapter, I develop several hypotheses concerning the relationship between executive information search in top management teams and organizational innovation. I first deal with the impact of the characteristics of the search terrain, followed by the impact of the characteristics of the search process as utilized by a top management team. Further, interactions are hypothesized which argue for the importance of search integration capability in allowing for a TMT's effective utilization of individual managers' search terrain. A model of the proposed relationships is shown in Figure 2.

Figure 2: Model of Proposed Relationships



Search Terrain

In reviewing the literature on scanning, decision-making, and innovation, there does not appear to be a theoretical framework that draws distinctions between the categories of information sources in terms of relationships to performance. However, several studies have shown that differing categories of sources may be utilized to differing degrees depending upon the situation of the decision-maker (e.g. Kaish & Gilad, 1991; O'Reilly, 1982). More generally, extant research in the use of information by managers argues that organizational performance is better when managers receive a diverse range of information from multiple sources (Daft, Sormunen & Parks, 1988). If managers receive a wider range of information, this is more likely to alert them to problems than if their vision were narrower (Kiesler & Sproull, 1982). Managers are also better able to identify opportunities if they scan broadly (Hambrick, 1982).

Research in the decision-making literature has suggested that decision-making comprehensiveness is related to organizational performance (Fredrickson, 1984; Fredrickson & Mitchell, 1984; Simons, Pelled & Smith, 1999). Comprehensiveness can be defined as the "extent to which an organization (or individual) attempts to be exhaustive or inclusive in making and integrating strategic decisions" (Fredrickson & Mitchell, 1984: 402). Similarly, scanning intensity of top management teams has been shown to positively relate to corporate entrepreneurship, where corporate entrepreneurship is reflective of a firm's tendency towards innovation, risk-taking, and proactiveness (Barringer & Bluedorn, 1999). However, while both comprehensiveness and scanning intensity incorporate notions of scope in the information sources utilized,

these measures are confounded with the level of effort or intensity with which information is gathered.

Research into the relative 'distance' between a searcher and information sources has shown a difference between internal and external sources of information. While this dichotomy is the typical focus of research in this area, some studies have shown a difference between external sources that are within a firm's industry (intraindustry sources) and sources that are outside a firm's industry (extraindustry sources).

Dealing first with the internal-external distinction, Smith *et al.* (1991) found that managers with external orientations were more likely to gather a richer array of information than those with internal orientations. However, there is also evidence that use of both internal and external information can contribute to organizational performance (Smith *et al.*, 1988). The literature on organizational learning and technology search are also instructive on the costs and benefits of the distance to an information source. The concept of local search suggests that an entity will search for solutions in the neighborhood of its current expertise or knowledge (e.g. Stuart & Podolny, 1996). Inwardly focused search (local search) has the benefit of allowing a firm to build on existing competencies and can lead to an increase in incremental innovation (e.g. Sorenson & Stuart, 2000). However, this type of search comes at the cost of decreased relevance of such innovations and the possibility of leading a firm into a competency trap (Levitt & March, 1988; Levinthal & March, 1993; Sorenson & Stuart, 2000). On the other hand, firms that span their organizational boundary when pursuing knowledge have been shown to innovate in ways that have a greater impact within their market domain (Rosenkopf & Nerkar, 2001).

Intraindustry information sources facilitate interactions that expose managers to a certain amount of commonality in perceptions (Hambrick, 1982; Spender, 1977). However, extraindustry sources expose managers to more novel information and a greater diversity of perceptions and practices. Such interactions have been noted to allow managers to challenge longstanding beliefs and assumptions, thus allowing for greater innovation (Kimberly & Evanisko, 1981; Rogers, 1983). Given that utilizing intraindustry versus extraindustry information sources affects the extent to which managers make decisions that conform to industry practices (Geletkanycz & Hambrick, 1997), this has implications for organizational legitimacy (Deephouse, 1999), technical efficiency (Meyer & Rowan, 1977), and access to resources (DiMaggio & Powell, 1983) – all of which have an impact on organizational performance. Geletkanycz and Hambrick (1997) provide empirical evidence to suggest that intraindustry sources are more important for firms facing uncertain environments. For firms in high-technology environments were uncertainty is a greater concern, intraindustry sources may prove to be beneficial.

From these past findings, it is difficult to clearly show how scope and distance in information sources can be of benefit to an individual manager. In a given problem situation, an individual manager's cognitive limitations may make it difficult to utilize a wide range of sources (Kiesler & Sproull, 1982; Simon, 1955). However, from the perspective of a top management team, there may be specialization where some managers can utilize some types of information sources that are different from those used by other managers. The team as a whole can therefore gather information from a broad range of sources, which may positively impact awareness of innovation opportunities and inform

decisions that increase organizational performance (cf. Daft *et al.*, 1988; Hambrick, 1982). Diversity in the information sources utilized by a top management team should therefore positively impact the number of innovations that the organization pursues.

Hypothesis 1: *The greater the diversity in the scope of information sources utilized in a top management team's search terrain, the greater the number of organizational innovations.*

Hypothesis 2: *The greater the diversity in the distances of information sources utilized in a top management team's search terrain, the greater the number of organizational innovations.*

Furthermore, prior research has suggested that the search that spans the external boundaries of an organization results in greater non-conformity in the decisions made by top-managers and greater novelty in organizational innovation (e.g. Geletkanycz & Hambrick, 1997; Rosenkopf & Nerkar, 2001; Sorenson & Stuart, 2000). Top management teams that, on average, place greater emphasis on information sources that are external to the firm, should therefore introduce more radical organizational innovations.

Hypothesis 3: *The greater the average use of external information in a top management team's search terrain, the greater the introduction of radical organizational innovations.*

The innovation literature provides evidence of the benefits of exploring new and unfamiliar knowledge bases. Searching in unfamiliar territory has been shown to

positively affect the number of innovations discovered (e.g. Katila & Ahuja, 2002), as well as the extent to which new innovations are considered radical (e.g. Rosenkopf & Nerkar, 2001). Managers that are not biased to search only within familiar areas are therefore more likely to discover useful information that is suggestive of opportunities for innovation. Through combining information from a number of different knowledge domains, a manager may gain insight into new and useful innovations. Such innovations are also more likely to have a wide ranging impact both within and outside of the firm's current market, depending upon the extent to which knowledge domains are spanned (Rosenkopf & Nerkar, 2001).

While unfamiliarity in the search terrain may expose managers to novel information that may suggest new innovations, this is an inherently uncertain and risky choice if the terrain becomes too unfamiliar. In fact, in order to absorb or interpret the importance of new information, managers must typically begin with some basic understanding of this information (Cohen & Levinthal, 1990). As managers depart from familiar knowledge domains, difficulties may arise due to reduced applicability of their schema[1]. As such, their appreciation for the value of unfamiliar information is reduced (Fiske & Taylor, 1991), and the less likely that the search will prove fruitful (cf. Cooper, Folta & Woo, 1995). Individuals are also limited in their ability to process information (Simon, 1955). Therefore, as they are exposed to new and unfamiliar information they will reach a point beyond which they will be unable to process the information effectively.

[1] Schema may be defined as cognitive structures that influence the encoding of new information (Fiske & Taylor, 1991).

Given that too much unfamiliar information may have a negative impact on an individual manager's ability to recognize and pursue an innovation, there should be a balance in the search for new versus old information (March, 1991). A top management team that has some variability in terms of information familiarity may therefore better exploit this information through the combination and exchange of this information (Nahapiet & Ghoshal, 1998). However, high levels of unfamiliarity may lead to a greater difficulty in processing such information, and thus reduce the number of ideas and alternatives generated by the top management team. Further, given the need for prior knowledge as a precursor to some basic understanding of unfamiliar information, too much unfamiliar information may prevent the effective sharing of information and ideas among top management team members. Stated formally:

Hypothesis 4: *There will be a curvilinear (inverted-U) relationship between the average emphasis placed on unfamiliar search terrain by members of a top management team and the introduction of radical organizational innovations.*

Wiklund and Shepherd (2003) provide empirical evidence that firm performance is positively related to the bundle of knowledge-based resources available to the firm. In their study, knowledge-based resources are defined to include both market knowledge and technological knowledge. The arguments presented state that both types of knowledge affect firm performance as they increase the ability of a firm to discover and exploit opportunities (i.e. to innovate). Market knowledge provides awareness of consumer problems and allows managers to better assess the value of new technologies, and has been shown to affect the discovery of innovative solutions (e.g. Shane, 2000).

Technological knowledge can lead to breakthroughs, as well as allowing a firm to determine optimal configurations of an innovation (e.g. in terms of functionality, features, cost, reliability, etc.). Technological knowledge also allows a firm to respond quickly to its competitors (Cohen & Levinthal, 1990; Greve, 2003). Rice *et al.* (2001) also suggest that managers are important in recognizing opportunities for firms to pursue given that they have the market knowledge to realize the value in technical insights developed by firm technologists.

Bringing both market and resource information into the top management team should therefore increase the number of innovation opportunities recognized by the top management team. Therefore, top management teams which have diversity in the extent to which individual members bring information either emphasizing market or resource knowledge, should be able to recognize more opportunities and thereby have a positive impact on the number of organizational innovations.

Hypothesis 5: *The greater the diversity in resource versus market information emphasis in a top management team's search terrain, the greater the number of organizational innovations.*

An underlying assumption for the above five hypotheses has been that the top management team can effectively integrate diverse information and apply this in the form of decisions concerning organizational innovation. As discussed earlier, this capability should depend upon the ability of the top management team to integrate their search activities.

Research in the scanning and information processing literatures has shown that an effective information-processing structure in top management teams is an important

factor to consider in the utilization of information, preventing information overload and high levels of nonproductive stress (Dollinger, 1984; Thomas & McDaniel, 1990; Mintzberg, 1983). In the teams literature, group processes that facilitate information sharing are argued to contribute to more effective group outcomes (e.g. Taggar, 2002; Woodman *et al.*, 1993).

Hollenbeck and colleagues' (1995) multilevel model provides an outline of how individuals can contribute to effective decision-making in a hierarchical team with distributed expertise. Such a team is characterized by one individual that has greater authority than other members of the team (e.g. the CEO) and that each member of the team brings different amounts of knowledge and information to the team (e.g. TMT members with different functional backgrounds). One proposition put forward in this model is that in situations where the entire team is focused on addressing a common problem, decision making accuracy for well-informed teams will be higher than for poorly informed teams. Executive information search may be viewed as the mechanism by which individual executives gather the information needed to inform their contribution to the team's decision making process. Search integration capability then becomes important in order for the information gathered by individual top managers to be shared with the team and thus contribute to the situation at hand. In other words, search occurs at the individual level, but through interaction in a common decision making process, individual executives' contributions can inform a strategic outcome.

Taggar's (2002) investigation of individual- and group-creativity demonstrated that the creativity of a team is affected not just be the creativity of its individual members, but also by the presence of team creativity relevant processes. Several aspects

of this study are informative in a search context given that creativity is defined as the production of useful and novel ideas (of which search may be seen as a contributor), whereas innovation is defined as the successful implementation of creative ideas within an organization (Amabile *et al.*, 1996). Taggar proposed and found evidence of the importance of team processes such as 'effective communication' and 'informing others' which provided an indication of how group members support each other's creativity. These findings support the notion that the effective use of individual contributions to the innovation process is influenced by the level of information sharing within the group (Woodman, Sawyer & Griffin, 1993).

Search integration capability is conceptualized to operate in a similar way, allowing the top management team to effectively utilize diverse information gathered through individual search activities through participation and interaction. Search integration capability will thereby moderate the relationship between the information gathering activities by top management team members and organizational innovation, allowing for higher levels of innovation when this capability is stronger.

Hypothesis 6: *Organizational innovation will be an interactive function of the diversity in (a) the scope, (b) the distance, and (c) market/resource emphasis in a top management team's search terrain and its search integration capability, in such a way that the relationship between top management team search terrain characteristics and the number of organizational innovations will be stronger when there is a high level of search integration capability.*

Hypothesis 7: *Introduction of radical innovation will be an interactive function of the (a) external emphasis, and (b) unfamiliarity in a top management team's search terrain, and its search integration capability, in such a way that the relationship between top management team search terrain characteristics and the number of organizational innovations will be stronger when there is a high level of search integration capability.*

Search Process

While the preceding section presents arguments for the importance of information sources for a top management team, this only addresses the question of what type of information sources are important for organizational innovation. The actual process through which these sources are utilized is also an important consideration.

As suggested in the decision making literature, the amount of effort or intensity in the decision making process has implications for making effective decisions (Fredrickson, 1984; Fredrickson & Mitchell, 1984). Especially when faced with an uncertain environment, managers require information in order to determine the best strategies to pursue. Intensity in information gathering has been shown to positively affect financial performance (Dollinger, 1984). Taking R&D intensity as reflective of the emphasis and therefore effort placed on the search process, research in the technology search literature has also shown a positive relationship between effort and innovation (e.g. Cohen, 1995; Greve, 2003).

Search theory would suggest that the greater the aspirations of the searcher, the greater their motivation to search for solutions to the challenges that they are facing. Similarly, expectancy theorists (e.g. Vroom, 1964) would suggest that the more the

individual values an outcome, the greater the effort they will expend to achieve the desired outcome. Search effort should therefore be related to how motivated managers are to solve a given problem. The greater the motivation of top managers to pursue search, the greater their attention will be focused on acquiring new knowledge. The downside to greater attention to search is that over-emphasizing the search for new innovation opportunities may detract from a focus on developing and exploiting existing innovation in the organization (e.g. Koput, 1997; Rivkin & Siggelkow, 2003). Ancona and Caldwell's (1992) examination of team 'scouting' activities (a form of information gathering) was negatively related to team performance when there was prolonged scouting activity. This finding was argued to be due to 'analysis paralysis' were teams became too caught up in information gathering and did not put the information to use. Further, given human limitations in information processing ability, the greater the amount of information that a manager has to process, the less likely they will be able to do so in an effective manner, eventually resulting in a decline in decision making performance (O'Reilly, 1980; Simon, 1955). Excessive search effort is therefore likely to have a negative impact on the innovative performance of an organization.

Hypothesis 8: *The average level of search effort in a top management team will have a curvilinear (inverted-U) relationship with the number of organizational innovations.*

A common theme in the search literatures in economics, decision-making and innovation concerns the limits to rationality of searchers. Searchers are predicted to satisfice with less than complete information (Cyert & March, 1963; Kohn & Shavell, 1974). The extent to which this impacts search is therefore of concern for generating

decision alternatives and selecting the best solution to a given problem. Schwenk (1984) offers several biases that may result from this limitation of searchers. For example, a searcher may tend to over-value favored alternatives or make more negative inferences about less-favored alternatives. However, of the greatest concern is the extent to which a searcher stops the search process after finding a single solution. This simplification may therefore exclude other possibilities and may therefore result in a sub-optimal outcome. A poor choice has implications for firm performance but also for the selection of an idea that after further evaluation does not lead to an innovation.

Research into the strategic decision making process has examined the importance of procedural rationality (e.g. Dean & Sharfman, 1993; 1996). Procedural rationality reflects the extent to which managers desire to make the best decision possible and involves how extensive managers are in the gathering of information relevant to a decision. This extensiveness indicates the level of persistence with which the search is conducted, and has implication for the effectiveness of the final decision (Dean & Sharfman, 1996). Nutt (1993) also showed that single searches, those that stopped after only one round of information gathering, had poor sustained rates of idea adoption (i.e. the identified idea was rejected after a period of time). Top managers that are more persistent with their search processes are therefore predicted to do a better job of making optimal decisions and selecting ideas and alternatives that will lead to organizational innovation. Top management teams that are, on average, comprised of top managers that are more persistent in their search processes will therefore result in a greater number of organizational innovations.

Hypothesis 9: *The greater the average level of persistence in search by members of a top management team, the greater the number of organizational innovations.*

The process of search may be viewed as involving two iterative efforts (Carlile & Rebentisch, 2003). The first is the identification of potentially useful knowledge sources, and the second is the assessment of the value of the source identified. Indeed, the search terrain may evolve over time as the assessment of each source suggests other useful sources to be targeted. The increasing complexity of the search that results is reflective of the adaptability of the searcher to previous experience and a potential reframing or more accurate understanding of the issue stimulating the search. If, however, the searcher adheres to formal routines or set protocol, there is less likelihood that they will adapt to changing circumstances. On the other hand, search which is more iterative in the sense that there is less of an emphasis on sequential, systematic and complete examination of elements in the search terrain, has greater potential to be adaptive. Research in decision-making suggests that more-knowledgeable decision makers should follow less sequential search strategies than less-knowledgeable decision makers (Barrick & Spilker, 2003). This should allow for faster gathering of relevant information as the searcher does not spend time with irrelevant information. Decision making performance is therefore likely to improve given better access to relevant information.

Search that is more sequential and less adaptive is also better suited for improving efficiency in a given area. A more sequential search should therefore allow for more complete gathering of information on a given issue as it is constrained to the neighborhood of the problem symptom or the current alternative (Cyert & March, 1963).

This method of search should therefore result in refinements to existing technology, thus leading to more incremental forms of innovation. Formal search should therefore have a greater effect on total innovation as it leads to the introduction of innovations that are more closely aligned to previous innovations.

In contrast, an adaptive search process is more suited to learning about new ideas and will be more likely to lead to innovative ideas (Nutt, 1993). Adaptiveness makes judgment concerning effective decisions easier, since comparing alternatives strengths and weaknesses becomes easier (Eisenhardt, 1989). Adaptiveness also improves cognitive ability to shift with new information, reducing attachment to one particular alternative in light of changing conditions (Eisenhardt, 1989). Greater adaptation in search is therefore conducive to flexibility and the ability to change direction from areas of the search terrain which may not be relevant to the problem stimulus. Search adaptation is therefore hypothesized to have a positive effect on the introduction of radical organizational innovation, while search formality is hypothesized to have a greater effect on total innovation.

Hypothesis 10: The greater the average level of search formality in a top management team, the greater the number of organizational innovations.

Hypothesis 11: The greater the average level of search adaptation in a top management team, the greater the introduction of radical organizational innovation.

CHAPTER 5: RESEARCH METHOD

This research was conducted as part of a larger study funded by the National Science Foundation and involved four PhD students and two faculty members at the University of Maryland and one faculty member at Stanford University.

A variety of methods were used to collect the data: (1) semi-structured interviews with CEOs; (2) in-depth questionnaires completed by CEOs and members of the top management team; and (3) publicly available data (e.g. annual reports, SEC filings). The use of these three methods contributed to the strength of this study, and was important for several reasons.

The use of the CEO interviews conferred several advantages. First, they allowed the researcher to more fully explain the goals of the research and obtain the CEO's approval and endorsement of the study, thus gaining access to other individuals in the companies in the sample. Second, these interviews allowed the researcher to identify the TMT members to be surveyed thus more closely approximating Cyert and March's (1963) notion of the dominant coalition (cf. Pettigrew, 1992) as opposed to Hambrick and Mason's (1984) suggestion that the use of executive titles indicate team membership. Finally, the interviews provided the opportunity to collect information on organizational innovation in order to determine a measure of this study's dependent variable.

One of the 'selling points' to gain access to CEOs was that the amount of their time required would be minimal. Several CEOs expressed concern about giving up time in their busy schedules. As a concern that was noted from the conceptual stages of this project, the use of other methods to collect necessary data addressed this concern. Financial data on each company was collected from publicly available data, so as to

allow the other instruments to focus on the main variables of interest. The surveys, which were all completed after the corresponding CEO interviews, allowed for the collection of data from top managers (including the CEO) on search. Design of these surveys ensured that completion time was under 45 minutes, and every effort was made to be flexible with companies that indicated that they would need extra time to respond.

An added benefit of this multi-method approach is the avoidance of method variance (Campbell & Fiske, 1959), as different groups of variables were determined from the use of different methods. The dependent variables came from the interview data, some of the controls used came from the publicly available data, and the other independent variables came from the survey responses.

Sample and Research Procedures

Sample Selection Criteria

The target sample for study was top management teams in high-technology companies located in several geographic regions in the northeast U.S. – the Baltimore-Washington, D.C. area, Northern Virginia, and Philadelphia. There were two main reasons for these criteria. First, due to the need to conduct interviews with company CEOs, firms' headquarters needed to be located within a one to two hour drive from a researcher's office. Second, in order to have a focused sample of companies which faced a competitive environment in which search is important (Weiss & Heide, 1993), the companies to be included had to conform to the definition of a high-technology company. A high-technology company was defined to include "firms that emphasize invention and innovation in their business strategy, deploy a significant percentage of their financial resources to R&D, employ a relatively high percentage of scientists and engineers in their

workforce, and compete in worldwide, short-life-cycle product markets" (Milkovich, 1987: 80).

Contact Protocol

An overall sample of public firms was generated through a search of Hoover's Online service of companies in industries typically considered to be high-technology. The exact list was based on 3-digit SIC codes utilized by Acs (1996; Acs *et al.*, 2002). Each of these companies was sent a letter explaining the purpose of the research, guaranteeing the anonymity of participants, and setting the expectation that a member of the research team would be calling in order to solicit participation (see Appendix III). Along with this letter of introduction was included a letter of endorsement from the Dean of the R.H. Smith School of Business at the University of Maryland. This endorsement letter was important to provide legitimacy for the project and was thus provided on official stationary that was personally signed by the Dean.

The majority of the data collection was undertaken over two 3-month periods – the first between July and September 2004; the second between July and September 2005. Roughly twenty letters per week were mailed over each period in order to allow for time to contact the CEOs of each of the target firms. Approximately one week after each letter was mailed, a member of the research team would call the CEO of the target firm in order to solicit participation in the study. Once this offer was accepted, arrangements were then made for the CEO interview.

Appendix IV shows the interview protocol utilized for the CEO interview. During this initial interview, the CEO was asked to identify members of the top management team to participate in this study. The CEO was asked to sign a letter of

endorsement to be included in the survey packet to go to the indicated TMT members (see Appendix V). After the interview, these survey packets were individually addressed and left with a contact person (also identified by the CEO) for distribution within the firm.

Respondents were typically asked to complete the surveys within a week, except in cases were CEOs indicated that more time would be needed due to the work load of top management. Several reminders were used as appropriate, either via email, phone call, or letter addressed to the non-responding top managers.

Research Instruments

CEO Interview

The primary purpose of the CEO interview was to obtain participation in the research. Once this was received, the interview was used to collect information on the innovation activity within the organization and financial information that could not be obtained through archival sources. The CEO interview was also important for determining members of each firm's top management team that have an impact on organizational innovation, and to whom surveys could be directed. This method of defining the top management team is supported by the range of work that "rather than assuming titles and positions as indicators of involvement … identif[ies] which players are involved" (Pettigrew, 1992: 178; e.g. Bantel & Jackson, 1989; Smith *et al.*, 1994). Appendix IV contains the script used in the CEO interview and the questions asked.

Questionnaires

A survey instrument was developed to capture the characteristics of search outlined in the previous chapters. Items in each search scale were original given that no

scales exist for capturing the search characteristics defined in this study. The characteristics of search were developed in a two-stage process:

First, preliminary research using four case studies was used to explore a model of search and discovery and to suggest search characteristics of the companies studied. In each of these four companies, the CEO and other key executives and knowledge workers were interviewed to discuss the process of search and innovation in their companies. Common themes and patterns were extracted from interview transcripts to develop a model of search and the various behaviors exhibited within these companies (see Appendix II for a more complete discussion of this research). These case studies were conducted over a period of eleven months, and involved regular and frequent meetings of the research team in which active discussion of the results in comparison to the search literature lead to the specification of the terrain and process dimensions of search and the identification of search characteristics.

Second, an extensive review of various literatures was used to identify additional characteristics of information gathering behaviors that had a parallel in a search context. This review further helped to define and distinguish between the search constructs identified in the case study phase.

Search terrain items were developed in the form of point allocation tables. This format guards against social desirability[2] in simply checking off a list of information sources, and also forces representatives to evaluate their search behavior in terms of the inherent costs of information acquisition behaviors (cf. Choudhury & Sampler, 1997). For example, if an individual only spent one hour searching for information, that hour

[2] "Social desirability is the tendency for a respondent to choose the socially desirable response, regardless of the veracity of that response" (Spector, 1987: 438).

would necessarily have to be divided between the various information sources utilized. The use of a point allocation system to measure the use of the search terrain therefore forces respondents to weight their usage of the various aspects of the terrain in terms of perceived importance.

This method of capturing information acquisition behavior, to the best of my knowledge, has not been used before. Typical approaches to measuring scanning behaviors utilize some combination of a checklist to indicate sources used and/or Likert-type scales to measure the degree of importance of a source (e.g. Daft, Sormunen & Parks, 1988). The downside of applying measures such as these in a search framework stems from the fact that scanning is an undirected, sometimes continuous information acquisition behavior whereas search is stimulus driven and ends when the desired information is found (e.g. Choudhury & Sampler, 1997; also see Appendix I). These differences between search and scanning therefore result in different approaches to information acquisition, reducing the suitability of scanning measures in a search context.

Given that search is triggered by a stimulus (either the perception of an opportunity or a problem), all search scales had to be based on some form of motivation for the search. A hypothetical scenario was therefore developed to provide a common stimulus which would act as a standardized point of comparison across respondents[3]. An alternative would have been to ask respondents to reflect on a past search, but this would likely introduce differences in the interpretation of the search context, which could potentially have affected the variance of between-respondents differences in search. The scenario was designed to be general, but focus on an external stimulus, and to convey a

[3] In keeping with my conceptualization of search as an individual-level behavior, the stimulus developed makes specific reference to the individual acting as the sole searcher in relation to a problem.

sense of urgency, but not specify a timeframe for completion. Five 5-point Likert scaled questions were included in the survey to assess if respondents found the scenario to be realistic ($\alpha = 0.9061$). These questions are shown in Table 2 below. The mean response per respondent was 4.0 (median = 4.2), indicating that the scenario provided was realistic.

Table 2: Questions to Assess Realism of Search Scenario

The above scenario …	
1.	… reflects an actual problem our organization has faced (or is facing).
2.	… is directly relevant to my role within the organization.
3.	… reflects a situation which I would normally be called upon to deal with as part of my role in this organization.
4.	… presents a situation is which I would typically search for information.
5.	… reflects a situation that would demand my personal attention.

Due to the unique nature of the search items, two pretest activities were conducted. First, three doctoral students with managerial experience were asked to go though the search instrument and 'think-aloud' as they responded to the questions (cognitive interviewing - e.g. Forsyth & Lessler, 1991). This procedure allowed the researcher to assess the understandability of the search questions, the amount of effort required by respondents to interpret the questions, and any confusion that could potentially arise with the items. In addition to allowing the detection of problems with the survey instrument, questions concerning the overall impression and interpretation of the survey were asked following the interview. After making revisions based on this feedback, the search instrument was given to three MBA students and four CEOs (not participating in the final sample) to complete. Comments and responses from these subjects allowed for further refinement in the search instrument. From the survey

questionnaire developed, the items pertaining to this dissertation have been extracted and are presented in Appendix VI.

Archival Source

As all of the companies contacted were public companies, financial data was obtained from the *COMPUSTAT* database. Company 10-K reports were also utilized to fill in some of the missing financial information. Summary financial data for the participating companies is shown in Table 3 below. There is a difference in the number of companies for which these summary statistics are based due to the presence of missing data.

Table 3: Summary Financial Data for Participating Companies

	N	Minimum	Maximum	Mean	Std. Deviation
Employees 2004	55	1.941	4.687	0.017	23.200
Sales 2004	56	283.209	673.625	0.198	4510.143
Net Income 2004	56	17.721	96.826	-43.586	682.527
SG&A 2004	51	70.886	125.462	0.793	701.629
R&D 2004	42	12.139	14.137	0.000	48.766
Assets 2004	56	356.017	657.619	0.530	3010.415

Note: Raw data are in 000's

Sample Response

An initial set of 358 companies met the sample criteria outlined above, 31 of which were disqualified at the time data collection began (e.g. no longer in operation, headquarters located outside of region, etc.). Of the remaining 327 companies, 92 CEOs agreed to be interviewed, a participation rate of 28.1%.

Of the 91 viable companies[4], at least one TMT survey and the CEO survey were returned for 61 of these companies (67% participation). This size sample may raise some concerns of adequate statistical power to detect the effects of independent variables.

[4] The death of one of these CEOs reduced that sample size by an additional company.

Considering past research that has examined the effect of top management teams on innovation (e.g. Bantel & Jackson, 1989; Hoffman & Hegarty, 1993; West & Anderson, 1996), it would be reasonable to expect values for R^2 in the range of 0.09 to 0.28, which would be considered between a medium and a large effect size (Cohen, Cohen, West, & Aiken, 2003). Assuming that my theoretical search model will generate an R^2 level of around 0.25 and my power level is .8 and alpha level is .05, with a maximum of eleven independent variables the required samples size is 61 firms. Since my usable sample contains 60 firms, there should be adequate power to detect the effects of search variables.

An independent samples t-test for the equality of means was used to compare the 61 complete companies and the 30 incomplete companies as shown in Table 4 below. As shown in Table 4, the sample of complete companies is not significantly different from incomplete companies in terms of number of employees or net sales.

Table 4: Test of Sample Response Bias

		Mean	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Employees	Complete	1.87	0.39	84.00	0.698	0.396	1.017
	Incomplete	1.48					
Net Sales	Complete	276.19	0.91	86.00	0.366	118.408	130.353
	Incomplete	157.79					

Of the final sample of 61 companies, 212 top managers responded to the survey. Other than the CEO (28.6% of total), these top managers held a range of positions, such as Chief Operating Officer (6%), Executive Vice President (5.5%), Senior Vice President (16.1%), Chief Financial Officer (9.2%), Vice President (17.1%) and Other (17.5%). The category for other includes several individuals nominated by the CEO as having senior positions within the company and having an influence on strategic decisions related to

innovation, but not necessarily on the top management team. For example, individuals such as Senior Engineers in charge of R&D departments were identified in a few cases.

The average age of the respondents was 48.8 years; 96.2% were male; and average postsecondary education was 5.8 years. The average length of organizational tenure was 8 years, with 4.7 years on average in the current position, and an average of 2.4 positions held with the same employer. The average number of years worked full-time was 26.4 years, 16.3 years on average within the same industry, and an average of 2.5 industries worked was reported.

In terms of primary expertise, the proportions were as follows: Marketing & Sales (26.5%), Operations & Engineering (23.3%), Finance / Accounting (18.6%), R & D (13.5%), Administrative / Legal (5.6%), HR / Personnel (1.4%), and Other (11.2%).

Variable Definition and Measurement

Dependent Variables – Innovation

Organizational innovation was examined as the key outcome of top management team search activities within high-technology organizations. A measure of total innovation was obtained through the CEO interview, in which the CEO was asked to provide the total number of innovations introduced by the organization in the last year with respect to four categories: product innovation, services innovation, market innovation, or internal process innovation. The sum total of innovation across these four types was used as the overall measure of total innovation for a firm. Use of these four categories was important to account for the differences in innovative activity across firms. While some firms innovated through introducing new products and services, others were more focused on adapting their existing products or services to new markets,

or improving the methods by which they produced existing products or services. This is consistent with Damanpour's (1991) definition of innovation as "adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization" (p. 556).

The CEO interview also asked questions concerning the type of innovations introduced by each organization, and whether these innovations could be considered as being radical. Radical innovations produce "fundamental changes in the activities of the organization and represent a large departure from existing practices (Damanpour, 1996: 699). A measure of radical innovation was obtained by asking the CEO to provide the total number of new innovations introduced by the organization in the last year, where new innovation was stated in the interview to mean innovations that were distinct or novel in comparison to more typical innovations introduced by the firm.

To determine the validity of this method of determining organizational innovation, additional data was collected using structured content analysis of articles in the business press (Ferrier *et al.* 1999; Miller & Chen, 1994; Smith *et al.* 1991; Young *et al.* 1996). This structured content analysis was conducted through coding of actions related to new product and service announcements on the basis of a series of keywords and decision rules. These keywords were used in combination with the firm names to search the *Lexis-Nexis* database and identify articles containing possible firm innovative activity in the year 2005. A measure of organizational innovation was then calculated as a count of the number of new products and services introductions for each company as reported in the business press for the year 2005. This measure of innovation conforms to a more widely used measure of innovation (Damanpour, 1991). This variable was found

to be significantly positively correlated with the total number of firm innovations as determined by the interview measure ($\rho = 0.3546$; $p < 0.001$), even after controlling for firm size ($\rho = 0.3447$; $p < 0.001$). Additionally, total innovation was correlated positively with a measure of the number of scientists employed by each firm[5] ($\rho = 0.3053$; $p < 0.05$), but not significantly correlated to R&D expense.

Determining the validity of the measure of radical innovation was not as straightforward. Generally, there did not appear to be any issues during the CEO interviews with respect to the CEO understanding what was meant by 'new' or 'novel' innovation. In comparing the mean difference between the total number of innovations and the total number of radical innovations, there was a statistically significant difference ($t = 2.971$, $p < 0.01$). That is, the number of radical innovations reported was significantly lower than the total number of innovations reported. The number of radical innovations were also significantly correlated with the number of scientists employed by the firm ($\rho = 0.3860$; $p < 0.01$), but as with total innovation, not significantly correlated with firm R&D expense.

An additional question asked during the CEO interview was to solicit a response to the percentage of old ideas and concepts that were used in new products. It was expected that for CEOs who indicated a high degree of reuse of old ideas and concepts, that there would be a smaller number of radical innovations. Indeed, correlating the response of the concept reuse question to the measures of innovation found that only the correlation with total innovation was significant ($\rho = 0.2206$; $p < 0.05$). Taken together, these results suggest that both innovation variables based on CEO responses have validity

[5] During the CEO interview, each CEO was asked to indicate the number of scientists employed by his/her firm.

in that they relate as expected to other indications of the number of organizational innovations, and that they were distinct from one another.

Independent Variables

A Note on the Aggregation of Search Variables

As my interest is in a top management team's utilization of the search terrain, aggregating individual search data had to reflect the information available once individual information was pooled at the team level. Figure 3 demonstrates this by showing four patterns of terrain usage and diversity measures based on first aggregating to the team level and second based on averaging individual manager's diversity scores.

Figure 3: Team vs. Individual Terrain Search Patterns

Team A	Source			
	a	b	c	d
Manager 1	1/4	1/4	1/4	1/4
Manager 2	1/4	1/4	1/4	1/4
Manager 3	1/4	1/4	1/4	1/4
Manager 4	1/4	1/4	1/4	1/4
Team	1/4	1/4	1/4	1/4

Team Diversity in Terrain: 0.75
Avg. Manager's Diversity in Terrain: 0.75

Team B	Source			
	a	b	c	d
Manager 1				1
Manager 2			1	
Manager 3		1		
Manager 4	1			
Team	1/4	1/4	1/4	1/4

Team Diversity in Terrain: 0.75
Avg. Manager's Diversity in Terrain: 0.00

Team C	Source			
	a	b	c	d
Manager 1	1/2	1/2		
Manager 2	1/2	1/2		
Manager 3			1/2	1/2
Manager 4			1/2	1/2
Team	1/4	1/4	1/4	1/4

Team Diversity in Terrain: 0.75
Avg. Manager's Diversity in Terrain: 0.50

Team D	Source			
	a	b	c	d
Manager 1	1			
Manager 2			1/2	1/2
Manager 3			1/2	1/2
Manager 4			1/2	1/2
Team	1/4	0	3/8	3/8

Team Diversity in Terrain: 0.66
Avg. Manager's Diversity in Terrain: 0.38

As Figure 3 demonstrates, simply averaging the diversity of sources utilized by individual managers does not capture the diversity of information available to the team. For instance, in Team B, each manager utilizes only one information source. There is therefore no diversity in the sources utilized by each manager, and consequently,

averaging the diversity score across managers would result in a team diversity score of zero, which would not reflect the actual level of diversity of sources searched *across* members of the team. In comparison, given that each manager utilized a different source, four *different* information sources were brought to bear when considering the team's overall search terrain. Computing diversity by first aggregating the use of different sources to the team level better represents the diversity of sources utilized in the search terrain. Team C provides a further example of this concept. As all sources are utilized by Team C, aggregating first to the team level results in a diversity score of 0.75. However, computing the average of individual diversity scores results in considerably lower diversity scores for the entire team as compared to Team A.

Distance Diversity and Scope Diversity were both computed in this fashion, a calculation that is very similar to the one commonly used to calculate functional heterogeneity in teams (e.g. Bantel & Jackson, 1989). Market / Resource Diversity was calculated using the coefficient of variation as this measure was based on a single item. However, this is also in keeping with calculations typically used to determine diversity scores from single item responses (e.g. age diversity or organizational tenure diversity - Auh & Menguc, 2005; Knight *et al.,* 1999).

Another way of viewing the aggregation of the above search variables is in terms of a compilation process (Bliese, 2000). Search is an individual level phenomenon as it is carried out by an individual, and each individual's search behavior can vary. Search behaviors can, however, be aggregated to the team level in order to reflect the general characteristics of how a top management team searches. Some teams may be relatively homogeneous in how they search, but others may be heterogeneous depending on

individual preferences. Diversity scores for scope, distance, and market/resource emphasis are of theoretical interest and there is no need to empirically justify aggregation.

The remaining search variables (process: effort, persistence, adaptation, formality; terrain: external, unfamiliar) utilize averages of individual top manager's scores to form aggregated variables at the team level. Following the additive logic (cf. Chan, 1998) described by LePine *et al.* (1997), aggregation of search variables is "not meant to characterize teams in terms of attributes, but to characterize teams in terms of their members' attributes" (p. 804). The information and knowledge acquired through individual top managers' search is conceptualized as resources that are brought together to influence TMT effectiveness in response to the search stimulus. This additive form of aggregation is appropriate "when team members can compensate for one another with respect to task-focused contributions" (LePine, 2003: 33) and once this knowledge is integrated with other members' knowledge, the search experiences of individual members can be more effectively utilized. This rationale for aggregating individual level scores to the team level is also reflected in studies investigating creativity in team research. For example, Taggar (2002) finds evidence that "group creativity is an interactive function of aggregated individual creativity and the amount of team creativity relevant processes" (p.325). Given the additive logic outlined above, there is no reason to empirically demonstrate agreement (Chan, 1998).

Search Terrain

Search terrain variables were calculated using the point allocation tables shown in Appendix IV. These point allocations indicate the relative amount of time allocated to search in the specified area.

TMT Terrain Distance Diversity is defined as the diversity in the sources of information utilized by the top management team across three domains: i) sources internal to the organization; ii) intra-industry sources; and iii) extra-industry sources. These domains reflect three boundaries across which search can take place, each of which have been argued to provide information that has an effect on organizational information through search (e.g. Rosenkopf & Nerkar, 2001; Sorenson & Stuart, 2000; Geletkanycz & Hambrick, 1997). Top manager point allocations across the three categories of distance were utilized in a diversity measure computed using the following formula:

$$1 - \sum_{d} \left(\sum_{t} S_{dt} / \sum_{t} ST_{t} \right)^{2},$$

where S_d/ST is the share or proportion of search conducted in the *d*th distance category, aggregated across all members of the top management team. A higher score on this measure indicates greater diversity in the distances 'traversed' by members of the top management team in acquiring information.

TMT Terrain Scope Diversity is defined as the diversity in the scope of information sources utilized across all members of the top management team. Building on measures of scanning scope (e.g. Beal, 2000; Daft, Sormunen & Parks, 1988), information sources were broken down into twelve categories as follows: TMT members, managers not part of the TMT, non-managers, consultants, suppliers, customers, alliance

partners, competitors, government, university, investors, and other sources outside the industry. Top manager point allocations across the twelve categories of information sources were utilized in a diversity measure computed using the following formula:

$$1 - \sum_{b} \left(\sum_{t} S_{bt} / \sum_{t} ST_{t} \right)^{2},$$

where S_b/ST is the share or proportion of search conducted in the *b*th information source category, aggregated across all members of the top management team. A higher score on this measure indicates greater diversity in the scope of information sources utilized across members of the top management team.

TMT Terrain Market/Resource Diversity is defined as the extent to which there is diversity in the top management team in the emphasis that individual managers place on resource information versus market information. Terrain Market/Resource Diversity was measured using the coefficient of variation (standard deviation / mean) for the ratio of the point allocations to resource emphasis and market emphasis. The coefficient of variation is commonly used in TMT research for calculating diversity scores on single response variables, for example, age diversity or organizational tenure diversity (e.g. Auh & Menguc, 2005; Knight *et al.,* 1999). A higher score on this measure indicates greater diversity in the resource and market information utilized across members of the top management team.

TMT Terrain Unfamiliarity is defined as the extent, on average, to which search by members of a top management team focuses on unfamiliar information. Respondents were asked to indicate the extent to which they searched unfamiliar information (information to which they have never been exposed, information that is different from other information which has been used in the past) as opposed to familiar information

(information that had been used in the past, or revisiting information that was once known) by assigning 100 points across both of these categories. The extent of the team's use of unfamiliar terrain was calculated as the average in the point allocation to unfamiliar information for all top management team members. A higher score on this measure indicates that, on average, top managers utilize a greater degree of unfamiliar as opposed to familiar information sources.

TMT External Terrain is defined as the extent, on average, to which search by members of a top management team focuses on external information (e.g. information about customers, markets, competitors) versus internal information (e.g. information regarding firm resources, employees) by assigning 100 points across both of these categories. The extent of the team's use of external terrain was calculated as the average in point allocation to external information for all top management team members. A higher score on this measure indicates that, on average, top managers utilize relatively more information from outside of the organization than from within.

Search Process

The following search process variables were calculated from 5-point Likert scales ranging from "strongly disagree" to "strongly agree" (Table 5). For each of the following variables, principal components analysis was utilized with varimax rotation (see Table 6 for factor loadings). Items that cross-loaded were dropped before extracting factors for an individual measure of each of the search process variables. In addition, the minimum average partial correlation (MINAP) criteria proposed by Velicer (1976) was used to determine the number of factors to extract as opposed to Kaiser's (1960) suggestion of extracting the number of factors equal to the number of eigenvalues greater than one,

which can lead to over-extraction. Variables not loading on hypothesized search measure (i.e. loading on a factor outside of the number suggested by the MINAP criteria) were dropped. To construct a team-level variable, the average response of members of each top management team was then calculated.

Table 5: Questions used to assess Search Process

Search effort relative to other job-related activities that demand your attention:

When searching for information in response to the above scenario, I would…

1. … make looking for new information a top priority for how I would spend my time.
2. … devote a large percentage of my time to searching for information.
3. … invest a great deal of personal effort into gathering potentially valuable information.
4. … go out of my way to find information sources that may have relevant information.
5. … let things emerge instead of continuously searching.

Level of persistence in search:

When searching for information in response to the above scenario, I would…

1. … continue searching until I was satisfied that I had identified all relevant information.
2. … stop searching as soon as a potential solution was identified.
3. … exhaustively search and study every possibility.
4. … persist until I found all the information pertaining to this problem.
5. … take as much time as needed to identify all available information.

Revisiting information, reflecting on information and cycling back in the search process:

When searching for information in response to the above scenario, I would…

1. … revisit information sources several times as my search for information becomes clearer.
2. … change the direction of the search process as I learn new things.
3. … base each new decision on where to search next on what I just found.
4. … adjust my search process as I become more familiar with the available information.
5. … change the sources utilized in my search as I learn new things.
6. … I would periodically reflect on what direction my efforts are taking me.
7. … I would spend time tracing relationships between disparate ideas and facts.
8. … I would try to draw parallels between this situation and others that I have solved before.
9. … I would spend time exploring how information could be combined to derive new ideas.

Using a formal search process:

When searching for information in response to the above scenario, I would …

1. … want to have a clear structure for conducting my search before I start.
2. … methodically utilize various interpersonal contacts and written media.
3. … be certain to adhere to a strict timeline in terms of what is to be accomplished and by when.
4. … follow an organized process of search.
5. … approach the search process in a systematic fashion.

TMT Search Effort is defined as the extent to which, on average, the time and energy of members of a top management team is devoted to search versus other activities that demand managers' attention. Search effort is based on a 4-item scale ($\alpha = 0.8060$), with higher values on this variable reflecting greater TMT search effort. Between-team variability was not significant (ICC(1) < 0), but had a mean r_{wg} of 0.7969 and a median r_{wg} of 0.8957.

TMT Search Persistence is defined as the extent to which, on average, members of a top management team continue to gather information despite the number of alternatives that have been found, in order to be exhaustive in determining the optimal outcome. A 4-item scale ($\alpha = 0.7490$) was used, with higher values reflecting greater TMT search persistence. Between-team variability was not significant (ICC(1) = 0.019), but had a mean r_{wg} of 0.7128 and a median r_{wg} of 0.8361.

TMT Search Adaptation is defined as the extent to which, on average, the search strategies utilized by members of a top management team are changed in order to account for information collected as the process continues or through reflection on how best to continue the search. Search adaptation is based on a 7-item scale that assesses the extent to which a manager utilizes information obtained as the search progresses or reflects on information from previous experiences to adapt during the search process ($\alpha = 0.7302$). Between-team variability was marginally significant (ICC(1) = 0.089; F = 1.34, $p < 0.10$) with a mean r_{wg} of 0.9282 and a median r_{wg} of 0.9545.

TMT Search Formality is defined as the extent to which, on average, the search strategies utilized by members of a top management team are systematic and follow set procedure. Search formality is based on a 5-item scale that assesses the extent to which a

manager utilizes a formal process when engaging in search ($\alpha = 0.8142$). Between-team variability was not significant (ICC(1) < 0), but had a mean r_{wg} of 0.8017 and a median r_{wg} of 0.8783.

Table 6: Factor Analysis of Search Process Variables using Principal Components Analysis with Varimax Rotation

Variable	Factor1	Factor2	Factor3	Factor 4
Effort 1	0.6616			
Effort 2	0.8446			
Effort 3	0.8536			
Effort 4	0.6830			
Effort 5				
Persist 1		0.6130		
Persist 2		0.7725		
Persist 3				
Persist 4		0.8460		
Persist 5		0.6549		
Adapt 1				
Adapt 2			0.5497	
Adapt 3				
Adapt 4			0.5326	
Adapt 5			0.5545	
Adapt 6			0.5687	
Adapt 7			0.6493	
Adapt 8			0.6403	
Adapt 9			0.6986	
Formality 1				0.7846
Formality 2				0.6096
Formality 3				0.6913
Formality 4				0.8226
Formality 5				0.8195

Search Integration Capability

TMT Search Integration Capability is defined as the extent to which top managers can integrate the knowledge obtained through their individual search behavior with those of other team members and is based on the degree to which there is interaction and participation among the top managers involved in search in an organization (cf. Thomas & McDaniel, 1990). The 5-item scale used to measure search integration was based in part on existing scales (e.g. Thomas & McDaniel, 1990; McGrath, 2001), but are original

items ($\alpha = 0.9061$). The items were scaled so that high values represented high participation and high interaction, indicating a structure with high capacity to process information gathered through search (cf. Galbraith, 1973; Thomas & McDaniel, 1990). See Table 7 for the list of items used in this scale. Principal components analysis was used to extract a single factor.

In order to provide justification for aggregating individual-level scores into a group-level variable, the James *et al*. (1984) procedure was utilized. An average value for r_{wg} was calculated at 0.7836, with a median value of 0.9137. Scores ranged from 0.2632 to 1.0, with five out-of-range values set to zero. These results for r_{wg} indicate a high level of agreement within teams, suggesting that aggregation is appropriate.

Additionally, utilizing an ANOVA based approach to compare within-group variance to between-group variance yielded an ICC(1) score of 0.0769, suggesting that roughly 7.7% of variance in this measure is due to group membership. This value for ICC(1) is slightly smaller than the 10% discussed by Bleise (2000) as a typical value.

The ICC(1) results not withstanding, the high value for r_{wg} is strong support for aggregation. George and James (1993) argue against relying too heavily on the use of ANOVA based methods to justify aggregation, as there may be situations in which between-group variation is low (see also Lindell & Brandt, 2000). On closer analysis, excluding the five companies that yielded out-of-range values in the calculation of r_{wg}, ANOVA results were significant ($F = 1.61$, $p < 0.05$) and the ICC(1) increased to 0.1538, demonstrating that within-group variability is present. This would suggest that there is some statistical support for aggregation for search integration scores which is being adversely affected by a lack of consensus in a small handful of teams.

Table 7: Questions used to assess Search Integration Capability

	Factor Loadings
1. Members of our top management team periodically reflect on what our search efforts are yielding in terms of generating new ideas.	0.7816
2. Members of our top management team actively work together to integrate the different information team members' find after searching on their own.	0.8818
3. Members of our top management team discuss what they have learned from their individual search activities with other team members to get new perspectives and share ideas.	0.9048
4. Members of our top management team openly share information with each other that might help other team members with their search activities.	0.8461
5. Members of our top management team regularly exchange ideas about what individual team members have identified in their search activities.	0.8586

Control Variables

TMT Functional Heterogeneity. Team heterogeneity has been argued to "bring more creativity to problem solving and product development" (Ancona & Caldwell, 1992b: 321). While Ancona and Caldwell's (1992b) study showed a negative relationship between product development team heterogeneity and new product development, Bantel and Jackson (1989) found a positive relationship when examining functional heterogeneity in top management teams. To control for any effects of team heterogeneity, TMT members were asked to specify the functional area which most closely represented their background. A score was then computed using Blau's heterogeneity index:

$$1 - \sum_{t} f_t^2,$$

where f is the proportion of top managers in the fth functional category.

TMT Size. Team size has been argued to "parsimoniously represent a team's structural and compositional context" (Amason & Sapienza, 1997: 32). Larger teams

have been argued to contain greater diversity of opinions and interests, but also to have more problems with conflict and information exchange (Amason & Sapienza, 1997; Bantel & Jackson, 1989; Simsek *et al.*, 2005; Smith *et al.*, 1994; Wiersema & Bantel, 1992. West and Anderson (1996) found evidence that TMT size predicted the radicalness of team innovation. Team size may therefore have an impact on the degree to which individual TMT member search experiences are utilized, and a measure calculated as the total number of individuals in a company's TMT (as reported by the CEO during the interview) was included as a control.

Firm Size. Given the large number of studies that have found a relationship between organizational size and innovation (e.g. Bantel & Jackson, 1989; Damanpour, 1991; Kimberly & Evanisko, 1981), a control for size was calculated as the natural logarithm of the total number of employees in the firm.

R&D Expense. At an organizational level, several studies have utilized R&D as a proxy for a firm's search activities and its inputs into the innovation process (e.g. Ahuja & Katila, 2002; Katila 2002; Greve, 2003). R&D Expense data was collected through *COMPUSTAT*, however, missing data for 18 firms posed a challenge. This missing data was then imputed using information collected in the CEO interviews, which asked CEOs to provide an indication of the amount of money spent on research and development. Data from the CEO interview was positively and significantly correlated with the data from COMPUSTAT ($\rho = 0.8375$, $p < 0.001$).

CHAPTER 6: RESULTS

Confirmatory Factor Analysis

To test the factor structure of the four search process variables proposed, a confirmatory factory analysis (CFA) was conducted using EQS v6.1 (Bentler, 2002). As the underlying variables are based on Likert-type scales, the data are multivariate nonnormally distributed. A maximum-likelihood estimation method with robust standard errors together with the Satorra-Bentler rescaled chi-square statistic was therefore utilized (Satorra & Bentler, 1994).

To test for convergent and discriminant validity, the procedures outlined by Anderson (1987) and Bagozzi & Phillips (1982) were used. First, a CFA with all measures was analyzed, followed by a CFA with a reduced set of measures as suggested by the exploratory factor analysis. This reduced set only included the measures with factor loadings above 0.400 as shown in Table 6. There was a significant difference between the all measures model and the reduced measures model ($\Delta\chi^2 = 173.27$, df=82). Further, the reduced measures model had better fit statistics (CFI = 0.895, RMSEA = 0.061, SRMR = 0.075) which were of an acceptable level (Hu & Bentler, 1999), and all standardized factor loadings in the model were above 0.409 (mean = 0.633; median = 0.589). As all measures loaded on their respective factors, convergent validity for the search process factors is confirmed.

To test for discriminant validity, a series of additional CFA models were run, each fixing a different covariance path between factors to 1. For example, setting the covariance between search effort and search persistence to 1.0 is the same as specifying that they are the same construct. Chi-difference test tests were then performed between

models. The 4-factor search process model with free covariance parameters between factors was found to be superior, providing evidence of the discriminant validity of the constructs. Each of the search process variables specified are therefore shown to be distinct constructs.

Analysis Techniques

Table 8 below provides descriptive statistics for the variables used in this study. Pearson correlation coefficients for these variables are shown in Table 9.

Table 8: Descriptive Statistics for Variables

	Mean	S.D.	Min	Max
Total Innovation	28.98	84.22	0	500
Radical Innovation	5.75	19.67	0	150
TMT Size	4.53	1.59	1	11
TMT Functional Heterogeneity	0.64	0.13	0.19	0.83
Firm Size	-1.38	2.02	-4.34	3.14
R&D Expense	10.20	16.01	0	85
Search Integration	-0.02	0.64	-1.70	1.39
Terrain Scope Diversity	0.87	0.03	0.73	0.91
Terrain Market/Resource Diversity	0.64	0.34	0.00	1.33
Terrain Distance Diversity	0.62	0.04	0.48	0.67
Terrain Unfamiliarity	61.89	11.45	31.67	87.50
External Terrain	68.90	9.13	38.33	85.00
Search Effort	-0.03	0.53	-1.25	1.28
Search Persistence	0.02	0.56	-1.66	1.45
Search Adaptation	-0.01	0.63	-1.56	1.60
Search Formality	-0.04	0.56	-1.39	1.81

Table 9: Pearson Correlation Coefficients for Variables

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Total Innovation									
(2)	Radical Innovation	0.82								
(3)	TMT Size	0.02	0.15							
(4)	Functional Heterogeneity	-0.09	0.03	0.03						
(5)	Firm Size	0.18	0.19	0.29	0.01					
(6)	R&D Expense	-0.06	-0.07	-0.00	-0.11	0.41				
(7)	Search Integration	0.03	0.06	-0.10	0.12	-0.10	-0.02			
(8)	Terrain Scope Diversity	-0.31	-0.19	0.20	-0.07	0.08	0.09	-0.04		
(9)	Terrain Market/Resource Diversity	0.13	0.05	-0.05	0.18	-0.21	-0.10	-0.09	-0.24	
(10)	Terrain Distance Diversity	-0.05	0.09	0.21	-0.06	0.17	0.01	-0.02	0.77	-0.17
(11)	Terrain Unfamiliarity	0.03	0.07	0.23	-0.02	0.01	-0.12	-0.16	-0.16	-0.05
(12)	External Terrain	-0.07	-0.02	0.11	-0.04	-0.32	-0.28	-0.03	-0.01	0.08
(13)	Search Effort	0.20	0.34	0.13	0.33	0.02	-0.23	0.14	0.04	0.06
(14)	Search Persistence	-0.09	-0.11	-0.14	-0.13	-0.21	-0.08	-0.06	-0.10	0.02
(15)	Search Adaptation	0.01	0.13	0.17	0.15	0.05	0.07	0.11	0.11	-0.15
(16)	Search Formality	0.10	-0.00	-0.02	0.11	-0.06	-0.07	0.07	-0.15	-0.05

		(10)	(11)	(12)	(13)	(14)	(15)
(11)	Terrain Unfamiliarity	-0.15					
(12)	External Terrain	-0.06	0.41				
(13)	Search Effort	0.19	0.11	0.04			
(14)	Search Persistence	-0.08	0.06	0.26	0.11		
(15)	Search Adaptation	0.06	0.20	0.25	-0.01	-0.07	
(16)	Search Formality	-0.23	0.11	-0.09	-0.01	0.01	0.22

NB: Values greater than 0.27 are significant at p > 0.05.

As the dependent variables are counts of the number of innovations per firm, simple linear regression is not appropriate. As described by Gardner *et al.* (1995), the application of a linear regression model on count data violates several assumptions underlying linear regression. First, there is typically a correlation between the expected counts and the absolute values of the residuals (a problem referred to as heteroscedasticity); and second, expected count values can have negative values.

In cases of non-negative count variables, the Poisson distribution is more appropriate (Gardner *et al.*, 1995). However, as the search models specified displayed characteristics of overdispersion, a variant of the Poisson regression – negative binomial regression – was utilized (Greene, 2000). In addition, a robust standard errors specification was utilized in order to account for the possibility of model misspecification. Additionally, before creating interaction terms, the independent variables were centered (cf. Cronbach, 1987).

Search Terrain Effects

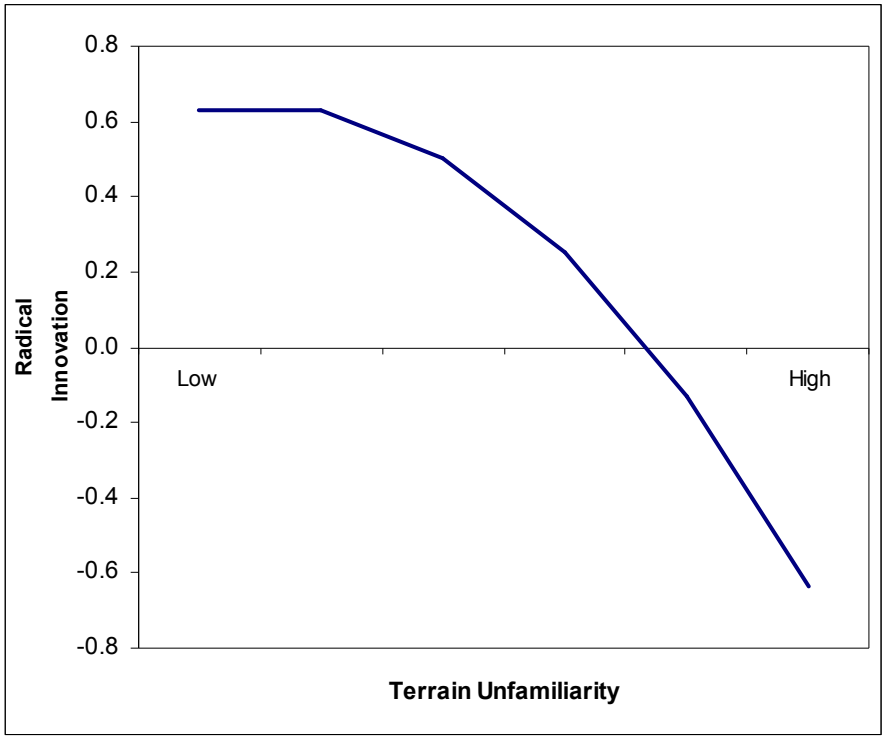
Hypothesis 1 argues that the greater the diversity in the scope of information sources utilized in a top management team's search terrain, the greater the total number of organizational innovations. Contrary to the direction hypothesized, Table 10 (model 2) shows that scope diversity has a significantly negative impact on total innovation (B = -21.042, $p < 0.05$). This result holds in model 3 (B = -15.708, $p < 0.10$), albeit more weakly, perhaps due to the additional terms included in this model. These results appear to indicate that when a top management team utilizes a wide variety of information sources there is a detrimental effect on organizational innovation.

Hypothesis 2 argues that the greater the diversity in the distances of information sources utilized in a top management team's search terrain, the greater the total number of organizational innovations. Examining the effect of the diversity of source distance on total innovation, Table 10 (model 2 and model 3) does not indicate any support for this hypothesis.

Hypothesis 3 argues that the greater the average use of external information in a top management team's search terrain, the greater the introduction of radical organizational innovations. Table 11 shows no evidence of this relationship, thus there was no support for this hypothesis.

Hypothesis 4 argues that terrain unfamiliarity will have a curvilinear effect on radical innovation, i.e. emphasis on unfamiliar terrain will at first have a positive effect on radical innovation, but at higher levels of emphasis there will be a negative impact. Table 11 shows only limited support for Hypothesis 4 as both the direct effect (B = 0.316, $p < 0.10$) and the square of terrain unfamiliarity (B = -0.003, $p < 0.10$) have marginally significant coefficients. However, the signs of these coefficients are as predicted, indicating that excessive emphasis on unfamiliar terrain by the top management team can have a detrimental effect on radical innovation at high levels of unfamiliarity (see Figure 4).

Figure 4: Curvilinear effect of Terrain Unfamiliarity on Radical Innovation



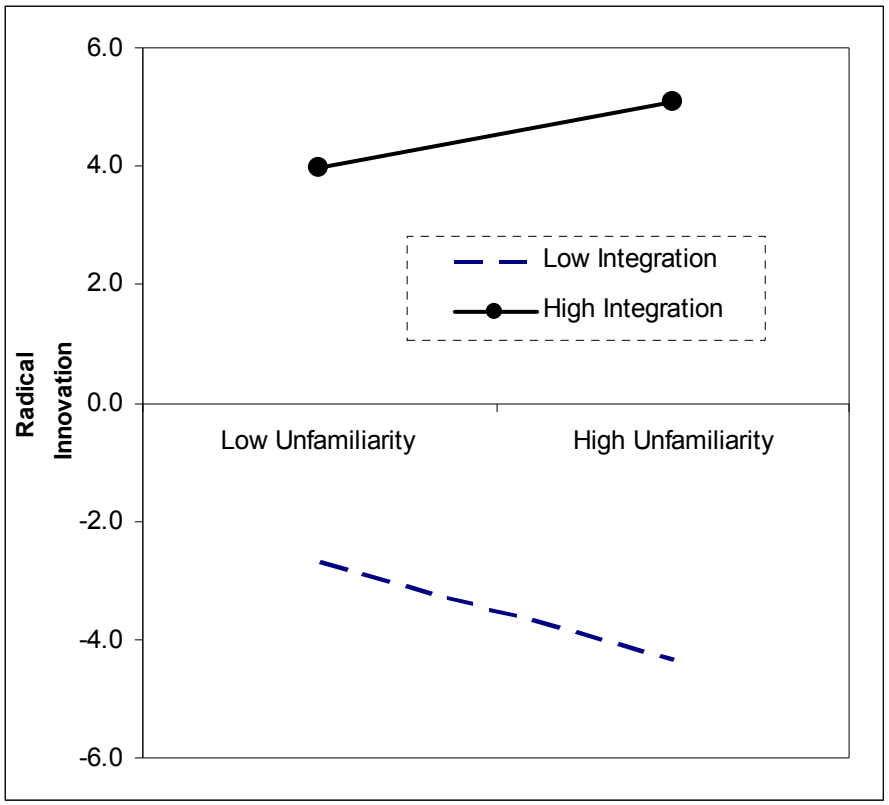
Hypothesis 5 argues that the greater the diversity in resource versus market information emphasis in a top management team's search terrain, the greater the total number of organizational innovations. Table 10 shows a positive and significant relationship (model 2: B = 1.569, $p < 0.05$; model 3: B = 1.363, $p < 0.05$) thus supporting Hypothesis 5.

Hypothesis 6 and Hypothesis 7 deal with the interaction between a top management team's search integration capability and search terrain on organizational innovation. Hypothesis 6 argues that diversity in the scope, distance, and resource versus market emphasis in a top management team's search terrain will have stronger effects on total innovation when search integration is high. Table 10 does not show significant interactions for either scope or resource versus market emphasis with search integration capability. There is however, a marginally significant interaction between distance

diversity and search integration capability (B = 20.877, $p < 0.10$), therefore providing weak support for Hypothesis 6b only.

Hypothesis 7 argues that an external terrain and terrain unfamiliarity will have stronger effects on radical innovation when search integration capability is high. Table 11 does not show a significant interaction with external terrain, but does show a positive and significant interaction with terrain unfamiliarity (B=0.095, $p < 0.01$). Figure 5 provides a graphical representation of this interaction, which clearly shows that TMT's that are more highly integrated with respect to their search activities have a greater impact on radical organizational innovation when they search unfamiliar terrains. Search of unfamiliar terrains would also appear to have a negative effect on radical innovation if a top management team did not have a high degree of search integration capability.

Figure 5: Interaction between Terrain Unfamiliarity and Search Integration



Search Process Effects

Hypothesis 8 argues that the average effort put into search by members of a top management team will have a curvilinear effect on total innovation. Search effort will initially have a positive effect on innovation, but this relationship will become negative at higher levels of effort. Table 12 shows that while there is indeed a curvilinear relationship between search effort and total innovation, it is a U-shaped relationship (see Figure 6). The squared term for search effort is both positive and significant (B = 1.357, $p < 0.05$). This relationship is contrary to that predicted in Hypothesis 8, in that average search effort by a top management team has an increasingly positive effect on total innovation.

Hypothesis 9 argues that the greater the average level of persistence put into search by members of a top management team, the greater the number of total innovations. Table 12 provides mixed support for this hypothesis as search persistence is not significant in model 2, but significant in model 3 (B = 0.959, $p < 0.05$).

Hypothesis 10 argues that the greater the average level of formality in search conducted by members of a top management team, the greater the number of total organizational innovations. Table 12 shows mixed support for this hypothesis as search formality has a positive and significant effect on total innovation in model 2 (B = 0.721, $p < 0.05$), but is not significant in model 3.

Hypothesis 11 argues that the greater the average level of adaptability of search conducted by members of a top management team, the greater the number of radical innovations. Table 13 provides support for this hypothesis as the coefficient for search

adaptability is significant in both models (model 2: B = 0.507, $p < 0.05$; model 3: B = 0.448, $p < 0.10$).

Figure 6: Curvilinear effect of Search Effort on Total Innovation

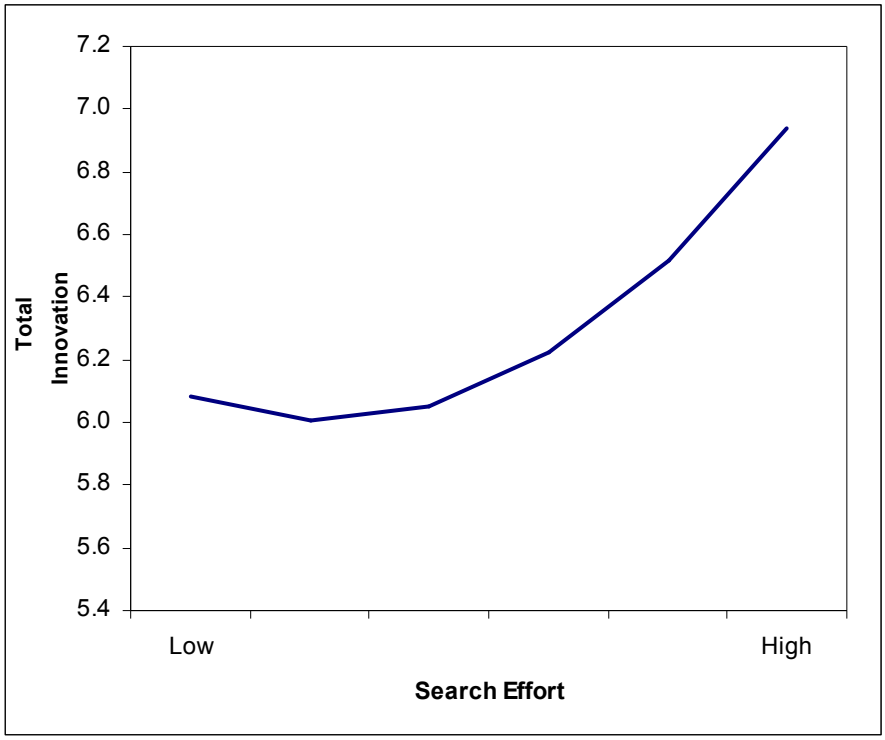


Table 10: Negative Binomial Regression with Robust Standard Errors for the effect of Search Terrain Characteristics on Total Innovation

	(1)	(2)	(3)
Constant	6.570**	16.839**	12.617*
	(1.543)	(5.441)	(6.180)
TMT Size	-0.130	-0.018	0.035
	(0.169)	(0.178)	(0.184)
TMT Functional Heterogeneity	-2.960	-2.737	-3.134*
	(2.061)	(1.730)	(1.550)
Firm Size	0.461**	0.368**	0.420**
	(0.140)	(0.131)	(0.118)
R&D Expense	-0.048**	-0.029**	-0.031**
	(0.012)	(0.011)	(0.011)
Search Integration		0.237	0.508
		(0.339)	(0.368)
Scope Diversity		-21.042*	-15.708†
		(9.002)	(9.430)
Market/Resource Diversity		1.569*	1.363*
		(0.743)	(0.595)
Distance Diversity		9.321	8.959
		(6.809)	(6.550)
Integration x Breadth			16.630
			(16.676)
Integration x Market/Resource			-0.266
			(1.102)
Integration x Distance			20.877†
			(12.086)
Observations	60	60	60
Wald chi2	20.220	43.134	84.602
Prob > chi2	0.001	0.000	0.000
Pseudo R2	0.030	0.060	0.070

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 11: Negative Binomial Regression with Robust Standard Errors for the effect of Search Terrain Characteristics on Radical Innovation

	(1)	(2)	(3)	(4)
Constant	1.872†	1.166	-7.674	1.233
	(1.121)	(1.617)	(4.912)	(1.599)
TMT Size	0.278	0.235	0.219†	0.225†
	(0.169)	(0.172)	(0.129)	(0.130)
TMT Functional Heterogeneity	-1.419	-1.295	-2.206	-1.136
	(1.439)	(1.420)	(1.395)	(1.259)
Firm Size	0.368**	0.399**	0.391**	0.380**
	(0.120)	(0.118)	(0.113)	(0.115)
R&D Expense	-0.041*	-0.038*	-0.040*	-0.044**
	(0.019)	(0.019)	(0.019)	(0.017)
Search Integration		0.402	0.424	0.384
		(0.319)	(0.306)	(0.308)
External Terrain		0.015	0.015	0.020
		(0.031)	(0.029)	(0.028)
Terrain Unfamiliarity		-0.003	0.316†	-0.010
		(0.027)	(0.177)	(0.024)
Terrain Unfamiliarity ^2			-0.003†	
			(0.001)	
Integration x External				-0.039
				(0.035)
Integration x Unfamiliarity				0.095**
				(0.035)
Observations	60	60	60	60
Wald chi2	12.581	18.831	22.411	26.040
Prob > chi2	0.014	0.009	0.004	0.002
Pseudo R2	0.060	0.060	0.070	0.080

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 12: Negative Binomial Regression with Robust Standard Errors for the effect of Search Process Characteristics on Total Innovation

	(1)	(2)	(3)
Constant	6.570**	7.103**	6.151**
	(1.543)	(1.406)	(1.612)
TMT Size	-0.130	-0.226†	-0.137
	(0.169)	(0.135)	(0.141)
TMT Functional Heterogeneity	-2.960	-3.519†	-3.630†
	(2.061)	(1.885)	(1.956)
Firm Size	0.461**	0.451**	0.394**
	(0.140)	(0.121)	(0.117)
R&D Expense	-0.048**	-0.034**	-0.032**
	(0.012)	(0.012)	(0.010)
Search Effort		0.970*	0.891*
		(0.430)	(0.427)
Search Persistence		0.215	0.959*
		(0.436)	(0.474)
Search Formality		0.721*	0.325
		(0.321)	(0.379)
Search Effort^2			1.357*
			(0.603)
Observations	60	60	60
Wald chi2	20.220	33.430	62.565
Prob > chi2	0.001	0.000	0.000
Pseudo R2	0.030	0.050	0.060

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 13: Negative Binomial Regression with Robust Standard Errors for the effect of Search Process Characteristics on Radical Innovation

	(1)	(2)	(3)
Constant	1.872†	2.641*	2.450*
	(1.121)	(1.049)	(1.091)
TMT Size	0.278	0.142	0.134
	(0.169)	(0.135)	(0.137)
Functional Heterogeneity	-1.419	-2.242†	-2.135
	(1.439)	(1.341)	(1.368)
Firm Size	0.368**	0.287**	0.271*
	(0.120)	(0.107)	(0.109)
R&D Expense	-0.041*	-0.030†	-0.027†
	(0.019)	(0.016)	(0.015)
Search Effort		1.065**	1.042**
		(0.356)	(0.335)
Search Adaptation		0.507*	0.448†
		(0.248)	(0.240)
Search Effort^2			0.386
			(0.376)
Observations	60	60	60
Wald chi2	12.581	28.621	35.135
Prob > chi2	0.014	0.000	0.000
Pseudo R2	0.060	0.100	0.100

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Post-Hoc Analyses

Top Management Team Characteristics and Search

Given that the above results demonstrate the importance of various search characteristics, an investigation into the characteristics of top management teams were conducted to determine in greater detail how they compared along the dimensions of terrain and process.

Examining the search terrain utilized by the top management teams more generally, there appeared to be greater emphasis of top managers on specific information sources. Customers and other top managers were the two main sources utilized. These

two sources combined for 83% on average of the relative amount of time spent searching information sources. Other extra-industry contacts also received a high proportion of time, but exact details on who these contacts were was not captured in the survey.

Table 14: Terrain Sources Utilized

Terrain: Sources Utilized	Mean % of time
Intra Industry - Customers	42.29
Internal - TMT	40.75
Extra Industry - Other	37.19
Internal - Managers	27.93
Extra Industry - Investors	24.75
Intra Industry - Partners	20.97
Intra Industry - Competitors	18.63
Extra Industry - Government	18.54
Extra Industry - University	18.39
Intra Industry - Suppliers	17.66
Internal - Non Managers	16.29
Internal - Consultants	14.98

In terms of the type of information utilized, the mix of market and resource/technology information clearly had precedence. Marketing/Sales information was the focus of time spent an average of 35% of time spent, while R&D and Operations/Engineering combined for 43.5% of the time.

Table 15: Terrain Information Type Utilized

Terrain: Type of Information	Mean % of time
Marketing/Sales	35.09
R&D	23.87
Operations/Engineering	19.63
Finance/Accounting	8.79
Administrative/Legal	6.26
HR/Personnel	4.13
Other	2.18

An examination of the characteristics of high search teams versus low search teams was then conducted. Top management teams were divided into groups for each of

the search characteristics using the median at a cut-point. A series of mean comparison t-tests were then utilized for the following group characteristics variables: team size, average years post-secondary education, average team tenure, and team functional heterogeneity.

Results showed that teams with high terrain scope diversity had a lower average level of team tenure ($t = 2.3036$, $p < 0.5$). Teams that had high resource versus market emphasis diversity had a smaller team size ($t = 1.7480$, $p < 0.10$) but a higher level of functional heterogeneity ($t = 1.7953$, $p < 0.10$). Teams that had a high level of search effort had a higher level of average team tenure ($t = 2.4949$, $p < 0.05$). Finally, teams that had a higher level of search adaptation had a higher level of average post-secondary education ($t = 2.0383$, $p < 0.05$).

In order to further compare extreme levels of search, cut-off points at the 25th quartile (low search) and 75th quartile (high search) were selected for all search characteristics. Only two significant results were found. Results showed that teams that were high on search effort had significantly greater diversity in functional backgrounds ($t = 1.8649$, $p < 0.10$) and that teams that were high on search persistence had significantly lower years of post-secondary education on average ($t = 1.9798$, $p < 0.10$).

Impact of CEO Search versus TMT Search

There is the possibility that the CEO in an organization exerts significant influence in the innovation process, and his/her search activities will have a dominant effect on this outcome. To compare CEO versus TMT influence on innovation through search, a hierarchical set of models was analyzed to show the relative importance of CEO Search versus TMT Search.

Table 16 and Table 17 show that a CEO's search effort has a positive and significant impact both on total innovation and on radical innovation. However, the results show that this impact differs depending on the type of innovation. When total innovation is the outcome, CEO search effort has the dominant impact on the number of total innovations. When radical innovation is the outcome, TMT search effort has the dominant impact on the number of radical innovations introduced. TMT Search Adaptation is also shown as having a significant impact on radical innovations, whereas CEO Search Adaptation is not significant. In terms of Search Processes, results show that a CEO may have a distinct impact on innovation over and above the TMT's Search Process, but the TMT Search Process is nevertheless important, especially in relation to radical innovation.

Table 18 shows that the CEO's diversity in terrain sources has a negative and significant impact on total innovation, whereas the TMT's source diversity does not have an effect when considered in the same model. Table 19 shows that the CEO's search of unfamiliar terrain has a positive and significant impact on radical innovation, whereas the TMT's search terrain does not have an impact.

Taken together, these results suggest that in this sample of high-tech companies, the CEO's search activities have a dominant effect on innovation outcomes. There is also an apparent difference in the impact of a CEO's search versus the TMT's search when it comes to radical innovation. When radical innovation is the outcome under consideration, the CEO and the TMT both have significant impacts, but in different ways. This would suggest that the TMT's search activities are an important complement to the CEO's search activities.

Table 16: Negative Binomial Regression with Robust Standard Errors for the Effect of CEO vs. TMT Search Processes on Total Innovation

	(1)	(2)	(3)
Constant	6.570**	6.073**	4.739**
	(1.543)	(1.454)	(1.381)
TMT Size	-0.130	-0.113	-0.001
	(0.169)	(0.160)	(0.168)
Functional Heterogeneity	-2.960	-2.629	-1.583
	(2.061)	(1.668)	(1.355)
Firm Size	0.461**	0.437**	0.361**
	(0.140)	(0.145)	(0.139)
R&D Expense	-0.048**	-0.038**	-0.034**
	(0.012)	(0.011)	(0.012)
CEO Search Effort		0.607**	0.663**
		(0.194)	(0.227)
CEO Search Persistence		0.280	0.307
		(0.302)	(0.304)
CEO Search Formality		0.150	-0.259
		(0.268)	(0.336)
TMT Search Effort			-0.147
			(0.560)
TMT Search Persistence			-0.231
			(0.362)
TMT Search Formality			0.686
			(0.452)
Observations	60	59	59
Wald chi2	20.2204	41.8872	54.2271
Prob > chi2	0.0005	0	0
Pseudo R2	0.03	0.06	0.07
$\Delta\chi^2$		14.82**	3.83

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 17: Negative Binomial Regression with Robust Standard Errors for the Effect of CEO vs. TMT Search Processes on Radical Innovation

	(1)	(2)	(3)
Constant	1.872†	1.428	2.274*
	(1.121)	(1.080)	(1.096)
TMT Size	0.278	0.341*	0.152
	(0.169)	(0.164)	(0.144)
Functional Heterogeneity	-1.419	-1.324	-1.896
	(1.439)	(1.339)	(1.382)
Firm Size	0.368**	0.269**	0.248*
	(0.120)	(0.102)	(0.102)
R&D Expense	-0.041*	-0.035*	-0.024†
	(0.019)	(0.018)	(0.014)
CEO Search Effort		0.431**	0.129
		(0.140)	(0.198)
CEO Search Adaptation		0.153	-0.340
		(0.212)	(0.235)
TMT Search Effort			0.865†
			(0.506)
TMT Search Adaptation			0.988**
			(0.323)
Observations	60	59	59
Wald chi2	12.5812	18.8469	36.6162
Prob > chi2	0.0135	0.0044	0
Pseudo R2	0.06	0.08	0.11
$\Delta\chi^2$		9.73**	11.58**

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 18: Negative Binomial Regression with Robust Standard Errors for the Effect of CEO vs. TMT Search Terrain on Total Innovation

	(1)	(2)	(3)
Constant	6.570**	14.367**	9.246
	(1.543)	(2.033)	(5.751)
TMT Size	-0.130	-0.049	-0.047
	(0.169)	(0.134)	(0.139)
Functional Heterogeneity	-2.960	0.198	0.350
	(2.061)	(1.344)	(1.384)
Firm Size	0.461**	0.255*	0.264*
	(0.140)	(0.120)	(0.119)
R&D Expense	-0.048**	-0.027*	-0.027*
	(0.012)	(0.011)	(0.013)
Search Integration		0.195	0.288
		(0.331)	(0.384)
CEO Source Diversity		-14.266**	-16.732**
		(4.084)	(4.626)
CEO R/M Diversity		0.013	0.012
		(0.097)	(0.111)
CEO Distance Diversity		1.123	2.610
		(3.958)	(5.054)
TMT Source Diversity			13.408
			(11.802)
TMT R/M Diversity			0.413
			(0.835)
TMT Distance Diversity			-9.265
			(8.413)
Observations	60	59	59
Wald chi2	20.2204	42.6001	57.9957
Prob > chi2	0.0005	0.0000	0.0000
Pseudo R2	0.03	0.09	0.09
$\Delta\chi^2$		29.04***	1.69

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 19: Negative Binomial Regression with Robust Standard Errors for the Effect of CEO vs. TMT Search Terrain on Radical Innovation

	(1)	(2)	(3)
Constant	1.872†	0.842	1.226
	(1.121)	(1.396)	(1.528)
TMT Size	0.278	0.285†	0.310†
	(0.169)	(0.169)	(0.169)
Functional Heterogeneity	-1.419	-1.539	-1.564
	(1.439)	(1.466)	(1.378)
Firm Size	0.368**	0.338**	0.371**
	(0.120)	(0.110)	(0.113)
R&D Expense	-0.041*	-0.032	-0.030
	(0.019)	(0.021)	(0.022)
Search Integration		0.314	0.341
		(0.289)	(0.296)
CEO External Terrain		-0.196	-0.782
		(1.288)	(1.557)
CEO Unfamiliar Terrain		1.747	2.773*
		(1.120)	(1.306)
TMT External Terrain			0.027
			(0.032)
TMT Unfamiliar Terrain			-0.042
			(0.026)
Observations	60	60	60
Wald chi2	12.5812	17.6494	21.9258
Prob > chi2	0.0135	0.0137	0.0091
Pseudo R2	0.06	0.07	0.08
$\Delta\chi^2$		2.49	2.58

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Perceptual Filtering versus Direct Search

Perceptual filtering by executives "amplifies relevant information and attenuates irrelevant information" (Starbuck & Milliken, 1988: 41). Filtering therefore occurs while a top manager is engaged directly in search behaviors, but may also occur as information is presented by employees. There is therefore the issue of top managers being directly involved in search, or being more reliant on receiving information from employees. Given that the scenario and search questions specifically reference the involvement of individual top managers in search activities, it is somewhat difficult to examine this distinction and its impact on the search process.

To provide a rough examination of filtering as it may occur through direct TMT search behaviors versus more passively through acquiring information through firm employees, a hierarchical regression examining the interaction between search effort and TMT Size and Organization Size was conducted. This examination shows the relative importance of TMT versus other organizational members in the search process as it relates to the time and energy (effort) invested in search. It could be argued that a significant interaction between organizational size and TMT search effort would reflect that the top managers are drawing upon information provided by organizational members. This would reflect some degree of filtering on the part of top managers as they are more reliant on the information collected by organizational members than by their direct efforts.

Table 20 shows that the interaction between TMT size and Search Effort has a greater impact on Total Innovation than the interaction between Organizational Size and Search Effort (also see Figure 7). Larger TMT's that expend more effort on search have

a greater impact on innovation, most likely due to information sharing within the TMT. Utilizing other TMT members as sources of information is likely to assist perceptual filtering as information from other TMT members is given a greater weighting and seen as being of greater importance given the cost of delegating information acquisition (Choudhury & Sampler, 1997).

Different problems may result in greater reliance on other organizational members to conduct search, but such a situation will depend on the problem at hand, and a top manager's decision to be more passive in the search process. In this study, the framing of the scenario, and the nature of the problem that stimulates the search, emphasized the personal involvement of a top manager at a strategic level. The significant interaction between TMT Size and Search Effort would therefore imply that the search process is contained at the level of the TMT without significant involvement by employees.

Figure 7: Interaction between TMT Size and Search Effort

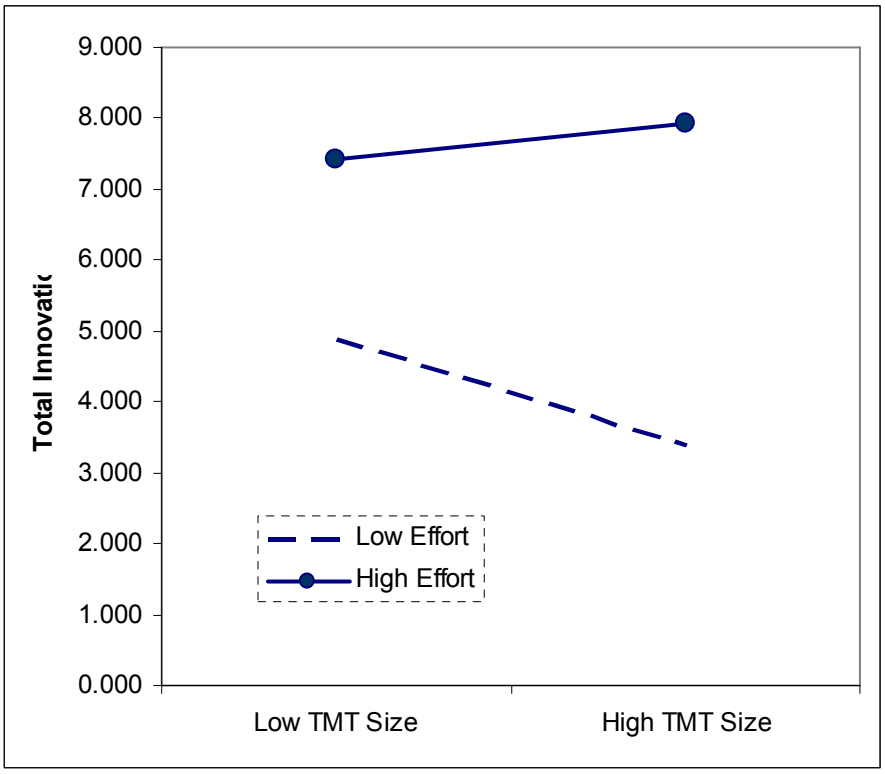


Table 20: Negative Binomial Regression with Robust Standard Errors for the Interaction between Search Effort, TMT Size and Firm Size on Total Innovation

	(1)	(2)	(3)	(4)
Constant	6.570**	7.370**	6.626**	6.500**
	(1.543)	(1.534)	(1.441)	(1.479)
TMT Size	-0.130	-0.271+	-0.135	-0.121
	(0.169)	(0.145)	(0.103)	(0.107)
TMT Functional Heterogeneity	-2.960	-3.504+	-3.964*	-3.777*
	(2.061)	(2.043)	(1.895)	(1.917)
Firm Size	0.461**	0.413**	0.354**	0.388**
	(0.140)	(0.126)	(0.114)	(0.122)
R&D Expense	-0.048**	-0.039**	-0.031**	-0.034**
	(0.012)	(0.013)	(0.010)	(0.010)
TMT Search Effort		0.619	0.609	0.585
		(0.453)	(0.370)	(0.373)
TMT Size x Effort			0.599**	0.662**
			(0.177)	(0.204)
Firm Size x Effort				-0.170
				(0.215)
Observations	60	60	60	60
Wald chi2	20.2204	24.1322	47.2083	43.7586
Prob > chi2	0.0005	0.0002	0	0
Pseudo R2	0.03	0.04	0.06	0.06
$\Delta\chi^2$		1.87	11.41***	0.62

Robust standard errors in parentheses; ^{T} p < 10%; * p < 5%; ** p < 1%

Interaction of Search Terrain and Process Behaviors

The model of executive information search presented in Figure 1 suggests that the dimensions of search form a *gestalt* – an integrated whole which can be used to describe any search process as it varies along the key characteristics of search. This conceptualization lends itself to a large number of possible interactions between search terrain and search process variables. The preceding analysis therefore attempted to determine which search characteristics were of greatest significance to the search process based upon past research. Interestingly, the results of the hypotheses presented were mixed in several respects, with not all variables demonstrating a significant impact on organizational innovation, and one even demonstrating a negative relationship. These results raise the question of the possibility of differences between top management teams in their behaviors across both dimensions of search. To explore this, interactions of the search variables defined previously were examined in a series of negative binomial regressions. Given the large number of variables involved, only one set of interactions were examined per model.

Table 21 examines the effect of terrain and process interactions on total innovation. Model 2 investigates the interactions between search effort and characteristics of the search terrain. Only the interaction between effort and distance diversity is significant ($B = 52.726$, $p < 0.01$). This interaction (see Figure 8) shows that high levels of search effort enable top management teams that have both high and low levels of distance diversity to have a positive impact on total innovation. Without high

levels of search effort, these is potential a negative effect of distance diversity on total innovation.

Model 3 investigates the interactions between search persistence and characteristics of the search terrain. Only the interaction between persistence and scope diversity is significant (B = 38.101, $p < 0.01$). This interaction (see Figure 9) shows that top management teams with high scope diversity have a stronger impact on total innovation if there is also a high degree of search persistence. Further, low levels of persistence when searching a diverse range of sources leads to a negative effect on total innovation.

Model 4 investigates the interaction between search formality and characteristics of the search terrain. Only the interaction between formality and unfamiliarity is significant (B = -0.152, $p < 0.01$). This interaction (see Figure 10) shows that top management teams with low average levels of formality in their search process can take better advantage of unfamiliar information.

Table 22 examines the effect of terrain and process interactions on radical innovation. Across all three models presented, only Search Effort and Search Adaptation appear to have positive and significant effects on radical innovation. No terrain and process interactions have a significant impact on radical innovation.

Figure 8: Interaction between Terrain Distance Diversity and Search Effort

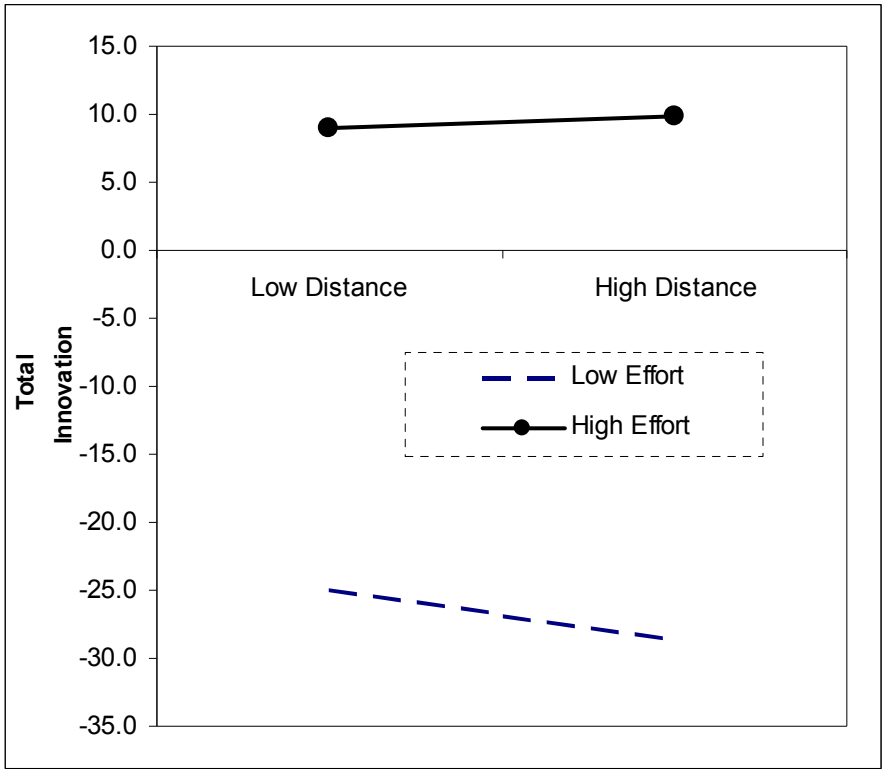


Figure 9: Interaction between Terrain Scope Diversity and Search Persistence

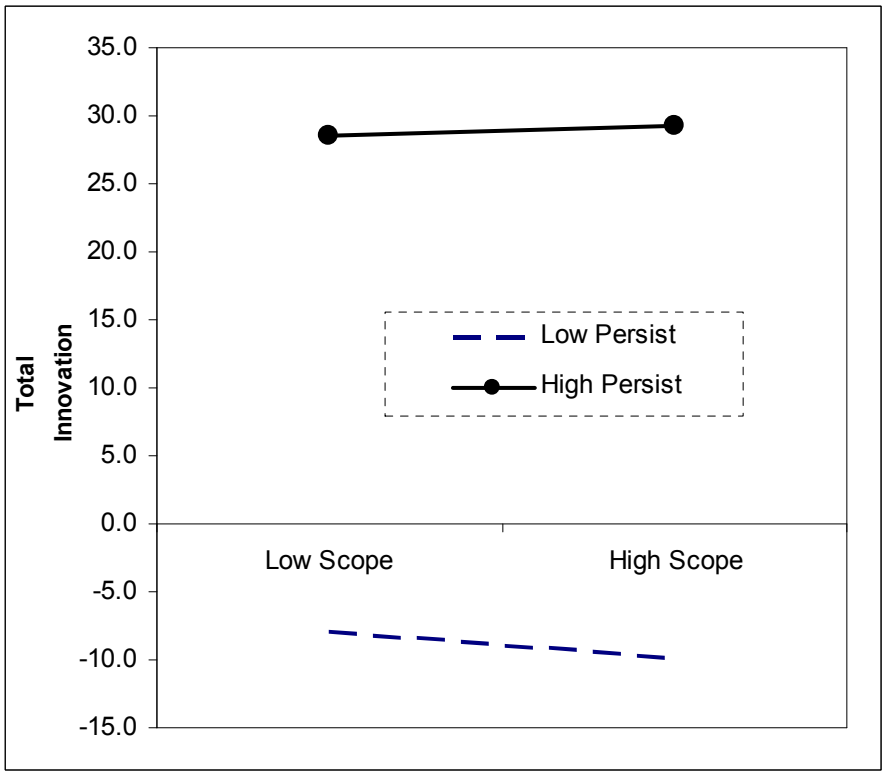


Figure 10: Interaction between Terrain Unfamiliarity and Search Formality

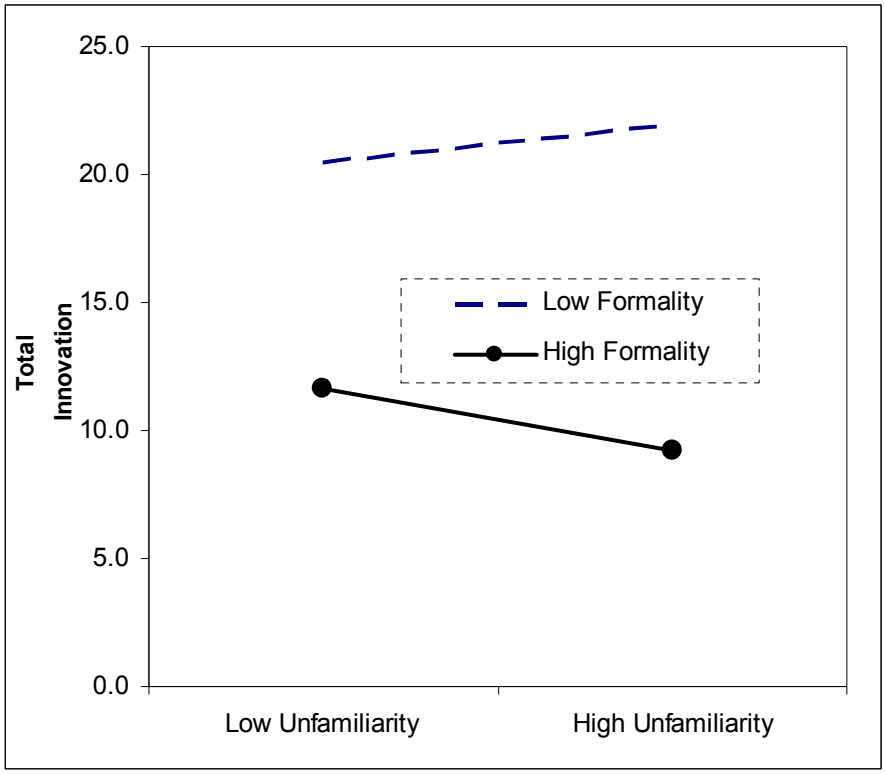


Table 21: Negative Binomial Regression with Robust Standard Errors for the Effect of Search Terrain and Process Interactions on Total Innovation

	(1)	(2)	(3)	(4)
Constant	24.336**	1.709	18.955**	17.209
	(9.034)	(8.062)	(6.229)	(10.516)
TMT Size	-0.005	0.032	0.036	-0.024
	(0.158)	(0.173)	(0.161)	(0.112)
Functional Heterogeneity	-3.603*	-3.855*	-3.719*	-2.788†
	(1.652)	(1.499)	(1.761)	(1.523)
Firm Size	0.368**	0.367**	0.348**	0.394**
	(0.127)	(0.112)	(0.120)	(0.128)
R&D Expense	-0.020	-0.018	-0.019	-0.018
	(0.013)	(0.012)	(0.012)	(0.012)
Search Effort	1.154*	1.493**	1.215*	1.167*
	(0.475)	(0.360)	(0.539)	(0.459)
Search Persistence	0.643†	1.273*	0.580†	0.994**
	(0.347)	(0.521)	(0.328)	(0.379)
Search Formality	0.167	-0.293	-0.194	-0.167
	(0.436)	(0.397)	(0.436)	(0.544)
Unfamiliar Terrain	-0.017	-0.026	-0.029	-0.029
	(0.027)	(0.024)	(0.030)	(0.021)
Source Diversity	-21.757*	15.362	-10.964	-17.776
	(10.467)	(11.577)	(8.369)	(13.194)
Resource/Market Diversity	1.415*	1.405**	1.508*	1.911**
	(0.593)	(0.531)	(0.667)	(0.687)
Distance Diversity	0.450	-15.014*	-5.312	6.147
	(8.055)	(7.112)	(8.162)	(8.018)
Effort x Unfamiliar		0.005		
		(0.072)		
Effort x Scope		-15.422		
		(12.117)		
Effort x Resource/Market		0.984		
		(1.249)		
Effort x Distance		52.726**		
		(8.324)		
Persist x Unfamiliar			0.049	
			(0.047)	
Persist x Scope			38.101**	
			(14.663)	
Persist x Resource/Market			0.512	
			(1.694)	
Persist x Distance			2.725	
			(10.738)	
Formality x Unfamiliar				-0.152**

				(0.042)
Formality x Scope				-29.898†
				(18.008)
Formality x Resource/Market				1.093
				(1.876)
Formality x Distance				8.685
				(16.126)
Observations	60	60	60	60
Wald chi2	81.336	207.223	104.635	169.173
Prob > chi2	0.000	0.000	0.000	0.000
Pseudo R2	0.080	0.120	0.100	0.110

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Table 22: Negative Binomial Regression with Robust Standard Errors for the Effect of Search Terrain and Process Interactions on Radical Innovation

	(1)	(2)	(3)
Constant	3.284†	3.201†	3.809†
	(1.933)	(1.927)	(2.292)
TMT Size	0.138	0.116	0.120
	(0.123)	(0.132)	(0.127)
Functional Heterogeneity	-2.345†	-2.167†	-2.553*
	(1.230)	(1.220)	(1.230)
Firm Size	0.330**	0.342**	0.320**
	(0.107)	(0.114)	(0.106)
R&D Expense	-0.033*	-0.031*	-0.032*
	(0.015)	(0.016)	(0.016)
Search Effort	1.104**	0.943*	1.139**
	(0.377)	(0.401)	(0.374)
Search Adaptation	0.626*	0.717†	0.659*
	(0.294)	(0.368)	(0.315)
Unfamiliar Terrain	-0.029	-0.030	-0.030
	(0.022)	(0.022)	(0.022)
External Terrain	0.019	0.020	0.015
	(0.027)	(0.029)	(0.030)
Adapt x Unfamiliar		0.043	
		(0.037)	
Adapt x External		-0.045	
		(0.053)	
Effort x Unfamiliar			-0.006
			(0.047)
Effort x External			-0.015
			(0.055)
Observations	60	60	60
Wald chi2	34.535	39.316	38.088
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.110	0.110	0.110

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

Direct Effects of TMT Search Integration Capability

TMT Search Integration Capability is argued as a key factor allowing top management teams to integrate the information acquired through individual search behaviors. While the effect of search integration was hypothesized as an interaction with search terrain characteristics, there is reason to suspect that there may be a direct impact of search integration on innovation in an organization.

Rationale for this argument can be based on Hambrick's (1994, 1995, 1998) research on TMT behavioral integration. Hambrick conceptualized behavioral integration as a metaconstruct consisting of three interrelated aspects of TMT process: i) level of collaborative behavior, ii) quantity & quality of information exchanged, and iii) emphasis on joint decision making. Additionally, Levinthal and Warglien (1999) argued that synchronized and cooperative behavior is important for search to achieve optimal organizational outcomes, especially when 'nonincremental search' is desired (i.e. search resulting in outcomes not incremental in comparison to previous outcomes).

While there are several theoretical reasons why search integration capability could have a direct effect on organizational innovation, it was interesting to note that between-group variability on this variable was affected by a handful of teams. This raises the issue of consensus among teams in their ratings of search integration capability.

Research on team consensus on variables such as leadership and organizational climate (e.g. Bliese & Halverson, 1998; Lindell & Brandt, 2000) has shown that consensus ratings can explain unique variance over and above absolute ratings on group-level variables. The possibility that team consensus on search integration capability could have an effect on organizational innovation is therefore an additional questions

suggested by the sensitivity of aggregation statistics to the effect of a small handful of teams as outlined in the previous chapter.

To explore the new hypothesis that greater TMT search integration capability will lead to greater numbers of organizational innovations, I therefore included a measure of the variability of the search integration capability variable. Use of the variability of the search integration capability variable is in keeping with studies that have utilized such variables as an indication of consensus or dissensus (e.g. Schneider, Salvaggio, & Subirats, 2002).

Following the procedure outlined by Schneider *et al.* (2002), I operationalized search integration capability consensus as the standard deviation of top managers' perceptions of search integration capability within their teams[1]. The magnitude of each team's rating of the search integration capability (i.e. the mean value), was found to be significantly positively correlated to the consensus score ($\rho = 0.4439$, $p < 0.001$). Hierarchical regression of the mean value on the consensus score with a quadratic term was utilized to determine if this relationship was linear or curvilinear. A nonsignificant quadratic term (incremental F = 0.98, NS) indicated that the mean and standard deviation were linearly related.

Hierarchical negative binomial regression was then utilized to test the relationship between search integration capability and innovation, accounting for the effects of consensus within teams on this variable. Results shown in Table 23 (model 6) show only marginally significant results for the effect of the interaction of search integration capability and search integration capability consensus on radical innovation (B = -1.102, $p < 0.10$). The graph of this interaction (shown in Figure 11) suggests that there is a

[1] The variability measure was converted into a consensus measure by multiplying the value by -1.

positive effect of search integration capability on radical innovation, but that this effect is stronger when there is low consensus among members of the team. There does not appear to be a relationship between search integration capability and total innovation (model 3).

Figure 11: Interaction between Search Integration Capability and Search Integration Capability Consensus

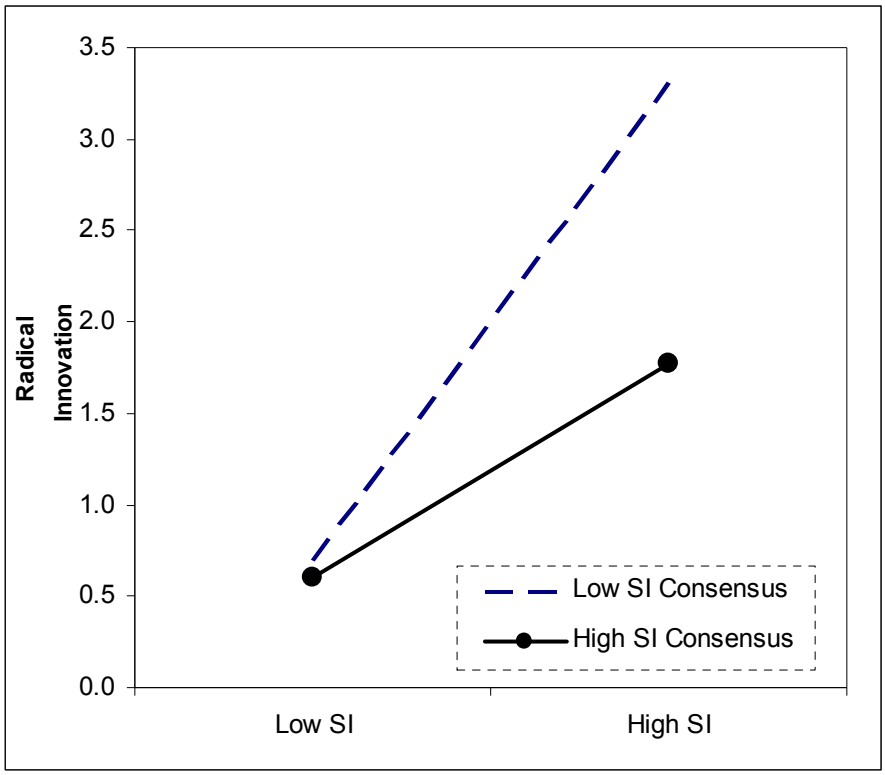


Table 23: Negative Binomial Regression with Robust Standard Errors for the Effect of Search Integration on Organizational Innovation

	(1) Total Innovation	(2) Total Innovation	(3) Total Innovation	(4) New Innovation	(5) New Innovation	(6) New Innovation
Constant	5.892**	5.099**	5.153**	0.849	0.785	0.940
	(1.658)	(1.481)	(1.473)	(1.206)	(1.109)	(1.092)
TMT Size	-0.078	-0.063	-0.091	0.306+	0.291†	0.236
	(0.197)	(0.174)	(0.173)	(0.183)	(0.169)	(0.163)
Functional Heterogeneity	-3.015	-3.890†	-3.787†	-0.661	-1.570	-1.510
	(2.246)	(2.117)	(2.087)	(1.628)	(1.621)	(1.559)
Firm Size	0.329*	0.210*	0.182	0.288**	0.240**	0.195*
	(0.128)	(0.103)	(0.114)	(0.108)	(0.091)	(0.095)
Search Integration	0.388	0.940†	0.848	0.505	0.634†	0.556
	(0.499)	(0.538)	(0.574)	(0.330)	(0.325)	(0.345)
Search Int. Consensus		-1.176*	-1.217*		-0.701†	-0.809†
		(0.483)	(0.498)		(0.416)	(0.424)
SI x SI Consensus			-0.610			-1.102†
			(0.612)			(0.612)
Observations	60	60	60	60	60	60
Wald chi^2	11.712	15.863	16.867	10.589	12.835	18.231
Prob > chi^2	0.020	0.007	0.010	0.032	0.025	0.006
$\Delta(chi^2)$		5.92*	0.99		2.84†	3.25†

Robust standard errors in parentheses; † p < 10%; * p < 5%; ** p < 1%

CHAPTER 7: DISCUSSION AND CONCLUSION

This dissertation sought to address two main questions: 1) What is the relationship between information search activities in top management teams and organizational innovation; and 2) to what extent is such a relationship affected by the ability of the top management team to integrate the information gathered through search? Results were supportive of the importance of information search as a contributor to organizational innovation, but only marginal evidence was found with regards to the importance of search integration capability in top management teams.

Prior theoretical and empirical work supports the fact that information gathering is a crucial function of top managers (e.g. Mintzberg, 1973; Aguilar, 1967; Boyd & Fulk, 1996; Daft *et al.*, 1988; Garg *et al.*, 2003). However, the specifics of this function as reflected in information search behaviors have received scant attention. Further, a comprehensive framework for understanding the concept of information search has been missing from the literature, despite the many studies that have drawn on this concept. To address this shortcoming, a model of executive information search was developed in this dissertation and evidence presented as to the validity of this model and its impact on organizational innovation. This model presented information search as having two interrelated dimensions – terrain (where you look) and process (how you look). Several characteristics of these dimensions were developed and their relationship to organizational innovation tested.

Several results that are consistent across all models presented are worthy of note. Search effort – the time and energy devoted by top managers to search – is consistently shown to have a positive and significant effect on organizational innovation. This finding

reflects the central role that information plays in the functions of managers (Hales, 1986; Kotter, 1982; Mintzberg, 1973; Stewart, 1976). At the most basic level, search will not occur unless there is some effort put into it. It is therefore important that this result is present in order to emphasize that information search is a key behavior of top managers. This is consistent with the behavioral theory of the firm (Cyert & March, 1963) that postulates that search and decision making jointly contribute to firm innovation.

Further, this may also explain the contrary finding of the curvilinear effect of search effort. One of the main functions of top managers is to solve problems and find new opportunities, which can best be achieved if they are directly and actively involved in acquiring the information needed to make effective decisions. The importance of this role might make it difficult to find any negative impact from excessive search – where nearly all of a manager's time is spent gathering information to the detriment of any other function.

Also of note is the positive and significant effect of search adaptation on the introduction of radical organizational innovation. Cyert and March's (1963) conceptualization of search as 'simple-minded' and 'biased' referred to the bounded rationality of individual decision-makers and their inability to find solutions too far removed from past solutions that had been adopted. Several studies demonstrate that organizations can be more adaptive, leaving the confines of 'local' search in order to increase performance (e.g. Stuart & Podolny, 1996; Levinthal & March, 1981). However, the exact mechanism through which this occurs has not been fully explored. This study's examination of search adaptation as a combination of the iterative use of information coupled with reflection on what has been learned presents some insights into

this process. Further, it presents some support to Gavetti and Levinthal's (2000) computer model that indicated the superiority of joint cognitive and experiential search as a means to engender adaptive behavior in organizations. Organizations whose top managers are more adaptive in their search behaviors are better suited to influence the introduction of radical organizational innovations that could potential confer greater organizational advantage (Gatignon *et al.*, 2002; Mitchell, 1989). This result points to the need for top managers to be more adaptive in how they gather information. Top managers' time is valuable, and those that can use it most wisely through searching in a way that takes into account what is being learned while searching can have a stronger impact on the introduction of radical innovations. These managers are not constrained by preconceived notions of where search should take place, but rather engage in some degree of exploration based on an evolving understanding of what defines an optimal solution alternative.

The third finding consistent across the models presented related to the importance of top management teams utilizing a diverse mix of resource information and market information. The importance of combining market and resource knowledge to determine the potential successfulness of an innovation is therefore confirmed as an important function of top managers (e.g. Ardichvili *et al.*, 2003; Wiklund & Shepherd, 2003). This finding is an important complement to the research of Henrich Greve, who highlighted the fact that "an innovation doesn't leap straight from the laboratory to the market; rather, the decision to launch it is an important intervening step guided by problem solving and risk taking" (2003: 697). It is also consistent with research on boundary spanning that demonstrates that the external interactions of managers affect organizational strategy and

thus performance (e.g. Geletkanycz & Hambrick, 1997). Overall, this result corresponds directly to the informational role of managers (e.g. Barnard, 1938; Mintzberg, 1973) and their essential function of positioning their organization at the *nexus* – the co-alignment of technology and the task environment (Thompson, 1967).

Overall, these three results are very much consistent with prior research that has demonstrated the importance of information gathering behaviors of managers. Specifically, however, the results show the significance of *search* as a complement to other forms of information gathering (cf. Huber, 1991). Across both the main analysis and the post-hoc analysis, the ΔR^2 that can be attributed to search variables ranged from 0.03 to 0.04, which at the very least was significant at $p < 0.05$. Search behaviors are therefore an important complement to other top management team characteristics and processes that have been shown to have an impact on organizational innovation (e.g. Bantel & Jackson, 1989; Hoffman & Hegarty, 1993; West & Anderson, 1996).

The theoretical distinction between search and other forms of information gathering is therefore not only important from a conceptual point of view, but highlights the empirical necessity of distinguishing these behaviors in order to determine the true cause of organizational outcomes. Past research has not taken proper account of this distinction – especially between search and scanning – and thus there is a question as to the clarity of their results (e.g. Garg, Walters & Priem, 2003).

While tests of the initial hypotheses presented mixed support for the direct effects of other search characteristics (namely search persistence and search formality) and an interesting negative finding for terrain scope, several post-hoc findings that explored the interactions between search process and search terrain shed additional light on the

importance of various search characteristics. Originally, hypotheses on these interactions were not developed in order to focus on an examination of the direct effects of search process and search terrain variables. I felt it important to test these effects first in order to show the significance of these variables, especially in relation to how they were conceptualized in earlier studies. Research on search in other literatures utilized proxies for search, tended to focus on only a very limited set of search characteristics, and often did not examine these characteristics in interaction (see Katila & Ahuja, 2002 for an exception), except where the constructs were combined (e.g. comprehensiveness – Fredrickson, 1984).

Given the large number of interactions possible with the eight search characteristics outlined in this dissertation, I only focused on a limited set of interactions that corresponded to the models originally hypothesized. For instance, the models that focused on radical innovations only utilized the search variables that were hypothesized to directly affect radical innovation. This is not to suggest that other interactions are not important, but this limitation offers more correspondence with prior research. In these interaction models, several characteristics of search that did not manifest significant direct results are shown as having significant interactions. Interpreting these interaction results demonstrates the significance of a *gestalt* model of search in which both dimensions of search are considered simultaneously.

Three specific interactions were shown to be significant. First, distance diversity and search effort interacted in such a way that top management teams that placed more effort into search across a variety of boundaries had a greater effect on the total number of organizational innovations. Search terrains with both low levels and high levels of

distance diversity had a negative impact on innovation when low levels of search effort were involved. These findings indicate that crossing organizational boundaries requires more time and energy from top managers in order to be of use (e.g. Dollinger, 1984). This may be indicative of the cost of maintaining relationships with contacts outside of the firm. Cultivating and maintaining contacts in an external network requires repeated interaction (i.e. time and effort) in order to develop trust and facilitate enhanced knowledge flows (e.g. Walker *et al.*, 1997).

Second, the negative finding with the direct effect of scope diversity appears to stem from the fact that high levels of persistence are needed in order for a top management team to derive benefit from a wide variety of information sources. This may be due to the number of different alternatives that may arise from different sources. A top management team that is not persistent in trying to determine the optimal alternative is not able to effectively utilize the variety of alternatives that may arise across a wide scope of information sources.

Third, search formality and terrain unfamiliarity interacted in such a way that high search formality in an unfamiliar terrain had less of an impact on total innovation. This would seem to indicate that it makes little sense to apply set routines in circumstances where the searcher in not familiar with the information being searched. This finding is reflective of the work of Barrick and Spilker (2003), who argued that searchers utilizing unfamiliar terrain were more systematic in their approach, but less efficient in their search than someone who was more familiar with the information.

The last question addressed in this dissertation was an examination of the impact of search integration capability on the relationship between search and innovation.

Search integration capability was proposed as a new concept that encapsulated a top management team's ability to utilize the information gathered by each of its members. Search integration capability was therefore proposed to allow the individual contributions made through search to be integrated into a team decision making process. While models such as Hollenbeck and colleagues' (1995) multilevel hierarchical team decision making model incorporate notions of the importance of the sharing of the information held by individuals (e.g. team informity), there are other mechanisms and constructs that are argued to contribute to the overall team decision-making process. Search integration capability may then be only a small part of the overall mechanism that influences the emergence of group-level search from individual-level search. The point of defining this new construct, as opposed to falling back on other more established group processes, was to focus directly on information search and the emergence of a group process centered on search activities.

Contrary to predictions, only marginal support was found for the effects of search integration capability. Search integration capability only appeared significant when it came to top management teams searching in unfamiliar terrains. This may be reflective of the importance of sharing unfamiliar information as a means of understanding its implications for the firm. Teams that shared unfamiliar information and discussed such information openly seemed to be better equipped to utilize this information and to apply it to the introduction of radical innovation.

This finding suggests that teams that overcome the common knowledge problem can have a greater impact on organizational innovation. The common knowledge problem exists when unshared information is omitted from discussion, with team

members instead focusing on information that is common among the team (Stasser & Titus, 1985, 1987; Stasser, Taylor & Hanna, 1989). This problem is exacerbated when individual team members have large amounts of information to remember, as well as in large groups as these are more likely to discuss shared information (Stasser & Titus, 1987). This would appear to correspond with the negative curvilinear effect of terrain unfamiliarity. Teams that venture too far into unfamiliar terrain may run into difficult in recalling unfamiliar information, and therefore are not able to effectively share this information in the group.

The interaction between search integration and terrain unfamiliarity notwithstanding, the lack of findings overall suggest that there is more room to explore the problem-solving processes of top management teams with respect to the use of information search. Research that has examined team diversity variables and process variables (e.g. Simons, Pelled & Smith, 1999) may shed more light on the interaction processes in top management teams that allow the diversity of information sources utilized to contribute to group decision-making and hence firm performance. While search integration capability is proposed as a construct to measure information sharing within the top management team, processes such as debate and decision comprehensiveness may be more important to study in relation to search as they better capture the *use* of information collected through search.

Additionally, research on search behaviors of executives may also prove a useful complement to studies that examine the impact of top management team diversity on performance. Research has shown that demographic diversity among top management teams does have some predictive power concerning organizational outcomes (e.g.

Simons, Pelled & Smith, 1999), and that cognitive diversity is also an important consideration (e.g. Kilduff, Angelmar & Mehra, 2000), but to fully explore how the diverse experience base of a team comes into effect, consideration should be given to the process through which this experience is built – and in particular how behaviors relating to information gathering impacts knowledge and experience. The mechanisms through which top management team diversity impacts organizational performance should therefore have direct bearing on the effectiveness of search.

In addition to the main findings concerning search that are discussed above, it is also interesting to note several findings with respect to the control variables used in this study. First, firm size is shown to have a consistently positive and significant effect on firm innovation in accordance with past research (e.g. Kimberly & Evanisko, 1981; Damanpour, 1991). Second, firm R&D expense is shown to have a significantly negative effect on firm innovation. This finding is surprising given the positive effect that R&D has been shown to have on innovation, and its use as a proxy for organizational search (e.g. Katila, 2002; Greve, 2003). One possible explanation for this relates to top management's role in deciding when to *launch* an innovation. Greve (2003) found evidence that R&D intensity added to a firm's 'stockpile' of innovations which were then introduced when needed. In the sample utilized in this dissertation, it may be the case that some companies were focusing on developing innovations but not necessarily introducing them to the market.

Limitations & Future Research

The research presented in this dissertation offers several encouraging findings for further exploration of the concept of information search. Several limitations are noted,

and although they do not detract significantly from this study, are areas for further improvement. First, the sample utilized was relatively small. Given the large number of search variables that were examined and the medium effect size found, the amount of statistical power to find significant effects is limited. In order to have a power level of 0.8, the sample size would have to double in order to accommodate the number of search variables utilized in some of the larger models. While there were a few consistent findings and significant results, there were instances where several search variables where just over the $p < 0.05$ threshold for significance. Second, the sample utilized focused on high technology companies. While this is appropriate for studying organizations for which innovation is important (Damanpour, 1991; Kessler & Chakrabarti, 1996), executive information search is a concept that should be of importance in strategic decision-making and should therefore apply to organizations in other contexts. Third, information search is likely to be of significant impact at the level of knowledge workers (e.g. scientists & engineers) in an organization. Innovation literature often discusses search within this context; however, this is typically done in terms of using proxies for search such as R&D expense as a reflection of the process of conducting studies, examinations, and the like. Specifically focusing on how knowledge workers acquire information may therefore get at a more fine grained level of detail which would allow a better understanding of how search is conducted at a level that has a more direct impact on the actual discovery and creation of an innovation.

Finally, there are several areas in which the search variables defined in this study can be explored in greater detail. For instance, in terms of their impact on other measures of organizational performance or further examination of different sets of interactions

between terrain and process variables. There is also scope to better understand the terrain that is utilized by high performing top management teams. For instance, the finding the other extra-industry sources were utilized very frequently begs the question of exactly who these sources were and what information they were contributing to top managers' search. Further, there did not appear to be a very clear distinction between the characteristics of top management teams that were high on various search characteristics versus other teams. This may be the result of particular patterns of search that do not have any particular search characteristic at the forefront, but certainly is an area for further investigation.

Conclusion

Drawing upon early conceptualizations of search by March and Simon (1958) and Cyert and March (1963), this study has provided an excellent starting point for expanding upon a theory of information search. This dissertation has provided a more thorough conceptualization of search than has been attempted in prior research. It has drawn on several literatures to better explore an overall conceptualization of search and its various parts. In particular, two dimensions of search, the terrain (where search takes place) and the process (how search takes place) are examined in terms of key behaviors and characteristics that a searcher may exhibit. These characteristics have been drawn from several literatures and operationalized in such a way as to provide a more exact test of the importance of these behaviors in the context of organizational innovation.

This research is therefore significant in two respects. First, it presents an integration of a wide body of both theoretical and empirical work that has utilized the concept of search. This more rigorous use of the concept of search better presents how

this concept should be used given that past research has already argued for its significance. Second, as opposed to the use of more distal proxies, the method outlined in this dissertation has allowed a finer test of the importance of search in the innovation process. These new measures of search have further scope for improvement, but clearly outline a specific and useful way of measuring search which is in contrast to more general information gathering behaviors (such as scanning) that have measures that are more specific to their own theoretical conceptualization.

While focusing on search from the perspective of top executives, results show the importance of specificity when discussing search as a mechanism influencing decision-making and innovation. Search that is more effortful, adaptive, or which draws upon a mix of resource and market information, can have significant impact on organizational innovation. Other characteristics of search are also important, but must be considered in terms of both how the search is conducted and where the search is conducted. While this finding seems intuitively obvious, the lack of specificity in past research concerning search shows that proper consideration of this information gathering behavior is lacking. Information search does have an impact on innovation, that much is clear from research in a number of domains. What has not received adequate attention is that fact that search can take a variety of forms, some of which have the potential to be more beneficial than others. Acknowledging this fact, the use of search in future research should treat this concept more carefully to ensure that both theoretical arguments and empirical tests are more exact. Information search is therefore a fruitful area for future research, with the potential for generating practical implications that will allow top executives and organizations to become more competitive and innovative.

APPENDIX I: OTHER CONCEPTS RELATED TO SEARCH

This appendix provides an overview of the differences between the concept of search and several other concepts related to information acquisition. In particular, executive scanning behavior and the use of personal networks are reviewed as alternative mechanisms through which managers can acquire information.

Search versus Scanning and Boundary Spanning

Two other areas of research that have placed particular emphasis on information gathering as an important influence on innovation have been in boundary spanning and executive scanning. Both of these areas build off of the premise that one critical aspect of the innovation process is the gathering of information from external domains (Mintzberg, 1973; Tushman, 1977).

The literature on boundary spanning focuses on the effective transfer of information – primarily across organizational boundaries, but also between organizational units (Tushman, 1977; Tushman & Scanlan, 1981). Boundaries are argued to exist due to specialization that occurs as organizations grow and develop. For instance, organizations may generate their own idiosyncratic norms, values, time frame, and coding schemes to permit effective processing of information. These differences may also exist between organizational subunits depending on the size of the organization. However, for the most part, executives' boundary spanning activities are considered in terms of their interactions with external entities (Geletkanycz & Hambrick, 1997).

While research into boundary-spanning has typically investigated boundary-spanning behavior of various organizational members, there has also been research that specifically addressed boundary spanning by managers (e.g. Dollinger, 1984;

Geletkanycz & Hambrick, 1997). This work has suggested that the external interactions of managers contributes to the shaping of organizational strategy, and hence to organizational performance. Executives' external ties "serve as conduits for information that shapes managerial views of the environment and contributes to the set of alternatives from which strategic choices are made" (Geletkanycz & Hambrick, 1997: 655). Research has also found that the external ties of executives contribute to the adoption of organizational innovations (e.g. Davis, 1991; Geletkanycz & Hambrick, 1997; Palmer, Jennings, & Zhou, 1993).

Originally conceptualized as a boundary spanning task, scanning was initially defined as "the managerial activity of learning about events and trends in the organization's environment" (Hambrick, 1981: 299). More recent definitions focus on scanning as an information gathering task that is an antecedent to interpretation and action and thus a key step in the process of organizational adaptation (Daft & Weick, 1984; Thomas, Clark, & Gioia, 1993). The primary concern of research into executive scanning has focused on the linkage between characteristics of the firm environment and scanning behavior (e.g. Boyd & Fulk, 1996; Culnan, 1983; Daft *et al.*, 1988; Kefalas & Schoderbeg, 1973). The general finding in this tradition has been that greater environmental uncertainty in areas of strategic concern stimulates greater levels of scanning in the area that is causing the uncertainty.

Recent work by Garg, Walters, and Priem (2003) argues that executive scanning represents a dynamic capability for selectively attending to both internal and external environments. A positive relationship between CEO scanning emphasis in selective areas of both the internal and external environments and organizational performance was found

in more dynamic competitive environments, which complements other research showing a positive link between scanning and organizational performance (Daft *et al.*, 1988; Dollinger, 1984; Tushman & Katz, 1980). While research into internal scanning is relatively limited in comparison to external scanning (Bluedorn *et al.*, 1994; Garg *et al.*, 2003), some researchers argue that internal scanning is better understood as performance monitoring (e.g. Huber, 1991).

While initial research by Aguilar (1967) into scanning included both formal and informal search, and both directed and undirected viewing, the literature on scanning developed to emphasize undirected viewing of the environment, including both formal and informal information gathering. Formal scanning is typically viewed as a function of a specific organizational unit (Ghoshal, 1988), whereas informal scanning relates to the daily scanning activities of individual managers. Fahey and King (1977) further differentiated scanning according to the frequency in which it was conducted. Irregular scanning related to ad hoc environmental study triggered by an unanticipated occurrence; regular scanning is described as more comprehensive and systematic, often taking place at regular intervals (e.g. annually); and finally, continuous scanning which involves continuous monitoring of the environment and is typically conducted through a formal organizational unit. Kiesler and Sproull (1982) also made the distinction that scanning may be automatic – an unconscious perception of phenomena.

Later research on organizational learning (e.g. Huber, 1991) made the clear distinction that while both search and scanning contributed to knowledge acquisition, the two activities took very different forms. Search is distinct from scanning in that it is a focused activity that is directed towards some element of a manager's environment, as

compared to the relatively wide-range sensing that occurs in scanning activities (Huber, 1991). Scanning affects awareness of trends and events in the environment and impacts on technology policy as well as strategic decision making (Garg *et al.*, 2003; Hambrick, 1981). On the other hand, search activities typically arise in the decision making process, with the purpose of search focused on problem-solving rather than general managerial awareness. Therefore the key difference between search and scanning relates to the purpose behind gathering information. The purpose of scanning activities is to increase awareness of the environment, and better enable the interpretation of environmental issues (Boyd & Fulk, 1996). The purpose of search activities is to address a specific issue that has arisen – whether the issue originates from the external environment or the internal environment. Search therefore begins with the recognition that an issue exists, and ends when the issue is resolved. Scanning occurs independent off any issues that may occur and is therefore more of a continuous process than search.

Search within a Social Network Perspective

The social network literature has also provided ideas and techniques that can be used to describe search behavior. For example, Stuart and Podolny used network techniques to demonstrate that firms do not search in isolation, but as "members of a population of simultaneously searching organizations" (1996: 36). Burt's (2000) review indicated the importance of network structure for the access and control of information, a contributing factor for developing social capital. Social capital is defined as "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998: 243). This perspective is concerned with the conditions necessary for the

exchange and combination of knowledge, conditions important for influencing creativity and innovation in organizations (e.g. Perry-Smith & Shalley, 2003). However, it is important to note that this literature typically emphasizes network structure to the exclusion of network content.

Rodan and Galunic (2004) empirically demonstrate this difference, showing that both network structure and network content can independently, and in interaction, have an impact on managers' overall performance and innovation performance. The arguments developed in this dissertation focus on the search for content in an individual's social network, an area for which there is almost no empirical research.

Several other considerations distinguish search from a network perspective. First, while a social network perspective focuses on interpersonal contacts as sources of knowledge and information, search is not limited to these contacts alone. Published media are an important source of information that must be considered. Information search therefore takes a broader perspective on knowledge acquisition than is utilized in a network perspective. Second, the search framework proposed in this dissertation deals with the behaviors and activities of managers. Social network research assumes that the existence of a network implies its use. Therefore, studies of both the structure and content of social networks does not examine how these networks are being utilized by managers in order to increase their performance. Finally, a network perspective provides limited guidance on how managers go about expanding their network of contacts in search of information. For instance, Rangan defines search as "acts involved in identifying potential exchange partner … when response to a need or opportunity for exchange is perceived to lie beyond known potential exchange partners" (2000: 814).

This theoretical discussion provides an integration of economics and network sociology to advance propositions on conditions under which search can lead to efficiency in economic actions. However, the actual mechanics of search are not clearly discussed.

In closing, information acquisition through search is concerned not just with the use of familiar contacts/media (i.e. a social networks perspective), but also how managers go about searching in unfamiliar information domains. Search takes place both within organizational boundaries as well as across them; and finally, search is purposeful and directed in nature, ending when a solution is identified.

APPENDIX II: SEARCH & DISCOVERY CASE STUDIES

Case Studies Overview

Four exploratory case studies were conducted prior to this dissertation in order to explore the search and discovery process within organizations. Two of the companies selected were early-stage companies participating in the technology incubator program at the University of Maryland. The second two companies were more mature publicly traded companies in the pharmaceutical industry. These two groups of companies were selected to on one hand provide the variance needed to detect differences in the search and discovery process in different contexts, but to also use pairs of companies as "controls" for one another following Yin's (1984) replication strategy.

For each company, data was collected in several ways. First, interviews with senior executives; second, interviews with key knowledge workers; and third, archival and secondary sources (such as published articles, business plans provided by the companies, and news reports and press releases). The interview protocol utilized is shown in the following section.

In order to analyze the data gathered, several themes were identified after a first round of reviews of interview transcripts by members of the research team. Subsequently, specific portions of text from interview transcripts were identified as corresponding to each theme and extracted for further review, categorized by company. This then allowed for comparisons across companies according to theme, and the identification of commonalities and dissimilarities in the paths these companies had taken to arrive at various innovations. Specific search behaviors were identified in these paths, thereby forming the basis of a model of search that was further refined and expanded

upon through an extensive review of various literatures pertaining to information gathering.

Interview Protocol

1. How did this new creative project get started? How long did it take?
2. What was your role in the process? How has it changed? Who else was involved?
3. Could you pls walk us through the different steps in the process. What was the first step? When did it occur? After the first step did you return to the same step again? What other steps followed? How much time on each step?
4. Was there a need to manage time during the project? How did you do it? What criteria/formal rules did you use to decide to stop the process – who said "we are done"? How did you decide it was time to stop, and move on to the next step?
5. If you think about the project, what motivated you in the beginning? How about later? If you had to place you and your team in a continuum from "need to develop cool new things/make a difference" (intrinsic) to "translate a new idea into a profitable venture" (extrinsic) where would you fall? Can you think of recent examples/occasions where one of these aspects was especially salient? What motivation was driving this process?
6. What was/is your typical day like when working on this project?
7. What was the role of brainstorming meetings in this project? Pls describe what happens during a typical mtg.
8. When you think about the different parts of the project, what kind of knowledge turned out to be (not/)useful in each phase? Can you think of specific examples of the types of internal/external information you used? Where did you go to search for information? What were the most frequent sources? What was the most credible source? What was the most efficient search process? How was the knowledge you used different from what other researchers generally used? How/did you process (organize) the knowledge you gathered?
9. Who did you talk to during the process? Has this changed over time? How did you find these people? What external contacts did you make? How many people (approximately) did you contact? Whose word was the most influential?
10. You probably encountered several roadblocks during the development – how did you deal with them? (who did you talk to, what more info gathered…) Can you think of specific examples?

11. Did you ever run into a situation where you could have proceeded using 2-3 different approaches and had to make a choice on how to proceed? How did you make this decision (who…)? Can you think of recent examples? Was it possible to proceed down two or three paths at the same time? How did you manage this?
12. If you think about the goals (process) you set or perceived for this project when you first became involved, how have those changed along the way? If you were originally set out to solve a specific problem, did that change?
13. Did some things surprise you (positively?) during the process? How did these affect the process?
14. It's notoriously difficult to evaluate and reward R&D workers. What/when were the types of motivators or rewards used in this project? How did you motivate yourself? How did others motivate you? Did they work in your opinion?
15. If you had to compare this process with your previous R&D project *(pick previous company x, previous project y from CV*), how would you say this project was different? How successful / good was the process in comparison with x? Was the climate for innovation different/similar? How about the technological and market prospects?
16. If you could restart this project, what would be the things that you would do differently?
17. What were the main **constraints** that affected you or your team and how did they affect your motivation and your work? What were the main **facilitators**? How did the context or the setting in which you went through this process affect the process and outcome (e.g., the organizational context, industry, financial, the people constraints, etc.).
18. Can you draw a picture of the steps involved in this process and how you iterated through these steps? How much time with each step? Who was involved when?

APPENDIX III: LETTERS OF INTRODUCTION AND ENDORSEMENT

Dear Mr. CEO:

I am writing to seek your help in a project conducted by the University of Maryland's Robert H. Smith School of Business, Stanford Technology Ventures Program, and funded by the National Science Foundation. I firmly believe that the issues under investigation will be of great interest to you.

The study targets a select group of high-technology companies in the Baltimore, Washington, Philadelphia, and Silicon Valley regions and will pose questions about the characteristics of the search and discovery behaviors that executives use to identify new business opportunities. As you know, in today's competitive environment, new business opportunities are the building blocks for future success. By developing a deeper understanding of this process, we hope to help companies like yours improve their adaptability and performance.

All results from the study will be strictly confidential. Only overall results will be published and no company or individual will be able to be identified. The time commitment we request is minimal and, in exchange for your participation, we will provide you with a detailed summary describing your company's position relative to other high-technology companies in our sample. This feedback could potentially be very valuable because it will allow you to benchmark your firm's characteristics and performance against that of similar organizations.

We would like to talk more with you about the aims of the project and to ascertain your interest in participating. Accordingly, one of our team will contact you by telephone in the next few days to set up an interview of approximately 45 minutes or less. If you have any questions, please feel free to contact a member of our research team via email or at 301-405-0553. Thank you for your time and we hope to talk to you soon.

Sincerely,

Dax Basdeo
dbasdeo@rhsmith.umd.edu

Patrick Maggitti
pmaggitt@rhsmith.umd.edu

Dr. Ken G. Smith
kgsmith@rhsmith.umd.edu

Dr. Paul Tesluk
ptesluk@rhsmith.umd.edu

Dear Mr. CEO,

As you may know, the Robert H. Smith School of Business is one of the world's leading research business schools. A team of researchers here at the Robert H. Smith School of Business has initiated a study to understand the drivers of competitive advantage in high technology industries. The study will investigate the reasons why certain firms are more successful than others in the discovery of new innovations. The core area of investigation is the acquisition of knowledge within top management teams and its impact on new innovation discovery. This could be a wonderful opportunity for you to learn more about the drivers of competitive advantage in your industry and the capabilities of your organization in identifying new opportunities for gaining competitive advantage.

Having been the CEO of several technology organizations, I believe that the types of insights this research will provide can be extremely valuable. Therefore, participating in this research effort may offer you insights into your own firm's competitive advantages and disadvantages. The research will explore key relationships between characteristics of executives' problem-solving behavior and new innovation opportunities, as well as questions about how best to leverage these skills so that the *firm* benefits.

With this letter, I am asking you to participate in this study. The researchers are very aware of the constraints on your time and have worked diligently to reduce the effort required from your organization. Data collection techniques are in the form of questionnaires plus a short interview with you. These questionnaires do not take very much time to complete. In exchange for your participation, you will receive detailed summary reports that may allow you to benchmark your firm against others in your industry segment. All data will be ***strictly confidential,*** only consolidated results will be published, and no individual company information will be identified.

In the next few days, a member of the research team will contact you by telephone to answer any questions that you might have, and to schedule an appointment for the on-site interview. In the meantime, if you have any questions or concerns, please contact the research team at 301-405-0553. Finally, thank you for your time and we look forward to working with you here at the Robert H. Smith School of Business.

Best Regards,

Howard Frank
Dean, Robert H. Smith School of Business
University of Maryland

APPENDIX IV: CEO INTERVIEW GUIDE

CEO INTERVIEW QUESTIONNAIRE ___/___/04 Company name: _____

Project Overview for CEO

Study Focus

- Discovery of new business opportunities (both administrative and technical)
- Effective actions and strategies of top-managers and knowledge workers
- approximately 100 firms similar to yours
- strict confidentiality

Payoffs:

- feedback reports and research summaries (benchmarking)
- Help out doctoral students

Participation:

- Three types of surveys (all taking approximately 30 minutes) and this interview (which will also take about 45 minutes): One survey for the top management team, one for CEO, and one for knowledge workers. All surveys can be completed at the individual's convenience at work or at home.
- Later, you will need to define the top management group and a set of key core workers within your organization.
- annual financial statements, and any other documentation

Interview Questions

1. COMPANY SIZE:

a. # of full-time employees in 2004: _____

b. # of full-time employees in 2003: _____

c. # of full-time employees in 2002: _____

2. INNOVATION: Does your firm innovate mainly: products / services / markets / internal processes?

If **Products**:

a. **Total # of products** developed in the last year: _____, 3 years: _____.

b. **# of completely new products** developed in the last year: _____, 3 years: _____.

c. **Percentage of** ideas/concepts from old products that are used **in new** products? ____

d. Average **cycle time** for each product from beginning to end? _____

e. Average **dollar investment** in each innovation? _____

f. **Dollars spent on R&D**: _____

g. **Spending** to keep employees **up-to-date** on current industry knowledge/technology: _____(y/n) ; Estimated spending: $ _____.

h. **# of personnel assigned** to R&D: _____

i. # of **scientists:** _____

j. # of **patents** in the last year: _____, 3 years: _____

If **Services**:

a. **Total # of services** developed in the last year: _____, 3 years: _____.

b. **# of completely new services** developed in the last year: _____, 3 years:_____.

c. **Percentage of ideas**/concepts from old service that are **used in new service**? _____

d. Average **cycle time** for each new service from beginning to end? _____

e. Average **dollar investment** in each service innovation? _____

f. **Dollars spent** for development of new services: _____

g. **Spending** to keep employees **up-to-date** on current industry knowledge/technology: _____(y/n) ; Estimated spending: $ _____.

h. **# personnel assigned** to new service development: _____

If **Markets**:

a. **Total number** of markets entered/developed in the last year: ____, 3 years: _____.

b. # of completely **new** markets entered/developed in the last year: _____, 3 years:_____.

c. Percentage of new market that involves extension of existing products and services versus completely new products or services. _____

d. **Dollars spent** on **new market development**: _____

e. # personnel assigned to development of new markets: _____

If **Internal Processes**:

a. # of completely new processes developed in the last year: _____, 3 years: _____

b. Dollars spent on internal process innovations: _____

c. # personnel assigned to development of internal process innovations: _____

3. OPEN-ENDED QUESTIONS ON INNOVATION

a. Could you please describe **a recent innovation**? _____

b. When did this occur? _____

c. How was the innovation discovered? _____

d. How long did it take (cycle time from beginning to end)? _____

e. How much did it cost (investment)? _____

f. How many people were assigned to this project? _____

g. Briefly, what was the process? _____

h. Typically, what is the impact of the introduction of your organization's innovations on your firm's market share? _____

i. How radical would you consider your firm's innovations to be in comparison to those of your competitors? _____

j. Are there any professional associations or research centers with which your organization has contact that have some impact on your organization's innovation activities? _____

What % of your business falls in each of the following categories?

	Existing Products/ Services	New Products/ Services
Existing Customers		
New Customers		

4. PERFORMANCE (*OPTIONAL*):

a. What is **the proper way to evaluate** your firm's performance (your objective), and why?: _____

b. How does your firm compare to the industry average on this measure? _____

c. Please provide the most up-to-date figures for the last calendar year; And for the year prior, for the following: _____

Identifying Other Individuals to be Surveyed

We are now done the interview questions and would like to wrap-up by asking you to help us identify the other people in your company that should receive a survey.

First, can you tell me the names of the members of your **top management group**? **Top management group members** consist of those individuals that make or are involved with decisions affecting your company's strategy. At the extreme, the team could include all employees. However, we only want to tap the **very top-level** members, perhaps the top 5 or 6 most important employees.

Next, we would like the names of the individuals in the company that you would consider **key knowledge workers**.

Key knowledge workers are those individuals that are not top managers but are typically responsible for innovations that occur within the company. At the extreme, the key knowledge workers could include all employees. However, we only want to tap the **most key knowledge workers**, perhaps the top 5 or 6 most important employees – when it comes to innovation.

Finally, we ask that you sign or initial this letter to the individuals in the company that you just identified. The letter indicates your desire for them to complete the questionnaire in the next seven days. I will include the letter in a special envelope for each participant.

I will return in two weeks for the completed questionnaires. If you don't mind, can you give me the name of a **contact person (_____)** who can hold the sealed envelopes containing the completed questionnaires until I return?

COMPANY:			
Circle One	**NAME**	**SURVEY NUMBER**	**DATE for Survey Return**
CEO			
TMG / KW			
TMG / KW			
TMG / KW			
TMG / KW			
TMG / KW			
TMG / KW			

APPENDIX V: CEO ENDORSEMENT MEMO

MEMORANDUM

To:

From:

Date:

Subject: Completing the Attached Survey

I have decided that our company will participate in a study being conducted by the University of Maryland. I believe that we will ultimately benefit by helping to provide the information requested and from being able to obtain overall study results. Our involvement requires the completion of questionnaires by select members of our management, including myself. Completion of the survey will take approximately 45 minutes of your time. Responses will only be available to the research team, and results will not identify any individual or particular company.

I am asking you to complete the survey by _____ and return it to _____, sealed in the envelope provided. Please be sure to return the survey by this date because the research team will be coming back to pick them up.

Thank you for your help.

APPENDIX VI: SEARCH QUESTIONNAIRE

Please read the following scenario in order to answer the questions in this section.
Assume that your firm has competitive advantages (for example, advantages in know-how, technological expertise, patents, low cost plant and equipment, etc.) over other firms in your industry and that your products/services are in high demand by customers. However, a new competitor has recently entered your industry with a new product/service and a new and different set of competitive advantages. This new competitor will definitely undermine your existing products/services and may even threaten your firm's survival. The CEO has given you the responsibility of actively searching and identifying strategic alternatives or opportunities so that your organization can effectively respond to this new challenge. Because this responsibility is so important, you have decided that this is not something that you can delegate (i.e., you are going to take this on personally). Your CEO anxiously awaits your suggested alternatives.

********PLEASE ANSWER ALL QUESTIONS IN PART B BASED ON THE ABOVE SCENARIO********

Given this scenario, for each of the following questions, please **distribute 100 points** to indicate the relative amount of time you would allocate to searching in the areas indicated. Note that **each row must total 100**.

1) Market vs. Resource

Resources vs. Markets		
Searching for information on resources (e.g. knowledge, assets, technologies, operating processes)	**Searching for information on markets** (e.g. customers, suppliers, competitors, consumer markets, raw material markets)	**TOTAL**
		=100

2) Internal vs. External

Internal vs. External		
Searching for internal information (e.g. information regarding firm resources, employees)	**Searching for external information** (e.g. information about customers, markets, competitors)	**TOTAL**
		=100

3) Familiarity

Familiar vs. Unfamiliar		
Searching familiar information (e.g. information you have used in the past, revisiting information you once knew)	**Searching unfamiliar information** (e.g. information to which you have never been exposed, information that is different from other information you have used in the past)	**TOTAL**
		=100

4) Distance and Scope

Please indicate the relative amount of time you would allocate to searching for information from sources in each of the following categories. Information from each source may come through communication with others, published materials, the internet, etc.

Sources from within your organization (e.g. top managers, other managers, non-managerial employees, paid consultants, company newsletters, company website)	**Sources from outside your organization but inside your industry group** (e.g. customers, suppliers, competitors, alliance partners, trade publications, newspapers/magazines, books, internet)	**Sources from outside your industry** (e.g. governmental contacts, university contacts, investors, trade publications, newspapers, magazines, books, internet)	**TOTAL**
			= 100

Based on each of the three sources you just indicated above, please indicate the relative amount of time you would spend searching for information more specifically within each of these sources.

Sources within your organization				
Top Management Team Members	Managers NOT part of the Top Management Team	Non-managers in the organization	Consultants paid by your company	**TOTAL**
				= 100
Sources outside your organization but inside your industry group				
Suppliers	Customers	Alliance Partners	Competitors	**TOTAL**
				= 100
Sources outside your industry				
Governmental Contacts	University Contacts	Investors	Other sources outside the industry	**TOTAL**
				= 100

5) Search effort:

When searching for information in response to the above scenario, I would…
1. … make looking for new information a top priority for how I would spend my time.
2. … devote a large percentage of my time to searching for information.
3. … invest a great deal of personal effort into gathering potentially valuable information.
4. … go out of my way to find information sources that may have relevant information.
5. … let things emerge instead of continuously searching.

6) Level of persistence in search:

When searching for information in response to the above scenario, I would…
1. … continue searching until I was satisfied that I had identified all relevant information.

2.	… stop searching as soon as a potential solution was identified.
3.	… exhaustively search and study every possibility.
4.	… persist until I found all the information pertaining to this problem.
5.	… take as much time as needed to identify all available information.

7) Search Iteration:

When searching for information in response to the above scenario, I would…	
1.	… revisit information sources several times as my search for information becomes clearer.
2.	… change the direction of the search process as I learn new things.
3.	… base each new decision on where to search next on what I just found.
4.	… adjust my search process as I become more familiar with the available information.
5.	… change the sources utilized in my search as I learn new things.
6.	… I would periodically reflect on what direction my efforts are taking me.
7.	… I would spend time tracing relationships between disparate ideas and facts.
8.	… I would try to draw parallels between this situation and others that I have solved before.
9.	… I would spend time exploring how information could be combined to derive new ideas.

*******PLEASE NOTE*******

The remaining questions are unrelated to the previous scenario.

7) Top management team's search integration capability

Members of our top management team …	
1.	… periodically reflect on what our search efforts are yielding in terms of generating new ideas.
2.	… actively work together to integrate the different information team members' find after searching on their own.
3.	… discuss what they have learned from their individual search activities with other team members to get new perspectives and share ideas.
4.	… openly share information with each other that might help other team members with their search activities.
5.	… regularly exchange ideas about what individual team members have identified in their search activities.

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