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# Accomplishment Of Dual Focus In Exploration And Exploitation: The Influential Role Of The Customer Relationship Management (crm

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# ACCOMPLISHMENT OF DUAL FOCUS IN EXPLORATION AND EXPLOITATION: THE INFLUENTIAL ROLE OF THE CUSTOMER RELATIONSHIP MANAGEMENT (CRM) PROCESS

by

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## ABSTRACT

Organizations that can successfully develop both radical and incremental innovations positively impact sustained competitive advantage, dramatically improving their chances of survival and success in both dynamic and stable environments (Han et al. 2001; Tushman and O'Reilly 1996). Experimentation and radical innovation are mandatory knowledge assets for competitive play in emerging markets, but efficiency and incremental innovation are essential for mature markets (He and Wong 2004; Tushman and O'Reilly 1996).

The attainment of dual focus between radical and incremental innovation is challenging and calls for organizational architectures of sometimes conflicting processes, structure, and culture (cf, Tushman and O'Reilly 1996; Wind and Mahajan 1997). While prior research has investigated the structural and cultural determinants (Duncan 1976; Gibson and Birkenshaw 2004), there is a significant lack of research addressing the third major element of business processes. Without winning business processes in place that influence both exploration and exploitation, a successful portfolio mix of radical and incremental product innovations that maximize customer value and benefits will not be fully realized, and firm performance will suffer. Through core business processes, marketing's role and influence is significant in increasing customer value creation in the resulting product innovations.

By mapping the "inside-out" and "outside-in" processes of a market-driven organization (Day 1994) into the Srivastava et al. (1999) core business process framework, this dissertation develops and tests a model of business process influence on dual focus in innovation strategies in the context of the high technology manufacturing environment. Each of these processes is critical in generating maximum customer value and is an explicit input into strategic choices and decisions (Srivastava et al. 1999). Specifically, it is argued and proposed that the Product

Development Management (PDM) process, comprised of the processes of market experimentation, technology monitoring, and technology competence, predominantly influences *exploration* while the Supply Chain Management (SCM) process, comprised of the processes of channel bonding and quality process management, predominantly influences *exploitation*. The Customer Relationship Management (CRM) process, encompassing the processes of lead user collaboration, competitor benchmarking, and current customer knowledge process, acts as a moderator to add dual focus to these extremes by interacting with PDM processes to enhance *exploitation* and with SCM processes to enhance *exploration*. Furthermore, it is proposed that firms successfully achieving a dual focus have greater firm performance than firms entrenched in either extreme.

Hypotheses were tested with data collected from a nationwide sample of high technology manufacturers. The results largely supported the main effect hypotheses of the PDM processes and SCM processes on exploration and exploitation. Additionally, the hypothesis of a positive interaction between exploration and exploitation on firm performance was also supported, however no visible support was garnered for the moderating impacts of CRM processes on PDM and SCM processes as hypothesized. Post hoc analyses were performed, bringing additional insight into dual focus based on the successful implementation of opposing businesses processes. Specifically, dual focus firms were shown to have multiple processes in place that impact both types of innovation strategies and that these firms implement these processes to a greater extent than those firms operating in the more extreme positions. Academic and managerial implications are discussed, as well as study limitations and exciting future research directions.

"Mas vale tener deseo de aprender todo que permanecer en la ignorancia."
(It is worth more to have the desire to learn everything than to remain in ignorance.)
Refugio Roussell de Tinoco (1884-1966)

I dedicate this dissertation to my family, in particular my husband, children, mother, father, sisters, and my husband's family, and all of my friends who have been supportive and encouraging through this most challenging, yet rewarding, endeavor. I would also like to remember my grandparents who instilled the importance of hard work, education, and the incredible zest for learning into my parents, and, thereby, into me. I can only hope that I have made them proud and that my children and my children's children will continue this legacy that they have inherited. And to my God, Mary, and my angels for without their aid, strength, and guidance, I never would have made it through.

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## LIST OF ACRONYMS /ABBREVIATIONS

| | |
|---|---|
| CEO | Chief Executive Officer |
| CRM | Customer Relationship Management |
| ISBM | Institute for the Study of Business Markets |
| ISO | International Standards Organization |
| MEP | Manufacturing Extension Partnership |
| MSI | Marketing Science Institute |
| NPD | New Product Development |
| OEM | Original Equipment Manufacturers |
| PDM | Product Development Management |
| PDMA | Product Development Management Association |
| PLS | Partial Least Squares |
| R&D | Research and Development |
| ROA | Return on Assets |
| ROI | Return on Investment |
| ROS | Return on Sales |
| SBU | Strategic Business Unit |
| SCM | Supply Chain Management |
| SEM | Structural Equation Modeling |
| SG | Sales Growth |
| UK | United Kingdom |
| US | United States |

# CHAPTER 1: INTRODUCTION

> "To sustain excellence, companies need dual strategies—one for the present and one for the future." (Abell 1999, 73)

Due to naturally occurring inherent tensions between exploitation and exploration (e.g., Adler et al. 1999; March 1991; Peters 1991; Tushman and O'Reilly 1996), firms may strategically embed themselves in either extreme, severely reducing their performance (e.g., Bierly and Chakrabarti 1996; Han et al. 2001; March 1991; Tushman and O'Reilly 1996). More specifically, exploration of radical innovation to the abandonment of exploitation in incremental innovation brings elevated costs and risks of continuous experimentation without the benefits of accrued distinctive competences (March 1991). Conversely, exploitation to the abandonment of exploration may be the path of least resistance in cost and risk, but will likely lead to suboptimal performance (March 1991), especially in dynamic environments. A natural implication, therefore, is that customer value creation may suffer from disproportionate use of one strategy over the other. Excessive exploration may lead to an unnecessary abundance of costly underdeveloped radical innovations (March 1991) or loss of efficiencies while marketing and managing an innovation through its life cycle (cf, Utterback 1994). On the other hand, excessive exploitation may lead to cost effective incremental innovations that few customers purchase or may stifle further organizational creativity needed for radical innovation (Benner 2002). Therefore, in order to sustain long-term competitive advantage through maximum customer value creation, organizations must have dual strategies in place—"one for the present and one for the future."

Seventy five percent (75%) of marketing executives in US companies report that significant improvement is needed in the new product development (NPD) process, especially

with respect to portfolio mix where the number of incremental innovations overwhelmingly dominates the number of radical innovations (Eliasberg et al. 1997). With most innovations centering on incremental improvements or extensions to current products (Wind and Mahajan 1997), the need for dual focus of technology push of radical innovation (exploration) *and* market pull of incremental innovation (exploitation) is imperative for competitive advantage and increased short term and long term performance.

In this study, an innovation strategy of exploration encompasses those decisions and activities aimed at developing radical product innovations, while an innovation strategy of exploitation encompasses those decisions and activities aimed at developing incremental product innovations (He and Wong 2004; Varadarajan and Jayachandran 1999). Wind and Mahajan (1997) urge marketing academicians to lead the charge in examining the organizational co-existence of these dueling innovation strategies. Unfortunately, the simultaneous pursuit of both strategies is not effortless, made painfully clear as large successful firms fall from dominance, a result of deep entrenchment in exploration or in exploitation (Abell 1999). For example, some argue that in its earlier life Apple Computer was too deeply entrenched in exploration (Abell 1999), leading to a serious decline prior to its more recent and successful turnaround. Similarly, some argue that the IBM of recent history was entrenched in exploitation, before it navigated a rebirth. Firms can overcome the natural inclination for entrenchment, inertia and path-dependence (Han et al. 2001; Tushman and O'Reilly 1996; Wind and Mahajan 1997) by hosting multiple processes, structures, and cultures that often conflict (Tushman and O'Reilly 1996; Wind and Mahajan 1997).

Despite the importance of dual focus for firm competitive advantage, a review of the extant literature reveals several crucial shortcomings with respect to both its antecedents and consequences. First, with respect to antecedents, there have been very few empirical attempts to test the conceptual arguments of industry leaders and academicians that dual focus is attained through the use of opposing structures and cultures. Furthermore, and more importantly, there are *no* known studies with respect to business process influences on dual focus attainment.

Regarding structure for dual focus, Chandy and Tellis (2000) find that incumbent firms are able to explore and exploit by breaking their large, bureaucratic structures into separate smaller autonomous business units. These business units are characterized by varying degrees of formalization, centralization, and complexity needed for their core line of innovative activity, lower degrees for exploration and higher degrees for exploitation. With respect to culture, Gibson and Birkenshaw (2004) investigate the cultural antecedents and firm performance consequences of a firm's capacity to achieve alignment and coherence of business activities while simultaneously achieving the capacity to adapt business activities for a changing environment. They concentrate on the relevant cultural characteristics that allow individuals to make organizationally beneficial decisions in dividing time and work effort between these sometimes conflicting objectives.

Another crucial shortcoming is the lack of empirical studies with respect to the consequences of dual focus. Conceptually, firms that successfully achieve a dual focus are believed to have greater firm financial performance than firms entrenched in either extreme. As a by-product of their investigation on entry barriers and incumbent performance, Han et al. (2001) probe the implications of both radical and incremental innovations in an organization's

portfolio of products, citing a combination of both types has positive impacts on return on investment (ROI) relative to industry average. By ensuring such a portfolio mix, incumbent organizations are better adept at rapid response to new technological discontinuities in the environment and can better manage the evolutionary cycle of their own innovations from the initial discontinuity to the follow-up incremental innovations. While these results are promising, the Han et al. study lacks sufficient rigor in empirically testing the issue at hand, appearing as if dual focus was an after-thought following the main study. He and Wong (2004) take a different approach and conceptualize exploration as encompassing radical innovation and exploitation as encompassing process innovation. They discover firms scoring high in both exploration and exploitation have a higher sales growth rate than those concentrated in the extremes. Although empirically sound, the study does not include both the antecedents and consequences of dual focus in innovation. Finally, Gibson and Birkenshaw (2004) provide additional exploratory, yet empirical, evidence that organizations that can both align and adapt have higher performance than strongly adaptive organizations or strongly aligned organizations, but limit their performance measure to customer satisfaction and meeting full business potential.

While the aforementioned studies have moved the dual focus research forward, the discussion above reveals significant research holes. First and foremost, there is a significant lack of research, conceptual or empirical, addressing the third major element of dual focus: business processes. Without employment of multiple, often conflicting, business processes to simultaneously influence both exploration and exploitation, a dual innovation focus that creates products with superior customer value will be severely blurred, hampering firm competitive

advantage and profitability. Second, rigorous empirical testing on a more complete model with both business process antecedents and financial performance consequences is in dire need.

This dissertation responds to the above mentioned research deficiencies by proposing and testing dual focus in innovation strategies, concentrating on core business process influences and including firm performance consequences. It employs the business process framework suggested by Srivastava et al. (1999) to analyze process impacts on innovation strategy as it "facilitates developing and refining distinctions between market-focused theories of exploration and exploitation" (Srivastava et al. 1999, 117). In the context of innovation strategy, the framework provides an excellent mechanism in which to assess the necessary business processes that impact strategic choices in product innovation.

Srivastava et al. (1999) contend that there are three core business processes: PDM process, the SCM process, and the CRM process. The PDM process involves developing and managing the creation of product solutions that satisfy customer needs and wants. In the current study the PDM process includes the processes of marketing experimentation, technology monitoring, and technology competence. The SCM process involves designing and managing the supply chains that facilitate the design, production, and delivery of the product solutions, and in the current study includes the processes of channel bonding and quality process management. Finally, the CRM process entails all aspects of developing and managing customer relationships, including the identification of new sets of customers and understanding their needs and wants (Srivastava et al. 1999). The current study views the CRM process with respect to the processes of lead user collaboration, competitor benchmarking, and current customer knowledge process.

Each of the core business processes is critical in generating maximum customer value and is an explicit input into strategic "choices and decisions that affect both marketplace and financial performance" (Srivastava et al. 1999, 177). These processes are not independent (Srivastava et al. 1999). Their interactions provide an intriguing, yet uncharted, path into understanding process impacts on dual focus. More specifically, this study argues that while the PDM process predominantly influences *exploration,* the SCM process predominantly influences *exploitation*. The CRM process acts as a moderator to these extremes, interacting with PDM to enhance *exploitation* and with SCM to enhance *exploration*. Thus, the interactions of CRM with PDM and SCM processes enable firms to better attain a dual focus.

Examination of business processes contributes to the increased academic interest in substantiating and strengthening marketing's role in the firm (cf, Srivastava et al. 1999; Varadarajan and Jayachandran 1999). The marketing discipline has a direct influence into the successful attainment of simultaneous exploration and exploitation through core business processes, particularly through the CRM process where marketing, as a discipline, takes a leadership role (Srivastava et al. 1999).

A recent study reveals that marketing has the greatest influence on the strategic direction of the business unit relative to other departments, such as, sales, R&D, operations and finance (Homburg et al. 1999). Additionally, a survey by Booz Allen Hamilton and the Association of National Advertisers (ANA) indicates that 75% of respondents (marketers and non-marketers) concur that marketing is significantly more important to corporate success today than in recent history (Rubel and Guterl 2004). This research will aid in validating the role of marketing in corporate success in a number of ways. The emphasis on core business processes, particularly

on the CRM processes, will highlight the role of marketing as a generator of customer value in innovation strategies that lead to "customer-relevant" radical and incremental innovation. This study also provides one avenue for customer portfolio management whereby dual focus between radical innovation for customer acquisition and incremental innovation for customer retention is empirically addressed.

Lastly, both academia and industry acknowledge the need for more research in innovation and strategy. This continuing need is notably identified by prominent marketing researchers (cf, Varadarajan and Jayachandran 1999; Wind and Mahajan 1997) and further illustrated by the continuation of product innovation and new product development (NPD) as a top research priorities set by MSI, Product Development Management Association (PDMA), and the Institute for the Study of Business Markets (ISBM).

## Research Contributions

Against this backdrop, the objectives and contributions of this research are summarized as follows.

- To develop a model of dual focus in product innovation strategies that encompasses market-driven business process antecedents and firm performance consequences, spotlighting the moderating influences of CRM business processes. Specifically, it is argued and proposed that the PDM process, comprised of the processes of market experimentation, technology monitoring, and technology competence, predominantly influences *exploration* while the SCM process, comprised of the processes of channel bonding and quality process management, predominantly influences *exploitation*. The CRM process, encompassing the processes of lead user collaboration, competitor

benchmarking, and current customer knowledge process, acts as a moderator to add dual focus to these extremes by interacting with PDM processes to enhance *exploitation* and with SCM processes to enhance *exploration*.

- To uncover empirical support that dual focus between exploration and exploitation, proposed as a positive interaction between these strategies, provides greater firm performance than by concentration at either extreme.
- To render empirical support that dual focus firms have higher levels of all three business processes in place, despite their antagonistic natures, compared to highly exploitative or highly explorative firms.
- To promote the role of marketing in achieving a dual focus between exploration and exploitation through its activities within the core business processes, especially with respect to the CRM process, thereby exalting its contributions to the firm.
- To extend the knowledge of academia and practitioners alike on successful product innovation strategies in today's competitive climate—strategies that aid firms in attaining positive impacts for short-term *and* long term firm performance.

## Dissertation Structure

This dissertation is organized in the following manner. Chapter 2 captures the literature review on exploration and exploitation, as well as, on culture, structure, and business process research germane to this effort. Chapter 3 proposes the conceptual model of dual focus in innovation strategy of exploration and exploitation, its antecedents and consequences. Research hypotheses are developed to empirically test the model. Chapter 4 discusses the research methodology, including the sampling frame, research design, and scales. Chapter 5 provides a

detailed analysis of the findings of this dissertation. Chapter 6 concludes the dissertation with discussions, implications, limitations, and directions for future research.

## CHAPTER 2: LITERATURE REVIEW

Key literature areas for this dissertation include innovation types relevant for this study, three theoretical approaches to exploration and exploitation, key business processes germane to exploration and exploitation, as well as structure and culture characteristics germane to exploration and exploitation. Pertinent extant research on the implications of firm external environment, firm scanning behavior, and organizational size and age are also reviewed. Table 1 in Appendix A contains a list of definitions to increase reader comprehension of terminology used throughout this dissertation.

### Innovation Types

In this dissertation radical innovation is defined as a new product that incorporates a large new body of technical knowledge (Chandy and Tellis 1998; Gatignon et al. 2002; Varadarajan and Jayachandran 1999). Incremental innovation is defined as a new product that incorporates relatively minor changes in technology (Chandy and Tellis 1998; Gatignon and Xuereb 1997). Table 2 in Appendix A summarizes and compares the characteristics of purely explorative innovation (radical) and purely exploitative innovation (incremental). Clearly, exploitation of incremental innovations is easier, quicker, and less risky than exploration of radical innovations as it builds on current customer and current technology competence. Assessment of market potential and projections of returns on investment on incremental innovations are relatively straightforward and more certain (Danneels 2002). Conversely, radical innovations are more challenging, time-consuming, and full of uncertainty. Future market potential assessment for exploration is extremely difficult and new knowledge must be obtained where no customer or technological competence may exist.

## Theoretical Approaches to Exploration and Exploitation

In the current study three theoretical perspectives are reviewed for insight into firm exploration and exploitation, these being organizational learning/technology management, population ecology, and evolutionary economics. Although different in their theoretical bases, these three research streams essentially agree that exploration and exploitation are deeply different. Exploration involves flexibility, experimentation, uncertainty, long term performance gains, and "complex" distant search while exploitation involves refinement, efficiency, risk-averse activities, short term performance gains, and local search (Cheng and Ven 1996; Durand 2001; March 1991).

Organizational learning theorists examine the dynamic friction between exploitation and exploration, arguing that there is a fundamental trade-off between explorative and exploitative strategies, that is, firms typically choose one over the other, leading to "refinement of an existing technology" or "the invention of a new one" (March 1991, 72). Availability of resources, established organizational structures and cultures, etc. often restrict firms in their strategic selection (March 1991).

Abernathy and Utterback (1978) had somewhat comparable arguments when they proposed that efficiency and innovation are diametrically opposed. In their 'productivity dilemma' thesis, an organization cannot be both highly productive and have a high rate of innovation (Ghemawat and Costa 1993). This may have been the precursory thinking to their later work on innovation and the industry life cycle whereby they argue that the benefits of production efficiency are more pronounced during the growth and maturity phases of the life cycle when process innovations, economies of scale, and incremental innovations are more

prominent and more critical to success than radical product innovations. Similarly, economics research analyzes the inherent tension between exploitation and exploration via efficiency arguments with respect to search processes, categorizing efficiency as static or dynamic. Statically efficient organizations typically display efficiencies in production and incremental product improvements while dynamically efficient organizations display efficiencies in new product development and new technology (Ghemawat and Costa 1993).

Population ecologists frame exploration and exploitation in terms of variation and selection. Selection of forms, routines, and practices is essential for survival, but so is the generation of variation through new forms, routines, and practices (March 1991). This stream of research bases most of its arguments on inertia. The population ecology perspective states that structural inertia may inhibit established firms in their flexibility and rapid adaptability to dynamic environments (Hannan and Freeman 1977; Lambkin and Day 1989; Sorensen and Stuart 2000). This "liability" manifests in low organizational exploration (Baum and Amburgey 2002).

Regarding the apparent dichotomy of high production efficiency or high rate of radical innovation, population ecology argues that certain types of firms (those that are highly innovative versus those that are highly efficient) have different survivability chances and performance depending on stage of life cycle and environmental conditions (Hannan and Freeman 1977). Delineation exists such that entrepreneurial r-strategists have a higher rate of innovation (exploration) and K-strategists have a higher degree of efficiency (exploitation), each performing best at different stages of market evolution (Lambkin and Day 1989).

Evolutionary economics also draws on structural inertia as a factor in exploration versus exploitation, but strengthens the notion of routines. Existing organizations have an advantage over younger organizations in that it is easier to continue existing routines (exploitation) than to create new ones (exploration) or borrow old ones (cf, Nelson and Winter 1982). Yet, established routines may also have a certain amount of inertia associated with them, that is, a firm's behavior and action may be reflective of their behavior and actions of the past according to established routines (Nelson and Winter 1982). As a result, they may loathe changing routines even when required for economic growth (cf, Chandy and Tellis 2000). Since the innovation process itself can be a routine, older firms may have well-defined practices and procedures for the support and direction of their innovative efforts. These routines may exert a positive influence on exploration as they give direction to and smooth innovation development (Nelson and Winter 1982). Conversely, routines may be so old and outdated that they lack effectiveness or are sluggish with respect to generating radical innovations.

Lastly, in 1978, Miles, Snow, Meyer et al. discussed the contradictory pulls of exploration and exploitation in their seminal work on adaptation with respect to strategy, structure, and process. Couched in efficiency and effectiveness terms, they categorize firms as Defenders, Analyzers, Prospectors, and Reactors, the first three being the most relevant to this research. With respect to the innovation, Defenders have a limited, stable product line, such that pursuit of innovation or product development is incremental with respect to their current product base. Technology is based on cost minimization, and competitive strategy is based on competitive pricing or higher quality products. Thus, they are highly efficient, but ineffective organizations, running the risk of mortality in a changing environment. Prospectors chase new

product and market opportunities. Due to their penchant for prototypical technologies and entrepreneurship, Prospectors are more likely to create radical product innovations. Thus, they are highly effective, but inefficient organizations, running the risk of low profitability and overextension of resources. Analyzers are a cross between Prospectors and Defenders, whereby they scan for new products and opportunities while defending their current product line. Analyzers have the ability to be both efficient and effective, but run the risk of inefficiency and ineffectiveness if a dual focus is not created. Interestingly, the researchers hinted that the strategy, structure, and processes implemented by the Analyzers may be the direction of the future.

While it is more common for exploitation to drive out exploration (Levinthal and March 1993), organizations create heightened exploration by a "dynamic of failure" (Levinthal and March 1993). If failure in exploration leads to more exploration which subsequently fails, a dynamic of unending failure is set and difficult to break (Levinthal and March 1993). Emphasis of both experimentation and exploitation, directed toward achieving dual focus, will preclude or reduce the detrimental impact of the dynamic of failure and excessive exploration.

In organizational learning literatures, exploration and exploitation is also characterized as fundamentally different search modes (March 1991). Organizational search contributes to the learning process by which firms endeavor to solve problems (Katila and Ahuja 2002). It is generally viewed as either local or distant (not local). Local search is defined as the "behavior of any firm or entity to search for solutions in the neighborhood of its current expertise or knowledge" (Rosenkopf and Nerkar 2001, 288). Conversely, distant search is the behavior of a

firm or entity to search for solutions outside the neighborhood of its current expertise or knowledge (e.g., Rosenkopf and Nerkar 2001; Stuart and Podolny 1996).

The perspectives of population ecology and evolutionary economics are similar with respect to search behavior. Population ecologists view technological innovation as a result of firm search and adaptation to environmental pressures. A dynamic uncertain environment increases the firm's need to search for new innovations in order to improve their chances of survival (Hannan and Freeman 1989). As a product of continuous organizational search and routine, innovation itself is evolutionary, that is, not a single event, but instead as a continuing process commencing with the initial innovation and progressing to encompass all related product improvements and process improvements (Foxall and Fawn 1992; Gort and Klepper 1982). The difficulty and extent of technological innovation progress is based on the firm's employment of the direction and pace of a specific trajectory within a technological regime (Metcalfe and Gibbons 1989).

Search is one of three central concepts in evolutionary economics. Nelson and Winter (1982) argue that search denotes firm activities associated with the evaluation of current routines, their modification or replacement. At any time, firms employ established routines to function. More specifically, they retain an assortment of competences and capabilities, procedures, and decision rules that dictate their actions given their external environmental conditions (Nelson and Winter 1982). Firms "search" to ascertain and evaluate possible modifications to or replacement of their routines.

For any firm occupied in exploration of new technological possibilities, search is typically "local" in that the probability distribution of what is found is concentrated on

technologies close to the current one (Nelson and Winter 1982). Thus, local search is more internally focused, is guided by the firm's current technological trajectory, and leads to incremental innovations based on that trajectory and current knowledge (Nelson and Winter 1982). Conversely, firms search non-locally, outside their organization and outside their technological trajectory, for knowledge needed for radical innovation. This non-local search leads to discontinuous innovations based on technologies that are new to the firm. Firms may choose to pursue multiple technology trajectories because of uncertainty surrounding user preferences and technology required to satisfy these preferences (Nelson and Winter 1982).

Katila and Ahuja (2002) define search as a two-dimensional construct (search depth and search scope) with respect to technological product search. These authors define search depth as "the degree to which search revisits a firm's prior knowledge" (1184) and search scope as "the degree of new knowledge that is explored" (1184). These dimensions are clearly linked to local and distant search, respectively. There appears to be an optimum for information search depth and scope such that the number of new products declines once this optimum is reached (Ahuja and Katila 2001). In contrast to obsolescence of internal knowledge, the mean age of external knowledge has a positive linear association with the number of new products introduced by a firm, the argument being that there is a time lag between new knowledge gained and realistic application of that knowledge into the product development process (Katila 2002).

## Processes for Exploration and Exploitation

Processes are those "routines or patterns of current practice and learning" (Teece et al. 1997, 518). The implementation of successful processes is one step toward a firm's competitive advantage (Teece et al. 1997). Once implemented, they display a high level of coherence and

stability by becoming "embedded" in the organization. These "deeply embedded" processes become self-reinforcing, eventually becoming institutionalized (Garvin 1998). As such, they play an influential role in strategic choice (Moorman 1995; Srivastava et al. 1999), a strategic choice that is strongly influenced by the processes currently instituted in the firm.

Depending on their characteristics, institutionalized processes can either promote exploration or promote exploitation. Thus, if the embedded processes are more oriented towards exploration, firm competence in exploitation is significantly reduced and vice versa (Holmqvist 2004). The embeddedness of processes explains, in part, the rigidity of many incumbent firms to "stay the course" of exploration or exploitation. For exploiters, in-place processes increase their efficiency and effectiveness through incremental innovation while decreasing their ability to change or develop new processes that promote radical innovation (e.g., Nelson and Winter 1982; Teece et al. 1997). For explorers, failure to learn from unsuccessful radical innovation proliferates exploration without significant gain and benefit (Levinthal and March 1993). The same embedded processes that brought failure will be employed repeatedly until lessons-learned solicits process reformation.

Past research has categorized processes in a variety of ways. This research review addresses categorization of processes by their overarching roles in the organization as specified by three frameworks: the dynamic capabilities framework of Teece et al. (1997), the market-driven organization framework by Day (1994), and the core business framework of Srivastava et al. (1999).

Under the dynamic capabilities framework, Teece et al. (1997) classifies organizational processes under the labels of coordination/integration, learning, and reconfiguration.

- Coordination/Integration: Alliances and partnerships, buyer-supplier relationships, customer relationships, collaboration on technology development, and interdepartmental/intraorganizational communication and collaboration are all examples of organizational processes of coordination and integration (Teece et al. 1997). It is well understood that higher degrees of intrafirm and interfirm coordination and integration promote strategic advantage (Teece et al. 1997), and, as will be argued in this dissertation, can influence both exploration and exploitation.
- Learning: Learning "is a process by which repetition and experimentation enable tasks to be performed better and quicker" (Teece et al. 1997, 520). Thus, learning processes can be exploitative or explorative. They occur at both the individual and organizational levels, are social and collective, and require communication and coordination of search activities (Teece et al. 1997).
- Reconfiguration: Reconfiguration processes include those that the organization employs to sense external changes in markets and technology, as well as to transform the organization in accordance with changing competitive conditions. Constant scanning, benchmarking, honest evaluation of markets and competitor, and the capacity for transformation are necessary reconfiguration processes to retain strategic advantage (Teece et al. 1997).

Day (1994) highlights "outside-in" and "inside-out processes" of the market-driven organization. Outside-in processes connect the organization to information from its external environment and include market sensing, customer linking, channel bonding, and technology monitoring activities. Inside-out processes are those that are "deployed" from within the organization and include such processes as financial management, cost control, technology

development, logistics, and manufacturing, among others. Processes relevant to this research are as follows:

- Outside-in processes: Market sensing processes relevant to exploration and exploitation include "open minded inquiry" through active environmental scanning, competitor benchmarking, and market experimentation, in addition to synergistic interaction of departments which allow information dissemination and shared understandings of the chosen innovation strategy. Relevant customer linking processes include communication and collaboration with current customers and lead users for exploitation and exploration, respectively. The channel bonding process includes communication, collaboration, and coordination of activities with channel members and is studied in this dissertation with respect to suppliers. The technology monitoring process entails sensing state of the art technological advances outside the organization, critical for exploration, but also relevant for exploitation.
- Inside out processes: Relevant inside-out processes include technology development and manufacturing/transformation processes which connect the organization to the environment through its output of customer valued innovations. The technology development process includes the core technological base of the firm, conceptualized herein as technology competence. Manufacturing/transformation processes include quality management processes that increase efficiency and repeatability.

Srivastava et al. (1999) argue that there are three core business processes: the PDM process, the SCM process, and the CRM process. The PDM process involves developing and managing the creation of product solutions that satisfy customer needs and wants. The SCM

process involves designing and managing the supply chains that facilitate the design, production, and delivery of the product solutions. Finally, the CRM process entails all aspects of developing and managing customer relationships, including the identification of new sets of customers and understanding their needs and wants. These processes are placed in the organization's collective memory (Day 1994), and, directly impact their strategic choice.

Table 3 in Appendix A is an excerpt from Srivastava et al. (1999), illustrating sample processes within each of the core business processes. Some, but not all, business processes are inputs to strategic choices of exploration and exploitation. The nature of the processes to be studied must have relevance to the content of the strategy and the industry being studied (Huff and Reger 1987). For example, order rebates of the SCM process may not impact exploration and exploitation strategic choice. However, the process of designing work flow in product/solution assembly does. As will be discussed in more depth in Chapter 3, quality assurance processes, such as those involved in the ISO9000 programs, can lead to more exploitative behaviors (Benner and Tushman 2003; Benner and Tushman 2002).

Huff and Reger (1987) argue that process researchers must consider the nature of the strategy and the industry to assess relevancy and impacts of processes. Thus, in the current study appropriate process antecedents were chosen based on the nature of the strategy (exploration and exploitation in product innovation) and the type of the industry (high technology manufacturing). In doing so, Day (1994)'s conceptual article on the capabilities and underlying processes of a market-driven organization was consulted for process constructs relevant to an organization that seeks sustained competitive advantage through technology-based innovation strategies of exploration and exploitation. These processes create economic value by way of superior

customer value in product attributes and cost effectiveness (Day 1994) and include the product development processes of market experimentation, technology monitoring, and technology competence; supply chain processes of channel bonding and quality process management; and customer relationship processes of competitor benchmarking, current customer knowledge process, and lead user collaboration.

Integrating Day (1994) with the Srivastava et al. (1999) core business process framework, the PDM business process includes ascertaining new customer needs through market experimentation and designing tentative new product solutions and reinvigorating old products through technology monitoring and technology competence (Day 1994; Srivastava et al. 1999). The SCM business process includes channel bonding activities of collaboration, coordination, and communication with suppliers (Day 1994) and the quality process management activities that are involved in manufacturing and product/solution assembly. Finally, the CRM process includes determining the needs of existing customers and potential new customers through competitor benchmarking of rival products (Day 1994), the current customer knowledge process (Li and Calantone 1998), and lead user collaboration (Wind and Mahajan 1997). These processes within each core business process influence the subject innovation strategies with varying levels of intensity, this being studied further in Chapter 3.

## Firm Culture for Exploration and Exploitation

Culture is defined as "the pattern of shared values and beliefs that help individuals understand organizational functioning and that provide norms for behavior in the organization (Deshpande' and Webster 1989, 4). An organizational culture that promotes exploration can also be described as opportunistic, experimenting, risk taking, decisive, willingness to cannibalize,

and taking initiative (Chandy and Tellis 1998; Chatman and Jehn 1994; DeTienne and Koberg 2002; Miller and Friesen 1982; O'Reilly et al. 1991; Thompson 1964). Lawson and Samson (2001) state that cultures advocating tolerance of ambiguity, empowerment of employees, allowance of creative thinking time, and open communication are critical for innovative output, in addition to an orientation toward innovativeness with open and creative work environments (Capon et al. 1992; Hurley and Hult 1998; Kenny 2003; Woodman et al. 1993).

## Firm Structure for Exploration and Exploitation

Structural variables, listed as key to both exploitation and exploration, include formalization, centralization, and complexity (Duncan 1976; Ettlie et al. 1984). Both formalization, defined as the emphasis on rules and procedures in conducting organizational activities, and centralization, defined as the extent decision-making is centralized or dispersed throughout the organization, have been postulated to have negative effects on innovation in general (Damanpour 1991; Pierce and Delbecq 1977; Thompson 1965). In a highly formalized structure, exploratory learning required for radical innovation is hindered. For exploration to occur, the organization must be flexible and open to new sources of information and alternate courses of action (Duncan 1976). On the other hand, a highly formalized structure is often associated with an exploitative strategy that requires efficiency and stability (Ettlie et al. 1984).

With respect to centralization, decentralized organizations in various forms, such as teams, strategic business units (SBUs), etc., increase empowerment, awareness, and commitment of individual employees as they function like smaller firms (Chandy and Tellis 2000; Damanpour 1991). Individuals that enjoy greater involvement in decision-making bring new insights and new diverse sources of information for exploration activities (Damanpour 1991;

Duncan 1976). Decentralization also fosters internal competition between business units, spurring radical innovation in the younger business units (Chandy and Tellis 2000).

Lastly, organizational complexity is defined as "patterns of links among subunits" (Hannan and Freeman 1984, 162). Higher complexity reflects a strong hierarchical system with decreased information flow and stringent chain of command (cf, Hannan and Freeman 1984). As such, organizations high in complexity shy away from exploration and toward exploitation (cf, Ettlie et al. 1984; Hannan and Freeman 1984).

## Firm Age and Size for Exploration and Exploitation

The population ecology perspective reveals structural inertia, which grows with age and size, may inhibit older firms in their flexibility and rapid adaptability to dynamic environments (Hannan and Freeman 1977; Lambkin and Day 1989; Sorensen and Stuart 2000). This inflexibility would manifest in lower innovative output, particularly with respect to exploration. Inflexible, inadaptable firms may decide not to innovate at all (Baum and Amburgey 2002), may be slow to respond to a need to innovate, or may not innovate fast enough to fit environmental changes. However, structural inertia can also dampen incremental innovation. Organizational structure that strengthens exploration is often to the detriment of exploitation (Hedberg et al. 1976).

In conflict with the perspective of structural inertia, population ecologists also argue that young, small firms may possess "liabilities" with respect to age and size. The liability of newness thesis indicates that older firms have accumulated experience, knowledge, resources, etc. relevant to innovation and the innovation process that younger firms lack (Sorensen and Stuart 2000). Thus older firms may be better equipped to innovate. Likewise, the liability of

smallness argument stipulates that young firms lack sufficient resources to effectively operate and simultaneously must create organizational and procedures necessary for survival (Baum and Oliver 1991).

As stated earlier, evolutionary economics research can be said to conflict with respect to size and age. It identifies size as a positive influence on innovation due to the availability of resources and R&D spending. Conversely, older firms may have well-defined practices and procedures for the support and direction of their innovative efforts, often leading to incremental improvements.

Chandy and Tellis (2000) reveal that size is less of a factor on innovativeness when time is added to the equation. As size increases, radical innovativeness decreases, but there is a supported interaction of size and time. In the past, larger firms introduced less radical innovations but, in recent years, larger firms have been introducing more radical innovations. Especially, under conditions of uncertainty, organizations that have the resources can create dedicated groups and personnel to respond to environmental changes (cf, Damanpour 1996). Large, established organizations contain R&D divisions that can have the culture and structure characteristics of small organizations, allowing faster responses to dynamic environments.

Certainly, there is evidence in technology management studies that early in the product or industry life cycle, young, small entrepreneurial firms produce radical innovations. Later in the life cycle, larger, more experienced firms produce less radical innovations and more incremental innovations or process innovations (Abernathy and Utterback 1978; Lambkin and Day 1989; Utterback 1994; Utterback and Abernathy 1975).

## Environmental Turbulence and Intensity

Previous research indicates that environmental turbulence highly impacts innovation and performance (cf, Utterback 1994; Windrum 1999), particularly turbulence in markets and technology (Anderson and Tushman 2001; Damanpour 1996). Additionally, competitive intensity impacts innovation and performance (Tushman and Anderson 1986; Utterback 1994; Utterback and Abernathy 1975). Prior studies indicate that turbulence and competitive intensity have a positive impact on innovation, but a negative impact on firm performance (e.g., Anderson and Tushman 2001; Damanpour 1996; Tushman and Anderson 1986; Utterback 1994).

Market turbulence is defined as the "rate of change in the composition of customers and their preferences" (Jaworski and Kohli 1993, 57) while technological turbulence is the "rate of technological change" (Jaworski and Kohli 1993, 57). Competitive intensity is the degree of competitiveness with respect to competitor ability, resources, and behavior to differentiate their products (Jaworski and Kohli 1993).

## Environmental Scanning

Environment scanning is defined as the process to identify key trends, changes, and events in the organization's environment that may impact how the firm functions now and in the future (Hambrick 1982; Milliken 1990). Its purpose is to aid the firm in forming a complete understanding of the current and future states of five environmental factors: social, economic, political, regulatory, and technological (Maier et al. 1997).

Data acquired from scanning assists in opportunity and threat detection (Barringer and Bluedorn 1999) and is used in problem definition and decision making (Maier et al. 1997),

therefore scanning has a direct influence on the organization's strategic choices (cf, Hambrick 1982), including innovation strategies (cf, Kanter 1988).

Environmental scanning has been conceptualized on a continuum of intensity as ranging from irregular or passive scanning (a state of alertness) to continuous or active scanning (high vigilance) (Aguilar 1967; Huber 1991). Entrepreneurial firms immersed in dynamic environments tend to have higher degrees of environmental scanning (Miller, 1983; Stevenson and Jarrillo-Mossi, 1986; Zahra, 1991) as their need to identify opportunities and threats in a rapid manner is critical (Barringer and Bluedorn 1999). Miles, Snow, Meyer et al (1978) find that the most aggressive radical innovators, the Prospectors, have the broadest, most active scanning in place. Supporting these findings, Barringer and Bluedorn (1999) uncover empirical support that increasing scanning intensity and entrepreneurial behavior are positively correlated. Scanning brings information into the firm critical for both radical and incremental innovation. Analyzers and Defenders maintain environmental scanning in their organizational processes, however its intensity and breadth may be more limited than Prospectors (Miles et al. 1978).

Some argue that firms in more stable environments find scanning is less critical for firm competitive advantage (Covin 1991). However, in market-driven organizations, regardless of environment, managers must actively scan the periphery to look for new opportunities (Day 2002) that may eventually also lead to exploitation. Firms that do not actively scan may have erroneous "mental" models of their environment (Martins and Kambil 1999). Furthermore, narrow limited scanning may reduce the organization's insight into new trends or opportunities that firms can seize with either radical or incremental innovation.

## Dual Focus versus Strategic Flexibility

While strategic flexibility is not the subject of this dissertation, its essence is reviewed with respect to dual focus in order to highlight the differences between the two perspectives. On the surface, dual focus in exploration and exploitation and strategic flexibility appear synonymous. Strategic flexibility has been defined as "the capability of the firm to enact and respond quickly to changing competitive conditions and thereby develop and/or maintain competitive advantage" (Hitt et al. 1998, 27). From this definition, one can observe that the focus is on firm response or adaptation to environmental changes (cf, Ansoff 1965; Bowman and Hurry 1993). Strategic flexibility is noted to allow firms to deal with consequences or opportunities arising from changes in demand or in competition (Das and Elango 1995; Lau 1996) and has been linked to modifications in production processes and redistribution of resources (Johnson et al. 2003).

In attempts to lend a proactive marketing element, Johnson et al. (2003) define market-focused strategic flexibility as "the firm's intent and capabilities to generate firm-specific real options for the configuration and reconfiguration of appreciably superior customer value propositions" (77). In utilizing the options approach, they argue that strategic flexibility allows for the creation of a bundle of options that firms can exercise on a case-by-case basis for quick response to changing environmental conditions or for a proactive tactical move. These options are created based on the "interplay of the organization's *existing* [emphasis added] investments, its knowledge and capacities, and its environmental opportunities" (Bowman and Hurry 1993, 762). These options provide viable strategic plans for both exploitation and exploration, however they note that options geared to exploitation and those geared to exploration are

mutually exclusive, that is, firms may shift strategies but cannot pursue both simultaneously (Johnson et al. 2003).

Based on this background, key differences between a dual approach to innovation strategy and strategic flexibility are now apparent. First, strategic flexibility is the development of options that may or may not be exercised. Second, it is limited to *existing* capabilities, assets, and knowledge, thereby excluding new capabilities, assets, and learning necessary for exploration. Lastly, as aforementioned, the concept of strategic flexibility as defined by researchers includes a mutually exclusive relationship between exploration and exploitation, such that, they cannot be exercised simultaneously.

## Summary

In this chapter key literature areas applicable to this dissertation were reviewed for insight into the characteristics of explorative and exploitative innovation, theoretical perspectives for exploration and exploitation, key business processes germane to exploration and exploitation, as well as structure and culture characteristics germane to exploration and exploitation. Pertinent extant research on the implications of firm external environment, firm scanning behavior, and organizational demographics were also reviewed for their impacts on innovation. In the next chapter a conceptual model is developed and presented whereby processes are proposed as antecedents to innovation strategy choice in exploration and exploitation while culture, structure, environmental turbulence and intensity, scanning, and organizational demographics are proposed as controls.

## CHAPTER 3: CONCEPTUAL MODEL AND HYPOTHESES

The conceptual model of Figure 1 in Appendix A identifies the antecedents and firm performance consequences of innovation strategies of exploitation and exploration. It builds on the thesis that appropriate, sometimes conflicting, processes must be present within the organization to accommodate concurrent strategies of exploration with radical innovation and exploitation with incremental innovation (Tushman and O'Reilly 1996; Wind and Mahajan 1997).

As stated in the Chapter 2 literature review, appropriate process antecedents for the current study were chosen based on the nature of the strategy (exploration and exploitation in product innovation) and the type of the industry (high technology manufacturing) by using the integration of Day (1994)'s conceptual article on the capabilities and underlying processes of a market-driven organization into the Srivastava et al. (1999) core business process framework.

The PDM business process includes ascertaining new customer needs through market experimentation and designing tentative new product solutions and reinvigorating old products through technology monitoring and technology competence (Day 1994; Srivastava et al. 1999). The SCM business process includes channel bonding activities of collaboration, coordination, and communication with suppliers (Day 1994) and the quality process management activities (e.g., ISO9000) that are involved in manufacturing and product/solution assembly. Finally, the CRM process includes determining the needs of existing customers and potential new customers through competitor benchmarking of rival products (Day 1994), the current customer knowledge process (Li and Calantone 1998), and lead user collaboration (Wind and Mahajan 1997).

In this model, it is argued that PDM processes predominantly influence *exploration* (H1 - H5) while SCM processes predominantly influence *exploitation* (H6 - H8). CRM processes act as moderators to these extremes by interacting with PDM processes to enhance *exploitation* (H9 – H14) and with SCM processes to enhance *exploration* (H15, H16). Thus, the interactions of CRM with PDM and SCM processes enable firms to better attain a dual focus. Lastly, firms that successfully achieve a dual focus have greater firm performance than firms entrenched in either extreme (H17). Table 4 in Appendix A summarizes the hypotheses.

The remainder of the chapter proceeds as follows: First, the main effects of the PDM processes and the SCM processes on exploration and exploitation are presented. Second, arguments for the moderating influences of the CRM processes on the PDM-innovation strategies links and of the CRM processes on the SCM-innovation strategies links are presented. Lastly, the influence of dual focus in both exploration and exploitation on firm performance is argued and proposed.

## Organizational Core Business Processes

### Main Effects of the PDM Process

#### Market Experimentation

Firms ascertain customer needs through market experimentation. Market experimentation is defined as the activities undertaken by the firm to gain information through testing new ideas on current and potential customers (Day 1994; McCardle 2005; Slater and Narver 2000). It encompasses systematic testing, evaluating, and responding to information on

new ideas that may create superior customer value (Slater and Narver 2000). Firms that include experimentation learn about the behavior of the product's technology, the characteristics and potential of the current market, and the possibility of market creation (Day 1994; O'Connor and Ayers 2005).

Experimentation has been largely linked to exploration in prior literature as it is a manifestation of an organization's entrepreneurial values that include innovativeness and risk taking (March 1991; Slater and Narver 2000). But, because of its ability to aid firms in detection of both current and future market trends and needs, it can lead to either exploration or exploitation, respectively, but its influence is greater on exploration.

The use of active and continuous experimentation permits firms to gain new insights into market development (Day 2002), whether it be for explorative or exploitative gains. Garvin (1993) notes that experimentation takes two forms: one form for prototype demonstration programs and another for ongoing programs. Larger, more complicated demonstration programs "represent a sharp break from the past" (exploration) while ongoing programs involve a continuous string of small experiments designed for incremental knowledge gains (exploitation).

For firms interested in an explorative strategy, market experimentation is essential to development of radical new products where so often customers have difficulty expressing their needs or understanding the benefits of such innovations, especially in dynamic environments (Hamel and Prahalad 1994; Slater and Narver 2000). However, continuous experimentation for smaller product improvements is fundamental for short term success. These experiments assist in developing incremental innovations that are linked with increased product quality and reliability, as well as increased customer satisfaction through customer-driven marginal changes

to product (cf, Wind and Mahajan 1997). Therefore, while experimentation is strongly tied to exploration, it can also lead to exploitation but to a lesser degree.

> *H1: a) The greater the degree of market experimentation, the greater the degree of exploration of radical innovations. b) The greater the degree of market experimentation, the greater the degree of exploitation of incremental innovations.*
>
> *H2: The positive influence of market experimentation on exploration of radical innovations will be greater than the positive influence of market experimentation on exploitation of incremental innovations.*

**Technology Monitoring**

Prior research indicates that technology monitoring is required for a firm to shift its technological trajectory (Gatignon and Xuereb 1997; Han et al. 2001). Technology monitoring is defined as the process in which an organization acquires knowledge about and understands new technology developments in its external environment (Day 1994; Srinivasan et al. 2002). In order for exploration to occur, firms must make a conscious effort to monitor new technological developments outside the organization. Technology monitoring, an "outside-in process," enables the business to compete by sensing new technologies fundamental to radical innovation development. Gatignon and Xuereb (1997) find that the more technologically oriented a firm is in terms of willingness and ability to sense and acquire a new technology, the more the radical the innovation is.

On the other hand, this "outside-in process" also enables firms to compete in exploitation as it aids firms in acquiring the latest information on incrementally innovative technologies that are fundamental to new paths of exploitation. Without employing this process fundamental to innovation in general, exploitation will be limited to the firm's prior efforts and experience. This

limitation begets incremental product improvements that eventually cease or become obsolete unless new information on innovative technologies outside the firm is acquired. Thus, a strong technological orientation which includes systematic monitoring of technological improvements inside and outside the firm's core industry should advance both explorative and exploitative innovation (Han et al. 2001). It is proposed that while technology monitoring is strongly tied to exploration, it can also lead to exploitation but to a lesser degree.

> *H3: a) The greater the degree of technology monitoring, the greater the degree of exploration of radical innovation. b) The greater the degree of technology monitoring, the greater the degree of exploitation of incremental innovations.*
>
> *H4: The positive influence of technology monitoring on exploration of radical innovations will be greater than the positive influence of technology monitoring on exploitation of incremental innovations.*

**Technology Competence**

Technology competence is defined as the set of technological skills, knowledge, and experience resident within the firm that is necessary to design the product innovation (Deshpande' and Webster 1989; Hamel and Prahalad 1994). In this research, it is defined *relative to the frontier* such that organizations with high technology competence are technologically closer to the technology frontier than those with lower technology competence. Considered an *intangible* process (e.g., Hamel and Prahalad 1994; Nelson and Winter 1982), technology competence plays a significant role in the development and design of new product innovations for exploration and reinvigorating prior products through incremental innovations.

Technology competence has tremendous weight in directing organizational innovation strategy. It has been noted that exploitation builds on a firm's prior technology competences while exploration changes the technological trajectory, often forcing firms to acquire new

competences if they cannot compete based on their resident technological know how (cf, Dosi 1982). Unless carefully watched and managed by the firm, capabilities and investments from the development of a radical innovation will become obsolete or migrate over time towards core rigidities and away from the technological frontier (Leonard-Barton 1992). A firm rich in exploration proactively and continuously builds technology competences that facilitate on-going radical product development pushing state of the art, while a firm that consistently employs its prior technological knowledge and experience on former radical innovations will tend toward more exploitation (cf, Chandy and Tellis 1998; Leonard-Barton 1992).

*H5: a) The greater the degree of technology competence, the greater the degree of exploration of radical innovation. b) The greater the degree of technology competence, the lesser the degree of exploitation of incremental innovations.*

## Main Effects of the SCM Process

### Channel Bonding

Channel bonding is defined as the process in which durable relationships with channel members are created via activities of communication, joint problem solving, and coordination between the parties (Day 1994). Channel bonding is an "outside-in" process that allows firms to compete by creating long-lasting relationships with channel members, thus building competitive advantage (Day 1994; Sudharshan 1995).

In this dissertation, channel bonding between supplier and manufacturer is examined. Suppliers have been noted to be sources of innovation in several streams of literature, most notably in technology management studies and interorganizational relationship studies. Traditionally, technology management argues that supplier involvement in manufacturer

innovation is largely apparent in the final phase of an industry life cycle when manufacturer's concentrate on incremental improvements in product design, productivity, and quality (Utterback 1994). Yet, as part of the value chain, suppliers can be involved in the manufacturer's innovation development from its very early stages (Wind and Mahajan 1997).

Innovation is increasingly viewed as a multi-disciplinary, multi-organizational effort (Roy et al. 2004, Wind and Mahajan 1997). Scholars have long argued that interorganizational learning through collaboration and cooperative relationships is critical to competitive advantage (cf, Dyer 1998; March and Simon 1958), citing that in some industries, the majority of innovations can be traced to the suppliers or the network in which the firm is embedded (Powell et al. 1996; von Hippel 1988). Network ties act as a channel for innovations (Galaskiewicz and Wasserman 1989) and innovation alliances are often sought for their benefits through technology co-development, through the pooling and transfer of knowledge, through cooperative creation of new products, and through distribution and absorption of risk between parties (Dyer 1998; Gulati 1998; Kogut 1988; Varadarajan and Jayachandran 1999).

Channel bonding creates long-term relationships which allow for stability and predictability (Hult et al. 2004). Firms that have successful bonding processes in place for managing collaborative relationships find their strategies are more integrated with channel members and can reap competitive advantage through quality improvement and a reduction in time to market for products as a result (Day 1994). This may well be evidenced in exploitation of incremental innovations where many of these innovations are based on improved quality and production efficiency (Utterback 1994).

Stability and predictability also bring inertia. Buyers who have established strong ties with suppliers perceive less technological change in the environment and have higher switching costs (Weiss and Heide 1993). These switching costs arise from buyer specialized investments that are tied to the supplier, as well as to prior contractual commitments. Ties may insulate manufacturers from detecting and/or acting on pertinent changes occurring in technology and in market environments (Weiss and Heide 1993). This tie-generated insulation, beneficial to exploitation (Roy et al. 2004), can also challenge a firm's efforts to explore. Therefore, while channel bonding may lead to some exploration of radical innovations, it overwhelmingly leads to more exploitation of incremental innovations.

> *H6: a) The greater the degree of channel bonding, the greater the degree of exploitation of incremental innovations. b) The greater the degree of channel bonding, the greater the degree of exploration of radical innovations.*
>
> *H7: The positive influence of channel bonding on exploitation of incremental innovations will be greater than the positive influence of channel bonding on exploration of radical innovations.*

**Quality Process Management**

Quality process management is defined as process management techniques, such as ISO9000, employed to improve the efficiency of operational processes and reduce variance (Benner and Tushman 2002). These process techniques allow for increased customer satisfaction with higher quality and more reliable products and for standardization to ensure the customers consistently receive the same product (Naveh and Erez 2004; Syamil et al. 2004).

Past research indicates that increases of efficiency associated with these techniques also may *reduce* exploration for new radical innovations as they elicit internal firm biases for certainty, predictability, and reliability (Benner and Tushman 2003; Levinthal and March 1993).

Repeatable processes allow organizations to easily create incremental improvements (cf, Hackman and Wageman 1995), faster and more cost effectively. The committed use of process management in the organization directs innovation strategy to greater exploitation and reduces overall exploration efforts (Benner and Tushman 2002). As a result, it is posited that

> *H8: a) The greater the degree of process management, the greater the degree of exploitation of incremental innovations. b) The greater the degree of process management, the lesser the degree of exploration of radical innovations.*

## Moderating Role of the CRM Process

The processes that make up the CRM process can aid firms in achieving dual focus by shifting focal attention away from extreme exploration or extreme exploitation. As stated earlier, the CRM processes researched herein include competitor benchmarking, current customer knowledge process, and lead user collaboration. While PDM processes often lead to exploration, the CRM processes of competitor benchmarking and strong current customer knowledge process often lead to more exploitative innovation attempts. These two extremes are dampened when interactions occur between these CRM processes and the aforementioned PDM processes. Likewise, the CRM process of lead user collaboration has a strong positive influence on exploration while SCM processes of channel bonding and quality process management lead to more exploitation. Therefore, when lead user collaboration interacts with these SCM processes, the primary focus of SCM on exploitation is reduced as the more exploration-focused CRM process pulls the firm away from the extreme to a dual focus of innovation strategy. The following paragraphs outline in detail the arguments to the general propositions made above.

## Competitor Benchmarking

Competitor benchmarking is a "market-based learning process by which a firm seeks to identify best practices that produced superior results in other firms" and uses this information to "to enhance its own competitive advantage" (Vorhies and Morgan 2005, 81). Competitor benchmarking entails analyzing competitor's actions by performing tear down analyses of competitor products, strategy, capabilities, or performance outcomes (Day 1994; Day 2002; Vorhies and Morgan 2005). In this research, it is limited to benchmarking against rivals' current and potential product offerings to their customers.

Traditionally, competitor benchmarking has been noted to lead to imitation (e.g., Massa and Testa 2004; Pemberton et al. 2001) as organizations focus on rival best practices and gap-closing imitative moves (Vorhies and Morgan 2005). Continuous benchmarking may lead to a protective strategic approach as organizations adjust to competitor strategies through emulation before the competition gets too far ahead (Day 2002; Johnson et al. 2003). It reduces organizational risk by allowing for easier assessment of the feasibility of the technology while permitting the firm to create less risky incremental improvements (Day 2002). However, firms may fall into a competitor focus trap when they rely on benchmarking without regard to technology shifts (Day and Wensley 1988). When Echard Pfeiffer became the new Chief Executive Officer (CEO) of Compaq Computers, he recognized the company's fatalistic focus on IBM, its chief rival at the time, as it masked the arrival of new imposing competitors (Day 2002). Hence, a strong competitor focus leads to a lesser degree of exploration and product creativity and a greater degree of exploitation (Bierly and Chakrabarti 1996; Moorman 1995)

As stated earlier, there are important interactions between competitor benchmarking and each of the PDM "subprocesses" of marketing experimentation, technology monitoring, and technology competence that reduce their biases toward exploration. These interactions allow for a dual focus of both exploration and exploitation. For example, while market experimentation highly influences exploration, the scale is tipped toward increased exploitation as information on competitor offerings and rival customers' needs and wants induces emulation or incremental improvements on competitor products.

Table 5 of Appendix A illustrates the results of varying degrees of competitor benchmarking and market experimentation on exploration and exploitation. Dichotomous independent variables are assumed for illustrative purposes only. In Cell 1, there is little-to-no beneficial exploration or exploitation as a result of low experimentation and low benchmarking, respectively. With minimal attention paid to experimentation and competitor offerings, innovation efforts would likely be inferior with low market acceptance and lack a competitive advantage or be competitively unnecessary. In Cell 2, high degrees of benchmarking overtake low degrees of experimentation leading to greater exploitation. These firms are exploiters, using benchmarking as an emulation tool and creating incremental improvements of rival products based on their perception of competitor moves. With little experimentation efforts risk of failure increases as the untested products enter the market. Failure can be in the form of technology malfunction or lack of market acceptance. In Cell 3, higher degrees of experimentation overtake lower degrees of benchmarking. These firms are highly exploratory in nature and do not focus on emulating competitor products. They concentrate on costlier radical innovation, but reduce risk through testing of products. In Cell 4, a dual pursuit is obtained as higher degrees of both

benchmarking and market experimentation allow for higher degrees of exploitation *and* exploration, respectively. Firms not only expand on current product line with incremental innovations based on competitors' successes but also look for new radical products through experimentation. Firms that are entrenched in Cell 2 and firms entrenched in Cell 3 may have higher degrees of exploitation and exploration, respectively, relative to those obtained in Cell 4. However, Cell 4 will have higher degrees of exploitation and exploration relative to those obtained in Cells 3 and 2, respectively. Thus, it is posited that

> *H9: Competitor benchmarking to rival offerings will moderate the relationship between market experimentation and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between market experimentation and exploitation of incremental innovation.*

Similar cells can be developed for the interactions of benchmarking with technology monitoring based on low and high levels of each variable. Refer to Table 6 of Appendix A. With low levels of both benchmarking and technology monitoring, technology shifts are not anticipated nor are they sensed and recognized. Any incremental improvements to the product line, if they occur, will be based on the firm's current technological trajectory and blind to competitor offerings. When high degrees of benchmarking overtake low degrees of technology monitoring, greater degrees of exploitation occur. The firm is alert to rival offerings and the needs of the competitor's customer. Incremental improvements are more likely to be developed as a substitute or improvement to competitor products based on the firm's current technology. The firm is relatively oblivious to new technological developments entering the industry or on the horizon. With high degrees of technology monitoring and low degrees of benchmarking, firms will tend toward exploration based on new technologies, perhaps developed outside the

firm, and without regard to competitor offerings. Finally, a dual pursuit is obtained as high degrees of benchmarking and high degrees of technology monitoring allow for higher degrees of exploitation *and* exploration. In short, firms high in both benchmarking and technology monitoring will monitor new technological developments in the external environment and benchmark against competitor products for differentiation in radical and incremental innovations. Firms that are entrenched in Cell 2 and firms entrenched in Cell 3 may have higher degrees of exploitation and exploration, respectively, relative to those obtained in Cell 4. However, Cell 4 will have higher degrees of exploitation and exploration relative to those obtained in Cells 3 and 2, respectively. As such, the following proposition is offered:

> *H10: Competitor benchmarking to rival offerings will moderate the relationship between technology monitoring and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between technology monitoring and exploitation of incremental innovations.*

Lastly, cells can be created for the interactions of benchmarking with technology competence based on low and high levels of each variable. Refer to Table 7 of Appendix A. For low levels of both variables, there may be no exploration or exploitation activities as a result of low benchmarking and low technology competence. If the firm innovates, it does so without regard to their competitor's product offerings and state-of-the art technology. Incremental improvements are path-dependent and far from the technological frontier. With high degrees of benchmarking and low degrees of technology competence, greater levels of exploitation and greater levels of path-dependent "me too" products may occur. With low technology competence relative to the frontier, incremental product innovations to competitor offerings are based on the firm's prior technology experience or may be a less technology-intensive product. On the other

hand, high degrees of technology competence and low degrees of benchmarking result in greater levels of exploration. These firms are highly exploratory in nature, possibly taking multiple exploratory paths with significantly higher costs and risk. They care less about their competitor's offerings and customers and more about the next new radical innovation and pushing the state of the art. For high levels of both variables, a dual pursuit is obtained as higher degrees of benchmarking and technology competence allow for higher degrees of exploration *and* exploitation. New products may be influenced by greater knowledge of competitor products and state of the art technology. Firms that are entrenched in Cell 2 and firms entrenched in Cell 3 may have higher degrees of exploitation and exploration, respectively, relative to those obtained in Cell 4. However, Cell 4 will have higher degrees of exploitation and exploration relative to those obtained in Cells 3 and 2, respectively. As such, the following proposition is offered:

> *H11: Competitor benchmarking to rival offerings will moderate the relationship between technology competence and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between technology competence and exploitation of incremental innovations.*

**Current Customer Knowledge Process**

Current customer knowledge process is defined as a "set of behavioral activities that generates customer knowledge from current customers pertaining to their needs for new product innovations" (Li and Calantone 1998, 14). Customer involvement is critical to new product development (NPD). However, firms often rely too heavily on too few segments. Current customers, those in the center of the target market, are too familiar with existing products which impedes the ability to envisage exploratory attributes and uses (Lilien et al. 2002). Furthermore,

traditional market research techniques are designed to collect customer information from current customers, ultimately reducing product creativity in its wake (cf, Lilien et al. 2002). This leads to new product innovations that are incremental in nature.

As with the moderating impacts of benchmarking, there are important interactions between current customer knowledge process and each of the PDM subprocesses of marketing experimentation, technology monitoring, and technology competence that again reduce their natural biases toward exploration. These interactions allows for a dual focus of both exploration and exploitation. Refer to Table 8 of Appendix A. While market experimentation highly influences exploration, the scale is tipped toward increased exploitation as information from current customers detail their needs and wants. The goal of dual focus is aided when firms are high in both current customer knowledge process and experimentation. This interaction leads to higher levels of both exploitation and exploration. Incremental innovations are based on current customer feedback, but radical innovations may also be influenced by current customers. This may result in radical innovation with more immediate market potential for current customers while attracting innovative customers with new exciting products. Low levels of both experimentation and customer input would yield lower levels of innovation of any type or some innovation developed blindly with respect to customer input. High levels of experimentation with low levels of current customer knowledge may yield radical innovations based on customer feedback from experiments but do not benefit from customer information gathered prior to the experimentation, possibly causing higher product development costs as more reiterations are required for successful product launch. Low levels of experimentation with high levels of current customer knowledge may yield incremental innovations that lack creativity, are based on

customer familiarity with existing products, and are developed and marketed with little test time. Firms that are entrenched in Cell 2 and firms entrenched in Cell 3 may have higher degrees of exploitation and exploration, respectively, relative to those obtained in Cell 4. However, Cell 4 will have higher degrees of exploitation and exploration relative to those obtained in Cells 3 and 2, respectively.

> *H12: Current customer knowledge process will moderate the relationship between market experimentation and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between market experimentation and exploitation of incremental innovations.*

Refer to Table 9 of Appendix A. Firms high in both current customer knowledge process and technology monitoring will exploit more based on new incremental technological developments and customer needs and wants while exploring more radical innovations based on new technological developments outside their organization. However, this dual focus is lost when only one variable is high. With high degrees of current customer knowledge process and low degrees of technology monitoring, greater levels of exploitation occur based on the current technology trajectory of the firm and the current product line. With low levels of current customer knowledge process and high levels of technology monitoring, product innovations are more radical based on new technologies in or entering the industry. Current customers have little input as to the attributes, benefits, functions, etc. of the radical new product. Low levels of both variables may lead to needless incremental innovation or non-innovative products that have little benefit for current customers.

*H13: Current customer knowledge process will moderate the relationship between technology monitoring and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between technology monitoring and exploitation of incremental innovations.*

Similar can be said of firms high in both current customer knowledge process and technology competence. Refer to Table 10 of Appendix A. For low levels of both variables, there is little-to-no exploration or exploitation as a result of low current customer knowledge process and low technology competence. Another scenario is that some minor incremental innovation may occur based on the increasingly obsolete technology skill set but has not been influenced by customer input. These needless incremental innovations would be developed and marketed only for the firm to find there is no market. With high degrees of current customer knowledge process and low degrees of technology competence, path-dependent incremental innovations on current products may be more marketable as they are based on customer input, but there is no technological advance in the product or the firm. With high technology competence and low current customer knowledge process, greater exploration occurs based largely on the state of the art and technology know how and skills resident in the firm. Once again, dual focus is attained with high levels of both variables. Exploration continues as the firm pushes state of the art and develops radical new products. This is concurrent with continued exploitation based on current customer input.

*H14: Current customer knowledge process will moderate the relationship between technology competence and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between technology competence and exploitation of incremental innovations.*

## Lead User Collaboration

Lead users are defined as those users "whose present strong needs will become general in the marketplace months or years in the future" (von Hippel 1986, 791) and are best at stretching the firm with new ideas for radical innovation (Lilien et al. 2002). Von Hippel (1988) notes that 77% of innovations in scientific instruments and 67% of innovations in semiconductors were developed by lead users. On the other hand, the characteristics and needs of innovators and lead users are not the same as other segments in the product life cycle (Moore 2002). Therefore, over-reliance on lead users may lead to unnecessary or inappropriate radical innovation (Wind and Mahajan 1997) when incremental innovation may be the more profitable route.

Lead user collaboration is defined as a set of behavioral activities that generates knowledge from lead users pertaining to their current and potential needs for new product innovations (Wind and Mahajan 1997). The CRM process of lead user collaboration extracts and acquires information from lead users and potential new customers for exploration. Employment of non-traditional lead user research techniques (cf, Lilien et al. 2002) will aid firms in their quest for exploration.

Both SCM processes of channel bonding and quality process management were proposed as having a more positive influence on exploitation than exploration. Because lead user collaboration overwhelmingly supports exploration over exploitation, this research takes the position that lead user collaboration moderates the relationships between the SCM processes and innovation strategies, that is, the positive influences of channel bonding and quality process management on exploration will increase when moderated by lead user collaboration, thus the

firm's natural tendency toward exploitation as a result of these SCM processes is dampened but not erased.

Refer to Table 11 of Appendix A. Firms high in both channel bonding and lead user collaboration can reap the benefits of the interorganizational relationships (i.e., shared risk with an established partner, time-tested channels of communication and collaboration) and explore radical innovations with inputs received from lead users. Concurrent with exploration, they can continue to exploiting products through incremental innovation made faster and more efficiently with their trusted suppliers. Problems that may arise in both innovation endeavors can be jointly resolved in a more expedient and efficient manner. The pace of new product development is quickened issues are worked on early in the development phase. This is especially critical when supplier parts play a major function in the new product. On the other hand, firms that are low in both channel bonding and lead user collaboration may not attempt innovation at all or may attempt some incremental innovation, but go it alone as they have an arm's length relationship with suppliers. Suppliers are less willing to joint problem-solve technical issues manufacturers may be experiencing, possibly resulting in inferior products. They are not brought into the development process at all. Mutual commitment to higher product quality and reliability standards may be severely reduced. High levels of channel bonding with low levels of lead user collaboration will propel firms toward more exploitation with supplier input, but lower levels of exploration based on lead user input. Conversely, high levels of lead user collaboration with low levels of channel bonding will increase exploration but without the benefits a strong, trusted, and committed supplier brings.

*H15: Lead user collaboration will moderate the relationship between channel bonding and exploration of radical innovations, such that the greater the degree of lead user collaboration, the stronger the relationship between channel bonding and exploration of radical innovations.*

Similar interactions occur with lead user collaboration and quality process management which ultimately lead to a more dual focused innovation. Refer to Table 12 of Appendix A. Firms high in both quality process management and lead user collaboration will tend to explore more while exploiting, reaping the benefits of quality process management, such as stability to organizational routines and reduced product development time (cf, Benner and Tushman 2002), while bringing in new information on lead user wants and preferences. This information acquisition and collaboration brings diverse knowledge and aids in removing the bias (Tabrizi and Walleigh 1997) toward exploitation that is created by the quality process management techniques. Firms that are low in both quality process management and lead user collaboration may not attempt innovation at all or may attempt some incremental innovation. Products are riddled with errors, resulting in low quality and low reliability. High levels of quality management techniques with low levels of lead user collaboration will pitch firms toward lower cost and more efficient exploitation based on current product lines without the input of lead user foresight. High levels of lead user collaboration with low levels of quality management techniques may improve levels of exploration but with less production efficiency, reduced reliability, and increased rework costs.

*H16: Lead user collaboration will moderate the relationship between quality process management and exploration of radical innovations, such that the greater the degree of lead user collaboration, the stronger the relationship between quality process management and exploration of radical innovations.*

## Innovation Strategy and Firm Performance

The overwhelming majority of innovation research indicates that innovation is good for a firm (e.g., Han et al. 1998; Nelson and Winter 1982). It increases performance in many ways, financial and otherwise, although the cost of developing, producing, and marketing the new product may cause a drop in short-term financial performance (cf, Gatignon and Xuereb 1997). It increases survivability while failure to innovate increases mortality (cf, Jovanovic and MacDonald 1994).

The inherent contradictions of exploitation and exploration create tensions in organizations. Because of these tensions, many firms choose one strategy over the other and suffer in performance as a result (e.g., Bierly and Chakrabarti 1996; March 1991; Tushman and O'Reilly 1996). Firms that focus on exploration bear the costs and risks associated with experimentation for long term gains, and find that short term performance decreases. On the other hand, firms that focus on exploitation find that long term performance suffers (March 1991).

Only a handful of papers have actually attempted to empirically test the performance of firms implementing both innovation strategies. He and Wong (2004) found support for a positive interaction between exploration via product innovations and exploitation via process innovations and sales growth rate. Han et al. (2001) found a positive relationship between "ambidexterity" in scope of innovation (incremental, incremental to competence-enhancing radical, incremental to competence-destroying radical) and ROI. Gibson and Birkenshaw (1994) provide additional exploratory, yet empirical, evidence that organizations that can both align and adapt have higher firm performance (measured as customer satisfaction and meeting full

business potential) than strongly adaptive organizations or strongly aligned organizations. Finally, Bierly and Chakabarti (1996) find that the dual focus firm in the pharmaceutical industry enjoys higher profitability over the highly exploitative firm, but not necessarily over the highly explorative firm.

In summary, the ability to achieve dual focus between exploration and exploitation is challenging, thus firms generally choose one strategy over the other. Future innovation efforts will sway to the strategy that is already present and dominant in the firm. Firms that focus on exploration bear the costs and risks associated with experimentation for long term gains, and find that short term firm performance decreases. On the other hand, firms that focus on exploitation find that long term firm performance suffers (March 1991). There is growing empirical support that firms that pursue both exploration and exploitation have greater firm performance than firms operating in either extreme (cf, Han et al. 2001). Thus, it is posited that there is an interaction between exploration and exploitation that increases firm performance over the extreme strategies.

> *H17: Exploitation of incremental innovations will positively moderate the relationship between exploration of radical innovation and firm performance, such that the greater the degree of exploitation of incremental innovation, the stronger the relationship between exploration of radical innovation and firm performance.*

# CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

This section outlines the research design and methodology that was employed to test the model conceptualized in Chapter 3. First, a description of the research setting, sampling frame, and respondents used in this study will be addressed. Next, questionnaire development, as well as how constructs were operationalized, followed by an outline of the mail survey procedure, including steps used to increase response rates and address single respondent bias issues. Finally, data analysis techniques and procedures used in hypotheses testing.

## Research Setting

Cross-sectional survey research via self-administered questionnaire was chosen as the most appropriate avenue for this dissertation. This type of survey research attempts to provide an accurate representation of reality through the single administration of a research instrument (Churchill 1999; Kerlinger and Lee 2000) and is the most frequently used descriptive design in marketing strategy research (Gatignon and Xuereb 1997). It also has the advantage of allowing a large amount of information to be collected from a variety of respondents and is considered significantly more economical for the amount of information it garners (Kerlinger and Lee 2000). What's more, most research on simultaneous pursuit of exploration and exploitation has been conceptual in nature. As such, survey research allows a better depiction and understanding of dual innovation strategies, their business process determinants and interactions, and firm consequences from the viewpoint of the top executives leading the firm and making the strategic decisions. Regarding the use of perceptual measures versus objective measures, prior research indicates that these two types of measures, particularly in performance, demonstrate statistically

significant correlations, therefore perceptive measures can be considered reliable indicators (e.g., Pearce et al. 1987). Finally, in the past a large portion of the published empirical research on technological innovation and strategy has been based on patent data (cf, Katila and Ahuja 2002). Since patent data is an observable outcome of strategy, this operationalization does not capture the perspectives and beliefs of executives in their strategic decision making.

Questionnaire use brings some disadvantages, the most significant being the typically low response rate. To counteract the low response rate and the analysis issues it brings, methods promoted by Dillman (2000) were employed to improve low response rate. These methods are discussed later in this section.

Survey research in radical innovation is often limited to a three year period (cf, Chandy and Tellis 1998), however this study used a five year period, following the lead of marketing studies involving both incremental and radical innovation (cf, Li and Calantone 1998). In order for both radical and incremental innovation to occur and have financial performance impacts, a greater time period to five years is critical. Organizations must have a history for exploitation to occur. Second, a benefit of a greater time period is the ability to capture more long term radical innovation projects that many advanced high technology firms engage in (He and Wong 2004). Third, prior research indicates that organizational memory in high technology companies is "imperfect" (Katila and Ahuja 2002). New knowledge gained for radical innovation loses significant value in approximately five years (Argote 1999; Katila and Ahuja 2002). As such, the greatest proportion of incremental innovations that develop from the initial radical innovation should occur within five years. Finally, a set time period for all respondents and for collection of secondary data increases cross-comparability of data.

## Sampling Frame and Sample Construction

The sampling frame consisted of manufacturers, with a minimum firm age of five years, from US high technology industries. These industries were chosen based on the following rationale. First, the model includes technology-related constructs of technology competence and technology monitoring, and builds on prior innovation research with respect to technological frontier, trajectory, and path-dependence. Second, the existence of both radical and incremental product innovations is widespread in the high technology industries. Shortened life cycles, a characteristic of high technology industries, propel firms to innovate more frequently (Capon et al. 1992). Third, knowledge intensive environments tend to produce more investment in further knowledge development (Levinthal and March 1993). R&D expenditures on innovation and product development are significantly greater in technologically- and knowledge-intensive industries, than in food and textiles (cf, Duckworth 1967). Lastly, according to Weiss and Heide (1993), marketing research is noted to have "a historical bias" toward low technology products despite the calls for studying high technology industries due to their unique characteristics and demands (Glazer 1991; Robertson and Gatignon 1986; Weiss and Heide 1993).

The American Electronics Association (AEA) was consulted as to the link between the definition of a high technology industry, that is, an industry that is a maker/creator of technology (Platzer et al. 2003), and the corresponding North American Industrial Classification System (NAICS) codes, limited by this study to manufacturers. According to Platzer et al. (2003), high technology manufacturing industries and their corresponding NAICS codes are defined as follows: 1) *Computer and Peripheral Equipment*: Electronic Computers (334111), Computer Storage Devices (334112), Computer Terminals (334113), Other Computer Peripheral

Equipment (334119); 2) *Communications Equipment*: Telephone Apparatus (334210), Radio & TV Broadcasting & Wireless Communications Equipment (334220), Other Communications Equipment (334290), Fiber Optic Cables (335931); 3) *Consumer Electronics*: Audio and Video Equipment (334310); 4) *Electronic Components*: Electron Tubes (334411), Bare Printed Circuit Boards (334412), Electronic Capacitors (334414), Electronic Resistors (334415), Electronic Coils, Transformers and other Inductors (334416), Electronic Connectors (334417), Printed Circuit Assembly (334418), Other Electronic Components (334419); 5) *Semiconductors*: Semiconductor and Related Devices (334413), Semiconductor Machinery (333295); 6) *Defense Electronics*: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments (334511); 7) *Measuring and Control Instruments*: Automatic Environmental Controls (334512), Industrial Process Control Instruments (334513), Totalizing Fluid Meter and Counting Devices (334514), Electricity Measuring and Testing Equipment (334515), Analytical Laboratory Instruments (334516), Other Measuring and Controlling Instruments (334519); 8) *Electromedical Equipment*: Electromedical and Electrotherapeutic Apparatus (334510), Irradiation Apparatus (334517); and 9) *Photonics*: Optical Instrument and Lens (333314), Photographic and Photocopying Equipment (333315). Accordingly, the aforementioned nine high technology manufacturing industries were chosen for this study. Their diversity added to the increase in generalizability of findings within the overarching high technology sector.

Using the above specified industries, both public and private corporations for the sampling frame were drawn from CorpTech, Directory of Technology Companies, produced by infoUSA. This directory has been increasingly used in marketing research with respect to high

technologies industries and innovation studies (cf, Im and Workman 2004; Srinivasan et al. 2002). Once the sampling frame was constructed, a sample of 1000 corporations was drawn by systematic sampling in order to draw a sub-sample of approximately 111 firms from each of the nine overarching industry categories, that is, 111 firms from the category of *Computer and Peripheral Equipment,* 111 firms from the category of *Communications Equipment*, etc. The goal was to obtain a relatively equal sub-sample from each category for increased generalizability across high technology industries. Using this approach, it is believed that the constructed sample was representative of the population as a whole, allowing this researcher to make estimates of the thoughts and behaviors of the larger population. Specific profiles of the firms in the sample are further discussed in Chapter 5.

The intended respondents for this study were chief executive officers (CEOs)/presidents/chairman and vice presidents of marketing at the corporate level. Based on the model and the theoretical framework employed in the dissertation, respondents had to be well-informed with respect to organizational functions/departments, as well as multiple strategic business units (SBUs) or divisions within the corporation; be knowledgeable of organizational innovation strategies, organizational characteristics (age, size, culture), structure, PDM, SCM, and CRM processes, and have access to firm performance information. To ensure that individuals had an equal breadth and depth of firm knowledge, respondents were limited to these select individuals in the upper echelon of the corporation. Due to variance in firm size and organizational structure in terms of job title and responsibility, some firms did not list a vice president of marketing. If no such individual was listed, then the second survey went to the top executive listed for marketing (director, manager), business development, or strategy, in that

order. Likewise, some very small firms listed only one executive, e.g., the CEO/president/chairman. As a result, 1000 CEOs/presidents/chairman and 838 second-level respondents were ultimately contacted.

## Common Method Bias

Common method bias can occur when both independent and dependent variables are collected from a single informant (common rater effects) and could negatively impact study results (Podasakoff et al. 2003). Common method bias, a source of systematic error, can lead to erroneous conclusions by inflating Type I error. Common method bias was controlled by surveying two respondents per firm (where possible), by using the suggested questionnaire improvement techniques of Dillman (2000) and Podsakoff et al. (2003), i.e., counterbalancing, reverse coding of items, etc., and by collecting secondary data on performance variables, specifically data on firm sales over the most recent five year period (2001 – 2005 inclusive) and current firm size were collected from CorpTech.

## Scale Development and Use

All scales were chosen based on their relevance to this research, as well as their successful track record in previous research in terms of reliability and validity. With respect to scale format, during the course of executive interviews, it was clear that the 7-point format was too cumbersome and time-consuming for the large majority of executives. As a result, for increased continuity and fluidity throughout the survey, survey visual appeal, and response rate, all scales were formatted for five-point. For the scale items and the survey itself refer to Appendix B.

One new scale was developed to complete this research. Channel bonding, as conceptualized by Day (1994), has been implemented in a limited number of empirical studies although its measurement is often restricted to one general item asking respondents to rate their channel bonding activities (cf, Desarbo et al. 2005; Song et al. 2005). To improve reliability and decrease error, a new scale was developed to include a composite of items that accurately reflect the key elements of Day (1994)'s conceptual description of channel bonding and includes multiple, specific activities. Proposed items measuring the level of manufacturer-supplier communication, joint problem solving, and coordination were developed and were measured with a five-point scoring format (1=strongly disagree; 5 = strongly agree). In-depth executive and academic interviews were conducted to aid in construct development ensuring that academic and practitioner knowledge and thought were considered and appropriately applied. Suggestions from academic reviews indicated a need to isolate channel bonding measures to one top supplier of the firm, while executive interviews revealed that the most appropriate wording to use was "major supplier in terms of performance and cost."

In order to test the nomological validity of channel bonding measure, a measure for supplier trust was added to the survey. Marketing research indicates that trust is a significant component in channel relationships (Anderson et al. 1987). Firms that trust will use less coercive influence (Kim 2000) and more joint problem solving and coordination of activities. As such, a measure of supplier trust was added with the expectation that trust and channel bonding would be highly correlated if channel bonding was measured appropriately. The scale used was based on trust items of credibility, reliability and integrity from Ganesan (1994) and Morgan and Hunt (1994).

The remaining constructs were measured with existing scales, modified as follows, following academic and executive review and comment incorporation.

### Market Experimentation Scale

Earlier, market experimentation was defined as the activities undertaken by the firm to gain information through testing new ideas on current and potential customers (Day 1994; McCardle 2005; Slater and Narver 2000). Two scales were reviewed for research applicability: 1) Intelligence Generated through Experimentation scale by Slater and Narver (2000), and 2) the Customer Knowledge Development scale of Joshi and Sharma (2004). The three-item scale by Slater and Narver (2000) has acceptable reliability (.71), however does not adequately address the full extent of market experimentation. In particular, it addresses small experiments which are more prevalent in incremental innovation efforts ("We often conduct small market-focused experiments." "We often conduct small, internally focused experiment."), but fails to address large scale experiments which are prevalent in the development of radical innovations. On the other hand, the five-item scale by Joshi and Sharma (2004) does not bring experiment size into any item, instead concentrating on testing, evaluating and responding to experimentation (i.e., "We develop and test lots of new ideas over the course of new product development." "Our product development involves numerous failed experiments."). This scale exhibits good reliability (coefficient alpha) of .89; however comments from preliminary survey reviews indicated that these scales may lack items that are highly correlated to both exploratory and exploitative experimentation efforts. In order to capture experimentation efforts that may lead to both exploration and exploitation, a composite of both scales was ultimately used. This

composite scale had seven items and a five-point scoring format, anchored by 1=strongly disagree and 5 = strongly agree.

### Technology Monitoring Scale

Technology monitoring is defined as the process in which an organization acquires knowledge about and understands new technology developments in its external environment (Day 1994; Srinivasan et al. 2002). Technology monitoring was measured using a scale from Srinivasan et al. (2002) on technology sensing (a dimension of technological opportunism). This scale includes items on seeking and detecting technology change, has a five-point scoring format (1=strongly disagree; 5 = strongly agree) and has exhibited a reliability (coefficient alpha) of .77. Comments from preliminary survey reviews indicated that an additional item was necessary to capture monitoring that leads to more exploitative strategies. As a result, it was modified to include one additional item ("We actively monitor small technology changes that may impact our products."). The final scale contained five items with a five-point scoring format (1=strongly disagree; 5 = strongly agree).

### Technological Competence Scale

Technological competence is conceptualized in this research as the current set of technological skills, experience, and knowledge resident within the firm *relative to the technological frontier*. Items for this scale were extracted from the Specialized Investments scale of Chandy and Tellis (1998) (coefficient alpha of .93) and modified to assess the technological competence of the firm based on the construct definition. Specifically not used were items reflecting current assets and facilities, marketing abilities, operating procedures and

tasks, and retraining employees. Items used were modified using terms of skills and knowledge and state of the art technology (in lieu of "established technology."). One item was also reverse-coded. The final scale contained four items with a five-point scoring format anchored by 1=strongly disagree and 5 = strongly agree.

### Quality Process Management Scale

Benner and Tushman (2002) empirically examine the relationship between process management and exploitation and exploration. They operationalize process management as the number of ISO9000 certifications in the firm via objective data obtained from a third party source. Since this research is survey-based, a scale that effectively captures process management techniques that may impact radical and incremental innovation strategies is necessary. This research used items selected from an existing scale of ISO9000 benefits by Huarng et al. (1999) (coefficient alpha of .94 in its original form). Scale items were carefully chosen that reflect efficiency of operational processes and variance reduction and reformatted to reflect techniques instead of benefits. The final scale had five items based on a five-point scoring format (1 = Not at all; 5 = A very great extent) and asked executives to assess the extent they used process management techniques (i.e., ISO9000).

### Competitor Benchmarking Scale

Competitor benchmarking is conceptualized as a learning process in which firms seek to benchmark competitors' current and potential offerings in the innovation context. The semantic differential scale, Competitor Knowledge Process, from Li and Calantone (1998) with a coefficient alpha of .95 was modified slightly to accommodate the requirements of this research

with respect to processes leading to exploration and exploitation. Specifically, one research-specific item from Li and Calantone (1998) ("We rarely/regularly study our competitors' software.") was removed and one item was added to capture benchmarking for an explorative strategy ("We seldom/continuously investigate what radical new products our competitors have or will have on the market."). The final five-point semantic differential scale contained four items.

### Current Customer Knowledge Process Scale

The scale, Customer Knowledge Process, from Li and Calantone (1998) was employed to assess this construct. This scale captures the essence of the construct, conceptualized as activities that generate knowledge on current customer needs for new product innovations. This scale is a five-point semantic differential and has exhibited a good reliability (coefficient alpha) of .94. Wording, specific to the Li and Calantone (1998) research, was removed. Three items from the original scale were also not used. One item ("We seldom/regularly use customers to test and evaluate new products.") fell within the domain of the experimentation construct, compromising discriminant validity. The remaining two items were not activity-based ("We barely/fully understand our customers' business.") and ("Our knowledge of customer needs is scant/thorough."). The final scale contained five items.

### Lead User Collaboration Scale

The scale from McCardle (2005) was employed to assess lead user collaboration. This scale assesses the degree to which the firm employs lead user collaboration in new product development. The McCardle (2005) scale is also based on the research by Day (1994), therefore

contains the appropriate items reflecting the input of lead users. This scale has a five-point scoring format (1 = strongly disagree; 5 = strongly agree) and has exhibited a good reliability (coefficient alpha) of .87.

### Innovation Strategies Scales

As defined earlier, an innovation strategy of exploration encompasses those decisions and activities aimed developing radical product innovations, while an innovation strategy of exploitation encompasses those decisions and activities aimed developing incremental product innovations. In this research, the degree of an exploration strategy and degree of an exploitation strategy was measured in three ways. First, the exploration and exploitation strategy scales of He and Wong (2004) were used. Unmodified, these scales reflect an acceptable reliability at .81 and .75 for exploitative and explorative strategy, respectively. However, their research examines process innovations with respect to exploitative strategy. Since process innovations are outside the context of this study, the final scale was expanded by four items that reflected the desired product innovation strategies. It was decided that one item specifically reflect technology ("Make minor improvements in a current technology.") and the remaining three items ("Develop completely new or different technology knowledge bases." "Reuse your existing technology knowledge." "Combine knowledge of different existing technologies into a new product.") reflect knowledge reused or developed, drawing from organizational learning literature with respect to knowledge and innovation strategy. The latter items were based on knowledge statements with respect to innovation from Katila and Ahuja (2002). Additionally, one item was removed during the critical review process as a result of reviewer comment (i.e., "Open up new markets" was considered nebulous with respect to exploration or exploitation.) In the final

survey, executives were asked to rate decision and objective statements based on innovation projects their corporation had undertaken in the last five years regardless of the source of funding. The scale was five-point format, anchored by "Not important" to "Very important." Second, respondents were asked to rate the degree of their product innovation strategies over the past five years with respect to their competitors. This one-item semantic differential scale had a five-point format anchored by "Largely exploitative with incremental innovations" and "Largely explorative with radical innovations." As a final measure, firms were asked to approximate the number of innovative products (in total, radical, and incremental) introduced in the past five years. Note that due to the fact that the interval measure of innovation strategy exhibited satisfactory validity and reliability, the second and third measures discussed above were not used in the final analysis.

### Firm Performance Scale

Recognizing that firm performance is a multi-dimensional construct, past innovation research on similar investigation with respect to exploration and exploitation strategies was consulted as to the appropriate measures. In their study on incumbent performance and advantage with respect to varying levels of radical and incremental innovation, Han et al. (2001) use perceptual measures of ROI relative to the industry average. In their study on ambidexterity, He and Wong (2004) measure firm performance by sales growth rate (perceptual), noting that this measure has been found to be a reliable proxy for other dimensions of firm performance, including long-term profitability (Henderson 1999; Timmons 1999). Furthermore, they find a positive correlation between their perceptual measure and archival secondary measures of sales growth rate, return on sales (ROS) and return on asset (ROA) indicators. Gibson and

Birkenshaw (2004) take a different approach and ask respondents to reflect on performance over the most recent five years and indicate their agreement with respect to whether the SBU is meeting its full potential, the level of satisfaction of employees with respect to firm performance, the level of customer satisfaction, and the level of work opportunity and encouragement for the individual. They find that the aggregate response of these perceptual indicators is highly correlated with secondary data of ROA, Return on Equity (ROE) and shareholder return. In light of the three studies and their different approaches, perceptual measures of ROA, market share, sales growth, ROS, ROI, and profitability were employed. Respondents were asked to rate these measures relative to their competitors over the past five years using a five-point Likert scale, anchored by Much Worse (1) to Much Better (5). As stated earlier, secondary data in terms of firm size (number of employees) and sales (most recent and over five years) was also collected from the CorpTech database to validate the subjective assessments of performance.

## Measurement of Controls

Based on extant literature, the following variables were chosen as controls: environmental turbulence and intensity, environmental scanning, organizational structure and culture. Each of these variables has been noted to significantly impact innovation (either amount or type) and firm performance (cf, Vincent et al. 2004). Industry was not used as a control as the sampling frame was limited to high technology industries. Additionally, variation across high technology industries was accounted for by use of the environmental controls and by requesting respondents to report information on firm performance relative to their competitors (Judge and Douglas 1998). Although size was not used as a control, it was measured to assess the correlation between perceptual and objective measures of same and also used as a proxy for firm

performance. To reduce the length of the survey and subsequently respondent fatigue, age was removed from the survey and measured using secondary data from the CorpTech database.

**Scale for Environment Turbulence and Intensity**

Previous research indicates that environmental turbulence highly impacts innovation and performance (cf, Utterback 1994; Windrum 1999), particularly turbulence in markets and technology (Anderson and Tushman 2001; Damanpour 1996). Additionally, competitive intensity impacts innovation and performance (Tushman and Anderson 1986; Utterback 1994; Utterback and Abernathy 1975). Market turbulence is defined as the "rate of change in the composition of customers and their preferences" (Jaworski and Kohli 1993, 57) while technological turbulence is the "rate of technological change" (Jaworski and Kohli 1993, 57). Competitive intensity is the degree of competitiveness with respect to competitor ability, resources, and behavior to differentiate their products (Jaworski and Kohli 1993).

Scales for these control variables were borrowed from Jaworski and Kohli (1993), as adapted by Joshi and Sharma (2004). The turbulence scales for marketing and technology tap into changing customer composition and preferences and industry technological change, respectively. The competitive intensity scale assesses the degree of competitiveness in the industry. All three scales employ a five-point scoring format (1=strongly disagree; 5 = strongly agree) and have been widely adopted by marketing researchers and successfully employed in other research endeavors (cf, Grewal and Tansuhaj 2001). They have exhibited reliabilities (coefficient alpha) of approximately .7 or greater (.79, .76, .81 for market turbulence, technology turbulence, and competitive intensity, respectively). Although the individual reliabilities of the

constructs were considered in the choice of measures, in this research, the firm environment is a *formative* construct composed of market turbulence, technology turbulence, and competitive intensity.

**Environmental Scanning Scale**

Environment scanning is defined as the process to identify key trends, changes, and events in the organization's environment that may impact how the firm functions now and in the future (Hambrick 1982; Milliken 1990). Its purpose is to aid the firm in forming a complete understanding of the current and future states of five environmental factors: social, economic, political, regulatory, and technological (Maier et al. 1997). Note: Following the precedent set by Day (1994), this dissertation does not integrate technology monitoring under environmental scanning, but leaves it as separate construct. For this reason, a scale suitable for measuring social, economic, political, and regulatory factors was necessary.

Environmental scanning has been conceptualized on a continuum of intensity as ranging from irregular or passive scanning (a state of alertness) to continuous or active scanning (high vigilance) (Aguilar 1967; Huber 1991). Scanning is often measured in both frequency and scope. Due to the fact that scanning is not the central focus of this research, a simple scale addressing both frequency and scope of scanning in the above mentioned factors was sought. Although several scales were reviewed for applicability, including those of Barringer and Bluedorn (1999), Beal (2000) and McCardle (2005), these scales in their entirety were deemed excessive and did not adequately address all of the environmental factors in which scanning occurs. After careful review, a reduced portion of the scales of Beal (2000) and Barringer and

Bluedorn (1999) were used. Items chosen address economic, demographic, political and regulatory trends with respect to frequency of information collected. Executives were asked to assess collection of information with respect to environmental trends. This five-item, five-point scale was anchored by "Never" and "Frequently." Additionally, an item to assess scanning with respect to technology trends was included to evaluate its correlation to items in the technology monitoring scale.

**Scales for Organizational Size**

Firm size is measured in a variety of ways, the most common being number of employees, sales, or value of assets (Chandy and Tellis 2000). The most widespread in the innovation literature is number of employees (cf, Chandy and Tellis 2000). To reduce respondent fatigue and frustration with a lengthy survey, organizational size was measured by asking respondents how many employees in terms of full-time equivalent are currently employed at their corporation (less than 100, 100-499, 500-1999, 2000-4999, 5000-9999, >10,000). Note: Firm size by employee count was subsequently removed from the analysis of the structural model as it is often used a proxy for items that were already included in the firm performance measure. Furthermore, firm size by sales was an objective measure using secondary data.

**Scale for Organizational Structure**

Past research indicates exploitation is associated with mechanistic structures of high formalization, high centralization, and high complexity while exploration is associated with organic structures of low formalization, low centralization, and low complexity (cf, Burns and

Stalker 1961; Duncan 1976; Ettlie et al. 1984). Organizational structure characteristics necessary for support of successful product development must change as the initial radical innovation gives way to incremental innovations (Zaltman et al. 1973). Chandy and Tellis (2000) find that incumbent firms are able to explore and exploit by breaking their large, bureaucratic structures into separate smaller autonomous business units. These business units are characterized by varying degrees of formalization, centralization, and complexity needed for their core line of innovative activity, lower degrees for exploration and higher degrees for exploitation. This suggests that a scale assessing dual structures may be appropriate as a control.

Although the concept of dual structures has been studied in management literature for many years (cf, Duncan 1976), a dual structure scale for empirical research is virtually non-existent. Discussions with Dr. Michael Tushman, the leading researcher in this area, verified this conclusion. Suggestions were made that the semantic differential scale of Khandwalla (1977) which measures organicity may be adequate for dual structure assessment. Organizations that possess moderate levels of both would report middle-of-scale assessments and could be assumed to have dual structures. However, this approach is fraught with issues as the organizational structure data would need to be trichotomized (mechanistic, organic, dual structure) from a five-point scale (see earlier explanation on five-point format) prior to use in data analysis. As an alternative, the one-item, five-point interval scale by Capon et al. (1992) was also reviewed for applicability whereby respondents are asked whether new product development is the responsibility of a separate organizational unit. However, this measurement may not be the most appropriate path due to the limitations of a one-item scale.

In lieu of attempting to develop a new scale for a control variable, it was decided to use the structure scale by Khandwalla (1977) and assess general organizational structure impacts on performance, independent of whether the firm has dual structures in place. The seven items assessed openness of communication and information, formalization, decision-making, and adaptation of management to the changing environment. Item ratings were then averaged to obtain an overall organicity index for use as the control variable. The aforementioned one-item, five-point interval scale by Capon et al. (1992) was expanded to two items and included in the survey for future research.

**Organizational Culture Scale**

Although multiple scales are available for culture assessment, the context scales employed by Gibson and Birkenshaw (2004) in their ambidexterity-performance study were acceptable both as a control for this research and for future dual focus research. The scales assess two distinct constructs which underlie culture: performance management and social support. Performance management, a seven item scale, includes items assessing discipline and stretch, while social support, a nine item scale, includes items assessing trust and support. These scales, in their entirety, have exhibited good reliabilities (coefficient alpha) of .89 and .93 for performance management and social support, respectively. However, in order to reduce the length and complexity of the survey, items with factor loadings less than .68 were dropped from consideration. Additionally, items that were theoretically similar to items in the organization structure measurement, e.g., "give ready access to information that others need," were dropped from consideration to improve discriminant validity between structure and culture. The final

scales contained four items for performance measurement and three items for social support, measuring culture on a five-point scale, at "Not At All" to "To a Very Great Extent." While Gibson and Birkenshaw (2004) retained both performance management and social support as separate constructs and assessed their interaction on performance, it adds unnecessary complexity and decreases power in this research effort. As such, items for both variables were judged suitable for formative construct (for example, they were not expected to co-vary) and were loaded accordingly to create a *formative* construct for culture.

## Questionnaire Development

Dillman (2000) suggests there are two objectives of questionnaire design that must be achieved. The first objective is an increase in response rate with a respondent-friendly design. (Response rate increase is moderate compared to survey implementation). The second objective is the reduction or avoidance of measurement error. In order to meet these objectives, Dillman (2000) guidelines to questionnaire construction were employed. As time and effort are the biggest costs associated with completing the questionnaire, efforts must be made to limit these effects by carefully designing the research instrument. Questions must be clear and easy to comprehend, in an order easily followed by the respondent, and in a layout that is visually appealing (Dillman 2000). Guidelines followed include format, ink color, font size, spacing, numbering of questions, instruction location, back cover design, etc..

Elements from Bagozzi (1996) were also employed for questionnaire construction. More specifically, once a draft questionnaire was prepared, a critical review was performed. First, three academic reviewers provided comments to the draft instrument. Following incorporation of academic comments, face-to-face interviews were conducted with upper

echelon executives (i.e., CEOs and Vice Presidents) of high technology manufacturing corporations. These interviews were voice-recorded by tape when permission was granted and copious notes were taken during the interview to chronicle non-verbal cues, pauses, indications of confusion or impatience, etc.. After five interviews, the instrument converged into its pretest form. Two additional interviews were conducted on the pretest form to provide evidence that the survey was stable and did not require additional changes prior to pretest. Besides taking the survey, interview subjects provided insight as to the effectiveness of monetary incentives on response rate, as well as survey transmittal via post or email. These executives indicated that monetary incentives would have little-to-no bearing on response rate. Furthermore, they indicated that surveys sent by post may have a higher probability of making it to the intended respondents as Internet firewalls instituted by corporations may preclude delivery of surveys via email.

## Pre-Test

Following the critical review, a pretest on a small representative sample of respondents was conducted to address remaining conceptual or measurement issues. Sixty CEOs, chosen from the research sampling frame, were sent the pretest survey via personalized email explaining the intent of the study. Although response rates for email surveys are consistently lower than those post-mailed (paper copy) (Mavis and Brocato 1998), the expense and length of time expended with post mail overrode concerns of reduced response rate. CEO email addresses used were provided by CorpTech. Of the 60 sent, 33 were returned as "Not deliverable." In a parallel effort, 40 CEOs were contacted by a government representative of the Florida Manufacturing Extension Partnership (MEP). Of the 67 executives that were contacted successfully through the

combined efforts, 11 executives responded (10 from this researcher's email collection and one from the MEP collection) for an effective overall response rate of 16.4%. Non-disclosure agreements were signed when requested.

Pretest data collection provided insight into remaining survey construction issues and into possible response rate issues for the final data collection effort. Pretest surveys were individually examined with respect to missing data, frequency of responses, and executive comment. Inspection of pretest data did not highlight lingering conceptual or measurement issues, therefore no additional changes to the survey were made after pretest evaluation. A copy of the survey is included in Appendix B. With respect to response rate, there was some evidence that offering to sign non-disclosure agreements may increase response rate as it served to instill an increased sense of confidentiality, as well as authenticity. Additionally, the mechanics of emailing the survey and an estimate of the expected response rate were also assessed.

## Survey Implementation

According to Dillman (2000), the construction of the questionnaire is not the main determinant of response rate. Implementation procedures have a much greater influence on response rates that questionnaire construction, including ease of respondent completion. As such, the letter content, envelope characteristics, personalization, and sponsorship have a more significant positive impact on response rate. Considering response rates of 10 to 20% (Menon et al. 1996) are typical for this type of data collection, every effort to follow recommended procedures to increase response rate was made.

In order to achieve an acceptable response rate, the "tailored design method" by Dillman (2000) was consulted and modified according to Cycyota and Harrison (2006). A basic premise

of the tailored design method (TDM) (updated from the Dillman (1978) total design method) is that the questionnaire is a social exchange between researcher and respondent. Social exchange theory suggests that respondents will return the questionnaire, completed, if the benefits of doing so outweigh the costs associated with completing the questionnaire. However, Dillman (2000) has key limitations. While he addresses basic survey methods for consumer and employee populations, he does not adequately address the problems faced when surveying business executives and their appropriate solutions. He does indicate, however, that the TDM may need additional tailoring in method and design for surveying executives, the type of organizations involved, and the nature of information that is sought.

Dillman (2000) advocates five elements in the TDM: 1) a response friendly questionnaire, 2) four-wave mailing, 3) return envelopes with real first-class stamps, 4) personalization of correspondence and 5) prepaid financial incentive. Meta-analysis results from Cycyota and Harrison (2006) indicate that some elements in TDM are significantly less successful in executive populations when compared to other populations. Specifically, they found that advance notice, follow-up, and personalization do not provide statistically significant increases to response rate. (Financial incentives were also studied, but insufficient data was gathered to test the impact of this technique on executive response rate. However, as noted earlier, during face-to-face interviews for this study, executives indicated that the financial incentives would have little-to-no impact on whether they responded.)

On the other hand, topic salience, consent screen, and social networks provide the greatest positive impacts to response rate (Cycyota and Harrison 2006). With respect to topic salience, product innovation and the challenges of dual focus in exploration and exploitation are

of concern to both academicians and practitioners alike (cf, Wind and Mahajan 1997), thus it was expected that the topic would be of industry importance, be of current interest, and offer potential benefits to the organization. This belief was solidified during executive interviews when consulted individuals described the research as interesting, relevant and "timely." While consent prescreening increases response rate, there is also a higher danger of biased results and threatened external validity (Cycyota and Harrison 2006). Despite the probability of a higher response rate, if prescreening is done, then participants should be treated as their own group and not representative of the executive population (Cycyota and Harrison 2006). Regarding social networks, although limited, networks of the author increased contacts for interviews and may have impacted pretest response rate, but provided little promise for the final data collection. Since this research taps into nine high technology industries and was not sponsored or supported by an existing social tie, it was not a viable path to increasing response rate.

In summary, due to limitations and possible negative implications presented by prescreening and social network establishment, it was deemed that topic salience, along with careful survey construction and implementation, provided the most effective and efficient means of increasing response rate in this study. This decision also echoes the recommendations by Cycyota and Harrison (2006) that researchers may find it more fruitful to spend more time on personal interviews and survey enrichment than to focus attentions on prescreening and network establishment. Moreover, cost and time expended must be addressed in any research effort. The added expense and time associated with consent prescreening and social network establishment (for instance, if a snowball approach was taken) were not affordable.

Combining TDM with knowledge gained from the meta-analysis and information received during interviews and pretest, the author felt that a higher response rate would be garnered using a response friendly questionnaire; correspondence which highlighted the relevance of the topic to the executives; and a three-wave mailing. The fourth mailing for pre-notice/prescreening was dropped, however two follow-up mailings were retained as well as the personalization for each mailing. The use of financial incentives was also dropped from consideration for reasons mentioned above.

The questionnaire displayed the university logo to lend credibility to the study (Cavusgil and Elvey-Kirk 1998; Faria and Dickinson 1996; Faria and Dickinson 1992). The personalized cover letter assured respondents of total confidentiality and was personally signed by the researcher in blue ink. Cover letters stressed the usefulness of the study, the importance of the respondents to the success of the study, and confidentiality of responses. (Confidentiality has been shown to be significant in increasing response rates (Clark and Kaminski 1989; Faria and Dickinson 1996; Tyagi 1989)). The author also offered to provide an executive summary of final results for participation and to put non-disclosure agreements in place where necessary to increase response rate. Lastly, executives were notified that each survey contained a unique identifier for mailing purposes only. This identifier also facilitated assessment of non-response bias as each survey was labeled with an alphanumeric identifier corresponding to the firm and intended executive respondent. Additionally, the identifiers were color-coded such that black denoted a first mailing survey (early respondent) and red denoted a second mailing survey (late respondent).

A first class stamped package containing a one-page personalized cover letter, questionnaire, and self-addressed, first class stamped return envelopes was mailed to the intended respondents. One week later, a thank you/reminder postcard was sent to all intended respondents. Three weeks following the postcard, a replacement questionnaire was sent to non-respondents, again accompanied by a personalized cover letter and self-addressed, first class stamped return envelope. The schedule for mailings followed Dillman (2000). The correspondence used in this study is included in Appendix B.

## Methodology

Once data was collected, a multi-step approach to data analysis was employed for this research. Standard procedures for pre-analysis data screening were followed, investigating and correcting for possible presence of missing data, outliers, non-normality, non-linearity, and heteroskedasticity in accordance with Mertler and Vanetta (2002). Of the 257 surveys received, 16 surveys (including two surveys from one firm) had more than 15% missing data and were subsequently removed from the data set, leaving the number of usable surveys at 241, including two each from 10 firms. Missing data on any one item was less than 5%, the cut-off recommended by Mertler and Vanetta (2002). Hence, no item and its associated data were deleted from the database. The remaining missing values were replaced with the mean score of available cases for the item in question (mean imputation). With respect to non-normality, the variable, firm size, with respect to number of employees was transposed via logarithmic transformation (Log10) to remove substantial positive skewness. Following implementation of the above data screening procedures, re-analysis of the data for violation of multivariate assumptions (normality, linearity, and homoskedasticity) determined that the data was ready for

measurement and structural model assessment. Note: As stated below, the multivariate technique, partial least squares, is robust to moderate departures of multivariate normality, but data were screened regardless as a safeguard and for use in other tests where said departures may impact results.

To test the hypothesized relationships, depicted in Figure 1, partial least squares (PLS) was used with the software package, PLS Graph, Version 03.00, Build 1126. Although the hypotheses could have been tested with separate regression equations (one for each endogenous construct), the model involves independent equations that need to be estimated simultaneously. Because PLS considers all path coefficients simultaneously (thus allowing analysis of direct, indirect, and spurious relationships) and estimates multiple individual item loadings in the context of a theoretically specified model rather than in isolation, it allows the researcher to avoid biased and inconsistent parameter estimates for these equations.

PLS is most appropriate when the model incorporates both formative and reflective indicators, when assumptions of multivariate normality and interval scaled data cannot be made, and when the primary concern is with the prediction of dependent endogenous variables (Fornell and Bookstein 1982). It is ideally suited at the early stages of theory building and testing, and has been used across multiple disciplines (e.g., Barclay 1991; Birkinshaw et al. 1995; Chin 1998). PLS, as opposed to traditional Structural Equation Modeling (SEM) methods, imposes minimal demands on measurement scales, sample size, and distributional assumptions thereby avoiding two serious problems of SEM: inadmissible solutions and factor indeterminacy (Fornell and Bookstein 1982). Lastly, interactions may be tested using PLS (Chin et al. 1996), while appropriate interaction testing using SEM is questionable (Fornell and Yi 1992).

Interactions in PLS were tested using a technique proposed by Chin et al. (1996). Product indicators were developed by creating all possible products from the two sets of indicators (one for predictor variable and one for the moderating variable). This new set of product indicators reflects the latent interaction variable. For example, all indicators of the construct, competitor benchmarking, were multiplied by all indicators of the construct, technology monitoring. The new latent interaction variable (competitor benchmarking*technology monitoring) was represented by the new set of product indicators.

# CHAPTER 5: ANALYSIS AND FINDINGS

This chapter outlines the findings from data collection. First, assessments of firm response rate, non-response bias, and common method bias are discussed. Next, sample characteristics and quality is presented, followed by psychometric assessment of the measurement model. The results of hypotheses testing are presented and further examined with post hoc test data.

## Firm Response Rate

As outlined earlier, 1000 corporations, public and private, were contacted via a three-wave mailing (1000 CEO/Presidents and 838 VPs or other top executive). At the firm level, mailings to 86 firms were returned as undeliverable and 37 firms indicated that for various reasons they could or would not participate for a total of 123 firms. From the effective sampling frame of 877 firms, 246 firms[1] responded for an effective firm response rate of 28%.

## Assessment of Non-Response Bias

Two methods were employed to assess non-response bias. First, executive respondents and non-respondents were compared using secondary data. Second, early and late executive respondents were compared on key variables of interest using primary data. As noted in Chapter 4, to facilitate assessment of non-response bias, each survey was labeled with a unique alphanumeric identifier corresponding to the firm and intended executive respondent. Additionally, the identifiers were color-coded such that black denoted a first mailing survey

[1] As stated earlier, 257 completed surveys were returned, however surveys from both the CEO and second-level executive were received from 11 firms. This resulted in 246 firms responding. Thus, the response rate is based on the number of firms that responded, not the number of responding executives or the number of usable surveys.

(early respondent) and red denoted a second mailing survey (late respondent). These identifiers were highly visible on the upper right hand corner of the survey cover page. All correspondence notified respondents of the identifier, its main purpose, and ensured confidentiality. Regardless, one survey was returned from the first mailing with the unique identified removed. With the exception of this one survey, all surveys could be identified by firm and respondent.

In the first comparison, secondary data, specifically firm size based on number of employees and firm sales for the year 2005, were collected from the CorpTech database on both responding and non-responding firms. Data for both variables were transformed using a log transformation (Lg10) to accommodate high levels of skewness. Following the data transformation and prior to comparing the two groups with an independent samples t-test, it was necessary to determine whether or not the variances in the underlying populations were heterogeneous or homogenous for each variable of interest. The results of Levene's Test of Equality for Variances indicated that homogeneity in variance could be assumed for both variables as evidenced by a non-significant F statistic (Firm Size, $F(1, 908) = .011$, $p > .05$; Firm Sales, $F(1, 908) = .587$, $p > .05$). With this established, the independent samples t-test was run which demonstrated that the means of the two groups on both variables did not differ significantly (Firm Size, $t = -.635$, $p > .05$; Firm Sales, $t = .086$, $p > .05$). Refer to Table 13 of Appendix A.

In the second comparison, early and late respondents were compared on key variables of interest using primary data. Past research suggests that by comparing early versus late respondents on select variables of interest, one can detect the possibility of non-response bias (Armstrong and Overton 1977). A statistically significant difference between means on key

variables between groups indicates a possible problem with non-response bias. Group sizes for early and late respondents were 183 and 57, respectively, for a total of 240. As noted above, one survey was returned from the first mailing but with the unique identified removed, as such the firm could not be identified. Furthermore, it was imperative that this comparison using key variables was restricted to usable surveys following the removal of those surveys with more than 15% missing data.

An independent sample t-test was run, comparing the two groups on the main variables of interest: innovation strategy of exploration, innovation strategy of exploitation, and firm performance. First, it was necessary to determine whether or not the variances in the underlying populations were heterogeneous or homogenous for each variable of interest. The results of Levene's Test of Equality for Variances indicated that homogeneity in variance could be assumed for all three variables (Exploration Strategy, $F(1, 238) = .628$, $p > .05$; Exploitation Strategy, $F(1, 238) = 1.342$, $p > .05$; Firm Performance, $F(1, 238) = 1.275$, $p > .05$). Having established the assumption of homogeneity, results of the independent samples t-test established that the means of the two groups on all three variables did not differ significantly (Exploration Strategy, $t = -1.513$, $p > .05$; Exploitative Strategy, $t = 1.171$, $p > .05$; Firm Performance $t = -.261$, $p > .05$). Table 14, Appendix A, summarizes the results of the independent samples t-test.

Based on the results of these two tests, non-response bias was not considered a concern and data analysis continued with the assessment of common method bias.

## Assessment of Common Method Bias

Common method bias is best controlled with appropriate questionnaire development and implementation (Podsakoff et al. 2003). As a result, every attempt was made to control the

subject bias by careful survey design and implementation and by collecting data from two executives per firm. Regardless two tests were conducted to examine a lingering possibility of common method bias in the sample. Results of these tests indicated that common method bias was not an issue in this study.

First, bivariate correlations were assessed between objective and subjective measures of firm size, as well as between the subjective measure of firm size and the objective measure of firm sales. If common method bias were present, a statistically significant positive correlation between the objective performance data and the respondents' corresponding subjective data would not be present. Secondary data collected on firm size were first categorized to match the five-point measure used in the survey, i.e., less than 100, 100 – 499, 500 – 1999, 2000 – 4999, 5000 – 9999, and 10,000. Following categorization, assessment of the bivariate correlation between the objective and subjective measures of firm size followed, resulting in a positive correlation of .723 ($p < .01$, two-tail significance). Because the survey did not ask respondents for average sales over a five-year period, a one-to-one assessment of the correlation between average sales (subjective) and average sales (objective) was not conducted. However, since previous studies use firm size as a proxy for sales (Chandy and Tellis 2000), the bivariate correlation between the subjective measure of firm size and the objective measure of average sales was assessed. The assessment indicates a positive correlation of .588 ($p<.01$, two-tail significance) between the two measures.

In addition to the above assessment, Harmon's single factor test was conducted as a matter of standard course. Although not without critics, this test is widely recognized throughout research as a diagnostic technique for common method bias detection (Podsakoff et al. 2003). It

entails loading all the items in explorative factor analysis and examining the unrotated factor solution for a single factor or for one general factor which accounts for the majority of variance. If one such factor emerges, there may be cause for concern. Table 15, Appendix A, summarizes the results of both the unrotated and rotated solution following principal components extraction with Varimax rotation. 25 factors emerged from exploratory factor analysis with no one factor or general factor accounting for the majority of variance. (Note: Not all 25 factors were used in this study.)

## Data and Sample Characteristics

Blair and Zinkhan (2006) indicate that generalizability is rather robust to differences in sample quality, however, as a precaution, they recommend examining sample quality for sources of sample bias. As stated in Chapter 4, the sampling frame consisted of nine high technology manufacturing US industries. The sample of 1000 firms was constructed by systematic sampling with the goal of obtaining a relatively equal sub-sample from each industry. Using this approach, it is believed that the constructed sample was representative of the population as a whole. Furthermore, analysis of respondents and their representative firms versus the sample characteristics provides further confidence that the obtained data is representative of the larger population.

Data quality was assessed by analyzing respondent characteristics and firm characteristics. With respect to respondent characteristics, executives were asked to state their official job title on the survey. As noted in Table 16 of Appendix A, 153 CEOs/presidents/chairmen responded and 62 vice presidents, directors, or managers of marketing, business development, or strategy responded with 43 of these 62 having the title of

vice president of marketing. The remaining 26 respondents were high level executives from various functions, including research and development, operations, engineering, and quality control and assurance. In terms of percentages, 91.5% of the respondents were either the chief executive or the appropriate second-level executive as intended by this research. Further quality assessment was pursued by examining job title and responses on key variables. Results demonstrate that differences in job title had no significant impact on the key variables of interest (Exploration Strategy: $F(2, 238) = .562$, $p>.05$; Exploitation Strategy: $F(2, 238) = 1.999$, $p > .05$; and Firm Performance: $F(2, 238) = .138$, $p>.05$). Thus, based on job title and key responses, the quality of the respondents is high and reflects the intended executive population.

Quality was also examined by firm demographics and sales. Table 17, Appendix A, contains the descriptive statistics of the respondents' firms versus the sample firms. These statistics indicate that the respondent firm characteristics are aligned with the sample characteristics and represent a broad range of firms in terms of the nine high technology industries in the sample, recent sales, size in terms of number of employees, and firm age. These results indicate that not only is the data quality high with respect to the intended executive population, but also with the intended firm population.

## Psychometric Assessment

Although the measurement and structural parameters were estimated simultaneously using PLS, per Hulland (1999) recommendations, the models were also assessed separately in sequential steps. This process ensures that reliable and valid constructs are used in the estimation of the structural paths and enables greater confidence in the results. The measurement model was

assessed by examining factor loadings, individual item reliability, composite reliability, and discriminant validity.

Individual item reliabilities were assessed by examining loadings of the measures on their respective constructs. A rule of thumb is to check for loadings of .70 or more (which implies a shared variance of 50% or greater between the item and the construct) (Hulland 1999). An examination of the initial measurement model revealed that of the 51 items, 37 of them had loadings greater than .7. Items less than .7, but greater than .6, were assessed for theoretical importance and appropriateness and, subsequently, retained. Despite the fact the items with loadings under .6 were theoretically relevant; they were removed from the construct due to the reduced amount of shared variance. The remaining items demonstrate good individual-item reliabilities. Furthermore, all reflective constructs had three or more items retained. Table 18 of Appendix A provides the list of individual items used in the analysis for reflective constructs, their means, standard deviations, loadings, and construct composite reliability. Formative constructs included firm performance, environmental turbulence and intensity, and organizational culture.

Additional examination of the construct, channel bonding, was necessary as the scale was newly developed for this research. The initial six-item scale was reduced to five items, following the removal of one item ("We use negotiations over joint problem solving with our major supplier.") that had a factor loading of -.603 After item removal, the scale displayed a good reliability of .90. To verify its nomological validity prior to incorporation in the full-up model, supplier trust was regressed on channel bonding. The anticipated strong correlation was supported with $\beta = .267$ ($t = 4.284$), $p<.05$.

The measurement statistics reported in Table 19 in Appendix A include a measure of composite reliability, internal consistency ($\rho_c$), to assess construct validity. Researchers have proposed that this measure is superior to Cronbach's alpha because, unlike Cronbach's alpha, it does not assume that all items load equally on the latent construct (Fornell and Larcker 1981). Overall, the measures demonstrate good reliability with composite reliabilities range from .77 to .97, exceeding the .5 – .6 range established by Nunnally (1969) for exploratory work.

Two different tests provide evidence that all constructs exhibit satisfactory discriminant validity, which represents the extent to which measures of a given construct differ from measures of other constructs in the same model. First, as shown in Table 19, the diagonal elements of the correlations matrix are significantly greater than the off-diagonal elements, that is, the square root of the average variance extracted is greater than all corresponding correlations (Barclay et al. 1995; Fornell and Larcker 1981), thereby satisfying a major condition of discriminant validity. Second, an examination of the theta matrix confirmed that no item loaded more highly on another construct than it did on its associated construct (Barclay et al. 1995; Hulland 1999). Overall, these statistics indicate that the psychometric properties of the model are sufficiently strong to enable interpretation of the structural estimates.

## Tests of Hypotheses

Results of the partial least squares analysis of the structural model are reported in Tables 20 and 21. Table 20 summarizes the results based on hypothesis and Table 21 summarizes the results based on the main effects model, the full-up model with both main and interaction effects loaded, and the associated $R^2$ for each endogenous construct in both models. Since PLS makes no distributional assumptions, traditional parametric methods of significance testing (e.g.,

confidence intervals, chi-square, etc.) are not appropriate. Therefore, a bootstrapping method (sampling with replacement) was used to ascertain the stability and significance of the parameter estimates. The t-values were computed on the basis of 500 bootstrapping runs. Details of hypotheses testing results will proceed in accordance with order of Chapter 3 hypotheses development: First, the main effects of PDM and SCM processes will be discussed, followed by the moderating effects of the CRM process. Next, the interaction effect of the diverse innovation strategies on firm performance will be discussed.

### Test Results of PDM Process Main Effects

Market experimentation was proposed to positively impact both exploration (H1a) and exploitation (H1b), with the greatest positive impact on exploration (H2). Results supported the hypothesis that market experimentation led to greater exploration (H1a: $\beta = .194$, $p < .05$), but did not support the hypothesis that it also led to greater exploitation, although the positive direction of the hypothesis held (H1b: $\beta = .019$, $p > .05$). Clearly, market experimentation has a greater impact on exploration than exploitation as evidenced by the lack of statistical support for H1b. In order to formally test H2, the procedure by Dunn and Clark (1969) to compare correlated correlations with a common variable was employed. Using this procedure, if $Z > 1.96$, $p < .05$, two tail significance, then there is statistical support that the impact of market experimentation is greater on exploration then exploitation. Indeed, H2 was supported with $Z = 2.226$, $p < .05$.

Technology monitoring was proposed to positively impact both exploration (H3a) and exploitation (H3b), with the greatest positive impact on exploration (H4). Results supported the hypothesis that technology monitoring led to greater exploration (H3a: $\beta = .124$, $p < .05$) and

supported the hypothesis that it also led to greater exploitation (H3b: $\beta$ =.279, $p<.05$). However, clearly the greatest impact was to exploitation. H4 was not supported ($Z = 1.32$, $p>.05$).

Technology competence was proposed to positively impact exploration (H5a), but negatively impact exploitation (H5b). Results supported the hypothesis that technology competence led to greater exploration (H5a: $\beta$ =.143, $p<.05$) and supported the hypothesis that it also led to less exploitation (H5b: $\beta$ = -.158, $p<.05$).

## Test Results of SCM Process Main Effects

Channel bonding was proposed to positively impact both exploitation (H6a) and exploration (H6b), with the greatest positive impact on exploitation (H7). Results did not support the hypothesis that channel bonding led to greater exploitation (H6a: $\beta$ =-.049, $p>.05$), but did support the hypothesis that it led to greater exploration (H6b: $\beta$ =.078, $p<.10$). However, H7 was not supported ($Z = -1.199$, $p>.05$).

Quality process management was proposed to positively impact exploitation (H8a), but negatively impact exploration (H8b). Results supported the hypothesis that quality process management led to greater exploitation (H8a: $\beta$ =.289, $p<.05$), but did not support the hypothesis that it led to less exploration although the direction holds (H8b: $\beta$ = -.071, $p>.05$).

## Test Results of Interactions

Competitor benchmarking to rival offerings was proposed as a moderator between market experimentation and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between the two constructs. This hypothesis was not supported (H9: $\beta$ =.000, $p>.05$). Similarly, competitor

benchmarking was proposed as a positive moderator between technology monitoring and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking, the stronger the relationship between technology monitoring and exploitation of incremental innovations. This hypothesis was also not supported (H10: $\beta = -.012$, $p>.05$). Finally, the positive moderation of competitor benchmarking to the causal link of technology competence and exploitation of incremental innovations was also not supported (H11: $\beta = .030$, $p>.05$).

Current customer knowledge process was proposed as a moderator between market experimentation and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between the two constructs. This hypothesis was not supported (H12: $\beta = -.043$, $p>.05$). Similarly, current customer knowledge process was proposed as a positive moderator between technology monitoring and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship. This hypothesis was also not supported (H13: $\beta = -.194$, $p<.05$). Finally, the positive moderation of current customer knowledge process to the causal link of technology competence and exploitation of incremental innovations was also not supported (H14: $\beta = .081$, $p>.05$). Although not hypothesized, the main effect of current customer knowledge process on exploitation was positive and statistically significant ($\beta = .169$, $p<.05$) as anticipated.

Lead user collaboration was proposed as a positive moderator between channel bonding and exploration of radical innovations (H15) and between quality process management and exploration of radical innovations (H16). Neither hypothesis was supported (H15: $\beta = -.161$,

p<.05; H16: β = .017, p>.05). Although not hypothesized, the main effect of lead user collaboration on exploration was positive and statistically significant (β = .115, p<.10) as anticipated.

Exploitation of incremental innovation was proposed as a positive moderator between exploration of radical innovation and firm performance (H17). This hypothesis was supported (β = .102, p<.05). Although not formally proposed, the main effects of exploration and exploitation on firm performance were not statistically significant (β = -.007, p>.10; β = -.050, p>.10, respectively).

## Test Results of Controls

Test results of the impacts of controls on firm performance remained stable between the main effects model and the interaction model. As such, only the β coefficients and p-values of these variables in the interaction model are discussed herein. The impact on environmental turbulence and intensity on firm performance was negative and significant (β = -.145, p<.05) while the impacts of environmental scanning, organizational structure, and organizational culture were positive and significant (β = .118, p<.05; β = .169, p<.05; β = .332, p<.05, respectively). These results were as anticipated.

As stated in Chapter 4, prior studies indicate that turbulence and competitive intensity have a positive impact on innovation, but a negative impact on firm performance. With respect to environmental scanning, firms immersed in dynamic environments, such as those of high technology industries, tend to have higher degrees of environmental scanning as the need to rapidly identify opportunities and threats is critical to firm performance. Regarding organizational structure, in a high technology environment where innovation is key to survival,

one would anticipate higher levels of organicity associated with higher levels of firm performance. Recall that organizational structure was assessed using an organicity index whereby the higher the index, the higher the organicity. Similarly, organizational culture was anticipated to have a positive and significant impact on firm performance based on prior research by Gibson and Birkenshaw (2004). These researchers found empirical support that both performance management and social support were correlated (positive and significant) to firm performance.

The influence of firm age on firm performance was not significant ($\beta = .039$, $p>.05$). There have been conflicting arguments and opposing empirical results associated with age and innovation. As stated earlier, structural inertia, which grows with age, may inhibit older firms in their flexibility and rapid adaptability to dynamic environments. This often results in less exploratory innovation, but more exploitative innovation. On the other hand, young firms may possess a liability of newness since they lack accumulated experience, knowledge, resources, etc. relevant to innovation, yet are often times they have more explorative innovation and less exploitative innovation.

## Post Hoc Analyses of Hypotheses Test Results

When failing to reject the null hypothesis, "There is no evidence either way concerning the truth of falsity of the hypothesized relationship" (Gay 1992, 493). On the other hand, post hoc tests can help researchers better interpret the sense and meaning of our research results, above and beyond hypotheses testing (Rosenthal and Rosnow 1991). To verify robustness of the results and grasp some understanding with respect to unsupported hypotheses, post hoc tests were performed at various discriminating levels. First, as noted earlier, the number of usable

surveys was 241, including two each from 10 firms or less than 4.1%. As such, it was not anticipated that the additional 10 double-firm surveys would impact hypotheses test results and the decision was made to include all 241 surveys in the analysis, similar to comparable research efforts in strategy. To support this conclusion, Wilcoxon signed-rank tests were conducted at the measurement *item* level on model independent and dependent variables for paired sample data to assess the distributional properties of item responses from two executives in one firm. In Wilcoxon signed-rank tests, small significance (<.05) indicates the two variables differ in distribution. Out of the 46 such tests performed at the item level for 20 surveys, 29 item tests (or over 63%) indicated there was no statistically significant difference between the respondents while17 item tests indicated a significant difference, most notably on the items of two key constructs of exploration and exploitation. Table 22 of Appendix A itemizes the above test results.

Due to the 17 statistically significant differences, particularly those impacting the key innovation strategy constructs, and to check the robustness of the hypotheses results, the structural model was assessed using PLS with a reduced dataset of 231 survey responses (that is, limiting the double responses to the top executive (CEO/president/chairman) and with 221 survey responses (that is, after removal of all double firm responses.) Table 23 of Appendix A compares the results. As can be seen, the results for the three model assessments for all hypothesized relationships remained stable, signifying robustness and increasing research confidence in hypotheses test results.

Overall, the majority of main effects hypotheses for the business process-innovation strategies links were supported, but interaction effects were not. After careful review of the

results, a plausible explanation for some of these unsupported results is a reduced statistical power, considering sample size and the large number of predictor variables. The model contained 17 predictor variables, including controls, plus an additional nine interaction variables. Many different values have been recommended regarding sample size and number of predictors, Stevens (1986) recommends 15 to 1, Tabachick and Fidell (1989) recommend a ratio of 20 to 1, while Pedhazur (1982) recommends a ratio of 30 to1. The ratio for the main effects model was approximately 14 to 1 and 9 to 1 for the interaction model, both of which fall short of the recommendations stated above.

To grasp the implications and repercussions of possible statistical power issues, power tests were conducted for each endogenous construct, employing $R^2$ between main and interaction models. To assess power post hoc, one merely works backward, knowing the number of predictors, the sample size, and the calculated effect size, to find the estimated power. As shown in Table 24 of Appendix A, power for the exploration and exploitation constructs were over the recommended .8 (Cohen et al. 2003), however power for firm performance was under the recommendation and fell between .6 and .7. This indicates that statistical power for the innovation strategy constructs may have been sufficient depending on the size of the effect. Also, while the hypothesis for the innovation strategies interaction on firm performance was supported, the lower power for the firm performance construct may help explain main effect results that were weaker than expected, but not hypothesized. A discussion of each unsupported hypothesis now ensues.

As noted above, results indicated that market experimentation led to greater exploration, but did not lend statistical support that it also led to greater exploitation, albeit to a lesser extent.

Yet, the positive direction held in accordance with the hypothesis. In order to determine possible explanations for the non-significant result, several areas were examined. First, measurement items for the variable were again reviewed for content validity. It was felt that the retained items adequately assessed market experimentation activities that could lead to both types of innovation strategies. Second, the main effects model was analyzed separately from the interaction model to provide another perspective into possible power issues although none were anticipated based on the post hoc power test results for the exploitation construct. As expected, the statistically insignificant outcome for the market experimentation-exploitation causal link held whether the assessed structural model contained the interaction terms or not ($\beta = .016$; $t = .2427$, $p>.05$ for the main effects model). Refer to Table 21 of Appendix A. Third, the associated β coefficient was examined for a general trend as sample size increased from 221, to 231, to 241. This evaluation revealed a positive trend, from $\beta = .001$ ($t = .0130$), to $\beta = .013$ ($t = .5618$), to $\beta = .019$ ($t = .2579$), respectively, shown in Table 23 of Appendix A. Although one cannot draw definitive conclusions from this progression, it does imply that perhaps sample size was indeed not adequate to assess a small, but statistically significant, effect size considering the number of predictors. As a final check, power analysis based on the bivariate correlation, r, between market experimentation and exploitation was performed. Knowing that the effect size for r is r itself, one can use r directly and interpolate an approximate value for power based on sample size and the desired α. In this test, for $r = .146$, $\alpha = .05$ (two tailed), and a sample size of 241, power was approximately .50, as interpolated from Table 19.3 of Rosenthal and Rosnow (1991). This suggests that power based on this effect size may have been insufficient to detect the relationship between these two specific variables. In summary, theory dictates that market experimentation

has a stronger positive influence on exploration, but should also positively influence exploitation to a lesser degree. While this research failed to find statistically significant support for the latter, post hoc tests revealed the likely culprit to be power related.

Results supported the hypothesis that technology monitoring led to greater exploration and supported the hypothesis that it also led to greater exploitation. However, the β coefficient of the link between technology monitoring and exploitation was significantly greater than that between technology monitoring and exploration. This was not as expected and required a deeper investigation as to the cause. A similar progression of analysis and thought as stated for the market experimentation-exploitation link was utilized to evaluate these results. As shown in Table 21, Appendix A, these results held whether the assessed model contained the interaction terms or not ($\beta = .154$; $t = 1.9667$, $p<.05$ for the technology monitoring-exploration link and $\beta = .299$; $t = 4.9228$, $p<.05$ for the technology monitoring-exploitation link for the main effects model). Changes in β coefficient as sample size increased displayed a positive trend as shown in Table 23, Appendix A, but provided no relevant insight into the issue at hand. Again, the individual measurement items of the construct were reviewed for applicability. Examination did not reveal content validity issues. Nevertheless, it is still possible that wording of items may have impacted the results, that is, if more specific items had been added with respect to monitoring of state-of-art technology changes, a stronger relationship between technology monitoring and exploration may have been supported. From a purely conceptual perspective, technology monitoring can bring in copious amounts of information with respect to new technological advances outside the firm, but the firm may largely use this knowledge to pursue

additional less risky, less costly incremental innovations than the riskier, more expensive alternative of radical innovations.

Results supported the hypothesis that technology competence led to greater exploration and also supported the hypothesis that it also led to less exploitation. These results verify earlier research efforts that firms with a high technology competence that approaches and pushes the technological frontier are less apt to exploit with incremental innovation.

With respect to channel bonding, results supported the hypothesis that the process led to greater exploration, but not greater exploitation. Power analysis, using the index, r, provided some evidence that power may have been insufficient to detect the relationship between channel bonding and exploitation. Using the same procedure described earlier, for r = .116 between channel bonding and exploitation, $\alpha = .05$ (two tailed), and a sample size of 241, power was approximately .35, as interpolated from Table 19.3 of Rosenthal and Rosnow (1991). Regardless of the low statistical power, channel bonding may indeed have a greater positive impact on exploration than on exploitation. This may be an outcome of the trust that builds over time with continued successful channel bonding activities. As trust builds between firm and supplier, more risky opportunities, such as radical innovation, may be sought out and pursued. Research indicates that prior collaborations reduce appropriation uncertainties and increase future collaborations (Katila and Mang 2002), as well as increase the understanding and acceptance of new ideas between the parties due to their shared knowledge and experience (Cohen and Levinthal 1990). As successful collaborations age, their benefits and impacts on exploration may actually be retained or increased over time.

Results supported the hypothesis that quality process management led to greater exploitation, but did not support the hypothesis that it led to less exploration although the negative direction held. Further analysis proceeded in a similar manner as described above. In order to determine possible explanations for the non-significant result, several areas were assessed. First, due to the possibility of statistical power reduction with the added interaction terms in the model, results from the main effects were analyzed. As illustrated in Table 21, Appendix A, the particular test outcomes for the quality process management-exploration causal link held whether the assessed structural model contained the interaction terms or not ($\beta = -.080$; $t = 1.1628$, $p>.05$ for the main effects model). But, examination of the $\beta$ coefficient as sample size increases from 221, to 231, to 241 reveals an increasingly negative trend, from $\beta = -.041$ ($t = .5669$), to $\beta = -.052$ ($t = .7951$), to $\beta = -.071$ ($t = 1.0905$), respectively. Refer to Table 23, Appendix A. Because of this visible trend, a post hoc power analysis was conducted using the index, r, between quality process management and exploration. Based on a bivariate correlation of $r = .123$, $\alpha = .05$ (two tailed), and a sample size of 241, power was less than .50, as interpolated from Table 19.3 of Rosenthal and Rosnow (1991). With this information, it is suspected that low statistical power contributed to the lack of detection of the main effect, and that the particular firm behavior still exists, but was left unobserved in this study. An alternate explanation is, of course, that there is no correlation between quality process management and exploration. In other words, these two factors are truly independent. Quality process management is highly tied to production efficiencies and manufacturing. On the other hand, concern with production efficiencies is virtually non-existent in R&D prototypes and demonstration units. In order for these units to turn into commercialized products, they must first be "productionized," that is

turned into reproducible designs for the factory floor. At this point quality process management is more than likely to be a factor, that is, at the point in the product life cycle where incremental improvements and efficiencies begin to come into play.

The hypotheses involving the interactions between business processes and their impacts to innovation strategies were not supported. With respect to the main effects of the CRM processes, the main effect of lead user collaboration on exploration was as anticipated, positive and significant, and greater than its impact on exploitation. Also, the main effect of current customer knowledge process on exploitation was as anticipated, positive and significant, and greater than its impact on exploration. Conversely, the anticipated positive impact of competitor benchmarking on exploitation was not found. For that matter, there was no evidence that competitor benchmarking impacted exploration either. No additional insight was discovered when the main effects were examined without interaction terms included in the model ($\beta$ =.044, $p>.05$ for competitor benchmarking-exploitation and $\beta$ =.043, $p>.05$ for competitor benchmarking-exploration) as shown in Table 21, Appendix A, nor could possible explanations be inferred when the analyzing a potential trends via sample size increases in Table 23, Appendix A. Nonetheless, low statistical power could not be discounted without further examination. Based on a correlation of $r = .248$, $\alpha = .05$ (two tailed), and a sample size of 241, the interpolated power was greater than .80 for the competitor benchmarking-exploitation link. Likewise for $r = .222$, $\alpha = .05$ (two tailed), and a sample size of 241, interpolated power was greater than .80 for the competitor benchmarking-exploration link. Overall this suggests that competitor benchmarking, itself, does not impact the decision to move forward on the types of innovation strategies studied herein.

Since past research on competitor benchmarking and innovation is not in line with these results, supplemental inquiry is warranted and provides possible plausible answers. Although a strong competitor focus leads to a greater degree of exploitation (Bierly and Chakrabarti 1996; Moorman 1995), what are the particulars of exploitation involved? Recall that exploitation can take the form and shape of production process innovations in lieu of incremental innovations to competitor products.

Also, moderators may be at play. This may well be part of the issue as prior research on the impact of competitor orientation on technology innovations found no statistically supported relationship in the banking industry (Han et al. 1998), keeping in mind that these results lack generalizability across industries. On the other hand, the same study found technology turbulence to be a positive moderator to the competitor orientation-technology innovation link. While a competitor orientation and competitor benchmarking are not identical constructs, they share some common elements with respect assessing and responding to competitor actions.

An alternate explanation is that competitor benchmarking is positively related to imitation, that is, a one-to-one emulation of competitor products, but not necessarily innovation based on those products. In fact, Pemberton et al. (2001) argue that in the case of the United Kingdom (UK) manufacturing sector, exploitation of innovation and creativity have no supported association with benchmarking, but there does seem to be an association with "generation of innovative product concepts." Unfortunately, the researchers did not provide additional insight into what was meant by exploitation nor into the specifics of innovative product concepts generation.

Lead user collaboration was proposed as a positive moderator between channel bonding and exploration of radical innovations and between quality process management and exploration of radical innovations. Although neither hypothesis was supported, the data revealed a negative, statistically significant interaction of channel bonding and lead user collaboration on exploration ($\beta = -.161$, $p<.05$). Thus, the visible pattern of interaction between these two determinants is one of interference or antagonism in which the main effects on exploration are both in the same the direction and significant, but the interaction is significant and in the opposite direction (Neter et al. 1996). Both channel bonding and lead user collaboration are important for exploration, but they have compensatory effects, that is, the importance of channel bonding on exploration may be lessened by lead user collaboration and vice versa. This implies that explorative gains achieved via collaboration and coordination efforts with suppliers can also be achieved with collaboration efforts with lead users and that they may be substituted, that is, different means to the same end.

Current customer knowledge process was proposed as a positive moderator between market experimentation and exploitation of incremental innovations, between technology monitoring and exploitation of incremental innovations, and between technology competence and exploitation of incremental innovations. These interactions were not supported, but similar to that of channel bonding and lead user collaboration, the data exposed a statistically significant negative interaction between current customer knowledge process and technology monitoring ($\beta = -.194$, $p<.05$). Again, an antagonistic interaction is present whereby both current customer knowledge process and technology monitoring are important for exploitation, but the importance of current customer knowledge process may be lessened by technology monitoring and vice

versa. Theoretically, both processes bring vital information into the firm for exploitation efforts, but the type of information they bring may be different. While current customer knowledge process brings in relevant information as to customer wants and needs, technology monitoring brings in different information with respect to technology developments outside the firm. Yet both types of information can lead to exploitation.

Exploitation of incremental innovation was proposed as a positive moderator between exploration of radical innovation and firm performance. In firm performance terms of profitability and ROS, this hypothesis was supported. Although not formally proposed, the main effects of exploration and exploitation on firm performance were not statistically significant. Recall that low statistical power fell (between .6 and .7) was present with respect to the firm performance construct and may be a factor in main effects results.

The positive interaction was consistent with the hypothesis, but triggers an inquiry as to whether the statistically significant interaction can be present without statistically significant main effects. This occurrence is similar to that which occurred in the published work of Moorman and Slotegraaf (1999), whereby they state that "Statistical treatments of this question indicate that this *is* [emphasis added] possible," citing arguments by Cohen and Cohen (1983), Keppel (1991), and Pedhazur (1982). Additionally, from a purely conceptual point of view, synergistic interactions are based on the perspective that $1 + 1 > 2$. With the theoretical arguments for the exploration*exploitation interaction being sound, the positive significant interaction resulting from two non-significant main effects adds empirical evidence to this point.

## Post Hoc Cluster Analysis

In strategy research, considerable knowledge is gained from the identification of distinct strategic archetypes (cf, Miller and Friesen 1978). This type of analysis reveals more complex phenomenon than would have been apparent otherwise (Bierly and Chakrabarti 1996). With this in mind, post hoc cluster analysis was pursued with the intent of uncovering strategic archetypes based on engaged innovation strategies and firm financial performance. Appendix A, Figure 2 graphically represents the relationship between exploration and exploitation based on the level of each strategy employed for each firm. A visual inspection of the graph reveals the possibility that some interesting clusters may be teased from the data. While the majority of firms appear to cluster around the average, a significant number of firms exhibit higher levels of both exploration and exploitation. Smaller numbers of firms exhibit higher exploration with lower exploitation, lower exploration with higher exploitation, and a very small number of firms exhibits lower levels of both.

Cluster analysis was performed to tease out the implications of this graph with respect to dual focus. Although theory (cf, Bierly and Chakrabarti 1996; Gibson and Birkenshaw 2004; Miles et al. 1978) would dictate the existence of four clusters (dual focused, explorers with higher ratings on exploration than exploitation, exploiters with higher ratings on exploitation than exploration, and neither with lower ratings on both exploration and exploitation), visual inspection of Appendix A, Figure 2 brought to light the possibility of five clusters (highly dual focused, moderately dual focused, explorers, exploiters, and neither).

Using the K-means algorithm of non-hierarchical clustering, analysis of both 4-cluster and 5-cluster grouping was performed using standardized data as required. Fit for each grouping

was acceptable based on high F-statistics (significance levels ignored) and high face validity following inspection of cluster means for both solutions. Predictive validity was then assessed. ANOVA F-tests for both 4- and 5- cluster groupings were conducted with respect to firm performance. Both ANOVA F-tests were insignificant ($F(3,240) = .850$, $p>.05$ for four clusters and $F(3,240) = 1.526$, $p>.05$ for five clusters), indicating the null hypotheses that all groups had the same performance levels could not be rejected. It is important to use caution in interpreting these results, as cluster analysis includes subjective assessments and support for the positive interaction of exploration and exploitation on firm performance was already found. Additionally, the data and subsequent clustering of firms may not have teased out the "extreme" players in the sample, that is, the highly explorative and highly explorative firms were not adequately captured in the cluster analysis.

Validity was also assessed for business processes based on the theoretically-based belief that dual focused firms should rank high on business processes relative to the remaining groups. Additional post hoc cluster analyses was performed using a 4-cluster grouping, that is, dual focused, largely exploiter, largely explorer, and neither a strong explorer or exploiter. Means and cluster sizes are shown in Table 25 of Appendix A. Visual examination of this information provides some insight into dual focused firms and business process implementation. Dual focused firms ranked highest, based on means, with respect to each business process. Firms that were neither strong explorers nor exploiters ranked lowest.

ANOVA F-statistics revealed that four groups did indeed differ significantly on all business processes. Specifically, F-statistics were as follows: market experimentation ($F(3,240)= 5.681$, $p<.05$), technology monitoring ($F(3,60.989) = 3.217$, $p<.05$), technology

competence ($F(3,240) = 2.526$, $p<.05$), channel bonding ($F(3,240) = 1.728$, $p<.05$), quality process management ($F(3,240) = 4.906$, $p<.05$), competitor benchmarking ($F(3,240) = 4.771$, $p<.05$), current customer knowledge process ($F(3,240) = 3.348$, $p<.05$, and lead user collaboration ($F(3,68.155) = 5.382$ , $p<.05$). For technology monitoring and lead user collaboration, homogeneity of variance could not be assumed, and the Brown and Forsythe test statistic was used in lieu of the ANOVA F-statistic.

Post hoc comparison tests were then conducted to determine whether the dual focus group was significantly different from the other groups for each business process. Refer to Table 26 of Appendix A. Results revealed that the dual focus group was significantly different than all other groups in market experimentation, and significantly different from at least one other group in all three CRM processes and the SCM process of quality process management, but not channel bonding. Somewhat perplexing were the results with respect to technology monitoring and technology competence in that there was no statistical difference shown between the dual focus group and the group that was neither a strong explorer nor strong exploiter. This could be the result of the particular clusters generated or a result of the particulars with respect to the firm characteristics in each cluster. Nonetheless, it is felt that these results lend additional statistical evidence to the proposition that dual focus firms implement multiple, yet conflicting, business processes to attain higher levels of both exploration of radical innovation and exploitation of incremental innovation. Further examination of the resulting managerial and theoretical contributions is presented in Chapter 6.

# CHAPTER 6: DISCUSSIONS AND IMPLICATIONS

In this final chapter, results of findings are further discussed. Theoretical and managerial contributions follow. Last, limitations will be presented, countered with offerings of exciting areas of future research.

## Discussion

The ability of firms to accomplish both exploration and exploitation in product innovation is challenging, but rewarding. The accomplishment of dual focus in innovation, was, and remains today, a perplexing and challenging task for many firms in the competitive high technology climate. This is made strikingly apparent by the continued multidiscipline calls by academia and practitioners for further study of this area, and by the substantial number and quality of responses and comments made by top executives to this research effort.

Both dual structure and culture have been shown to positively influence dual focus, however, until now, no research has been conducted with respect to impacts of core business processes on dual focus. Additionally, there have been few attempts in marketing to understand the complexities and challenges behind dual focus and marketing's contributions to its attainment.

This dissertation proposes and tests a model of business process determinants and outcomes of exploration and exploitation innovation strategies using data collected from U.S. high technology manufacturers. In terms of process influences, results provide insights into how these strategies are influenced by the firm's product development, supply chain, and customer relationship management processes, and that some of these processes, via interactions with CRM, may have substitution effects. Furthermore, dual focus firms were shown to have multiple

processes that impact both types of innovation strategies and that these firms implement these processes to a greater extent that firms operating in the more extreme positions. Regarding outcomes, the interaction of both strategies was shown to have a positive significant effect on firm performance.

As the principal creator and integrator of relevant market and customer information, marketing has a significant interest in and influence on the core business processes that impact strategic decisions. Marketing defines and articulates the customer value proposition and the market positioning of the product innovation, takes part in the decision-making process of strategic choices in innovation, and adds to firm knowledge by gathering and disseminating information about markets and customers. Marketing is highly relevant and visible in the PDM and SCM processes, now more than ever, as marketplace shifts to maximizing customer value in all business processes. In the context of exploration and exploitation of innovation, without marketing input, customer value creation and appropriation of innovation may be negatively impacted, jeopardizing a firm's short term and long-term profits.

### Dual Focus and the PDM Process

The PDM process involves designing new products and reinvigorating old products through market experimentation, technology monitoring, and technology competence. The specific PDM processes studied in this dissertation aid firms in recognizing and taking advantage of opportunity via testing new ideas for new and current market domains (market experimentation), sensing new technologies in the environment (technology monitoring), and by pushing firm technology competence to the technological frontier.

The impact of market experimentation on exploration highlights the importance of not only testing technology, but of understanding and incorporating customer requirements and preferences through experimentation efforts. Although the data did not support a positive statistically significant influence of market experimentation on exploitation, there is reason to believe that this impact still exists as dual focus firms employed this business process more than their competitors that focused on one strategy alone or lacked focus entirely.

Market experimentation can aid firms in their quest for dual focus can be engaged anywhere along the product development path in order to lower risk associated with technology and market. Marketing's role is to ensure that the interplay of customer and user community with prototype and demonstration units occurs and that the necessary improvements or re-design stemming from experimentation be incorporated prior to full-scale launch of the new product. Properly incorporated, customer feedback from market experimentation can lead to new products, radical or incremental, that diffuse more quickly. Marketing can take a prominent role in these interactions by connecting the right customers to the suitable product demonstration unit and ensuring customer feedback is properly considered and appropriately executed in the final product prior to launch.

Modern definitions of corporate entrepreneurship center on recognizing and taking advantage of opportunity (cf, Shane and Venkataraman 2000). Therefore, firm implementation of business processes that aid in opportunity recognition should foster corporate entrepreneurship, typically associated with exploration. As this research indicates, technology monitoring positively impacts not just exploration, but also exploitation. It is reasonable to conclude that this business process is invaluable to dual focus. Firms that actively incorporate this process in

their activities will not hinder dual focus in innovation, but help it. On the other hand, firms high in technology competence that push the technological frontier without considering smaller incremental technology advances will hinder exploitation efforts, thereby deterring dual focus efforts in its wake. As seekers of opportunity, marketing must keep abreast of the latest customer-relevant technology improvements in the firm's environment and must help bridge the gap between current customer and lead user needs, current technologies, and firm strategic directions, aiding firms in their dual focus quest.

### Dual Focus and SCM Process

The SCM process involves designing and managing the supply chains that facilitate the design, production, and delivery of the products. In this research, SCM processes of channel bonding with suppliers and quality process management were studied. Research findings supported a strong positive influence of channel bonding on exploration and a positive influence of quality process management on exploitation. Following cluster analysis, dual focus firms had higher levels of both processes than the remaining three groups. Further testing indicated statistically different levels with the "neither" group on both SCM processes and also statistically different levels of this group with explorers with respect to quality process management.

Lack of sufficient statistical power may have been at play for insignificant main effects with respect to channel bonding on exploitation. However, other theoretical explanations are present as well. As stated earlier, results indicated that channel bonding may indeed have a greater positive impact on exploration than on exploitation. This may be a reflection of the trust that builds over time with continued channel bonding activities.

Marketing's interest in channel bonding and innovation lies with getting product innovations in line with customer needs and wants, including *when* the customers want it. Channel bonding activities can quicken the release of innovative products in the marketplace as firms join forces with suppliers for joint development (Srivastava et al. 1999). Marketing must be involved in the channel collaboration effort to ensure product release is timely and that the probability of market success is high for both explorative and exploitative efforts. They can add to the long-term benefits of channel bonding by ensuring open communication and excellent coordination efforts between themselves, the supplier, and the remaining firm functions, leading to an innovative product that is not only highly valued by the customer, but is launched at the appropriate point in time with the best promotional strategy.

A conceptual study by Benner and Tushman (2003) proposes an increase in incremental innovation and a decrease in radical innovation based on increasing levels of process management practices. Results from this study statistically supported these propositions with one caveat. Low statistical power may have contributed to the lack of detection of a significant negative main effect of quality process management on exploration. On the other hand, dual focus firms ranked higher than all other groups with respect to quality process management with evidence supporting significant differences over explorers and the "neither" explorer/exploiter group. This indicates that while process management techniques exert a bias toward exploitation, dual focus firms can and do overcome this bias, using quality process management to their benefit, successfully achieving both innovation strategies. While marketing's input to and interest in production process management may be low, the function cannot ignore the

impact of increased efficiency and quality of products that they must market and sell to interested customers.

## Dual Focus and the CRM Process

The CRM process entails all aspects of developing and managing customer relationships, including the determination of the needs of existing customers and potential new customers through competitor benchmarking of rival products, collecting and understanding the needs of the firm's current customers, and ensuring lead users are polled and their desires and requirements collected, analyzed, and understood. Marketing takes a lead role in the CRM process and, therefore, has the greatest impact on attainment of dual focus through CRM.

As anticipated, this research confirmed the strong impacts of lead user collaboration on exploration and that of current customer knowledge process on exploitation. It also found support that dual focus firms incorporate both of these core business processes into their organization despite the pull of each toward one innovation strategy or another. Dual focus firms also ranked highest on competitor benchmarking of rival products although no statistically significant support was garnered for its positive impacts on exploration and exploitation in the assessment of the structural model.

The interaction of CRM processes with those of PDM and SCM did not support the hypotheses as written. However, the antagonistic interaction that was present for current customer knowledge process and technology monitoring and lead user collaboration and channel bonding are intriguing research paths. The importance of current customer knowledge process may be lessened by technology monitoring and vice versa. Similar can be stated for lead user collaboration and channel bonding. These interactions imply that, with respect to the particular

variables mentioned above, firms can compensate for weaker PDM and SCM processes with stronger CRM processes. This is a critical and significant implication for the marketing function and the business firms. This research indicates that not only is marketing critical to dual focus in innovation, but it can also help compensate for weaker business processes not under its direct functional domain.

## Dual Focus and Firm Performance

The results of this study supported a positive interaction between innovation strategies and firm performance. Therefore, dual focus firms enjoy better financial performance relative to their competitors that are embedded in largely explorative, largely exploitative innovation strategies, or lack focus in either. As such, dual focus can partially explain the success of some incumbents in high technology industries. Incumbent firms often relegate entrepreneurial activity in radical innovation to inventors and new entrants (cf, Agarwal 2002), and naturally restrict subsequent innovation activities along the same technological trajectory as their original radical innovation. Incumbent portfolios are often severely tipped toward exploitation as "…businesses are preoccupied today with minor modifications … while true product innovation has taken a back seat" (Oliva 2005, 5). This implies that many incumbents lack entrepreneurial thinking, intentionally choose not to pursue riskier entrepreneurship, or quite simply do not have multiple business processes in place to ensure both types of innovation are considered in their strategic decision-making. Business processes bring knowledge that is instrumental to effective innovation strategy decision-making, knowledge that is crucial to dual focus attainment and ultimately for firm performance.

Employing opposing business processes can also overcome the negative implications of legacy and core rigidities. Business processes are "deeply embedded" and become self-reinforcing, eventually becoming institutionalized (Garvin 1998) and part of the firm's legacy. Once embedded, they can trap the firm into either exploration or exploitation. However, companies can use embeddedness to their advantage by becoming proficient in processes that influence exploration *and* processes that influence exploitation, thereby reducing the negative implications of legacy. They can exert a positive influence on both innovation strategies as they give direction to innovation decisions and efforts. Firms will not become rigid in exploration or exploitation if they wisely and proactively incorporate multiple, yet often conflicting, business processes that influence both types of innovation strategies.

Christensen notes that "many of the incumbents he studied had no difficulty surviving competence-destroying technological shifts, as long as the competence-destroying technologies addressed the needs of incumbents' *mainstream customers* [emphasis added]" (Danneels 2004, 248). By employing business processes that divide incumbent attention in exploration and exploitation, bias toward current customers will be lessened, leaving a larger opening for firms to create value through radical product innovation based on the latest disruptive technologies, satisfying the needs of new and current customers, possibly in a new market domain.

In order for a firm to be dual focused, its departments must be dual focused as well. A firm aspiring for higher levels of both exploration and exploitation cannot be saddled with any department that strongly prefers and actively pushes one strategy over the other and implements its processes accordingly. For example, marketing must employ opposing business processes

such as lead user collaboration and current customer knowledge process to guard against natural biases in their department and in the firm.

Marketing clearly has an interest in and a significant contribution to the strategic direction of the firm's product innovations, and, thereby into firm performance. Their lead role in CRM and contributing roles in PDM and SCM make them vital members of the top management team of large corporations and small firms alike. Because of this, their influence in dual focus can and should be felt from the top of the organization, permeating through the ranks, to the working members that actively work the processes that influence dual focus.

## Theoretical and Managerial Contributions

The main purpose of this research was to investigate core business process influences, particularly with respect to possible moderating impacts of CRM, on dual focus in innovation strategy and provide enlightenment to academia and practitioners alike as to influence level and type. The second and third objectives were to uncover empirical support that firms that both explore and exploit in innovation have greater firm performance than those operating in extremes and to provide insight as to how firms can become dual focused based on business processes, respectively. The fourth objective was to emphasize the role of marketing in dual focus attainment, and, finally, the fifth objective was to aid practitioners and academicians alike on the accomplishment of dual focus in innovation, as it was, and remains today, a perplexing and a challenging task for many firms in today's competitive high technology climate. All of these objectives were successfully met.

This research makes a significant contribution to the strategy and innovation literatures with respect to business processes and dual focus. Until now, research in this area has been

limited to structure and culture antecedents, largely conceptual with minimal empirical attempts, and piecemeal in nature. The current study not only provided a new, uncharted path of business process impacts, but added a rigorous test approach to a full model that contained both antecedents and consequences of dual focus.

Results of this study show that the PDM processes studied herein play a significant role in determining the strategic direction of innovation toward exploration. Some processes, like technology monitoring, have positive influences on both exploration and exploitation, while market experimentation and technology competence strongly steer firms more toward exploration. The SCM process of quality process management greatly impact exploitation as was expected, however channel bonding has a positive association with exploration. Finally, the CRM processes of customer knowledge process and lead user collaboration have strong positive associations with exploitation and exploration, respectively. Competitor benchmarking was the only process studied that does not exhibit an association with either strategy. Regardless, this research found support that the dual focus firms, defined as those that had high levels of both exploration and exploitation, implement all eight processes more than their competitors, single focus or otherwise. This suggests that in order for firms to become dual-focused in product innovation, they must embed these processes in their organization, regardless of their antagonistic nature. Thus, besides structure and culture, this research provides an additional path to dual focus, one that incorporates the core business processes of the firm.

Different functions take the lead in core business processes, for example, marketing leads the CRM process, while R&D or engineering may lead the PDM process. This research highlights the necessary interactions between all functions and among the processes. Each

function within the organization, including marketing, must sign up and actively incorporate these processes in order to attain dual focus, even as each process pulls for capital and human resources. Once in place, these multiple, conflicting processes can evolve into core competences, striking a competitive advantage over firms not able to grow, nourish, and sustain these processes. In terms of firm performance, this research effort provides empirical support that dual focus firms should outperform others operating in the extreme.

While the proposed moderating impacts of CRM were not supported, the negative interactions between current customer knowledge process and technology monitoring and between lead user collaboration and channel bonding require further investigations into their compensatory effects. These interactions imply that strong CRM processes can be substituted for some weaker PDM and SCM processes (and vice versa) for the similar outcomes. However, not all interactions were compensatory. Research must tease out the compensatory processes and provide the necessary guidance to firms in the business community. Regardless, this research contributes both academically and managerially in that empirics uncovered that this substitution effect exists. From the marketing perspective, this type of knowledge signifies that marketing efforts in CRM can play a significant role in helping firms attain a dual focus strategy, especially in those firms where PDM and SCM processes are weaker.

Challenges to the reasoning, results, and contributions of this study will arise. Some academicians may argue that firms can achieve a dual focus through alliances and partnerships rather than take it upon themselves. This is true, however they must *first* make the strategic decision that exploration and exploitation will be simultaneously pursued. Employing multiple processes within the firm can aid in this first strategic step by ensuring the natural bias toward

one or the other is reduced. Additionally, arguments against the process-strategy causal link may ensue, citing that firms must first strategically choose dual focus in innovation and then put appropriate processes in place to successfully fulfill their choice. This argument is somewhat shortsighted as it ignores the implications of legacy and core rigidity on strategic direction. Thus, this research effort also contributes to the strategy literature on turning core rigidities into core competences and the resulting sustainable competitive advantage. Incorporating opposing businesses processes into one firm is no easy task. Successful firms can develop a sustainable competitive advantage that is difficult to imitate, valuable, rare, and for which there is no substitute.

As a final contribution, a channel bonding scale was developed that exhibits good reliability and validity. This is particularly useful for the academic world where heretofore it used a single, generally worded item to assess channel bonding activities. Use of this scale should improve empirical research efforts on channel bonding as either an antecedent or determinant. It can be easily modified for assessing the channel bonding activities at any point along the channel.

## Limitations and Directions for Further Research

The single largest limitation was statistical power due to the interplay of sample size and number of predictors in the model. While the response rate significantly exceeded typical values for executive respondents and the resulting sample size was a reasonable size, the large number of predictors in the model overpowered the sample size for some of the tests. This resulted in a lack of statistical support for some of the hypothesized relationships where theory strongly

dictated that the relationships stand. Subsequent research efforts will carve out smaller portions of the model, thus bringing heightened visibility and anticipated support for these relationships.

A second limitation was the measurement of firm performance. Firm performance measures were solely from the financial perspective. This was done purposefully to enhance the comparability of subjective and objective measures and to keep survey length manageable. Nonetheless, the research could have been enhanced using a balanced scorecard approach, that is, using financial measures but also incorporating other indicators such as customer satisfaction.

This research leads to several interesting subsequent studies. First, further investigation into the negative business process interactions is warranted, as well as investigations into other interactions among and within each process. For instance, does the interaction of lead user collaboration and competitor benchmarking help or hind the efforts of firms to attain dual focus? Second, the research should be expanded to include other business processes not studied herein. Third, further investigations into the influences of strategy on firm performance are also warranted. The main effects of these variables on firm performance may yet be uncovered in the analysis of quadratic relationships or by uncovering a mediator, such as number of radical versus incremental innovations. For example, quadratic main effect relationships may be present whereby a positive impact of exploration and a positive impact of exploitation to firm performance increase until such time maximums are reached, thereafter negative impacts occur. Finally, future research should include production process innovations which are traditionally linked to exploitative strategies, but not explorative. Research efforts combining both product and production process innovations are severely lacking and would paint a more complete picture of innovation strategies in firms.

Due to the decrease in statistical power discussed earlier, a smaller model, but similar in theory, may reveal significant main effects not found in the large model. Most intriguing is the direction of the main effects for firm performance, that is, if they continue to hold in the negative direction, but a positive interaction results, then a substitution effect is in place. Further analysis into obtaining balance in substitution between exploration and exploitation would be of great benefit to firms.

## Conclusion

This dissertation undertakes the challenge put forth by multiple disciplines to study the ability of firms to attain dual focus in product innovation. A conceptual model was proposed and tested, examining core business process impacts. The attainment of dual focus between radical and incremental innovation is challenging and calls for organizational architectures that include conflicting business processes. Firms that successfully embed these processes positively impact innovation strategies of both exploration and exploitation, resulting in a successful portfolio mix of radical and incremental product innovations that maximize customer value and boost firm performance. Specifically, dual focus firms were shown to have multiple processes in place that impact both types of innovation strategies and that these firms implement these processes to a greater extent than those firms operating in the more extreme positions.

Marketing's role in setting firm strategic direction is gaining prominence. Thus, marketing should take a key role in dual focus attainment. Through core business processes, especially with respect to CRM, marketing's role and influence is noteworthy in guiding firm innovation strategy, as well as by increasing customer value creation in the resulting product innovations, thereby increasing both short term and long term firm performance.

# APPENDIX A: TABLES AND FIGURES

## Table 1 Definitions of Terms and Constructs

| Term or Construct | Definition | Applicable References |
|---|---|---|
| Centralization | The extent decision-making is centralized or dispersed throughout the organization | Damanpour (1991); Pierce and Delbecq (1977); Thompson (1965) |
| Channel bonding | Process in which durable relationships with channel members are created via activities of communication, joint problem solving, and coordination. | Day (1994) |
| Competitor benchmarking | "Market-based learning process by which a firm seeks to identify best practices that produced superior results" and uses this information "to enhance its own competitive advantage." In this research, it is respect to rival offerings in the innovation context. | Vorhies and Morgan (2005, 81) |
| Complexity | Patterns of links among subunits | Hannan and Freeman (1984) |
| Culture | The pattern of shared values and beliefs that help individuals understand organizational functioning and that provide norms for behavior in the organization. | Deshpande' and Webster (1989, 4) |
| Current customer knowledge process | "Set of behavioral activities that generates customer knowledge pertaining to their current and potential needs for new product innovations." | Li and Calantone (1998), 14 |
| Dual structure | Co-existing, structurally distinct, yet loosely integrated, units within the organization. | Tushman and O'Reilly (1996) |
| Formalization | The emphasis on rules and procedures in conducting organizational activities | Damanpour (1991); Pierce and Delbecq (1977); Thompson (1965) |
| Innovation strategy | 1) Exploration: An innovation strategy of exploration encompasses those decisions and activities aimed at developing radical innovations.<br>2) Exploitation: An innovation strategy of exploitation encompasses those decisions and activities aimed at developing incremental innovations. | He and Wong (2004) |
| Incremental innovation | A new product that incorporates relatively minor changes in technology. It involves refining, improving, and exploiting an existing firm technological trajectory. | Chandy and Tellis (1998); Gatignon et al. (2002) |
| Lead user collaboration | Set of behavioral activities that generates knowledge from lead users pertaining to their current and potential needs for new product innovations. | Wind and Mahajan (1997) |
| Market experimentation | Activities undertaken by the firm to gain knowledge through testing new ideas on current and potential customers. | Day (1994); McCardle (2005) |
| Organizational context | Norms and values of an organization that shape individual behaviors and attitudes. In strategy process literature, culture and climate are conceptualized as organizational context. Performance management context includes discipline and stretch. Social context includes support and trust. | Goshal and Barlett (1994); Gibson and Birkenshaw (2004) |
| Quality process management | Process management techniques, such as ISO9000, employed to improve the efficiency of operational processes and reduce variance. | Benner and Tushman (2002) |

| Term or Construct | Definition | Applicable References |
|---|---|---|
| Radical product innovation | A new product that incorporates a large new body of technical knowledge. A radical innovation disrupts the current technological trajectory. | Chandy and Tellis (1998); Dosi (1982); Gatignon and Xuereb (1997); Gatignon et al. (2002); Varadarajan and Jayachandran (1999) |
| Search | Search is defined as local or distant, that is local search is the behavior of any firm or entity to search for solutions in the neighborhood of its current expertise or knowledge. Conversely, distant search is the behavior of a firm or entity to search for solutions outside the neighborhood of its current expertise or knowledge. | Rosenkopf and Nerkar (2001, 288); Stuart and Poldolny (1996) |
| Strategic flexibility | The capability of the firm to enact and respond quickly to changing competitive conditions and thereby develop and/or maintain competitive advantage. | Hitt et al. (1998, 27). |
| Technology competence | Set of technological skills, knowledge, and experience, present in the organization that is necessary to design the product. It is considered an *intangible* process. In this research, it is relative to the technological frontier. | Hamel and Prahalad (1994) |
| Technology monitoring | Process in which an organization acquires knowledge about and understands new technology developments in its external environment. | Day (1994); Srinivasan et. al. (2002) |

**Table 2 Characteristics of Product Innovation Types**

| Characteristics | Type of Product Innovation | |
|---|---|---|
| | Pure Exploitation | Pure Exploration |
| Market potential assessment | Relatively easy | Difficult |
| Technological feasibility assessment | Relatively easy | Difficult |
| Impetus from current customers | Strong | Weak |
| Returns | Relatively certain | Uncertain |
| Needed scope of market search | Narrow | Broad |
| Needed scope of technological search | Narrow | Broad |
| Project duration | Short | Long |

Source: Danneels (2002, 1106)

**Table 3 Sample Processes within the Three Core Business Processes**

| Product Development Management Process | Supply Chain Management Process | Customer Relationship Management Process |
|---|---|---|
| Ascertaining new customer needs | Selecting and qualifying desired suppliers | Identifying potential new customers |
| Designing tentative new product solutions | Establishing and managing inbound logistics | Determining the needs of existing and potential new customers |
| Developing new solution prototypes | Designing and managing internal logistics | Learning about product usage and application |
| Identifying and managing internal functional/departmental relationships | Establishing and managing outbound logistics | Developing/executing advertising programs |
| Developing and sustaining networks of linkages with external organizations | Designing work flow in product/solution assembly | Developing/executing promotion programs |
| Coordinating product design activities to speed up business processes | Running batch manufacturing | Developing/executing service programs |
| | Acquiring, installing, and maintaining process technology | Developing/ executing sales programs |
| | Order processing, pricing, billing, rebates and terms | Acquiring/ leveraging information technology/system for customer contact |
| | Managing (multiple) channels | Managing customer site visit terms |
| | Managing customer services such as installation and maintenance to enable product use | Enhancing trust and customer loyalty |
| | | Cross-selling and upselling of product service offerings |

Source: Srivastava et al. (1999, 170)

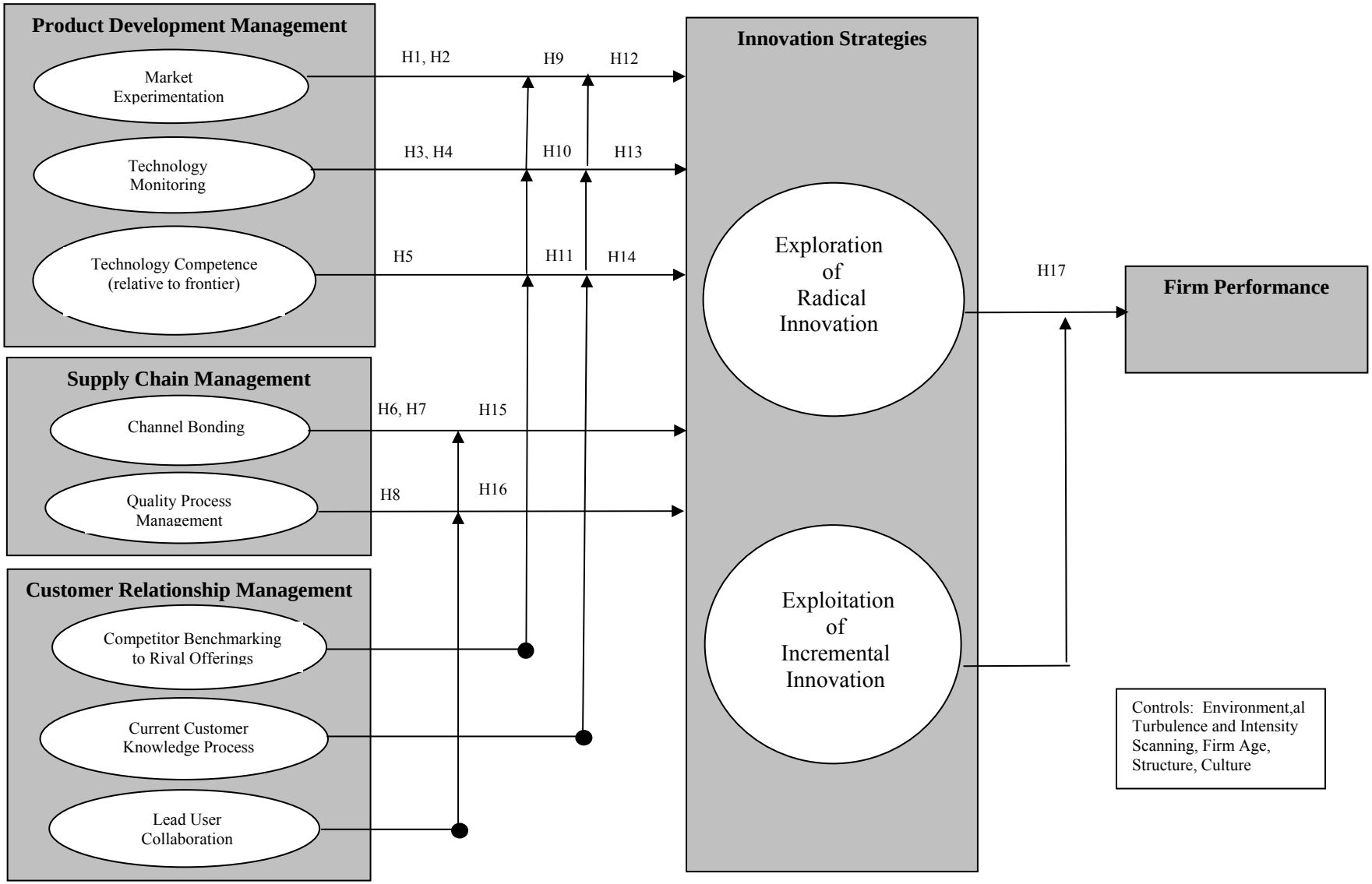



**Figure 1 Conceptual Model of Dual Focus in Innovation Strategy, its Antecedents and Firm Performance Consequences**

**Table 4 Summary of Hypotheses**

| Independent Variable | Dependent Variables | Hypothesis |
|---|---|---|
| PDM Process Main Effects | | |
| Market Experimentation | Exploration and Exploitation | H1: a) The greater the degree of market experimentation, the greater the degree of exploration of radical innovations. b) The greater the degree of market experimentation, the greater the degree of exploitation of incremental innovations.<br><br>H2: The positive influence of market experimentation on exploration of radical innovations will be greater than the positive influence of market experimentation on exploitation of incremental innovations. |
| Technology Monitoring | Exploration and Exploitation | H3: a) The greater the degree of technology monitoring, the greater the degree of exploration of radical innovation. b) The greater the degree of technology monitoring, the greater the degree of exploitation of incremental innovations.<br><br>H4: The positive influence of technology monitoring on exploration of radical innovations will be greater than the positive influence of technology monitoring on exploitation of incremental innovations. |
| Technology Competence | Exploration and Exploitation | H5: a) The greater the degree of technology competence, the greater the degree of exploration of radical innovation. b) The greater the degree of technology competence, the lesser the degree of exploitation of incremental innovations. |
| SCM Process Main Effects | | |
| Channel Bonding | Exploration and Exploitation | H6: a) The greater the degree of channel bonding, the greater the degree of exploitation of incremental innovations. b) The greater the degree of channel bonding, the greater the degree of exploration of radical innovations.<br><br>H7: The positive influence of channel bonding on exploitation of incremental innovations will be greater than the positive influence of channel bonding on exploration of radical innovations. |
| Quality Process Management | Exploration and Exploitation | H8: a) The greater the degree of process management, the greater the degree of exploitation of incremental innovations. b) The greater the degree of process management, the lesser the degree of exploration of radical innovations. |

| Independent Variable | Dependent Variables | Hypothesis |
|---|---|---|
| CRM Process Moderating Effects on PDM Process | | |
| Competitor Benchmarking*Market Experimentation | Exploitation | H9: Competitor benchmarking to rival offerings will moderate the relationship between market experimentation and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between market experimentation and exploitation of incremental innovation. |
| Competitor Benchmarking*Technology Monitoring | Exploitation | H10: Competitor benchmarking to rival offerings will moderate the relationship between technology monitoring and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between technology monitoring and exploitation of incremental innovations. |
| Competitor Benchmarking*Technology Competence | Exploitation | H11: Competitor benchmarking to rival offerings will moderate the relationship between technology competence and exploitation of incremental innovations, such that the greater the degree of competitor benchmarking to rival offerings, the stronger the relationship between technology competence and exploitation of incremental innovations. |
| Current Customer Knowledge Process*Market Experimentation | Exploitation | H12: Current customer knowledge process will moderate the relationship between market experimentation and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between market experimentation and exploitation of incremental innovations. |
| Current Customer Knowledge Process*Technology Monitoring | Exploitation | H13: Current customer knowledge process will moderate the relationship between technology monitoring and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between technology monitoring and exploitation of incremental innovations. |
| Current Customer Knowledge Process*Technology Competence | Exploitation | H14: Current customer knowledge process will moderate the relationship between technology competence and exploitation of incremental innovations, such that the greater the degree of current customer knowledge process, the stronger the relationship between technology competence and exploitation of incremental innovations. |

| Independent Variable | Dependent Variables | Hypothesis |
|---|---|---|
| CRM Process Moderating Effects on SCM Process | | |
| Lead User Collaboration*Channel Bonding | Exploration | H15: Lead user collaboration will moderate the relationship between channel bonding and exploration of radical innovations, such that the greater the degree of lead user collaboration, the stronger the relationship between channel bonding and exploration of radical innovations. |
| Lead User Collaboration*Quality Process Management | Exploration | H16: Lead user collaboration will moderate the relationship between quality process management and exploration of radical innovations, such that the greater the degree of lead user collaboration, the stronger the relationship between quality process management and exploration of radical innovations. |
| Innovation Strategies | | |
| Exploration*Exploitation | Firm Performance | H17: Exploitation of incremental innovations will positively moderate the relationship between exploration of radical innovation and firm performance, such that the greater the degree of exploitation of incremental innovation, the stronger the relationship between exploration of radical innovation and firm performance. |

**Table 5 Interaction between Competitor Benchmarking and Market Experimentation**

| Market Experimentation | Competitor Benchmarking | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. These firms are exploiters, using benchmarking as an emulation tool and creating incremental improvements over rival products based on competitor customer needs and wants. |
| High | Cell 3: Higher degrees of Exploration. These firms are highly exploratory in nature, taking multiple exploratory paths with significantly higher costs and risk, using experimentation to reduce risk. | Cell 4: Higher degrees of both exploration and exploitation. Firms not only expand on current product line with incremental innovations based on competitors' successes but also look for new radical products through experimentation. |

**Table 6 Interaction between Competitor Benchmarking and Technology Monitoring**

| Technology Monitoring | Competitor Benchmarking | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. These firms are exploiters, using benchmarking as an emulation tool and creating incremental improvements over rival products based on current technology. |
| High | Cell 3: Higher degrees of Exploration. These firms are highly exploratory in nature, taking multiple exploratory paths with significantly higher costs and risk. They care less about their competitor's customers and offerings and more about new technologies in the environment for their innovation efforts. | Cell 4: Higher degrees of both exploration and exploitation. Firms not only expand on current product line with incremental innovations based on competitors' successes but also look for new technologies that they can incorporate in their innovations. |

**Table 7 Interaction between Competitor Benchmarking and Technology Competence**

| Technology Competence | Competitor Benchmarking | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. These firms are exploiters, using benchmarking as an emulation tool and creating incremental improvements over rival products based on firm's prior technology experience. |
| High | Cell 3: Higher degrees of Exploration. These firms are pushing the technology frontier blind to competitor actions and their products. | Cell 4: Higher degrees of both exploration and exploitation. Firms not only expand on current product line with incremental innovations based on competitors' successes but also develop new radical products. New products may be influenced by greater knowledge of competitor products and state of the art technology. |

**Table 8 Interaction between Current Customer Knowledge Process and Market Experimentation**

| Market Experimentation | Current Customer Knowledge Process | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. These firms are exploiters, concentrating on smaller incremental improvements to the current product line. Low levels of experimentation with high levels of current customer knowledge may yield incremental innovations that lack creativity, are based on customer familiarity with existing products, and are developed and marketed with little test time. |
| High | Cell 3: Higher degrees of Exploration. High levels of experimentation with low levels of current customer knowledge may yield radical innovations based on customer feedback from experiments but do not benefit from customer information gathered prior to the experimentation, possibly causing higher product development costs as more reiterations are required for successful product launch. | Cell 4: Higher degrees of both exploration and exploitation. Firms not only expand on current product line with incremental innovations but may make also attempt radical innovations with current customer needs in mind. |

**Table 9 Interaction between Current Customer Knowledge Process and Technology Monitoring**

| Technology Monitoring | Current Customer Knowledge Process | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. Current customers drive the incremental innovations based more on the firm's abilities. Firms do not incorporate outside technologies in their products. |
| High | Cell 3: Higher degrees of Exploration. These firms explore more based on outside technologies and less on current customer needs and wants. | Cell 4: Higher degrees of both exploration and exploitation. Firms employ both strategies, using knowledge of current customers and outside technologies. |

**Table 10 Interaction between Current Customer Knowledge Process and Technology Competence**

| Technology Competence | Current Customer Knowledge Process | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. Firms use current customer needs and wants and may go outside the firm for additional technology knowledge. |
| High | Cell 3: Higher degrees of Exploration. Firms push technology frontier with little input from current customers as to direction. | Cell 4: Higher degrees of both exploration and exploitation. Radical innovations are based on current customer needs and wants, but firms also look at current customers for incremental innovation inspiration. |

**Table 11 Interaction between Lead User Collaboration and Channel Bonding**

| Lead User Collaboration | Channel Bonding | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. With little input from lead users, firms develop incremental innovations based on the knowledge present between themselves and their suppliers. |
| High | Cell 3: Higher degrees of Exploration. Firms explore new product areas based on lead user input but do not rely on collaboration with suppliers. | Cell 4: Higher degrees of both exploration and exploitation based on input from lead users. High channel bonding activities allow for joint development of both types of innovation. |

**Table 12 Interaction between Lead User Collaboration and Quality Process Management**

| Lead User Collaboration | Quality Process Management | |
|---|---|---|
| | Low | High |
| Low | Cell 1: Minimal-to-no exploration or exploitation as a result of these processes. | Cell 2: Higher degrees of Exploitation. High levels of quality management techniques with low levels of lead user collaboration will pitch firms toward lower cost and more efficient exploitation based on current product lines without the input of lead user foresight. |
| High | Cell 3: Higher degrees of Exploration. High levels of lead user collaboration with low levels of quality management techniques may improve levels of exploration but with less production efficiency, reduced reliability, and increased rework costs. | Cell 4: Higher degrees of both exploration and exploitation. Firms high in both quality process management and lead user collaboration will tend to explore more while exploiting, reaping the benefits of quality process management, while bringing in new information on lead user wants and preferences. |

**Table 13 Assessment of Non-Response Bias (Respondents versus Non-Respondents)**

| Variable | Respondents Mean (n = 279) | Non-Respondents Mean (n = 631) | t-statistic (p-value, two tail) |
|---|---|---|---|
| Firm Size (Number of Employees) | 1.6503 | 1.6153 | -635 (.526) |
| Firm Sales ($M) | 1.0504 | 1.0557 | .086 (.932) |

Note: Assessment is at the firm level. Out of a total of 1000 firms contacted, 86 firm surveys were returned as undeliverable and secondary data was not available for four firms for a total n = 910. Number of responding firms includes 37 firms that responded in the negative (declined or were unable to participate).

**Table 14 Assessment of Non-Response Bias (Early versus Late Respondents)**

| | Early Respondents Mean (n = 183) | Late Respondents Mean (n = 57) | t-statistic (p-value, two tail) |
|---|---|---|---|
| Exploration Strategy | -.0520 | .1471 | -1.513 (.132) |
| Exploitation Strategy | .0373 | -.1159 | 1.171 (.243) |
| Firm Performance | -.0022 | .0281 | -.261 (.794) |

Note: Assessment is at the executive level and is based on a total n of 241 usable executive surveys minus 1 survey where the alphanumeric identifier had been removed. All data previously mean-centered

**Table 15 Results from the Harmon Single Factor Test**

| Factor | % of Variance - Unrotated | Cumulative % - Unrotated | % of Variance – Rotated | Cumulative % - Rotated |
|---|---|---|---|---|
| 1 | 15.612 | 15.612 | 5.414 | 5.414 |
| 2 | 5.966 | 21.578 | 4.934 | 10.348 |
| 3 | 5.152 | 26.730 | 4.734 | 15.082 |
| 4 | 4.072 | 30.802 | 4.240 | 19.322 |
| 5 | 3.703 | 34.505 | 3.934 | 23.256 |
| 6 | 3.665 | 38.170 | 3.885 | 27.141 |
| 7 | 3.047 | 41.216 | 3.742 | 30.884 |
| 8 | 2.980 | 44.196 | 3.651 | 34.535 |
| 9 | 2.740 | 46.935 | 3.538 | 38.072 |
| 10 | 2.494 | 49.430 | 3.260 | 41.332 |
| 11 | 2.411 | 51.841 | 2.816 | 44.148 |
| 12 | 2.183 | 54.024 | 2.619 | 46.768 |
| 13 | 1.997 | 56.021 | 2.552 | 49.319 |
| 14 | 1.704 | 57.726 | 2.464 | 51.783 |
| 15 | 1.612 | 59.338 | 2.448 | 54.231 |
| 16 | 1.551 | 60.889 | 2.338 | 56.569 |
| 17 | 1.522 | 62.412 | 2.289 | 58.859 |
| 18 | 1.433 | 63.845 | 2.147 | 61.006 |
| 19 | 1.379 | 65.224 | 1.853 | 62.859 |
| 20 | 1.308 | 66.532 | 1.742 | 64.60 |
| 21 | 1.239 | 67.771 | 1.691 | 66.291 |
| 22 | 1.180 | 68.951 | 1.644 | 67.936 |
| 23 | 1.141 | 70.093 | 1.620 | 69.555 |
| 24 | 1.116 | 71.209 | 1.417 | 70.972 |
| 25 | 1.058 | 72.267 | 1.294 | 72.267 |

**Table 16 Frequency and Percent of Respondent Titles**

| Title | Frequency | Percent |
|---|---|---|
| CEO/President/Chairman | 153 | 63.5 |
| Marketing, Business Development or Strategy (Vice President/Director/Manager) | 62[a] | 27.5 |
| Other (Vice President, Director, Manager) | 26 | 10.8 |

[a] 43 of these 62 respondents were Vice Presidents of Marketing

**Table 17 Profile of Respondents versus Total Sample**

| Characteristic | Number of Respondents (% of total) | Sample (% of total) |
|---|---|---|
| Industry | | |
| Computer and Peripheral Equipment | 23 (9.5) | 108 (10.8) |
| Communications Equipment | 24 (10.0) | 114 (11.4) |
| Consumer Electronics | 18 (7.5) | 83 (8.3) |
| Electronic Components | 27 (11.2) | 122 (12.2) |
| Semiconductors | 29 (12.1) | 109 (10.9) |
| Defense Electronics | 22 (9.1) | 112 (11.2) |
| Measuring and Control Instruments | 28 (11.6) | 121 (12.1) |
| Electromedical Equipment | 37 (15.4) | 109 (10.9) |
| Photonics | 32 (13.3) | 122 (12.2) |
| Total | 240 [a] | 1000 |
| | | |
| Most Recent Firm Sales | | |
| <$2.5M | 57 (25.9) | 274 (30.9) |
| 2.5-4.99M | 42 (19.1) | 144 (18) |
| 5 – 19.99M | 68 (30.9) | 236 (29.6) |
| 20 – 99.9M | 34 (15.4) | 99 (12.4) |
| >1B | 19 (8.6) | 70 (8.7) |
| Total [b] | 220 | 800 |
| | | |
| Firm Size (# of Employees) | | |
| Less than 100 | 161 (66.8) | 732 (75.9) |
| 100-499 | 50 (20.7) | 167 (17.3) |
| 500-1999 | 20 (8.3) | 36 (3.7) |
| 2000-4999 | 7 (2.9) | 15 (1.6) |
| 5000-9999 | 2 (.8) | 6 (.6) |
| >10,000 | 1 (.4) | 8 (.8) |
| Total | 241 | 964 |
| | | |
| Firm Age (years)[d] | | |
| 5- 24 | 98 (40.7) | 453 (47.9) |
| 25-49 | 106 (43.9) | 412 (43.6) |
| 50 - 74 | 19 (7.9) | 69 (7.3) |
| 75 - 100 | 3 (1.2) | 11 (1.2) |
| >100 | 0 (0) | 1 (.1) |
| Total | 226 | 946 |

[a] One anonymous respondent

[b] Secondary data, "Sales," unknown for 21 respondent firms and 200 sample firms.

[c] Secondary data, "Size," unknown for 36 sample firms.

[d] Secondary data, "Age," determined by founding date, consistent with previous research (cf, Power 1992). Founding date unknown for 15 respondent firms and 54 sample firms.

**Table 18 Scales and Item Loadings**

| Construct | Items | Mean | Standard Deviation | Loading | $\alpha^a$ |
|---|---|---|---|---|---|
| Market Experimentation | | | | | .84 |
| | We go through many iterations based on customer feedback prior to launching new products in the market. [b] | 3.00 | 1.069 | -- | |
| | We learn customer requirements and needs through prototype/demonstration programs. | 3.51 | 1.118 | .749 | |
| | We develop and test many new ideas over the course of new product development. | 3.30 | 1.090 | .837 | |
| | We have on-going programs that involve a continuous string of experiments designed for incremental knowledge gains. | 3.01 | 1.201 | .726 | |
| | We often conduct small market-focused experiments. [b] | 2.41 | 1.178 | -- | |
| | We learn about the market benefits of a new technology through experimentation. [b] | 2.80 | 1.139 | -- | |
| | We learn about customer preferences as we work them through new product iterations. | 3.77 | .977 | .689 | |
| Technology Monitoring | | | | | .84 |
| | We are often one of the first in our industry to detect technological developments that may potentially affect our business. | 3.46 | 1.080 | .792 | |
| | We actively seek intelligence on technological changes that are likely to affect our business. | 3.81 | .990 | .860 | |
| | We are often slow to detect changes in technologies that might affect our business. (R) | 3.72 | 1.012 | .663 | |
| | We actively monitor small technology changes that may impact our products. | 3.44 | .926 | .677 | |
| | We periodically review the likely effect of changes in technology on our business. [b] | 3.57 | .936 | -- | |
| Technological Competence | | | | | .91 |
| | We have substantial investment in personnel dedicated to state of the art technology. | 3.60 | 1.209 | .857 | |
| | Our current set of technological skills and knowledge is lagging state of the art. (R) | 2.42 | 1.073 | .777 | |
| | We continuously reinvest to operate successfully in state of the art technology. | 3.50 | 1.028 | .859 | |
| | Much of our technical expertise is in state of the art technology. | 3.44 | 1.069 | .864 | |

| Construct | Items | Mean | Standard Deviation | Loading | $\alpha^a$ |
|---|---|---|---|---|---|
| Channel Bonding | | | | | .90 |
| | We develop team-based mechanisms (joint meetings, conferences, etc.) with our major supplier for continuous exchange of information and activity coordination. | 3.00 | 1.194 | .808 | |
| | Our major supplier participates in our product conceptualization and development. | 2.51 | 1.133 | .792 | |
| | We use negotiations over joint problem solving with our major supplier. (R) [b] | 3.14 | 1.156 | -- | |
| | Open communication between us and our major supplier occurs at many levels and functions. | 3.30 | 1.171 | .801 | |
| | We have joint product planning and scheduling with our major supplier. | 2.65 | 1.198 | .894 | |
| | We have put in place information system links so that we know the others' requirements and status in real-time. | 2.24 | 1.149 | .706 | |
| Quality Process Management | To what extent do you use process management techniques (e.g., ISO9000) to | | | | .97 |
| | improve product reliability | 3.52 | 1.321 | .934 | |
| | reduce process variance | 3.37 | 1.258 | .930 | |
| | improve product quality | 3.66 | 1.293 | .965 | |
| | reduce defect rate | 3.61 | 1.283 | .964 | |
| | improve manufacturing efficiency | 3.48 | 1.320 | .901 | |
| Competitor Benchmarking | | | | | .91 |
| | We rarely/regularly search and collect information about our competitors' products and product strategies. | 3.76 | 1.147 | .858 | |
| | We casually/systematically analyze information about what products the customers of our competitors purchase. | 3.42 | 1.068 | .818 | |
| | We seldom/continuously investigate what radical new products our competitors have or will have on the market. | 3.73 | 1.036 | .871 | |
| | Information about competitors' current and potential products is scarcely integrated as a benchmark in our product design. | 3.33 | 1.112 | .851 | |

| Construct | Items | Mean | Standard Deviation | Loading | $\alpha$[a] |
|---|---|---|---|---|---|
| Current Customer Knowledge Process | | | | | .83 |
| | We rarely/regularly meet our customers to learn their needs for new products. | 4.14 | 1.063 | .709 | |
| | We rarely/regularly use marketing research procedures to gather customer information.[b] | 2.66 | 1.143 | -- | |
| | We casually/systematically process and analyze customer information. | 3.39 | 1.031 | .673 | |
| | Information from customers is barely/fully integrated in new product design. | 3.99 | 1.049 | .770 | |
| | We rarely/regularly study our customers' operations for new product ideas. | 3.52 | 1.084 | .828 | |
| Lead User Collaboration | | | | | .86 |
| | We actively seek to identify customers that are considered experts in the uses and functions of our products. | 3.98 | 1.036 | .868 | |
| | We rarely contact lead users for their input on new product ideas. (R) | 4.05 | 1.056 | .833 | |
| | Working with lead users has allowed us to better understand the needs of our other customers. | 3.94 | .996 | .749 | |
| Innovation Strategy - Exploration | | | | | .77 |
| | Introduced a new generation of products. | 4.43 | .945 | .841 | |
| | Develop completely new or different technology knowledge bases. | 3.42 | 1.141 | .717 | |
| | Enter new technology fields. | 3.15 | 1.208 | .622 | |
| Innovation Strategy - Exploitative | | | | | .83 |
| | Extend product range (product extension). | 4.13 | .939 | .778 | |
| | Make minor improvements in a current technology. | 3.49 | 1.104 | .815 | |
| | Reuse your existing technology knowledge. | 3.95 | .929 | .767 | |
| | Combine knowledge of different existing technologies into a new product. | 3.82 | 1.034 | -- | |
| Environmental Scanning | | | | | .81 |
| | Economic trends | 3.33 | 1.045 | .833 | |
| | Demographic trends | 2.55 | 1.082 | .756 | |
| | Technology trends[b] | 4.12 | .879 | -- | |
| | Political trends | 2.49 | 1.178 | .717 | |
| | Regulatory trends[b] | 3.47 | 1.131 | -- | |

[a] Internal consistency.
[b] Item removed from consideration.

Note: (R) Reverse Coded

**Table 19 Internal Consistency, Square Roots of Average Variance Extracted, and Construct Correlation Matrix**

| Construct [c] | Internal Consistency[a] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Competitor Benchmarking | .91 | .85 | | | | | | | | | | | |
| (2) Current Customer Knowledge Process | .83 | .523 | .75 | | | | | | | | | | |
| (3) Lead User Collaboration | .86 | .421 | .484 | .82 | | | | | | | | | |
| (4) Market Experimentation | .84 | .265 | .360 | .423 | .75 | | | | | | | | |
| (5) Technology Monitoring | .84 | .395 | .329 | .467 | .358 | .75 | | | | | | | |
| (6) Technology Competence | .91 | .340 | .379 | .432 | .341 | .530 | .84 | | | | | | |
| (7) Channel Bonding | .90 | .242 | .279 | .229 | .238 | .283 | .334 | .80 | | | | | |
| (8) Quality Process Management | .97 | .237 | .354 | .261 | .172 | .137 | .163 | .344 | .94 | | | | |
| (9) Exploration | .77 | .248 | .230 | .359 | .365 | .384 | .370 | .216 | .060 | .73 | | | |
| (10) Exploitation | .83 | .222 | .280 | .173 | .146 | .281 | .072 | .116 | .330 | .123 | .79 | | |
| (11) Scanning | .81 | .345 | .266 | .213 | .128 | .196 | .173 | .249 | .244 | .139 | .200 | .77 | |
| (12) Organizational Structure[b] | Single Item Measure | .077 | .149 | .107 | .187 | .166 | .131 | .046 | -.113 | .160 | -.001 | -.024 | 1.00 |

[a] Internal consistency = $((\Sigma\lambda_{yi})^2 / ((\Sigma\lambda_{yi})^2 + \Sigma \text{ var}(\varepsilon_i))$ where $\text{var}(\varepsilon_i) = 1 - \lambda_{yi}^2$
Diagonal (in bold) shows the ***square root*** of the average variance extracted, where average variance extracted = $\Sigma\lambda_{yi}^2 / \Sigma\lambda_{yi}^2 + \Sigma \text{ var}(\varepsilon_i)$.
[b] Composite of seven measured items, referred to as the organicity index (cf, Brockman and Morgan 2003).
[c] Reflective constructs are included in the table. Firm performance, environmental turbulence and intensity, and organizational culture were formative constructs.

**Table 20 Summary of Hypotheses Test Results**

| Exogenous Variables | Endogenous Variables | Hypothesis | Path Coefficients (t-values) | Z | Result |
|---|---|---|---|---|---|
| Market Experimentation | Exploration | H1a | .194 (2.8953)** | | Supported |
| | Exploitation | H1b | .019 (.2579) | | Not Supported |
| | | H2 | --- | 2.226*** | Supported |
| Technology Monitoring | Exploration | H3a | .124 (1.7384)** | | Supported |
| | Exploitation | H3b | .279 (4.6259)** | | Supported |
| | | H4 | | 1.320 | Not Supported |
| Technology Competence | Exploration | H5a | .143 (2.0055)** | | Supported |
| | Exploitation | H5b | -.158 (2.2267)** | | Supported |
| Channel Bonding | Exploration | H6b | .078 (1.3035)* | | Supported |
| | Exploitation | H6a | -.049 (.7031) | | Not Supported |
| | | H7 | --- | -1.199 | Not Supported |
| Quality Process Management | Exploration | H8b | -.071 (1.0905) | | Not Supported |
| | Exploitation | H8a | .289 (4.0318)** | | Supported |
| Competitor Benchmarking | Exploration | --- | .037 (.5901) | | --- |
| Competitor Benchmarking | Exploitation | --- | .037 (.4350) | | --- |
| * Market Experimentation | Exploitation | H9 | .000 (.000) | | Not Supported |
| * Technology Monitoring | Exploitation | H10 | -.012 (.1210) | | Not Supported |
| * Technology Competence | Exploitation | H11 | .030 (.2877) | | Not Supported |
| Current Customer Knowledge Process | Exploration | --- | -.034 (.4350) | | --- |
| Current Customer Knowledge Process | Exploitation | --- | .169 (2.0812)** | | --- |
| * Market Experimentation | Exploitation | H12 | -.043 (.4928) | | Not Supported |
| *Technology Monitoring | Exploitation | H13 | -.194 (2.0146)** | | Not Supported |
| * Technology Competence | Exploitation | H14 | .081 (.8789) | | Not Supported |
| Lead User Collaboration | Exploration | --- | .115 (1.3483)* | | |
| Lead User Collaboration | Exploitation | --- | -.091 (1.2304) | | |
| * Channel Bonding | Exploration | H15 | -.161 (2.3959)** | | Not Supported |
| * Quality Process | Exploration | H16 | .017 (.2085) | | Not Supported |

| Exogenous Variables | Endogenous Variables | Hypothesis | Path Coefficients (t-values) | Z | Result |
|---|---|---|---|---|---|
| Exploration | Firm Performance | --- | -.007 (.1273) | | --- |
| Exploitation | Firm Performance | --- | -.050 (.8192) | | --- |
| Exploration*Exploitation | Firm Performance | H17 | .102 (1.7686)** | | Supported |
| Age (Control) | Firm Performance | | .039 (.7168) | | --- |
| Environmental Turbulence and Intensity (Control) | Firm Performance | | -.145 (2.3595)** | | --- |
| Scanning (Control) | Firm Performance | | .118 (1.7255)** | | --- |
| Culture (Control) | Firm Performance | | .332 (4.9328)** | | --- |
| Structure (Control) | Firm Performance | | .169 (2.7849)** | | --- |

Note: *p < .10 (one-sided); **p<.05 (one-sided), ***p<.05 (two-sided)

Note: $Z = \frac{(r_{12} - r_{13})\,(N)^{1/2}}{[(1- r_{12}^2)^2 + (1- r_{13}^2)^2 - 2\, r_{23}^3 - (2\, r_{23} - r_{12}\, r_{13})(1- r_{12}^2 - r_{13}^2 - r_{23}^2)]^{1/2}}$,

where $r_{12}$, $r_{13}$, $r_{23}$ are the correlations between the independent variable (1) and dependent variable (2,3).

**Table 21 Summary of Main Effects, Interaction Effects and $R^2$ Results**

| Exogenous Variables | Endogenous Variables | Main Effects Path Coefficients (t-values) | Main and Interaction Effects Path Coefficients (t-values) |
|---|---|---|---|
| Market Experimentation | Exploration | .196 (2.8059)** | .194 (2.8953)** |
| Technology Monitoring | | .154 (1.9667)** | .124 (1.7384)** |
| Technology Competence | | .147 (2.1219)** | .143 (2.0055)** |
| Channel Bonding | | .069 (1.1037) | .078 (1.3035)* |
| Quality Process Management | | -.080 (1.1628) | -.071 (1.0905) |
| Lead User Collaboration * Channel Bonding | | | -.161 (2.3959)** |
| Lead User Collaboration * Quality Process | | | .017 (.2085) |
| | $R^2$ | .25 | .27 |
| Market Experimentation | Exploitation | .016 (.2427) | .019 (.2579) |
| Technology Monitoring | | .299 (4.9228)** | .279 (4.6259)** |
| Technology Competence | | -.171 (2.3702)** | -.158 (2.2267)** |
| Channel Bonding | | -.055 (.7786) | -.049 (.7031) |
| Quality Process Management | | .281 (4.0110)** | .289 (4.0318)** |
| Current Customer Knowledge Process*Technology Monitoring | | | -.194 (2.0146)** |
| Competitor Benchmarking* Technology Monitoring | | | -.012 (.1210) |
| Current Customer Knowledge Process* Technology Competence | | | .081 (.8789) |
| Competitor Benchmarking* Technology Competence | | | .030 (.2877) |
| Current Customer Knowledge Process* Market Experimentation | | | -.043 (.4928) |
| Competitor Benchmarking* Market Experimentation | | | .000 (.000) |
| | $R^2$ | .20 | .23 |

| Exogenous Variables | Endogenous Variables | Main Effects Path Coefficients (t-values) | Main and Interaction Effects Path Coefficients (t-values) |
|---|---|---|---|
| Exploration | Firm Performance | -.032 (.5350) | -.007 (.1073) |
| Exploitation | Firm Performance | -.068 (1.1135) | -.050 (.8192) |
| Exploration*Exploitation | Firm Performance | | .102 (1.7686)** |
| Environmental Turbulence (Control) | Firm Performance | -.140 (2.2564)** | -.145 (2.3595)** |
| Environmental Scanning (Control) | Firm Performance | .123 (1.8590)** | .118 (1.7255)** |
| Organizational Structure (Control) | Firm Performance | .165 (2.5924)** | .169 (2.7849)** |
| Organizational Culture (Control) | Firm Performance | .324 (5.0323)** | .332 (4.9328)** |
| Firm Age (Control) | Firm Performance | .035 (.6494) | .039 0.7168) |
| | $R^2$ | .17 | .18 |

Note: *p < .10; **p<.05 (one-sided)

**Table 22 Wilcoxon Signed Rank Test Results**

| Construct | Items | Z | Two-Tail Significance (<.05) |
|---|---|---|---|
| Market Experimentation | We learn customer requirements and needs through prototype/demonstration programs. | -1.359 | .17 |
| | We develop and test many new ideas over the course of new product development. | -.339 | .74 |
| | We have on-going programs that involve a continuous string of experiments designed for incremental knowledge gains. | -.752 | .45 |
| | We learn about customer preferences as we work them through new product iterations. | -2.497 | .01* |
| Technology Monitoring | We are often one of the first in our industry to detect technological developments that may potentially affect our business. | 1.021 | .31 |
| | We actively seek intelligence on technological changes that are likely to affect our business. | -1.579 | .11 |
| | We are often slow to detect changes in technologies that might affect our business. (R) | -1.659 | .10 |
| | We actively monitor small technology changes that may impact our products. | -.414 | .68 |
| Technological Competence | We have substantial investment in personnel dedicated to state of the art technology. | -.076 | .94 |
| | Our current set of technological skills and knowledge is lagging state of the art. (R) | -2.369 | .02* |
| | We continuously reinvest to operate successfully in state of the art technology. | -1.469 | .14 |
| | Much of our technical expertise is in state of the art technology. | -.904 | .37 |
| Channel Bonding | We develop team-based mechanisms (joint meetings, conferences, etc.) with our major supplier for continuous exchange of information and activity coordination. | -1.350 | .18 |
| | Our major supplier participates in our product conceptualization and development. | -2.340 | |
| | Open communication between us and our major supplier occurs at many levels and functions. | -1.398 | .16 |
| | We have joint product planning and scheduling with our major supplier. | -2.442 | .02* |
| | We have put in place information system links so that we know the others' requirements and status in real-time. | -1.206 | .29 |
| QPM | Improve product reliability | -1.171 | .24 |
| | Reduce process variance | -.863 | .39 |
| | Improve product quality | -.905 | .37 |
| | Reduce defect rate | -1.017 | .31 |
| | Improve manufacturing efficiency | -.415 | .68 |

| Construct | Items | Z | Two-Tail Significance (<.05) |
|---|---|---|---|
| Competitor Benchmarking | We rarely/regularly search and collect information about our competitors' products and product strategies. | -1.022 | .31 |
| | We casually/systematically analyze information about what products the customers of our competitors purchase. | -1.204 | .23 |
| | We seldom/continuously investigate what radical new products our competitors have or will have on the market. | -2.275 | .02* |
| | Information about competitors' current and potential products is scarcely integrated as a benchmark in our product design. | -1.764 | .08 |
| Current Customer Knowledge Process | We rarely/regularly meet our customers to learn their needs for new products. | -2.376 | .02* |
| | We casually/systematically process and analyze customer information. | -1.546 | .12 |
| | Information from customers is barely/fully integrated in new product design. | -.264 | .79 |
| | We rarely/regularly study our customers' operations for new product ideas. | -2.326 | .02* |
| Lead User Collaboration | We actively seek to identify customers that are considered experts in the uses and functions of our products. | -1.094 | .27 |
| | We rarely contact lead users for their input on new product ideas. (R) | -2.529 | .01* |
| | Working with lead users has allowed us to better understand the needs of our other customers. | -.645 | .52 |
| Exploration | Introduced a new generation of products. | -3.992 | .00* |
| | Develop completely new or different technology knowledge bases. | -3.857 | .00* |
| | Enter new technology fields. | -3.767 | .00* |
| Exploitation | Extend product range (product extension). | -3.898 | .00* |
| | Make minor improvements in a current technology. | -3.854 | .00* |
| | Reuse your existing technology knowledge. | -3.959 | .00* |
| Firm Performance | Return on sales | -2.112 | .04 |
| | Profitability | -1.597 | .110 |

Note: **p<.05

## Table 23 Robustness Test Results of Path Coefficients for Study Hypotheses

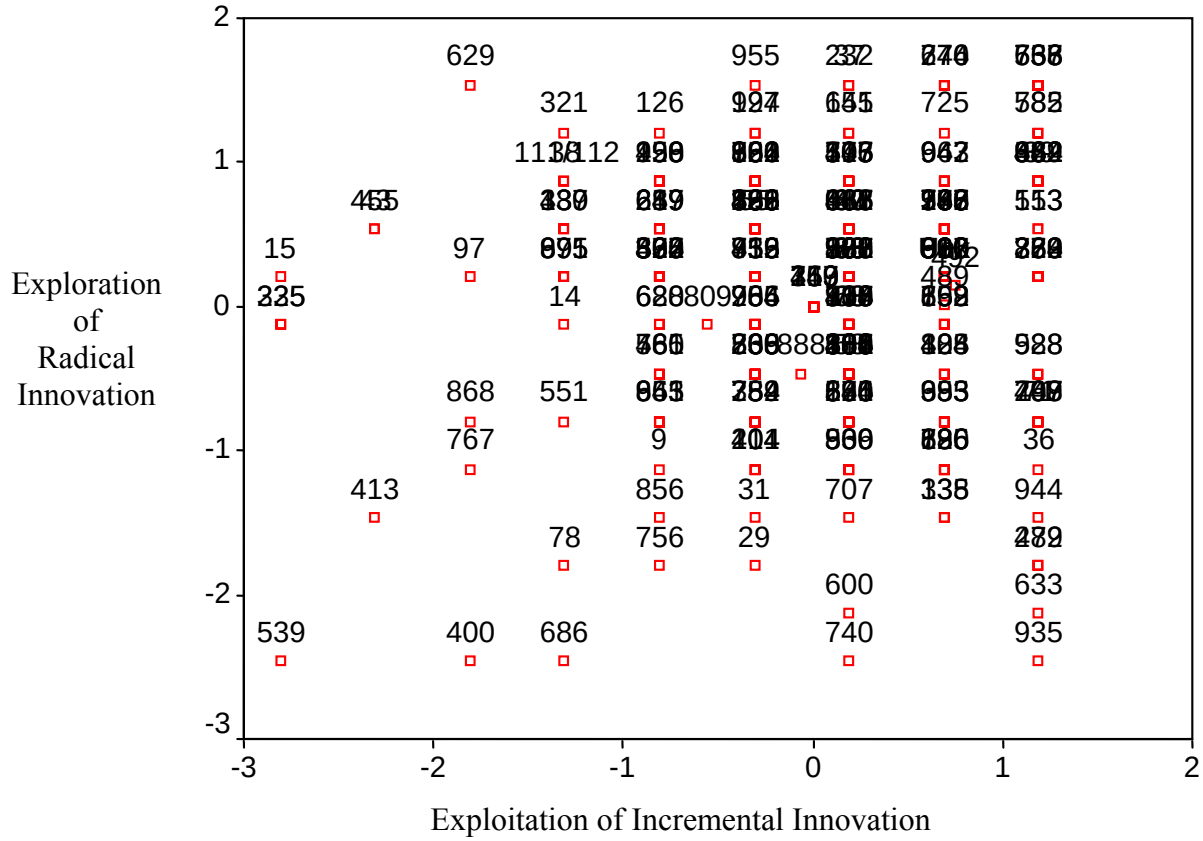
| Exogenous Variables | Endogenous Variables | Path Coefficients (t-values) n = 241 | Path Coefficients (t-values) n = 231 | Path Coefficients (t-values) n = 221 |
|---|---|---|---|---|
| Market Experimentation | Exploration | .194 (2.8953)** | .194 (2.7631)** | .202 (2.8700)** |
| Technology Monitoring | | .124 (1.7384)** | .114 (1.4214)* | .119 (1.4852)* |
| Technology Competence | | .143 (2.0055)** | .184 (2.6581)** | .194 (2.8398)** |
| Channel Bonding | | .078 (1.3035)* | .077 (1.2143)* | .078 (1.2922)* |
| Quality Process Management | | -.071 (1.0905) | -.052 (.7951) | -.041 (.5669) |
| Lead User Collaboration * Channel Bonding | | -.161 (2.3959)** | -.147 (1.9512)** | -.153 (2.1978)** |
| Lead User Collaboration * Quality Process | | .017 (.2085) | -.001 (.0114) | .008 (.0941) |
| Market Experimentation | Exploitation | .019 (.2579) | .013 (.1658) | .001 (.0130) |
| Technology Monitoring | | .279 (4.6259)** | .265 (4.5861)** | .253 (4.2709)** |
| Technology Competence | | -.158 (2.2267)** | -.128 (1.7054)** | -.144 (2.0456)** |
| Channel Bonding | | -.049 (.7031) | -.027 (.3960) | -.030 (.4203) |
| Quality Process Management | | .289 (4.0318)** | .285 (3.7471)** | .277 (3.4492)** |
| Current Customer Knowledge Process*Technology Monitoring | | -.194 (2.0146)** | -.199 (1.8846)** | -.184 (1.7287)** |
| Competitor Benchmarking* Technology Monitoring | | -.012 (.1210) | -.007 (.0718) | .001 (.0102) |
| Current Customer Knowledge Process* Technology Competence | | .081 (.8789) | .054 (.5138) | .070 (.6931) |
| Competitor Benchmarking* Technology Competence | | .030 (.2877) | .047 (.4497) | .042 (.4008) |
| Current Customer Knowledge Process* Market Experimentation | | -.043 (.4928) | -.066 (.6925) | -.064 (.6778) |
| Competitor Benchmarking* Market Experimentation | | .000 (.000) | .028 (.2549) | -.002 (.0170) |
| Exploration*Exploitation | Firm Performance | .102 (1.7686)** | .111 (1.8095)** | .109 (1.6766)** |

Note: *p < .10; **p<.05 (one-sided)

**Table 24 Power Analysis Results for the Endogenous Constructs**

| Endogenous Construct | Number of Predictors | $R^2$ (interaction) | $R^2$ (main effects) | $f^2$ | L | Power |
|---|---|---|---|---|---|---|
| Exploration | 10 | .272 | .250 | .081 | 18.63 | .85 <P< .9 |
| Exploitation | 14 | .234 | .205 | .124 | 28.02 | .95 <P< .99 |
| Firm Performance | 8 | .177 | .168 | .051 | 11.83 | .6 < P< .7 |

Note: The effect size, $f^2$, was calculated per Chin et al. (1996) whereby $f^2 = [R^2 \text{ (interaction model)} – R^2 \text{ (main effects)}]/ R^2 \text{ (interaction)}$; L was computed per Cohen et al. (2003), and power was estimated per Table E.2 of Cohen et al. (2003) for $\alpha = .05$.




Note: Numbers refer to firm identification numbers.

**Figure 2: Plot of Exploration versus Exploitation by Firm**

**Table 25 Results of Predictive Validity Tests for Cluster and Key Constructs**

| Variable | Cluster 1: Neither Explorer or Exploiter (N = 17) | Cluster 2: Largely Exploiter (N = 81) | Cluster 3: Largely Explorer (N = 65) | Cluster 4: Dual Focus (N = 78) | F-Statistics |
|---|---|---|---|---|---|
| Firm Performance | -.2797 | .0103 | -.0217 | .1006 | .850 |
| Market Experimentation | -.4510 | -.1132 | -.0449 | .2538 | 5.681** |
| Technology Monitoring | -.4476 | -.1325 | -.0018 | .2170 | 3.217** |
| Technology Competence | -.2947 | -.1561 | .0315 | .1912 | 2.526* |
| Channel Bonding | -.3912 | -.0165 | -.0220 | .0769 | 1.728** |
| Quality Process Management | -.5633 | .0242 | -.3557 | .3091 | 4.906** |
| Competitor Benchmarking | -.6188 | -.0785 | -.0312 | .2413 | 4.771** |
| Current Customer Knowledge Process | -.5696 | .0632 | -.0449 | .1295 | 3.348** |
| Lead User Collaboration | -.6571 | -.1136 | .0715 | .2322 | 5.382** |

Note: Based on mean centered data and n = 241.

Note: *p<.10; **p<.05

Note: Homogeneity of Variance could not be assumed for Lead User Collaboration or Technology Monitoring, therefore the Brown and Forsythe statistic was used where F (3, 68.155) = 5.382, p<.05 for lead user collaboration and F (3, 60.989) = 3.217, p<.05 for technology monitoring.

**Table 26 Results of Post Hoc Comparisons on Cluster versus Business Process**

| Variable | Test | Cluster (I) | Cluster (J) | Mean Difference (I-J) | Standard Error | Significance |
|---|---|---|---|---|---|---|
| PDM | | | | | | |
| Market Experimentation | Tukey's HSD | Dual Focus | Neither | .7048** | .20140 | .003 |
| | | | Exploiter | .3670** | .11937 | .013 |
| | | | Explorer | .2987* | .12637 | .087 |
| Technology Monitoring | Tamhane | Dual Focus | Neither | .6647 | .30015 | .213 |
| | | | Exploiter | .3495** | .13082 | .045 |
| | | | Explorer | .2188 | .12872 | .437 |
| Technology Competence | Tukey's HSD | Dual Focus | Neither | .4859 | .24530 | .198 |
| | | | Exploiter | .3473* | .14538 | .082 |
| | | | Explorer | .1596 | .15391 | .728 |
| QPM | | | | | | |
| Channel Bonding | Tukey's HSD | Dual Focus | Neither | .4681 | .20593 | .107 |
| | | | Exploiter | .0934 | .12205 | .870 |
| | | | Explorer | .0989 | .12921 | .870 |
| Quality Process Management | Tukey's HSD | Dual Focus | Neither | .8724** | .31924 | .034 |
| | | | Exploiter | .2850 | .18920 | .435 |
| | | | Explorer | .6648** | .20030 | .006 |
| CRM | | | | | | |
| Competitor Benchmarking | Tukey's HSD | Dual Focus | Neither | .8601** | .24110 | .002 |
| | | | Exploiter | .3198 | .14290 | .116 |
| | | | Explorer | .2724 | .15128 | .275 |
| Current Customer Knowledge Process | Tukey's HSD | Dual Focus | Neither | .6991** | .22741 | .013 |
| | | | Exploiter | .0664 | .13478 | .961 |
| | | | Explorer | .1744 | .14269 | .613 |
| Lead User Collaboration | Tamhane | Dual Focus | Neither | .8893** | .27199 | .025 |
| | | | Exploiter | .3457** | .11338 | .016 |
| | | | Explorer | .1606 | .13228 | .787 |

Note: *p<.10; **p < .05

# APPENDIX B: SURVEY AND LETTERS

**EXPLORATION AND EXPLOITATION:**
**A STUDY OF CORE BUSINESS PROCESSES AND INNOVATION STRATEGIES IN TECHNOLOGY MANUFACTURING INDUSTRIES**

**An Academic Research Project**

UNIVERSITY OF CENTRAL FLORIDA
COLLEGE OF BUSINESS ADMINISTRATION

This survey is part of a doctoral dissertation thesis at the Department of Marketing, College of Business Administration, University of Central Florida in Orlando, Florida. The primary objective of this research is to determine the influences of core business processes on innovation strategies, particularly on the strategic choices of exploring new product-market domains through state of the art products, exploiting current product-market domains through incrementally improved products, or simultaneously pursuing both exploration and exploitation. Your input is invaluable in understanding these relationships and the ultimate impacts of innovation strategy choice on firm performance when more than one strategy is chosen.

**YOUR ASSISTANCE IN THIS RESEARCH IS VALUED AND VERY MUCH APPRECIATED.**


Janet K. Tinoco
Doctoral Candidate

Dr. Jai Ganesh
Associate Dean of Graduate Programs and Research
Associate Professor of Marketing

Dr. Ronald Michaels
Professor of Marketing

College of Business Administration
Department of Marketing
University of Central Florida


**Please return your completed questionnaire in the enclosed pre-paid envelope to:**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## Introduction

This survey is intended for chief executive officers/presidents and vice presidents, therefore your responses should be from the perspective of **your corporation as a whole.** If you wish to make additional comments to the survey or qualify your answers, please use the space in the margins or the additional space provided at the end of the questionnaire.

- Your input is extremely **critical** to the success of this academic research endeavor. Please feel free to consult your colleagues, as necessary, to fill out the survey.
- All information you provide will be treated as **strictly confidential**. Furthermore, all data will be aggregated prior to analysis with only **industry-based findings** being reported.
- **NO** company-specific or individual responses will be disclosed.

**Thank you** for your time and assistance.

## Section 1: Innovation Strategy

We are interested in understanding your **product** innovation where the innovation ranges from an incremental improvement to existing technology to leap-frogging to a new state of the art technology used in your manufactured products. Additionally, we would like to know the importance of **process** innovations used in the manufacture and test of your company's products.

Listed below are statements that relate to your decisions and objectives in choosing product and process innovation strategies. Please rate the statements based on your understanding of **innovation projects** your corporation has undertaken in the **last 5 years** regardless of the source of funding (i.e., R&D, customer-sponsored, etc.). Circle the appropriate number.

| | **Not Important** | | | | **Very Important** |
|---|---|---|---|---|---|
| Introduce new generation of products. | 1 | 2 | 3 | 4 | 5 |
| Extend product range (product extension). | 1 | 2 | 3 | 4 | 5 |
| Improve production flexibility. | 1 | 2 | 3 | 4 | 5 |
| Develop completely new or different technology knowledge bases. | 1 | 2 | 3 | 4 | 5 |
| Improve yield. | 1 | 2 | 3 | 4 | 5 |
| Make minor improvements in a current technology. | 1 | 2 | 3 | 4 | 5 |
| Reuse your existing technology knowledge. | 1 | 2 | 3 | 4 | 5 |
| Reduce material consumption. | 1 | 2 | 3 | 4 | 5 |
| Combine knowledge of different existing technologies into a new product. | 1 | 2 | 3 | 4 | 5 |
| Enter new technology fields. | 1 | 2 | 3 | 4 | 5 |

## Section 1: Innovation Strategy– continued

Over the **past 5 years**, approximately how many **innovative products** has your firm introduced? _____

Of these innovative products, how many would be classified as

Radical (a product that incorporates new state of the art technology)? _____

Incremental (a product that incorporates relatively minor improvements in technology)?_____

Compared to your competitors, please rate your **product** innovation strategies in the **past 5 years.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Largely **exploitative** with incremental innovations | 1 | 2 | 3 | 4 | 5 | Largely **explorative** with radical innovations |

Over the **past 5 years**, approximately how many **production process innovations** has your firm developed and implemented?_____

## Section 2: Product Development Management

Listed below are statements that relate to your product development management process. Please read each statement and indicate the extent to which it characterizes your **corporation overall** by circling the appropriate number.

### A. Technology Monitoring

| | **Strongly Disagree** | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| We are often one of the first in our industry to detect technological developments that may potentially affect our business. | 1 | 2 | 3 | 4 | 5 |
| We actively seek intelligence on technological changes that are likely to affect our business. | 1 | 2 | 3 | 4 | 5 |
| We are often slow to detect changes in technologies that might affect our business. | 1 | 2 | 3 | 4 | 5 |
| We actively monitor small technology changes that may impact our products. | 1 | 2 | 3 | 4 | 5 |
| We periodically review the likely effect of changes in technology on our business. | 1 | 2 | 3 | 4 | 5 |

### B. Technological Competence

| | **Strongly Disagree** | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| We have substantial investment in personnel dedicated to state of the art technology. | 1 | 2 | 3 | 4 | 5 |
| Our current set of technological skills and knowledge is lagging state of the art. | 1 | 2 | 3 | 4 | 5 |
| We continuously reinvest to operate successfully in state of the art technology. | 1 | 2 | 3 | 4 | 5 |
| Much of our technical expertise is in state of the art technology. | 1 | 2 | 3 | 4 | 5 |

## Section 2: Product Development Management – continued

### C. Market Experimentation

| | Strongly Disagree | | | | Strongly Agree |
|---|---|---|---|---|---|
| We go through many iterations based on customer feedback prior to launching new products in the market | 1 | 2 | 3 | 4 | 5 |
| We learn customer requirements and needs through prototype/demonstration programs. | 1 | 2 | 3 | 4 | 5 |
| We develop and test many new ideas over the course of new product development. | 1 | 2 | 3 | 4 | 5 |
| We have on-going programs that involve a continuous string of experiments designed for incremental knowledge gains. | 1 | 2 | 3 | 4 | 5 |
| We often conduct small market-focused experiments. | 1 | 2 | 3 | 4 | 5 |
| We learn about the market benefits of a new technology through experimentation. | 1 | 2 | 3 | 4 | 5 |
| We learn about customer preferences as we work them through new product iterations. | 1 | 2 | 3 | 4 | 5 |

## Section 3: Supply Chain Management

Listed below are statements that relate to your supply chain management process. Please read each statement and indicate the extent to which it characterizes your **corporation overall** by circling the appropriate number.

### A. Quality Process Management

**To what extent do you use process management techniques (i.e., ISO9000) to:**

| | Not at all | | | | A Very Great Extent |
|---|---|---|---|---|---|
| improve product reliability | 1 | 2 | 3 | 4 | 5 |
| reduce process variance | 1 | 2 | 3 | 4 | 5 |
| improve product quality | 1 | 2 | 3 | 4 | 5 |
| reduce defect rate | 1 | 2 | 3 | 4 | 5 |
| improve manufacturing efficiency | 1 | 2 | 3 | 4 | 5 |

## Section 3: Supply Chain Management – continued

### B. Supplier Relationships

For the following questions on **both** Supplier Trust and Channel Bonding, please answer the questions based on your **major supplier** in terms of performance and cost.

| *Supplier Trust* | **Strongly Disagree** | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| Our major supplier has a high level of integrity. | 1 | 2 | 3 | 4 | 5 |
| Our major supplier cannot be trusted at times. | 1 | 2 | 3 | 4 | 5 |
| Sometimes our major supplier promises to do things without actually doing them. | 1 | 2 | 3 | 4 | 5 |
| Our major supplier is frank in dealing with us. | 1 | 2 | 3 | 4 | 5 |
| Promises made by our major supplier are reliable. | 1 | 2 | 3 | 4 | 5 |

| *Channel Bonding Activities* | **Strongly Disagree** | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| We develop team-based mechanisms (joint meetings, conferences, etc.) with our major supplier for continuous exchange of information and activity coordination. | 1 | 2 | 3 | 4 | 5 |
| Our major supplier participates in our product conceptualization and development. | 1 | 2 | 3 | 4 | 5 |
| We use negotiations over joint problem solving with our major supplier. | 1 | 2 | 3 | 4 | 5 |
| Open communication between us and our major supplier occurs at many levels and functions. | 1 | 2 | 3 | 4 | 5 |
| We have joint product planning and scheduling with our major supplier. | 1 | 2 | 3 | 4 | 5 |
| We put in place information system links so that we know the others' requirements and status in real-time. | 1 | 2 | 3 | 4 | 5 |

## Section 4: Customer Relationship Management

Listed below are statements that relate to your customer relationship management process. Please read each statement and indicate the extent to which it characterizes your **corporation overall** by circling the appropriate number. Please note the change in answer format from strongly disagree/agree to contrasts.

**A. Customer Knowledge Process:** For the following questions on Knowledge Process, please answer with respect to your **current** customers.

| | ▼ 1 | 2 | 3 | 4 | ▼ 5 | |
|---|---|---|---|---|---|---|
| We **rarely** meet our customers to learn their needs for new products. | 1 | 2 | 3 | 4 | 5 | We **regularly** meet our customers to learn their needs for new products. |
| We **rarely** use marketing research procedures to gather customer information. | 1 | 2 | 3 | 4 | 5 | We **regularly** use marketing research procedures to gather customer information. |
| We **casually** process and analyze customer information. | 1 | 2 | 3 | 4 | 5 | We **systematically** process and analyze customer information. |
| Information from customers is **barely** integrated in new product design. | 1 | 2 | 3 | 4 | 5 | Information from customers is **fully** integrated in new product design. |
| We **rarely** study our customers' operations for new product ideas. | 1 | 2 | 3 | 4 | 5 | We **regularly** study our customers' operations for new product ideas. |

**B. Competitor Benchmarking**

| | ▼ 1 | 2 | 3 | 4 | ▼ 5 | |
|---|---|---|---|---|---|---|
| We **rarely** search and collect information about our competitors' products and product strategies. | 1 | 2 | 3 | 4 | 5 | We **regularly** search and collect information about our competitors' products and product strategies. |
| We **casually** analyze information about what products the customers of our competitors purchase. | 1 | 2 | 3 | 4 | 5 | We **systematically** analyze information about what products the customers of our competitors purchase. |
| We **seldom** investigate what radical new products our competitors have or will have on the market. | 1 | 2 | 3 | 4 | 5 | We **continuously** investigate what radical new products our competitors have or will have on the market. |
| Information about competitors' current and potential products is **scarcely** integrated as a benchmark in our product design. | 1 | 2 | 3 | 4 | 5 | Information about competitors' current and potential products is **fully** integrated as a benchmark in our product design. |

## Section 4: Customer Relationship Management – continued

### C. Lead User Collaboration

Lead users are those customers, both current and potential, whose present strong wants and needs will become general in the marketplace months or years in the future. You may also consider lead users to be experts and opinion leaders due to their advanced product knowledge and use.

| | **Strongly Disagree** | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| We actively seek to identify customers that are considered experts in the uses and functions of our products. | 1 | 2 | 3 | 4 | 5 |
| We rarely contact lead users for their input on new product ideas. | 1 | 2 | 3 | 4 | 5 |
| Working with lead users has allowed us to better understand the needs of our other customers. | 1 | 2 | 3 | 4 | 5 |

## Section 5: Organizational Structure and Culture

Listed below are statements that relate to the structure and culture of your corporation. Please read each statement and indicate the extent to which it characterizes your **corporation overall** by circling the appropriate number. Please note the change in answer format from strongly disagree/agree to contrasts.

### A. Organizational Structure

**In general, the management philosophy in our corporation favors…**

| | ▼ 1 | ▼ 2 | ▼ 3 | ▼ 4 | ▼ 5 | |
|---|---|---|---|---|---|---|
| Highly **structured** channels of communication. | 1 | 2 | 3 | 4 | 5 | **Open** channels of communication. |
| Highly **restricted** access to important financial/operating information. | 1 | 2 | 3 | 4 | 5 | **Free-flowing** access. |
| A strong emphasis on giving the most say in decision making to **formal line managers.** | 1 | 2 | 3 | 4 | 5 | A strong tendency to let the **experts** have the most say, regardless of formal line of authority. |
| A strong emphasis on **holding fast** to current management principles despite changing in business conditions. | 1 | 2 | 3 | 4 | 5 | A strong emphasis on **adapting freely** to changing business conditions. |
| A strong emphasis on always following **formal procedures**. | 1 | 2 | 3 | 4 | 5 | A strong emphasis on **getting things done** regardless of formal procedures. |
| **Tight** formal control of most operations by means of advanced control and information systems. | 1 | 2 | 3 | 4 | 5 | **Loose** informal control. |
| A strong emphasis on close **adherence to formal job descriptions.** | 1 | 2 | 3 | 4 | 5 | A strong tendency to let the **needs of the situation** define on-job behavior. |

## Section 5: Organizational Structure and Culture – continued

Some companies have separate organizational units dedicated to innovation activities. Depending on the size of your corporation, a unit can be a strategic business unit (SBU) or division, functional department (e.g., R&D, Engineering, etc.), or product development team.

| | Not at All | | | | To a Very Great Extent |
|---|---|---|---|---|---|
| **Radical** product innovations are developed by separate organizational units (i.e., SBUs, divisions, departments, teams). | 1 | 2 | 3 | 4 | 5 |
| **Incremental** product innovations are developed by separate organizational units (i.e., SBUs, divisions, departments, teams). | 1 | 2 | 3 | 4 | 5 |

### B. Organizational Culture

| **In our corporation, managers generally…** | Not at All | | | | To a Very Great Extent |
|---|---|---|---|---|---|
| Set challenging/aggressive goals. | 1 | 2 | 3 | 4 | 5 |
| Issue creative challenges to their people instead of narrowly defining tasks. | 1 | 2 | 3 | 4 | 5 |
| Give everyone sufficient authority to do their jobs well. | 1 | 2 | 3 | 4 | 5 |
| Evaluate employee based on rigorous measurement of business performance against goals. | 1 | 2 | 3 | 4 | 5 |
| Hold people accountable for their performances. | 1 | 2 | 3 | 4 | 5 |
| Devote considerable effort to developing subordinates. | 1 | 2 | 3 | 4 | 5 |
| Treat failure in a good effort as a learning opportunity, not as something to be ashamed of. | 1 | 2 | 3 | 4 | 5 |

## Section 6: Your Environment

Please read each statement and indicate the extent to which your company collects information to remain abreast of changes in your environment.

| | Never | | | | Frequently |
|---|---|---|---|---|---|
| Economic trends | 1 | 2 | 3 | 4 | 5 |
| Demographic trends | 1 | 2 | 3 | 4 | 5 |
| Technology trends | 1 | 2 | 3 | 4 | 5 |
| Political trends | 1 | 2 | 3 | 4 | 5 |
| Regulatory trends | 1 | 2 | 3 | 4 | 5 |

## Section 6: Your Environment – continued

Please read each statement and indicate the extent to which it characterizes your industry environment.

| | Strongly Disagree | | | | Strongly Agree |
|---|---|---|---|---|---|
| Customers' product preferences/requirements change quite a bit over time. | 1 | 2 | 3 | 4 | 5 |
| We are witnessing demand for our products from customers who have never bought them before. | 1 | 2 | 3 | 4 | 5 |
| New customers tend to have product-related needs that are different from those of our existing customers. | 1 | 2 | 3 | 4 | 5 |
| The technology in our industry is changing rapidly. | 1 | 2 | 3 | 4 | 5 |
| It is unlikely that today's technological standard in our industry will still be dominant five years from now. | 1 | 2 | 3 | 4 | 5 |
| Technological breakthroughs contribute to the development of new product ideas in our industry. | 1 | 2 | 3 | 4 | 5 |
| Our competitors are constantly changing their product features. | 1 | 2 | 3 | 4 | 5 |
| Our competitors are constantly changing their sales strategies. | 1 | 2 | 3 | 4 | 5 |
| New competitors are entering our industry. | 1 | 2 | 3 | 4 | 5 |

## Section 7: Firm Performance

Please estimate the following firm performance indicators over the **past 5 years** relative to your competitors.

| | Much Worse | | | | Much Better |
|---|---|---|---|---|---|
| Return on assets | 1 | 2 | 3 | 4 | 5 |
| Market share | 1 | 2 | 3 | 4 | 5 |
| Sales growth | 1 | 2 | 3 | 4 | 5 |
| Return on sales | 1 | 2 | 3 | 4 | 5 |
| Profitability | 1 | 2 | 3 | 4 | 5 |
| Return on investments | 1 | 2 | 3 | 4 | 5 |

How many employees (in terms of full-time equivalent employees) does your organization currently employ?

_____Less than 100
_____100-499
_____500-1999
_____2000-4999
_____5000-9999
_____>10,000

**THANK YOU FOR YOUR THOUGHTS AND EFFORT**

Please check your present title: _____CEO/President

_____Vice President of Marketing

_____Other (Write-in _____)

Do you wish to receive an executive summary of findings and benchmark report? _____Yes

_____No

If there is anything else you would like to tell us, please use the following space for that purpose.

We appreciate you taking the time to assist us in the valuable research. Again, thank you!

Janet K. Tinoco
Department of Marketing
College of Business Administration
University of Central Florida
P.O. Box 161400
Orlando, FL 32816-1400
407-823-3891 (Fax)

The format and content of this questionnaire are not intended to express or reflect the opinions of or any official policy of the University of Central Florida.

University of Central Florida

Department of Marketing

August 22, 2006

Mr. David Gische
Microlog Corp.
20270 Goldenrod Ln
Germantown, MD 20876-4070

Dear Mr. Gische,

I am a doctoral candidate in the department of Marketing, College of Business Administration, University of Central Florida. I am writing to ask your help in an academic study on product innovation in technology. This study is part of a three-year doctoral dissertation effort to better understand the influential nature of business processes on innovation strategies, particularly on the strategic choices of *exploring* new product-market domains through state-of-the-art technology, *exploiting* current product-market domains through incremental technological improvements, or simultaneously pursuing *both*. Furthermore, this study examines the ultimate firm performance impacts when one or both strategies are pursued.

As an engineer and former technical manager in the high technology sector, I fully understand the challenges to developing and marketing high technology products. As a result, this dissertation research has been carefully crafted with both academic and practical implications in mind. However, my research will fail without input from industry executives such as yourself that are involved in guiding the firm through product innovation strategies, strategies that have short-term and long-term performance implications for the firm.

As a doctoral student, my research funding is severely limited; hence the success of my endeavor depends heavily on your response. As a token of my appreciation for your assistance, I will gladly provide you an executive summary of my findings with a benchmark report developed specifically for your firm. To receive a copy, simply check the box located on the last page of the survey.

The enclosed survey has an identification number for mailing purposes only. When you return your survey, your name and firm will be deleted from the mailing list. You will not be contacted again. All of your survey answers are treated as completely confidential. No company-specific or individual responses will be disclosed. Although not necessary, non-disclosure agreements can be signed when requested.

I look forward to your response. Please mail your completed survey in the enclosed stamped envelope or return it by fax to the number below. If you have any questions or comments about this study, please contact me at jtinoco@bus.ucf.edu or 407-758-7394 (cell). Thank you very much for helping me in this effort.

Sincerely,

Janet K. Tinoco
Doctoral Candidate in Marketing
University of Central Florida
College of Business Administration

College of Business Administration
4000 Central Florida Blvd. • Orlando, FL 32816-1400 • (407) 823-1409 • FAX (407) 823-3891
An Equal Opportunity and Affirmative Action Institution


Department of Marketing
August 29, 2006

Last week a survey was mailed to you seeking your executive input with respect to business process impacts on product innovation strategies.

If you have already completed and returned the survey, please accept my sincere thanks and gratitude. If you have not, I would very much appreciate if you can do so as soon as possible. My research will fail without input from industry leaders such as yourself.

If you did not receive a survey or if it was misplaced, please contact me at jtinoco@bus.ucf.edu. I will send another to you immediately.

Sincerely,

Janet K. Tinoco
Doctoral Candidate
Department of Marketing, UCF

College of Business Administration
P.O. Box 161400 • Orlando, FL 32816-1400 •
FAX (407) 823-3891

Department of Marketing

September 18, 2006

[RECIPIENT NAME
RECIPIENT ADDRESS]

Dear [RECIPIENT NAME],

About three weeks ago I sent a letter and survey to you, asking for your participation in an academic study on business processes and product innovation in technology. To the best of my knowledge, the survey has not yet been returned.

Executives that have already responded have indicated the timeliness and value of the study to innovation. Also, this dissertation recently received the American Marketing Association's Best Dissertation Proposal Award in technology and innovation. I firmly believe the results are going to be very useful for manufacturers in the high technology arena, especially those that struggle with developing innovative products. However, I desperately need your response for a successful and accurate data collection effort.

A few executives have written to say that the survey questions do not apply to their company or that company policy prevents their participation. If either of these concerns applies to you, please contact me at the email address (preferred) or telephone number below as soon as possible. This information is still extremely valuable, and your name and firm will be deleted from the mailing list.

As a doctoral student, my dissertation research is personally financed and funds are severely limited. I hope that you will fill out the enclosed questionnaire soon. All of your answers are treated as completely confidential. When you return your survey, your name and firm will be deleted from the mailing list and you will not be contacted again! Although not necessary, non-disclosure agreements can be signed when requested.

I look forward to hearing from you. Please mail your completed survey in the enclosed stamped envelope or return it by fax to the number below. If you have any questions or comments about this study, please contact me at jtinoco@bus.ucf.edu. Thank you very much for helping me in this effort.

Sincerely,

Janet K. Tinoco
Doctoral Candidate in Marketing
University of Central Florida
College of Business Administration

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