# Multiple Levels of Ambidexterity in Managing the Innovation-Improvement Dilemma: Evidence from High Technology Organizations

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**Dedication**

This dissertation is dedicated to my parents,

A.U. Chandrasekaran and Jayalakshmi Chandrasekaran

# ABSTRACT

The goal of this dissertation is to understand how high technology organizations simultaneously innovate and improve to maintain a competitive advantage. Too much attention paid to innovation does not address the problems of today, while too much attention paid to improvement may not build a better tomorrow. Gaining a competitive advantage requires that organizations balance both innovation and improvement. Ambidexterity is one mechanism that allows organizations to achieve the proper balance of the two. However, theoretical knowledge on ambidexterity is relatively new. Toward this end, this dissertation develops a multilevel theory on organizational ambidexterity through three interrelated essays.

The first essay, "Multiple Levels of Ambidexterity in Managing the Innovation and Improvement Dilemma: Evidence from Case Studies," adopts a grounded theory building approach using a case study design to develop a multilevel theory on organizational ambidexterity. Data for this study is collected from four high technology divisions and involves over 198 respondents. Both qualitative (53 semi-structured interviews) and quantitative data are collected from multiple levels within each division. Case study analyses indicate three complementary solutions to balancing: *cognitive ambidexterity*, *contextual ambidexterity,* and *structural ambidexterity*. Cognitive ambidexterity, a dynamic capability at the strategic level, facilitates decisions on the right balance of innovation and improvement. Contextual ambidexterity helps align decisions between the strategic and the project levels through disciplined project

management, metric alignment, and roll-over of divisional plans. Finally structural ambidexterity helps facilitate simultaneous execution of innovation and improvement at the project level through distinct rewards, project team and leadership structures.

The second essay, “Antecedents to Organizational Ambidexterity - A Multilevel Investigation,” empirically tests the theories developed from the case studies. Data for this study is collected through an online survey conducted at 34 high technology divisions and involves 110 innovation and improvement projects. Informants from multiple levels within each division are used in the data collection process. Results from this research suggest that organizational processes such as *information analysis and methods*, *customer and market focus*, and *inter functional multilevel planning teams* (grouped as *scanning practices*) synthesize internal and external information and predict cognitive ambidexterity, the ability to resolve strategic contradiction between innovation and improvement. *Disciplined project management* and *scorecard approach* are approaches to connect innovation and improvement project level decisions with the division’s strategies and promote contextual ambidexterity. Both cognitive and contextual ambidexterity impact the division’s ability to simultaneously pursue innovation and improvement strategies.

The third essay, “Explaining Structural Ambidexterity in High Technology Organizations,” delineates structural ambidexterity into two different contexts: macro organizational contexts (e.g., organizational processes, organizational structures) and micro organizational contexts (e.g., team leadership, team incentives, project team structures). Using multilevel data collected from 34 high technology divisions and 110 innovation and improvement projects, this research examines the effects of macro and micro organizational contexts on innovation and improvement project performance. Results from this multilevel research suggest that improvement projects benefit from both organizational macro contexts and certain micro contexts (project team leadership and project team incentives). Innovation projects, on the other hand, mainly depend on micro contexts and are negatively affected by organizational macro contexts. Results from this research also introduce a third classification of projects – *hybrid projects* – which have both innovation and improvement goals embedded in them. Theoretical and practical implications from this research are discussed.

The dissertation concludes with a discussion of the key findings from each of the three essays. Limitations and directions for future research are also identified.

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# CHAPTER 1

# Introduction

## 1.1. Research Background

> *"To survive, organizations must execute in the present and adapt to the future. Few of them manage to do both well." – Eric D. Beinhocker (2006)*
>
> *"It is difficult but vital for managers to strike a balance between short and long terms." – Richard Dobbs, Keith Leslie, and Lenny Mendonca (2005)*

The competitive landscape of high technology industries has changed in many ways. Rapid technological changes, compression of product and process life cycles and a surge in competition have forced high technology organizations to focus on both long term and short term performances for competitive advantage (Beinhocker, 2006; Michelman, 2005; Dobbs et al., 2005; Davis, 2005). Short term performances in these environments are usually focused on competing in the existing market by *improving* product and process quality and operational performance, while long term performances are aimed at exploring future markets through *innovation* or exploration. Matson and Prusak (2003) note that many high tech companies are confronted with the challenge of reducing performance variability without negating the ability to innovate. Further, "To strike this balance successfully," writes Michelman, "leaders must bring to bear a new perspective on how growth efforts are situated in their companies, how they measure and reward executing the present and building the future, and how they align the behaviors to their specific growth initiatives" (2005, p.1). Too much focus on innovation does not address the problems of today, while too much focus on improvement may not build a better tomorrow. Hence, gaining a competitive advantage requires organizations to simultaneously innovate and improve[1]. In fact, in their 2002 book *Built to Last: Successful Habits of Visionary Companies*, Collins and Porras argue the importance of going beyond the "tyranny of OR" (innovation *or* improvement) to embrace the "Genius of the AND" (innovation *and* improvement) to survive in existing competition. However, the problem still prevails with many high technology organizations failing to achieve this balance in recent years (Devan et al., 2005).

On a similar note, there has, lately, been an increase in the number of academic researchers investigating mechanisms for companies to achieve this balance between innovation and improvement (Smith and Tushman, 2005; Naveh and Erez, 2004; Benner and Tushman, 2002; Jansen et al., 2006; Ahuja and Lampert, 2001; Gibson and Birkinshaw, 2004; Tushman and O'Reilly, 2004; He and Wong, 2004; Cole and Matsumiya, 2007; Sitkin et al., 1994; Levinthal and March, 1993). Creating an ambidextrous organization has been suggested as one approach to balance innovation and improvement (Gupta et al., 2006; O'Reilly and Tushman, 2008). That said, how organizations become ambidextrous or the antecedents to balancing have yet to be understood and require further investigation (Tushman et al., 2006; Jansen et al., 2006; Gibson and Birkinshaw, 2004).

## 1.2. Research Objectives

The purpose of this dissertation is to understand the concept of ambidexterity and how it permits organizations to simultaneously innovate and improve. To do so, it is

[1] Consistent with previous works, the terms "balancing innovation and improvement" and "simultaneous execution of innovation and improvement" are used interchangeably in this research (see He and Wong, 2004; Jansen et al., 2009).

important to acknowledge the concept of ambidexterity at multiple levels within an organization (Tushman et al., 2006). For instance, at the highest level, ambidexterity involves resolving strategic dilemmas among business unit managers deciding the right levels of innovation and improvement initiatives for their company. There are numerous examples in the business press of organizations such as Polaroid, Samsung and Motorola that have made incorrect strategic decisions on innovation and improvement, resulting in catastrophic failures (Cole and Matsumiya, 2007; O'Reilly and Tushman, 2008). Christensen and Raynor (2003) in their book, *The Innovator's Solution,* discuss the perils of just listening to the best customers and innovating while ignoring disruptive ideas that may not be innovative in the first place (e.g., Motorola, IBM and Sony). According to these authors, disruptive ideas could very well improve an existing capability, catering to a seemingly unprofitable segment but eventually evolving to take over the marketplace (Christensen and Raynor, 2003). Managing these dilemmas, then, requires organizations to overcome strategic contradictions that reside at the senior management level (Smith and Tushman, 2005).

At the project level, ambidexterity is a resource allocation issue between innovation and improvement projects that coexist within the same physical setting (Cole and Matsumiya, 2007; Carrillo and Gaimon, 2004). Researchers have proposed *structural separation* (O'Reilly and Tushman, 2004), physically separating innovation from improvement, or *temporal separation* (Victor et al., 2000; Tushman and Anderson, 1986; Duncan, 1976), performing innovation followed by improvement as solutions to manage this issue. Both structural and temporal separations may not work well in high technology organizations wherein product and process innovation frequently coexist with improvement activities (Cole and Matsumiya, 2007; Jayanthi and Sinha, 1998).

The inherent complexities in high technology operations have caused strategic management researchers and innovation and technology management researchers to address these issues separately. Recent research by Gibson and Birkinshaw (2004) introduces alignment and adaptability between these levels as another alternative to manage innovation and improvement. The focus of my dissertation is to expand on their views and explore the following research question:

> *How do high technology organizations simultaneously manage the innovation and improvement demands that are required for high performance?*

## 1.3. Research Design

To adequately answer this central query, I investigate various research questions formulated at multiple levels within an organization. I answer these questions by arranging my dissertation into three different essays.

### 1.3.1. Chapter 2 – Essay 1

Due to the lack of theoretical explanations bridging the strategic and project levels, I begin my dissertation with a grounded theory building procedure (Suddaby, 2006; Strauss and Corbin, 1998). I use a multiple case study design to develop a multilevel theory that can explain the organization's capability to simultaneously innovate and improve.

The first objective of this dissertation, addressed in Chapter 2, is to develop a multilevel theory on ambidexterity by bridging strategic and project level characteristics. To succeed in fast changing environments, I argue that organizations should address three distinct questions. The first is, *How do managers decide on the right balance of innovation and improvement opportunities that are required for high performance?* With this question addressed at the strategic level (Smith and Tushman, 2005), innovation and improvement activities are deployed as projects competing for similar resources within these divisions. So, the second question is, *What are the organizational mechanisms that enable alignment and adaptability of decisions across the strategic and project levels in the face of change?* And finally, *What are the structural mechanisms that permit the coexistence of innovation and improvement projects?*

The unit of analysis for this part of the study is the project-division dyad. Using a grounded theory building approach, eleven projects in four high technology divisions belonging to two organizations are examined. At the strategic and project levels, 53 interviews (20 interviews at the strategic level and 33 interviews at the project level) involving more than 200 participants are conducted. Other sources of data, such as board meeting reports, training documents, IP documentations, company videos, financial analysis reports, industry publications, and project reports are analyzed using a qualitative data analysis procedure.

Findings from this research indicate three complementary solutions to balancing: *cognitive ambidexterity*, *contextual ambidexterity*, and *structural ambidexterity*. Cognitive ambidexterity, a dynamic capability at the strategic level, facilitates choosing the right balance of innovation and improvement. Practices such as an emphasis on a continuous planning approach, the use of multilevel planning teams, information analysis, and customer and market focus provide cognitive ambidexterity.

Contextual ambidexterity is a meso level capability influenced by practices such as disciplined project management, metric alignment, and roll-over of divisional plans. Structural ambidexterity is a project level capability ensured through distinct rewards and project team and leadership structures. All three forms of ambidexterity are required for balancing.

### 1.3.2. Chapter 3 – Essay 2

In Chapter 3, I test the multilevel theory developed from Essay 1's case studies across several high technology divisions. Data for this research is collected using a web survey from 34 high technology divisions that involve 110 innovation and improvement projects. The survey data collection takes place between January 2008 and March 2009. The web survey is divided into three parts: Strategic Level, Project Leader, and Project Team Member. The survey design requires at least two respondents (e.g., Divisional Manager, R&D Director) to complete the strategic level part of the survey, while the project leaders and project team members complete their corresponding parts of the survey. At the strategic level, 64 respondents complete the survey on decision making regarding innovation and improvement opportunities (4 divisions had just one strategic level respondent). At the project level, 110 projects (58 innovation projects and 52 improvement projects) provide data with the project team leader and at least one project team member as informants (249 respondents).

All constructs used in this study are measured using multi-item scales. Reliability and validity (content, construct, and criterion) for all these constructs are also established in this study. Six hypotheses investigating the antecedents and the impact of cognitive, contextual, and structural ambidexterity on the division's ability to simultaneously execute innovation and improvement are tested in this paper. I use a path analysis using Ordinary Least Square (OLS) regression as well as a three stage least squares (3SLS) procedure to test these hypotheses. Before running the models, I check for issues due to aggregation through intraclass correlations (ICC1 and ICC2) (Klein and Koslowski, 2000; George, 1990). I also test for self-selection issues using the Heckman two stage model (Heckman, 1979), finding no major issues of endogeneity.

Findings from this study indicate the importance of cognitive and contextual ambidexterity for the ability to simultaneously execute innovation and improvement, which impacts the division's performance. Strategic level practices, namely, using IMP teams, customer and market focus, and data and information analysis (collectively studied as *scanning*), positively impact cognitive ambidexterity. Both disciplined project management and the use of a scorecard approach positively influence contextual ambidexterity (the ability to align and adapt to market and customer changes). Finally, the structural ambidexterity of maintaining distinct organizational processes, cultures and structures to innovate and improve is found to have no effect on simultaneous execution of innovation and improvement. The importance of these study results to theory and the practice of managing innovation and improvement are discussed.

### 1.3.3. Chapter 4 – Essay 3

Chapter 4 addresses the role of structural ambidexterity in the ability to simultaneously execute innovation and improvement projects (Hayes et al., 2004). In fact, structural ambidexterity can be broken down into organizational macro and micro contexts. For example, team rewards, team leadership, and project team structures collectively represent the organizational micro contexts that vary across the teams within a division or a firm and are influenced by the project teams (Zellmer-Bruhn and Gibson, 2006). Organizational processes, cultures, and structures that are invariant across the teams within a division or a firm constitute the macro context (Gladstein, 1984). Both organizational micro and macro contexts influence how innovation and improvement projects are managed.

Although ambidexterity researchers have argued about the importance of organizational and team level differences, there is a lack of research exploring the specific factors that might permit simultaneous deployment of innovation and improvement (Adler et al., 2009; Raisch and Birkinshaw, 2008; Jansen et al., 2009). To my knowledge, this research is the first attempt to empirically examine how coexisting innovation and improvement projects are managed. Drawing from the organizational learning and leadership theories, I investigate the effects of both the macro context (organizational level characteristics such as project reporting structures and organizational processes) and the micro context (project team leadership, project incentives, and project team structures) on innovation and improvement project performance.

Four hypotheses suggesting moderation by strength fit between the type of activity (innovation or improvement) and macro (structural differentiation) and micro contexts (project team incentives, project team leadership, and project team structures) on project performance are argued. Data for this study is collected as a part of the multilevel survey from 34 divisions involving 110 projects. The number of projects from each division varies from two (one innovation and one improvement) to nine (four improvement, five innovation projects). To overcome the potential problems associated with the single informant bias and common method bias, I separate the measurement of the independent and dependent variables and the moderators, and I collect data through multiple respondents. All constructs are measured using multi-item Likert scales. A random effects regression is used to analyze the multilevel model.

Results from this research suggest three implications. First, structural differentiation, separating innovation and improvement in high technology divisions, benefits improvement projects while hurting innovation projects. Second, improvement projects benefit from infrastructural characteristics such as leadership (transactional) and incentives (outcome), while innovation projects mainly depend on team decision making and project team structures. Third, high technology divisions have many overlapping areas between innovation and improvement opportunities (hybrid projects that have both innovation and improvement goals) that cannot be explained using existing structural differentiations and require refinement in existing theories. The theoretical and practical implications of these results are discussed.

## 1.4. Research Contributions

### 1.4.1. Chapter 5 – Summary and Future Research

I am a firm follower of engaged scholarship, the virtuous cycle of connecting theory to practice (Van de Ven, 2007). To apply the results of my dissertation research to practice, I incorporate the diamond model research philosophy of advancing knowledge for science and profession. This involves traversing the four research bases:

*problem formulation, theory building, research design,* and *problem solving and communication*.

Chapter 5, then, summarizes the major findings from this dissertation research in advancing academic and professional knowledge. For example, one major contribution of this work is to identify three kinds of ambidexterity that exist at multiple levels within organizations. In the past, researchers have treated ambidexterity as either a strategic level or a project level issue and have failed to arrive at an optimal solution. In this dissertation, I argue that three different ambidexterities contribute to simultaneous execution of innovation and improvement: resolving strategic contradiction among the senior management teams by mitigating the innovation-improvement decision risks (referred to as cognitive ambidexterity); ensuring alignment and adaptability between strategic and project levels (referred to as contextual ambidexterity); and ensuring distinct structural mechanisms at the project level when managing these projects (referred to as structural ambidexterity). In my dissertation, I conceptualize and measure all three forms of ambidexterity and identify the antecedents of each.

## 1.5. Research Overview, Dissemination and Future Work

Table 1-1 provides an overview of the dissertation structure and the research activities involved in each of these chapters.

**Table 1-1:** Dissertation Structure and Research Activities

| Dissertation Structure | | Research Activities |
|---|---|---|
| Chapter 1 | Introduction | Research overview |
| Chapter 2 | Multiple Levels of Ambidexterity in Managing the Innovation-Improvement Dilemma: Evidence from Case Studies | Multiple case studies at four high technology divisions. Both qualitative (53 interviews) and quantitative data |
| Chapter 3 | Antecedents to Organizational Ambidexterity - A Multilevel Investigation | Survey data from 34 divisions and 110 projects. |
| Chapter 4 | Explaining Structural Ambidexterity in High Technology Organizations | Survey data from 34 divisions and 110 projects |
| Chapter 5 | Conclusion | Overall results, limitations. feedback and future research issues |

Chapter 5 also discusses possible future research questions originating from this dissertation. Data for some of these research questions are collected as a part of the multilevel survey and case studies. In particular, I discuss two major extensions to the current research: first, at the project level, future work might study the organizational macro and micro contextual practices that facilitate tacit and explicit knowledge generated from the projects. Second, at the strategic level, research might arise that develops a contingency framework to the ambidexterity phenomenon.

The research conducted in this dissertation is only a beginning. While some important results regarding organizational ambidexterity have been uncovered, there is still a lot of research to do in this area to gain a thorough understanding of this capability. I hope to follow up this dissertation research with a series of research projects expanding beyond the current contingencies.

# CHAPTER 2

# Multiple Levels of Ambidexterity in Managing the Innovation-Improvement Dilemma: Evidence from Case Studies

*"In the beginning of this century, we faced a dilemma on whether to improve our existing technology X*[2] *or to go along the new frontiers of technology Y. Our customers wanted technology Y. We chose the former, our competition banked on the latter. Our competitors are extinct, and we are still in business" – CEO, Firm A*

*"In our electronics division, we faced a major dilemma on whether to stay along Technology W*[2] *or move toward the newer technology Z. We decided on the former and since then have lost a significant portion of our market share to our competitor." – Director of Product Development, Firm B*

## 2.1. Introduction

The competitive landscape of high technology industries has changed in many ways. Rapid technological changes, shorter product and process life cycles and a surge in competition has forced high technology organizations to focus on both short and long term performance to sustain a competitive advantage (Beinhocker, 2006). In this environment, short term performance focuses on competing in existing markets by improving product and process quality, while long term performance focuses on innovating new products and processes to explore future markets. Too much innovation does not address the problems of today, while too much improvement may not build a better tomorrow.

Sustaining a competitive advantage in high technology organizations requires balancing both innovation and improvement. In fact, Collins and Porras (2002), in *Built to Last: Successful Habits of Visionary Companies*, argue the importance of going

[2] Due to confidentiality reasons, we are unable to disclose the technology choices adopted in these divisions.

beyond the “Tyranny of OR” (innovation *or* improvement) to embrace the “Genius of the AND” (innovation *and* improvement) in order to sustain a competitive advantage. However, a quick snapshot of the business press provides numerous examples of organizations such as Polaroid, Samsung and Motorola that have struggled to simultaneously innovate and improve (Devan et al., 2005). Although the challenge of balancing innovation and improvement occurs in diverse contexts, its impact is acute in high technology organizations where firms face frequent changes in customer preferences, accelerated product and process lifecycles and increased competition (Bourgeois and Eisenhardt, 1988). As a result, this research seeks to understand balancing in high technology organizations.

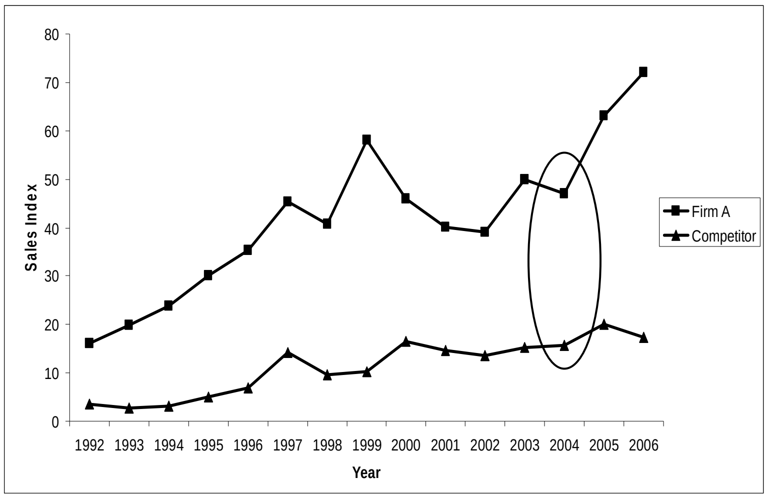
Ambidexterity is one approach to achieve this delicate balance. This research focuses on understanding the antecedents to the organizational ambidexterity (O’Reilly and Tushman, 2008; He and Wong, 2004). Several scholars have recently begun to investigate the impact of organizational ambidexterity on the ability to simultaneously innovate and improve (Jansen et al., 2009; Smith and Tushman, 2005; Benner and Tushman, 2002, 2003; Gibson and Birkinshaw, 2004; He and Wong, 2004). However, the antecedents to organizational ambidexterity have yet to be understood (O’Reilly and Tushman, 2008; Gibson and Birkinshaw, 2004). Understanding this problem requires investigating it at multiple levels within an organization. For instance, at the strategic level, the problem presents itself as a dilemma among senior managers who must decide on innovation and improvement opportunities (Smith and Tushman, 2005), while, at the project level, ambidexterity involves designing structural characteristics such as incentives, project team leadership, and team structures that allow innovation and improvement projects to occur in the same physical setting (Cole and Matsumiya, 2007; Carrillo and Gaimon, 2004). In addition, ambidexterity requires a connection between the strategic and project levels to ensure synchronization and alignment between these levels (Gibson and Birkinshaw, 2004).

This research proposes to develop a multilevel theory using grounded theory building (Glaser and Strauss, 1967) to provide a comprehensive understanding of an organization's ability to simultaneously innovate and improve. Although researchers have argued the importance of multilevel theories to explain organizational phenomena (Jansen et al., 2006; Hitt et al., 2007), there has been little research addressing organizational ambidexterity. To the best of our knowledge, our research is one of the first empirical investigations on this topic.

The quotes at the beginning of this section come from our case study of two high technology organizations (hereafter *Firm A* and *Firm B*). Just before the study, these organizations were the market leaders in their respective business segments and each was poised to make a strategic decision between improvement and innovation. Figures 2-1 and 2-2 illustrate these decision making instances and their impact on the market performance of each company. One failed (Firm B) and the other succeeded (Firm A) in the decision making process. This research investigates the antecedents to these decisions. In particular, we study the cognitive dilemma faced by senior managers when deciding on innovation and improvement and the organizational processes used to understand this dilemma. Managers of high technology organizations face this dilemma on a regular basis and, to maintain a competitive advantage, they must make the right decision between innovation and improvement. For example, in 2007 Olympus

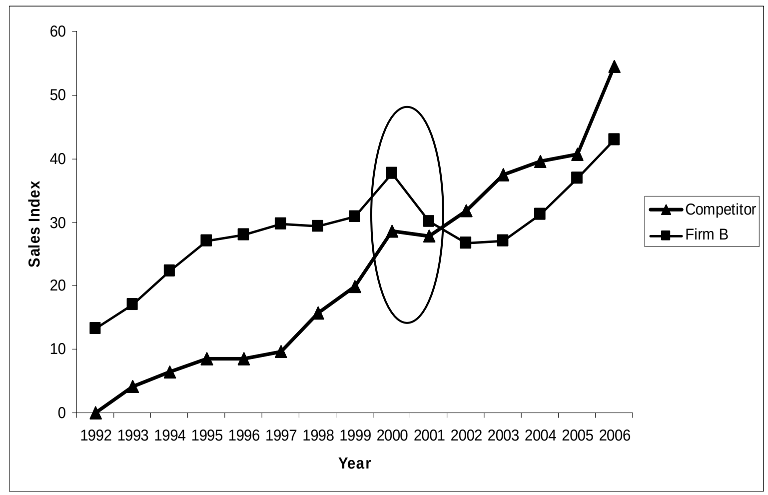
Incorporated introduced eight different versions of their Stylus Series digital cameras; of these, three were radical innovations and five were incremental improvements over the existing technology (www.dpreview.com). In the month of August alone, there were three different improvements (Stylus 790, 820 and 830) and one radical innovation (Stylus 1200). Operating in fast-paced environments require high technology organizations to maintain the right levels of innovation and improvement. How managers overcome the strategic paradox between innovation and improvement opportunities lacks a theoretical explanation and requires further examination (Smith and Tushman, 2005).

**Figure 2-1:** Market Share Change for Firm A




After 2002, Competitor was forced to move out of United States and merge with one of its customers in Southeast Asia.

**Figure 2-2:** Market Share Change for Firm B



To succeed in dynamic environments, high technology organizations need to address three distinct questions. *How do managers decide on the proper balance of innovation and improvement to sustain competitive advantage? What are the organizational mechanisms that permit alignment and adaptability of decisions across strategic and project levels?* and *What are the structural mechanisms that permit the coexistence of innovation and improvement projects?* The first question deals with the strategic level decisions, the second addresses how these decisions are implemented through projects, and the third applies to the execution of these projects.

Results from these case studies show that managers resolve the strategic contradiction between innovation and improvement using a decision risk framework. This can be referred to as *cognitive ambidexterity*. Then, *contextual ambidexterity* promotes alignment and adaptability between the strategic and project levels, and *structural ambidexterity* permits coexistence of innovation and improvement within the same physical setting. All three forms of ambidexterity complement each other to maintain an effective balance between innovation and improvement. This study proposes the concept of cognitive ambidexterity and presents empirical evidence for this capability. Further, it helps clarify the current debates on ambidexterity and provides empirical support for ambidexterity at multiple levels of the organization (Tushman et al., 2006).

This study defines innovation as “an idea, practice, or material artifact perceived to be new by the relevant unit of adoption” (Zaltman et al., 1973, p.10). More specifically, we focus on product or process innovations that are new to the unit of adoption - the division. In contrast, improvement is a systematic approach of ongoing change to existing product or process technology with the aim of enhancing performance (Boer et al., 2000; Zangill and Kantor, 1991). Balancing innovation and improvement can be viewed as an orthogonal process, where innovation and improvement are different dimensions of performance rather than polar extremes of a single dimension (He and Wong, 2004; Gupta et al., 2006). From this perspective, balancing innovation and improvement involves the simultaneous execution of innovation and improvement strategies through ambidextrous organizational designs.

## 2.2. Balancing Innovation and Improvement

Current research addressing the problem of balancing innovation and improvement falls into three streams: the learning myopia argument (Levinthal and March, 1993), the ambidexterity literature (Tushman and O'Reilly, 2004) and the dynamic capabilities literature (Teece et al., 1997). A short description and our intended contribution to these streams follow.

### 2.2.1. The Learning Myopia Argument

According to the learning myopia argument, once an organization accumulates sufficient experience in a particular capability, it is natural for it to become trapped in that capability and blinded to alternative opportunities (March, 2003; Gupta et al., 2006; Holmqvist, 2004). The organizational learning literature calls this the *competency trap*. High technology companies frequently fall into these traps by focusing on either too much innovation or improvement (Martin, 2004; Christensen and Raynor, 2004; He and Wong, 2004). Researchers looking at these organizational failures from a strategic decision making perspective have investigated the effects of: environment (Goll and

Rasheed, 1997; Judge and Miller, 1991; Eisenhardt, 1989b), decision speed and comprehensiveness (Talaulicar et al., 2005), and group diversity (Knight et al., 1999). Recently, researchers have begun to recognize that managerial cognitive frameworks can help organizations overcome these traps (Kaplan 2008a; Walsh, 1995; Amason, 1996; Lewis, 2000; Smith and Tushman, 2005). For example, Smith and Tushman (2005) argue that the solution to balancing depends on the senior manager's ability to resolve paradoxical contradictions between innovation and improvement opportunities. Empirical evidence from this case study supports this viewpoint and identifies specific tools and methods used by senior managers to overcome this strategic dilemma. We refer to this as *cognitive ambidexterity* capability.

### 2.2.2. The Ambidexterity Argument

Ambidextrous organizational design proposes one approach for organizations to simultaneously execute innovation and improvement strategies (Tushman and O'Reilly, 2004; Jansen et al., 2006). Nokia Corporation provides an illustration of an ambidextrous organization, as it offers a vast array of novel mobile technologies while also maintaining its dominance in the handset franchise market (Birkinshaw and Gibson, 2004). Alternative theories to explain ambidexterity include: structural ambidexterity, temporal ambidexterity, and contextual ambidexterity.

Structural ambidexterity involves the creation of different but loosely coupled organizational architectures within a company in the form of physical spaces, incentives, business models, metrics, or cultures (Burns and Stalker, 1961; Tushman and Anderson, 1986; O'Reilly and Tushman, 2004). In the past, structure often meant physical separation between innovation and improvement projects. For example, innovation occurs in the research and development units, while improvement takes place in the manufacturing units. However, structural separation becomes difficult in high technology organizations where innovation and improvement projects often coexist (Cole and Matsumiya, 2007). To the best of our knowledge, this case study is the first attempt to investigate the specific structural characteristics that allow organizations to successfully pursue both innovation and improvement concurrently (O'Reilly and Tushman, 2008).

Alternatively, temporal ambidexterity or the punctuated equilibrium argument, proposed by Duncan (1976), involves separation by time. In this situation, a unit focuses on only one set of tasks at any given time (Volberda, 1996; Victor et al., 2000), working on innovation projects first and improvement efforts later. In general, temporal ambidexterity assumes temporal separation between innovation and improvement activities (Utterback and Abernathy, 1975). However, absence of time lag between these activities in high technology environments makes temporal ambidexterity a suboptimal approach to balance innovation and improvement (O'Reilly and Tushman, 1997; Jayanthi and Sinha, 1998).

Contextual ambidexterity offers another form of the ambidexterity argument introduced in recent years (Gibson and Birkinshaw, 2004). It stresses alignment and adaptability across the organization to sustain superior performance. According to this argument, the ability of individuals, teams, or units to align and adapt across different levels naturally translates into a sustained competitive advantage. Recent research has investigated this capability at the individual level (Gibson and Birkinshaw, 2004). This study extends this argument to the project level, emphasizing the need for alignment between the strategic and project levels.

### 2.2.3 Dynamic Capabilities of an Organization

Managing innovation and improvement activities requires organizations to maneuver their capabilities, often referred to as dynamic capabilities (Winter, 2003; Teece et al., 1997). Researchers in the past have dealt with innovation and improvement capabilities in isolation. For example, Bhattacharya et al. (1998) and Shane and Ulrich (2004) review the research on innovation and the factors influencing innovation or new product development in high technology organizations, but do not consider improvement. On the other hand, Adler et al. (1999) and Victor et al. (2000) describe improvement capabilities and the factors influencing improvement capabilities in manufacturing but do not consider innovation. These works argue for tradeoffs between innovation and improvement (Argyris and Schon, 1978; Eisenhardt and Tabrizi, 1995; Hayes and Pisano, 1996). However, recent research shows that organizations are able to overcome these tradeoffs by maneuvering their structural and infrastructural characteristics (Lapre and Scudder, 2004; Hayes and Pisano, 1996; Ulrich and Eppinger, 2004). This facilitates balancing innovation and improvement. Findings from our own research supports this view and indicates that the ability to overcome these tradeoffs occurs at multiple levels of the organization (the strategic, project, and alignment levels, specifically). Collectively, these three levels help find the proper balance between innovation and improvement within a division.

## 2.3. Methods

### 2.3.1. Research Sites

The research setting in this study include four high technology divisions in two organizations, Firm A and Firm B. The research team spent two years studying these divisions. These divisions operate in environments that require high levels of product and process innovation to keep up with the frequent customer and industry changes. They also require high levels of product and process improvements to remain competitive. The divisions vary between medium to high industry clockspeed (Nadkarni and Narayanan, 2007; Stieglitz and Heine, 2007; Fine, 2000) and cater to different industry segments. They have little margin for error in strategic decision making, and any incorrect strategic choice between innovation and improvement could result in the failure of the entire business unit. Senior management spends considerable amounts of time making decision on innovation and improvement[3] and has few opportunities for hedging. Table 1 summarizes the research sites and data collected from these sites.

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[3] The PC Division, at the time, had around 35 competitors in the United States. Most of those competitors were driven out of the market due to incorrect decisions between innovation and improvement.

**Table 2-1:** Description of the Research Settings

| | Firm A | | Firm B | |
|---|---|---|---|---|
| **Industry** | PC Division (PC) | Medical Device | Electronics Manufacturer | Governmental and Network |
| **Research Setting** | Four plants within the United States | One plant within the United States | Corporate head quarters and pilot plants within the United States (Manufacturing outside US) | Corporate head quarters and pilot plants within the United States (Manufacturing outside US) |
| **Clockspeed** | High | Medium – High | High | Medium – High |
| **Size (No. of Employees)** | 6000 | 200 | 40000 | 10000 |
| **Age** | 40 years | 5 years | 80 years | 60 years |
| **Strategic Challenge** | Succeeded | New Unit | Failed | Learned from the Electronics division |
| **Primary customers** | OEM | Hospital and critical care units | General public | Governmental and educational institutions |
| **Strategic Level Informants (CEO, CTO, VP, DMs)** | 8 | 4 | 5 | 3 |
| **Number of Projects** | 5 | 1 | 3 | 2 |
| **Project Interviews** | 12 | 8 | 8 | 5 |
| **Method** | • Recorded interviews<br>• Annual Reports<br>• Review of company, division and project documents<br>• Training documents<br>• Banquet Videos | • Recorded interviews<br>• Annual Reports<br>• Review of company, division and project documents<br>• Training documents, and new product and process design procedures | • Recorded Interviews<br>• Annual Reports<br>• Supplementary books on product development approaches<br>• Portfolio Action Committee documents | • Recorded Interviews<br>• Annual Reports<br>• Supplementary books and procedures<br>• Portfolio Action Committee documents |

#### 2.3.1.1. Firm A

Firm A is a high technology company known for manufacturing precision electronic components. It has approximately six thousand employees and annual sales nearing a billion dollars. The R&D expenditure for Firm A accounts for fifteen percent of its sales. We studied two divisions within this company: the PC Division and the Medical Device division.

*PC Division*

In the PC division, Firm A leads the industry in the design and manufacturing of an electronic component used in computer storage devices. The division operates as a contract equipment manufacturer in this business segment, with the majority of their customers located in Southeast Asia. This group specializes in close-tolerance manufacturing that requires chemical, mechanical and electronic technologies. It leads the industry with 65% of market share and has four different facilities in the United States. Our research team visited three of these facilities.

Nearly a decade ago, the PC division confronted significant competition in the United States. At that time, the industry faced an important strategic technology decision between innovation and improvement. The PC division at Firm A made the right strategic decision, while their competition made the wrong decision. As a result, all competitors went out of business, merged, or relocated overseas. The PC division of Firm A still leads the market and is strategically located in the United States. In fact, as pointed out by the CEO of Firm A, this particular division shapes the very way in which its customers do business.

*Medical Device Division*

At the time of this study, Firm A introduced a non-invasive measurement device based on its proprietary medical metrology technology. The Medical Device division designed and developed this measurement device sold directly to the customers (critical care units and trauma centers). Product sales were in the hundreds of units during our site visits, but have increased exponentially since then. The design and manufacturing of this product takes place in one facility with sales focused in the European and American markets. Two hundred employees work for this division and that number continues to grow.

Both of the divisions at Firm A require high levels of innovation and improvement. In fact, the Chief Technology Officer (CTO) of Firm A notes, "We operate in an industry where one thing is certain: cost always goes down, while product and process requirements always change rapidly." Studying both divisions helps investigate balancing issues across different industry segments, sizes and clockspeed.

#### 2.3.1.2. Firm B

Firm B is a Fortune 500 company known for its global leadership in high technology manufacturing and specializing in embedded systems and integrated circuit design. It has three business units (electronic manufacturing, governmental network, and telecommunication), sixty thousand employees and sales exceeding forty billion dollars annually. The R&D expenditure accounts for twelve percent of its annual sales. We studied two of Firm B's business units (the Electronics and Governmental and Network divisions) both in fast-paced high technology markets.

*Electronics Division*

The Electronics division employs around forty thousand people and is the primary business for Firm B. This division leads the industry's communication and data management technologies. The division's design and pilot testing facilities are located within the United States, while its manufacturing is based in Mexico, South America, and Asia. Our research team visited its design and pilot testing facilities. The Electronics division remained the market leader until the late 1990s, when a strategic decision failure on a key innovation and improvement decision moved them out of the top spot. Studying this division helps understand the innovation versus improvement decision making characteristics that can result in failures.

*Governmental and Network Division*

Similar to Firm A, the Governmental and Network division at Firm B branched out of the Electronics division due to a technology competency. This division has over ten thousand employees and operates within the United States. It leads in the design and development of communication systems that are sold to governmental and public sector units. The division faced a similar strategic choice between innovation and improvement as the Electronics division, but succeeded in making the right decision by learning from the Electronics division's experience. Firm B remains the market leader in this industry segment.

### 2.3.2 Data Sources

This research investigates ambidexterity at different organizational levels: the strategic level, the project level, and the meso level, which connects the strategic and project levels. We conducted 53 interviews with over 200 participants across all 4 divisions. At Firm A, this involved 12 senior executives, including the Chief Executive Officer, Chief Technical Officer, Chief Quality Officer, Vice Presidents, Directors, and Divisional Managers making innovation and improvement decisions. We conducted 8 interviews at the strategic level, in Firm B, involving the Chief Quality Officer and four Senior Directors in charge of the innovation and improvement initiatives. All interviews lasted 1-2 hours and involved open-ended questions. Separate interviews with the personnel from planning and intellectual property (IP) departments helped our team understand the strategic initiatives in these divisions. Interviews involved multiple investigators, with one observing and the other leading the discussion. The researchers took notes during these interviews, using them for post interview discussions. We recorded and transcribed interviews for the qualitative data analysis. We included other sources of data (in the form of planning reports, training documents, IP documentations, company videos, financial analysis reports, industry publications and reports from board meetings) in our qualitative data analysis. Interviews took place between January 2007 and February 2008 and were based on a strategic level interview protocol (the protocol for all these interviews is available upon request).

**Table 2-2:** Description of Projects Studied

| Type of Project | Research Site | Project Name | Type of Activity | Time Span | Project Size | Outcome |
|---|---|---|---|---|---|---|
| Innovation | Firm A | Innov $A_1$. New process tech for manufacturing electronic components | Product/ Process Innovation | 2004-Present | 70 people | Delay |
| | | Innov $A_2$. Vision technology to eliminate manual inspection | Proprietary process Innovation | 1998-2005 | 20 people | Success |
| | | Innov $A_3$. A radically new product for health care systems | Product Innovation | 2005-2006 | 20 people | Delay |
| | Firm B | Innov $B_1$. Video sharing through digital signals | Product Innovation | 2004 – 2008 | 25 people | On-Course |
| | | Innov $B_2$. Development of a new way of communication | Product Innovation | 2006 – Present | 125 people | Success |
| | | Innov $B_3$. Development of a robust computer for usage in extreme conditions | Product Innovation / Process Innovation | 2006 – Present | 25 people | On-Course |
| Improvement | Firm A | Improv $A_1$. Improvement of 20% yield over 1.5 years | Product/ Process Improvement | 2005-2007 | 20 people | Success |
| | | Improv $A_2$. 30% reduction in direct labor | Product/ process Improvement | 2003 – Present | 30 people | Team Issues |
| | | Improv $A_3$. Focused customer improvement projects | Product Improvement | 2005-2007 | 12 people | Success |
| | Firm B | Improv $B_1$. Reducing the warranty costs on the new products catered | Product/ Process Improvement | 2005 – Present | 15 people | Delay |
| | | Improv $B_2$. Optimizing the third party systems in the supply chain | Process Improvement | 2005 – Present | 30 people | On-Time |

At the project level, this research investigates eleven projects across divisions of both firms, six from Firm A and five from Firm B. Of these, six projects (innovation) involved product and process changes perceived to be new to the adopting division, while five projects (improvement) involved refining existing products and processes within these divisions. Overall, we had 33 interviews with the project team members and project leaders. Senior management had top priorities for all these projects. Consistent with the grounded theory building approach, project sampling formed a part of data collection. We stopped sampling projects after attaining category saturation through 11 projects[4] (Suddaby, 2006; Strauss and Corbin, 1998). Table 2 illustrates the nature of these projects, completion times and the people involved in these projects. The sample consisted of 2 innovation and 3 improvement projects in the PC division (Innov $A_1$, Innov $A_2$, Improv $A_1$, Improv $A_2$ and Improv $A_3$) and 1 innovation project (Innov $A_3$) in the medical device division of Firm A. In Firm B, the sample consisted of 1 innovation and 1 improvement project from each the Electronics (Innov $B_1$, Improv $B_1$) and the Governmental and Network divisions (Innov $B_2$ and Improv $B_2$). We also included Innov $B_3$, a project that began as an improvement project and transformed into an innovation project in the Electronics division. We ensured that the projects varied in size, complexity and performance dimensions. For example, Innov $A_1$ (PC division) focused on introducing a radically new generation of product to the market. It had both product and process design changes and involved 70 members across 14 disciplines, while Innov $B_1$ (Electronics division) focused on introducing a new video sharing

[4] Sampling of projects was an ongoing part of data collection. We had access to other improvement and innovation projects but decided to stop with 11 projects when we found minimal information gained from sampling additional projects.

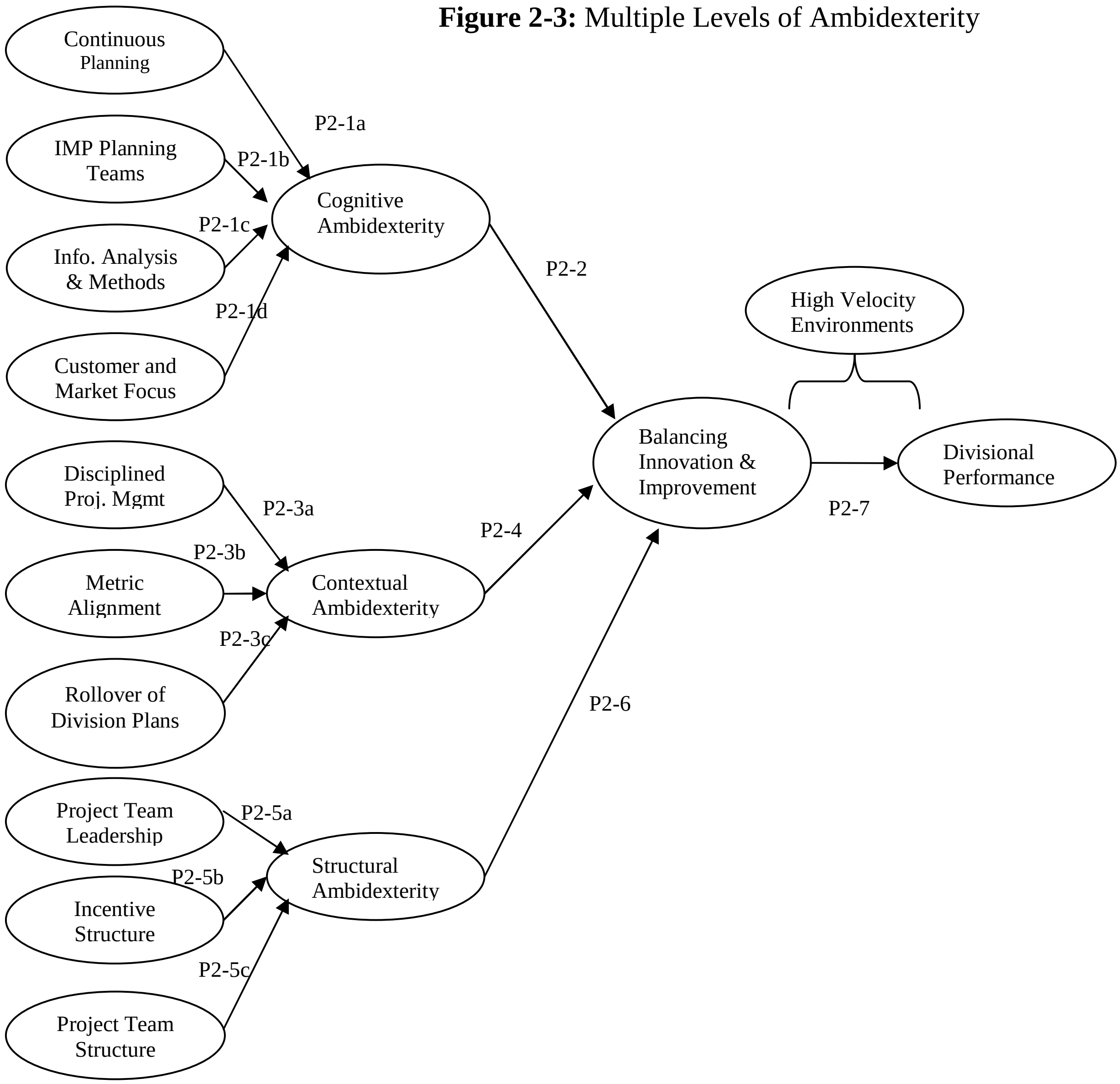
technology. This technology is based on the unspoken needs of the customer and had 25 people from 2 specific disciplines working on it. Both Innov $A_1$ and Improv $B_1$ had project completion time issues.

We had different interview protocols for the project leader and the project team members. Multiple team members during these interviews improved the reliability of their responses. Researchers took notes during these interviews and used them for post interview discussions. Similar to the strategic level interviews, we recorded and transcribed these interviews for the qualitative data analysis. Internal newsletters, project documents and power point presentations used during team meetings supplemented the project level interview data.

### 2.3.3. Analysis

A grounded theory building procedure was used to analyze the case evidence (Strauss and Corbin, 1998; Miles and Huberman, 1994). We followed the general guidelines of open coding, memoing and diagramming during the qualitative data analysis. All the researchers familiarized themselves with 800 pages of transcribed interviews and other related documents, including annual reports and business press articles. We used NVIVO 7 data analysis program to code the qualitative and quantitative data. The average inter-rater reliability (IRR) during coding was 0.915, in line with previous research (Morse, 1997). Consistent with the qualitative research, we performed a within-case analysis (within the firms) and followed it with a cross-case comparison.

**Figure 2-3:** Multiple Levels of Ambidexterity




Tables 2-3, 2-4 and 2-5 give the within- and cross-case comparisons. Figure 2-3 shows the emergent theory from the case study analysis.

**Table 2-3:** Strategic Level Cross-Case Comparisons

| **Divisions** | **PC Division** | **Medical Device** | **Electronics** | **Governmental and Network** |
|---|---|---|---|---|
| | **Successful Division** | **Early Stage Division** | **Failed Division** | **Successful (Learned from Electronics)** |
| **Continuous Planning Process** | **Hierarchy of Road Map Development Process** (Product, Process, Metrology, Service, Quality) | Practiced through a hierarchy of road maps | *Disconnect between strategic and operational plans (Created Failure)* | Marketing was a part of the planning process. It continuously monitored for market changes |
| **IMP Teams Used for the Planning Process** | **Planning teams from 14 discipline areas** (e.g., IC Production, precision cleaning, laser welding) | **Planning teams** comprised of surgeons, biostatisticians and engineers | *No use of IMP planning teams in late 90s led to failure* | Learned from the 1990s failure of the Electronics division (Incorporate IMP approach during strategic decision making) |
| **Information Analysis and Methods** | **Technology Forums** Heavy reliance on data driven decision making – Contributed to success when choosing between Tech X and Tech Y | **Trauma Advisory board** Heavy front end work before deciding on the clinical trials/ projects (grounded scientific theory) | **Portfolio Action Committee (PAC)**/ follows data driven decision making. *(Was not adopted in the late 90s)* | **PAC members rely** on method/ data driven decision |
| **Customer and Market Focus** | **Joint Planning Forums** with customers every 6 months (Helped their customers develop technology roadmaps) | **Territory Managers** at the trauma centers/ hospitals feed in information on weekly basis | ***Too much customer and market focus*** *led to the strategic failure of 90s (Still an issue)* | **Experiencing with the customers** (Tapping the spoken and unspoken customer needs) |

*Italics indicate failure characteristics*

## 2.4. Findings

### 2.4.1. Cognitive Ambidexterity – A Strategic Level Capability

Cross-case analysis indicate the importance of resolving the strategic paradox of deciding between innovation and improvement opportunities at the senior management level. The managerial cognition literature that views managers as "information workers" (McCall and Kaplan, 1985, p. 14) helps inform the case analysis. According to the managerial cognition literature, manager's roles involve absorbing, processing, interpreting and disseminating information about opportunities and problems, as well as learning from feedback while making decisions. This literature provides two complementary frameworks, *cognitive frames* and *cognitive process*, to resolving strategic contradictions (Walsh, 1995; Kaplan, 2008a). Cognitive frames provide knowledge structures that managers use to understand a phenomenon. According to Walsh (1995), they create a lens through which managers filter knowledge and direct their responses. In other words, cognitive frames help transform complex information from dynamic environments into manageable data. The case analyses indicate that mangers use *innovation-improvement decision risk* as a cognitive frame to evaluate the risks in deciding between innovation and improvement. The Chief Executive Officer (CEO) of Firm A made the following observation about the innovation-improvement decision risk:

> You know one of the key aspects to managing the right levels of innovation and improvement is to minimize the opportunity to make an incorrect decision. We have seen a few of our competitors wiped off the market just because of choosing one path over the other. At Firm A, we put a lot of effort to avoid such incorrect decision making.

Innovation-improvement decision risk can be defined as "the extent to which potentially significant and disappointing outcomes of decisions will be realized regarding an innovation or improvement opportunity" (Sitkin and Pablo, 1992, p.10). In the context of an innovation and improvement decision, the outcome can be a success trap, characterized by too much innovation compared to improvement; a failure trap, characterized by too much improvement compared to innovation (March, 1998) or a termination trap, characterized by the wrong choice in an innovation or improvement decision, leading to extinction. To avoid these traps, senior managers use multiple scanning routines (Weick and Roberts, 1993) to elicit the right type of information before making decisions. These routines function as cognitive processes to facilitate making the right decision (Lewis, 2000). For example, the Chief Quality Officer (CQO) of Firm A made the following comment about mitigating decision risk:

> I think what you got to do is that you have to make sure that you have assembled the right people that can give you the best information possible. You are going to have an exhaustive amount of analysis in order to really understand, Do I have the best information to justify a path whether it is innovation or improvement? Then I would say the other piece of it is what are the things that I have got to watch that I do not have enough information about? or what are the areas of risk in these innovation and improvements? What are my earliest indications? What is the new information that is coming out I did not know before that would alter my decisions? So when we talk about being right it is about being instantaneously right multiple times. Being able to follow the progression of being right is the approach adopted in our organization. It is more of the continuous feedback process.

High technology organizations require managers to mitigate these risks on a regular basis (Brown and Eisenhardt, 1997). Mitigating the innovation-improvement decision risk resolves ambiguities in innovation and improvement decisions and prevents organizations falling into success, failure, or termination traps. The ability to overcome this innovation-improvement decision risk depends on the cognitive ambidexterity capability of senior management. We define cognitive ambidexterity as *the ability of the managers to resolve the strategic contradiction between innovation and improvement that results in overcoming success, failure, and termination traps*. Managers gain this ability using both a cognitive frame (innovation-improvement decision risk) and the cognitive processes, and hence can resolve opposing views over innovation and improvement decisions (Smith and Tushman, 2005; Lewis, 2000). Cross-case comparisons illustrate four different processes that managers use to gain cognitive ambidexterity: continuous planning process, inter-functional multilevel planning (IMP) teams, information analysis and methods and customer and market focus. Table 2-3 shows the findings from cross-case analysis and their effect on cognitive ambidexterity.

#### 2.4.1.1. Continuous Planning Process – An IMP Approach

The case analysis finds that continuous planning provides a mechanism for senior managers to achieve cognitive ambidexterity. A continuous planning approach requires individual business units to continuously monitor technology and market changes and incorporate them into their decision making process. In contrast, strategic planning viewed as "a calendar driven ritual…which assumes that future is more like the present" (Hamel, 1996) leads to suboptimal results in unpredictable and dynamic environments (Schwab, 2007; Mankins and Steele, 2006; Brown and Eisenhardt, 1997). Grant (2003), in his study on the eight leading oil and gas majors, proposed a structured continuous planning approach for turbulent environments. The case analysis (see Table 3) concurs with Grant's (2003) findings on the importance of a continuous planning approach.

*Continuous Planning Forums at Firm A*

The PC division of Firm A has a planning manager dedicated to continuously monitor changes in product, process, measurement, service and supply chain technologies. This division develops technology roadmaps to understand the innovation-improvement decision risks. The development of roadmaps involves a hierarchical process starting with the product followed by process, metrology, quality and service roadmaps. When developing divisional plans, both divisions at Firm A adopt a bottom-up approach involving a multi-disciplinary planning team (Grant, 2003). They have minimal staff in their corporate planning departments (The PC division has just one full time employee while the medical device division has two employees.) They use an inter-functional multilevel planning (IMP) approach where multidisciplinary planning teams from various levels within the organization help identify the right information for assessing innovation-improvement decision risks. The IMP approach engages employees with diverse expertise from various levels of the organization. The divisional manager of Firm A's PC division notes the following about the IMP planning process:

> We have got PhDs in those areas and beyond [in our planning teams]. In case we do not have any representation we most often go and grab people which we even end up keeping with us. Because the breadth of what we do ranges from processes that are chip manufacturing, IC Production all the way to very precise fine assembly laser welding and precision cleaning and so on and so forth. So, we have huge breadth of complexity, we continually plan them in our on going plans and decide upon each of these issues. We have also got players in these plans that are part of a team. So it is not like a bunch of executives hanging around and making a decision. It is rather really a lot of people at various levels in the company feeding the key relevant factors under the table.

The IMP approach has several advantages when compared to the conventional planning approach. For example, Bates and Dillard (1993) found the IMP approach to be both internally and externally driven, and establishes a shared vision and common understanding across managers and executives. This approach also helps divisional managers comprehend the impact of the planning process on the long term goals of the division as well as its impact on the daily operations.

Cross-case analyses also indicate the importance of a continuous planning process in assessing the innovation-improvement decision risk. For example, the planning process in the PC division is done biannually while the division also continuously scans the environment for changes in the product, process, metrology, quality, and service technologies. It develops roadmaps on each of the attributes affecting the product and process development procedures. The continuous planning approach requires that the PC division's planning horizons are reduced from ten years to three years, with increase in emphasis on performance planning (i.e., mapping plans to operational and financial performance). Overall, senior managers in this division view the planning process as a continuous decision making process with their roles transformed from a "review and approve" role to a "debate and decide" role (Mankins and Steele, 2005).

The planning process in the medical device division follows a similar approach to that in the PC division. The product plans (e.g., launch dates for the measurement device) cascades into process plans, clinical trial plans, and the statistical analysis plans. During our site visits, the measurement device developed by this division went through several clinical trails to get FDA approval. Planning of the clinical trials and the statistical analysis were based on the overall product launch plans developed by the division. Cascading of these plans ensured high levels of coordination among individual entities and enabled faster response to changes (Brown and Eisenhardt, 1997).

*Planning Failure in Electronics Division*

In the past, the Electronics division at Firm B had a corporate planning structure without adequate representation from the division's technical units. The planning process involved a top-down, bureaucratic approach with the senior leadership driving decisions. During the late 1990s, the Electronics division came up with an innovative technology[5], Tech W, which senior management believed to be the future of communications technology. Although the division did not have the manufacturing capability to launch Tech W, escalating commitments from the senior management forced the division to launch this technology even after serious warnings from the development teams. Senior management made a commitment to Tech W based on early insights from North American consumers. However, their overseas development teams suggested Tech Z, which was based on a different communication technology. This technology, developed by the Electronics division was spreading at a faster rate in the European market. The process and product technology roadmaps clearly showed that Tech W was inferior to Tech Z. Failure to discuss and debate these technologies resulted in significant losses in the North American market share for this division. Figure 1b shows the division's market share before and after this decision. The division lost both market share and competitive advantage. A member of the development team made the following remarks on the planning approach when asked about the planning process:

> Quite frankly we did a very poor job of planning during the last three years because look where we're at right now. Previous senior leadership team just didn't put much credence in a formal planning process. They wanted to, more or less, do it themselves and so we're kind of in a retooling mode here. We're definitely doing it because well the person on my team that's an expert in this phase, is consulting, if you will, to the group that is developing the portfolio process for XYZ so we are going to inject some of these best practices and tools right from the get-go.

[5] We mask the details behind these technologies due to confidentiality reasons. Both Tech X—Tech Y (PC Division) and Tech W—Tech Z (Electronics Division) are choices with minimum overlap in their design architectures. An example of this would be flash drive and disk drive technologies

Evidence from the cross-case comparisons suggest that emphasizing continuous planning and the use of IMP planning teams promote cognitive ambidexterity capability (senior management's ability to assess and mitigate risks involved in an innovation-improvement decision). Failure to use an IMP approach proved catastrophic for the Electronics division at Firm B, while the PC division's decision to stay with existing technology can be attributed to the IMP team approach. The case analysis suggests the following propositions.

*Proposition 2-1a: The greater the division's emphasis on continuous planning, the higher the cognitive ambidexterity of its senior managers (i.e., the ability to resolve strategic contradiction between innovation and improvement).*

*Proposition 2-1b: The greater the division's emphasis on an IMP team approach, the higher the cognitive ambidexterity of its senior managers (i.e., the ability to resolve strategic contradiction between innovation and improvement).*

#### 2.4.1.2. Information Analysis and Methods

Cross-case analysis reveals that senior managers rely heavily on several forms of information analysis and methods to make decisions on innovation and improvement.

*When in doubt, trust the data: PC Division*

Several years ago the PC division at Firm A had to make a strategic choice between improving the existing technology (Tech X) and developing a new technology (Tech Y). These fundamentally different technologies required distinct resources, processes and knowledge. Hence, the possibility of hedging was minimal. The division faced pressure from its competition and customers to develop Tech Y. However, the PC division stayed with the existing technology as a result of data driven decision making.

The PC division had the highest level of expertise in metrology science, which clearly indicated the infeasibility of Tech Y. Making this decision involved using several data analysis methods such as the root cause diagnosis and fault tree analysis. The PC division also had technology forums headed by their Chief Technology Officer that analyzed the alternatives (Tech X and Tech Y). The technology forums factored in customer's technical changes over the next three years in their analysis. Results from the analyses indicated that the newer technology choice (Tech Y) could not provide the level of reliability and cost that the customers would require in three years. During a technology forum, the PC division used a process technology map that identified a refinement of the existing technology Tech X that would be able to meet future reliability and cost demands. In contrast, their competitors chose to innovate, moving to Tech Y and were ultimately driven out of business. Figure 2-1 shows the impact of this decision on the market share. Competitor 1 banked on Tech Y and lost a significant portion of its market share. This competitor moved out of the United States and eventually got acquired by its customer. When asked about this particular decision, the divisional manager of the Electronics division at Firm A noted:

> We put so much value on getting our fundamentals right so that our strategies becomes simple enough that we get it right most of the time. We drill so hard, we have forums like a technology forum headed by our CTO, where we are constantly drilling with what is happening with variation, how does that get translated into requirements for assembly. We have another one on resonance, another one on electrical performance and data rates. We just drill, drill and drill. We do not separate technology from marketing, it is all interconnected. Then we force, given that what is that tells us about where we should concentrate our energy levels…The early feasibility work is not necessarily that expensive. So we have all these things that lead us to best economic alternative to get to our technical requirements. These are all pretty cheap; we can put a couple of engineers to figure out all decisions. So we have already mitigated our strategic decision risks sorting things out early because we are fundamentally grounded on scientific concepts.

*Trauma Advisory Board: Medical Device division*

The medical device division in Firm A has a trauma advisory board comprised of seven trauma surgeons, a biostatistician, an anesthesiologist, and three technical engineers. The trauma advisory board utilizes variety of methods to aid decision making on innovation and improvement opportunities. For example, the decision to develop this new measurement device (Innov $A_3$) considered several factors including the propriety process technology, current manufacturing capabilities, and market and competitor evaluations. This also gave them accurate information about the variables that influences the clinical study design for Innov $A_3$ (the enrollment process of the patients, the location of these trials sites, arrival times of trauma patients, etc.). This exhaustive information analysis done by the trauma advisory board contributed to success of Innov $A_3$.

*Portfolio Action Committee at Firm B*

Both the Electronics and Governmental and Network divisions have Portfolio Action Committees (PAC) that consists of a team of managers involved in strategic decision making. This committee came into existence after the strategic decision failure in the late 1990s. The PAC employs a multilevel team structure, to assess risks by collecting extensive information. They also use rigorous computer simulation methods to identify high risk areas. One member of the PAC remarked,

> Making a decision on an innovation or improvement opportunity in this organization is viewed as moving a needle and we look at some of the leading indicators that allow you to realize whether you are moving the needle in the right direction. Then you drill down and say what do I need to do to drive the needle on that leading indicator, “What are my ‘X’s’? We are very big in drilling down to the final Xs. There is not a lot of forgiveness in our company for making decisions without hard core data.

When asked about the most critical factor used while assessing innovation-improvement decision risk, nineteen senior level executives (19/20 = 95 percent) in all divisions reported that they relied on rigorous Information Analysis and Methods as the primary way to resolve strategic contradiction.

*Proposition 2-1c: The greater the division's emphasis on Information Analysis and Methods, the higher the cognitive ambidexterity of its senior managers (i.e., the ability to resolve strategic contradiction between innovation and improvement).*

#### 2.4.1.3. Customer and Market Focus

*Customer Technology Forums – PC Division*

The PC division maintains real time information about customer and market changes. Understanding the customer's spoken and unspoken needs can create opportunities to improve or radically change existing products (Creveling, 2007). Although all of PC Division's customers are located in Southeast Asia, they maintain close working relationships with them by participating in their technology forums. A full-time staff member from the planning department participates in joint-planning sessions hosted by the customer to understand the changes in the market and technology requirements. This information helps tune the division's strategic intent. The PC division also educates its customers on its propriety roadmap development processes. The Vice President of the PC division made the following comment about the customer relationships:

> We work with our customers to understand their requirements a lot more than what we did, say 12 years ago. We have a lot of joint planning forums with our customers to understand their requirements. After several of these joint planning forums and after repeatedly asking the questions and talking about the risks and why it is important and so forth literally, our customers have started to develop roadmaps on all these initiatives. And so in terms of organization we now have technological roadmaps, technologically forums with our customers and in most cases twice a year.

*Multisite Trauma Study – Medical Device*

The measurement device developed by the medical device division was pilot tested in seven trauma centers across the United States and Europe. The division had territory managers (representatives) located at each of the trauma centers or critical care units, and they maintained close working relationship with the nurses and surgeons. Territory managers were trained in a variety of skill sets (physiology of oxygen transport, biostatistics, etc.) and worked very closely with their customers (nurses in the trauma centers). As described by one of the territory managers, they became "shadows" of these nurses, following them and interacting with them during non-work hours through lunches and other discussions. Information gained from these interactions was communicated on a weekly basis back to the medical device division to help improve the product design. The territory managers also held weekly online meetings to share insights and feedback from their respective centers. The decision to pursue this measurement device technology, in fact, came through interactions between the territory managers and the trauma surgeons from a previous clinical study testing another medical device product.

*Firefighting with the Governmental and Network group*

Both divisions at Firm B use techniques such as Quality Function Deployment (QFD) (Akao, 2004), competitive benchmarking, reverse engineering of competitors' products, and scanning for new patents to decide on innovation and improvement opportunities. In addition to these tools, the Governmental and Network division use techniques such as Kano Analysis (Kano, 1984) to identify unspoken customer needs. In fact, Innov B$_{2}$ (one of the projects studied in this division) emerged from identifying an unspoken need for video sharing required by the firefighters in rescue operations. Three representatives from this division had firefighting training, and they worked closely with firefighters to understand their technological requirements. The division's representatives traveled with the crews during firefighting missions and observed their customers in close proximity. This resulted in Innov $B_2$, a new process technology used to transmit signals and videos to fire stations, hospitals, and emergency service stations with real time information from the scene. The product development director in this division described the importance of customer focus:

> You know, you will sit it in front of the customer and they haven't had these thoughts, they are not going to tell you about, I have to have Mpeg- 4 compression, and I need to run one of those networks supporting 5-kilogbytes per second. (i.e., What do they need? What do they need it to do? How do you do it? Well what is getting in the way of you doing that today? What are you frustrated with?) So it is really our job to find what their exact needs are. And this gives us a clear picture whether to innovate or improve.

Identifying the spoken and unspoken customer needs provides a firm with the ability to overcome strategic contradictions when deciding whether to innovate or improve. Eighteen of the twenty senior executives (90 percent) across these divisions echoed the importance of customer and market focus to resolve strategic contradictions between innovation and improvement.

> *Proposition 2-1d: The greater the division's emphasis on customer and market focus, the higher the cognitive ambidexterity of its senior managers (i.e., the ability to resolve strategic contradiction between innovation and improvement).*

All these practices collectively resolve the strategic contradiction between innovation and improvement and promote cognitive ambidexterity among the senior managers. High technology organizations, in particular, benefit from cognitive ambidexterity since they frequently make decisions between innovation and improvement opportunities. Organizations with cognitively ambidextrous managers use organizational processes such as planning forums, technology forums, and customer and market focus forums to achieve a competitive advantage (Leonard-Barton, 1992). Cognitive ambidexterity can be viewed as a dynamic capability (Eisenhardt and Martin, 2000; Teece et al., 1997). Dynamic capabilities are high level processes that provide sustainable competitive advantage to organizations in the long run by maneuvering organizational capabilities (Winter, 2003). The case analysis finds that cognitive ambidexterity enables senior managers to consistently make the right decision between innovation and improvement opportunities, or reduce the risk of making the wrong decision. That is, cognitive ambidexterity helps senior managers more effectively maneuver between improvement and innovation opportunities. Cognitive ambidexterity helped the PC division make successful strategic improvement-innovation decisions, but the lack of this capability in the Electronics division resulted in a strategic decision failure.

> *Proposition 2-2: The higher the level of cognitive ambidexterity among senior managers, the greater the division's ability to balance innovation and improvement.*

### 2.4.2. Contextual Ambidexterity – A Meso Level Capability

Although decisions about innovation and improvement take place at the strategic level, they are administered as projects. As a result, it is essential to connect decisions across these levels to ensure that the organization has the ability to align and adapt to market changes. That is, strategy and execution need to be connected. The second part of Figure 2-3 shows the mechanisms incorporated by these divisions to align and adapt decisions across the strategic and project levels. Researchers have argued the importance of alignment and adaptability across business units to achieve a sustainable competitive advantage (Im and Rai, 2008; Bardhan et al., 2007; Jansen et al., 2006). Contextual ambidexterity helps organizations align and adapt decisions across levels (Gibson and Birkinshaw, 2004). Scholars have studied contextual ambidexterity at the individual level, but this study extends it to the project level (Gibson and Birkinshaw, 2004). Cross-case analysis (see Table 2-4) finds three distinct mechanisms used to align and adapt project level decisions with the strategic decisions: Disciplined project management approach (Ghoshal and Bartlett, 1994), Metric Alignment, and Rollover of Divisional Plans.

**Table 2-4:** Contextual Ambidexterity: Cross-case Comparisons of Projects

| | **Innov $A_1$** | **Innov $A_2$** | **Innov $A_3$** | **Innov $B_1$** | **Innov $B_2$** | **Innov $B_3$** | **Imp $A_1$** | **Improv $A_2$** | **Improv $A_3$** | **Improv $B_1$** | **Improv $B_2$** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Disciplined Project Approach** | Monthly reviews with market direction teams – Individuals knew their role in the teams | Establishing routine communication with the executive levels | *Delay in setting explicit work standard due to project novelty* | Existing business structure aiding alignment | Interim reviews by the project leader and the divisional manager kept the project on course | Go in front of PAC (Portfolio Action Committee) regularly | Establishment of a system to track project changes (even if it were to be small and make them visible to higher levels) | *S&OP was placed later. Initially there was freedom to do anything.* | Weekly meetings with project team members from all four plants | The gaps are clearly identified. Project goals are based on these established goals | Initial time spent on optimizing internal processes before beginning this work |
| **Metric Alignment** | *Product Process Development (PPD) sets clear expectation– Was not featured in the beginning causing delays* | PPD has scorecards that act as check points to the managers | Medical PPD to connect the strategic and project levels | Team penalized if the project requirements misaligned with divisional requirements | The "M" gate process helps connecting project objectives and goals | Different people own different pieces of the projects, it all comes together in the "M gate" process | Initial use of PPD to connect with the corporate objectives | --- | --- | Tool Scorecard, Task Scorecard, Project Scorecard and Overall Divisional Scorecard are connected. | Scorecard planning where the individual project goals are based on the overall divisional level scorecards |
| **Roll-over of the divisional Planning Process** | Projects are connected with the division's sales, marketing and production plans. Ensures Alignment | Long range planning rolls into the project planning process | Spending a lot of time upfront understanding the connection between the project goals and the overall corporate goals | --- | Greater business plan for the project is based on the overall divisional plan | --- | The goals and priorities of the projects gets re-evaluated every quarter | *Disconnect from the divisional plans caused friction* | Planning Process – Tool to align strategy with the operational tactics The tool used to align the strategy with the tactics is the planning process. | Development of a goal statement for each module of the project. Statement based on the overall divisional goal | --- |

*Italics indicate failure characteristics; Blanks indicate no particular evidence found in this cell*

#### 2.4.2.1. Disciplined Project Management

A disciplined project management approach establishes connection between strategic level decisions and project level decisions (for both innovation and improvement projects). Characteristics of the disciplined project management approach include: establishment and acceptance of clear performance standards, fast feedback cycles (due to constant reviews by the strategic leaders), and the involvement of strategic leadership in the project level decision making processes (Ghoshal and Bartlett, 1994).

All six projects investigated at Firm A have well established performance standards designed by senior management. As explained by the project manager of Innov $A_{1}$:

> The management sets clear expectations in times, expectations in meeting results and milestones for each of these projects. These projects are reported on a weekly basis and monitored very closely as far as how are they doing in either spending money or how are they doing with results, are they in track for hitting milestones and are they off on anything?
>
> We have a monthly review, with what we call the market direction team, a group of senior managers, directors, VPs and all the way up to our CEO. And, we put all our information together, process, equipment, manufacturing, long range manufacturing plans which are presented to them. We also have weekly meetings that are open to senior management, probably one or two show up every time. They go over the individual process steps or individual project with each engineer and typically go over concerns and questions on that.

The strategic level in both the divisions at Firm A has representatives assigned to monitor these projects. The representatives give frequent updates about the project's progress, and feedback on project outcomes to senior management executives. Additionally, senior management occasionally attends these weekly project team meetings. As described by the Chief Quality Officer (CQO) of Firm A:

> I would say it is pretty typical even at the executive level if you got some of the strategic initiatives either improvement or innovation. We would not be hesitant to have weekly meetings or more than that. So I would say that there is a quite a bit of involvement at least in the management led innovation or improvement.

To illustrate the Disciplined Project Management approach, consider Innov $A_3$ (a product innovation project) from the medical device division at Firm A. During the early stages of this project, there were extensive time delays in meeting the project requirement reviews. The medical device division borrowed its project management procedures from the PC division. However, there were several differences in the work culture between these divisions. For example, medical device division sold its products directly to the customers while the PC division functioned as a contract manufacturer. Customer requirements regarding the measurement device (Innov $A_3$) changed frequently, but were not tracked in the project requirement reviews. Also, the medical device division had clinical guidelines and regulatory procedures that were not tracked in these reviews. Innov $A_3$, hence suffered from extensive time delays, lack of support from the senior management and created tension between the engineering and the marketing group. This changed after the introduction of the medical device's own project management approach accommodating for the clinical regulations and customer and market requirements in its review process. As explained by the project leader of the Innov $A_3$ project:

> We have the PPD [Product Process Development] approach for our medical device division and its less refined when compared to the PC division, because again, on the PC side there are 20 active projects, so its going through and the process is exercised a lot and you will work out the bugs and so forth. On the medical side, we've had maybe 2 and so, but we manage through the same process and so we use the same methodology, project management style. There are several differences between the PC and medical device and it's really getting interesting. We faced delays in meeting deadlines and requirements in the beginning but have improved significantly over the past one year.

Both the divisions at Firm B have a higher level entity called the Project Leadership Team (PLT) for every innovation or improvement project. The PLT consists of organizational-wide representation at the senior management level. It meets with the individual project leaders once every two weeks to get updates about the technical aspects of the project. The information from these projects then gets presented to the executive review board in charge of assessing the overall risk of the portfolio of innovation and improvement projects. As reported by one of the project managers from Improv $B_{1}$:

> Once every 2 weeks there's a formal presentation with CPM [Critical Path Method] and DFSS [Design for Six Sigma] status, you don't need to wait for a meeting to communicate with rest of PLT, but that's the formal process…Our management has also established a standard review process which ensures that our queries are heard and addressed.

The evidence from the cross-case analysis suggests the following proposition.

> *Proposition 2-3a: The greater the division's emphasis on a disciplined project management approach, the higher its contextual ambidexterity.*

#### 2.4.2.2. Metric Alignment through Scorecard Approach

The divisions use a hierarchy of scorecards to connect decisions across the strategic and project levels (Kaplan and Norton, 2008 & 2004). A scorecard approach provides a general framework for linking a variety of project level metrics to the overall divisional metrics (Ittner and Larcker, 2003). Adapting a scorecard approach by identifying a limited number of key performance metrics at the divisional level facilitate decision making at the managerial level and ensures alignment with the project levels (Bendoly et al., 2007). Organizations have used balanced scorecards to link a variety of lower level operational measures with the strategic level measures (Kaplan and Norton, 2002). In recent years, organizations have begun to use this framework to align the strategic objectives with operational excellence, customer intimacy and product leadership (Ittner et al., 2003). Evidence from cross-case comparisons suggests that all four divisions studied use a comparable framework to connect project level measures with the overall divisional goals. The overall project performance for each of these projects is tracked with divisional measures on innovative performance, portfolio risk structures, quality defect rates and overall cost savings. When asked about this alignment process, the Chief Quality Officer (CQO) at Firm B said:

> I call it Performance Excellence because terms like Baldrige, Balance Scorecard (BSC) are specific to the United States and the scorecard approach as a technique for alignment is usually world wide and goes beyond the Baldrige and BSC. I am familiar with that because I am fortunate to have been a key participant when one of the businesses had won the National Quality Award. Our alignment process uses a scorecard approach that balances across strategy and tactics. Strategy includes results, risks and capabilities at the highest level and then drops down into a hierarchy of other scorecards for the individual processes.

The divisions at Firm B uses four different types of scorecards, beginning with a tool scorecard to measure the methods and tools adopted during a particular project. This scorecard is completed by the team members and cascades into the task scorecard used by the project team leaders. The task scorecard pools resources used by the team members and evaluates the risks involved in each of the individual project tasks. This information is fed into the PLTs' functional review scorecard, which measures how the individual projects contribute to meeting divisional requirements on innovative performance, portfolio risk goals, quality and cost. Finally, the information provided by the functional review scorecards feeds in to the division's summary scorecard prepared by the divisional managers. This scorecard measures the overall contribution of the innovation and improvement projects to the division's growth and profitability metrics. Both innovation and improvement projects use a similar scorecard approach that have different weights for each project level goal (e.g., improvement projects have higher weights on the quality and cost components, while innovation projects have higher weights on the risk structures and innovation measures). As mentioned by one of the project team members of Improv $B_{-2}$:

> From our Quality management perspective, our business does their annual [review], what we call scorecard planning and that's studying the corporate goals at the corporate level as well as at the individual business levels. Based on what those scorecard objectives and goals are on the overall quality and cost savings, the executive management team will then determine where they want focus for improvement. In the last couple of years, third party products and processes have been included on those business level scorecards.
>
> So for our business, its on our scorecard to improve third party processes and so what the organization then did is they looked at the various processes for third parties and identified where the greatest opportunity was for improvement. Now that target was often determined, or they would make decisions on where to focus their efforts based on cost per quality, based on loss of revenue, where can we improve our growth margin, things of that nature. The executive management really tries to help direct where they want to see their improvements and then from there, Black Belts are identified and teams are structured and formed and then the projects move forward.

Firm A also adopts a similar approach, using an internal scorecard to connect the technical and business goals of the division with the individual projects. Innov $A_1$, a project in the PC division, involves seventy project team members and has experts from fourteen technical areas (e.g., photo etching, laser welding, and fabrication). Because of the size and complexity of Innov $A_1$, the team had difficulties in the early stages with developing a hierarchy of scorecards to measure the overall project progress. It took seven months for the management teams to develop a scorecard that incorporated measures from all fourteen technical areas. This caused extensive delays. Currently, Innov $A_1$ uses a scorecard through a database that is built by the individual project leaders. The overall project leader compiles these reports and uses them for interim technical and business reviews.

This scorecard alignment process also serves as a tool for communicating requirements (bottom-up) to the higher levels of management. Although some of these approaches have been discussed in the project management literature for R&D projects (Kavadias and Loch, 2007; Cooper, 2003), evidence from this research indicates the use of scorecard to align strategic level and project level decisions across both innovation and improvement projects.

*Proposition 2-3b: The greater the division's emphasis on a scorecard approach to align the project level metrics with the divisional metrics, the higher is its contextual ambidexterity.*

#### 2.4.2.3. Rollover of the Divisional Planning Process

Both divisions at Firm A ensure the visibility of their divisional plans to every employee in their respective divisions. The divisions make employees aware of their short term (one year) and long term (three year) goals in the area of product, process, service, quality, and metrology. Everyone in the division has access to the roadmaps in these areas (product, process, service, and metrology). These planning roadmaps help the divisional managers identify areas to focus their resources. At Firm A, regardless of the nature of the project, a project exceeding 40 labor hours requires a project plan with approval from senior management. This plan has to clearly specify the outcomes of the project and has to be connected to the overall divisional goals to get approval. This mechanism ensures alignment of goals and objectives across the strategic and project levels. One of the project leaders of Innov $A_{-2}$. said in an interview:

> We are like again, it's that part about our culture is that if a project is much over, actually the guidelines that our CEO puts down, if you have an activity that is over forty hours, you should write a project plan for it. And so, that project plan might be a simple one page that says here is my objective, here is what I'm going to do and here is when I'm going to deliver, it could be half a page long, but it lays out what you're going to do. And this has to be approved by my supervisor.

The division revisits plans once every quarter, and reevaluates activities, budgets and other resource allocation priorities at this time. The Sales and Operational Plan (SOP) uses these divisional plans, to synchronize objectives within the division. The rolling over of divisional plans serves as both a "top-down" and "bottom-up" connecting mechanisms that provides the ability to react to changes.

*Proposition 2-3c: The greater the division's emphasis on rolling over of divisional plans, the higher is its contextual ambidexterity.*

The contextual ambidexterity of the division helps align and improve the operational efficiencies that facilitate managing divisional objectives. It also provides the capability to adapt and respond to market changes. Higher levels of contextual ambidexterity influences the division's ability to balance the right levels of innovation and improvement activities (Im and Rai, 2008; Gibson and Birkinshaw, 2004).

*Proposition 2-4: The higher the level of contextual ambidexterity, the greater is the division's ability to balance innovation and improvement.*

**Table 2-5:** Structural Ambidexterity: Cross-Case Comparisons of Projects

| | Innov $A_1$ | Innov $A_2$ | Innov $A_3$ | Innov $B_1$ | Innov $B_2$ | Innov $B_3$* | Improv $A_1$ | Improv $A_2$ | Improv $A_3$ | Improv $B_1$ | Improv $B_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Project Leadership Style** | Dual roles for the leader (Pusher at times & provide autonomy to come up with newer ideas at times) | Ensuring that team members are not carried with the experimental results (Limiting their out of box thinking) | Transactional during study enrollment times, Transformational providing guidance and direction during clinical trials | PLT (More than one leader; Setting and evaluating though milestones and targets) – Ensuring appropriate context for innovation | Dual Leaders (One ensuring the schedule is met and the other ensuring the technical quality is met) | Train the team members and suppliers in the DFSS activity and speed up the development process | Coordinating and ensuring that the goals and tasks are identified | Assigning individual project team member goals and meeting every Friday with the project teams | Coaching and task assignment on a regular basis | Set direction, clarify objectives and deliverables from the process | Set direction, clarify objectives and deliverables from the process |
| **Incentive Structure** | Innovation banquets rewards and training dollars for patents and trade secrets. Other rewards tied to the process and not the outcomes. | Banquets (Large rewards) – coupled with intrinsic satisfaction | Research publications at the end of the study recognized. Project team rewarded as they complete different phases of clinical PPD | "X-awards" for Intellectual Properties (worth up to couple of thousands of dollars) | Rewards through patent submission (Other rewards: for completing different stage gates) | Rewards based on number of disclosures (Up to thousands of dollars) | Juran Awards (Less monetary gains, more of prestige) based on project outcomes | No formal recognition (Pat in the back) | Thermos with recognitions imbibed on them upon project completion | I get a pay check! (None to very small rewards at the end) | Bravo Awards (small scale incentives) based on the cost and quality savings at the end of the project |
| **Project Team Structure** | 70 people with the core group of 15 remaining throughout the study | Cross functional and self-managed. Full time committed to the project | Team of Territory managers and Nurses remained throughout the study (Other members, e.g., biostatisticians were brought in at times) | Core group of Engineering and Marketing people remained throughout the project. Other people brought in when required | The person conceptualizing the project remained throughout the project (Core: 25, Overall team size: 100 spread throughout US And Asia) | 8 Core group members (Mktg, Supply Chain, Quality and Engineering) remaining throughout the project (Initially was not fulltime) | Team members dedicated close to 10% of time on this project. Worked on several other projects | Self-Managed Team Structure | 3 Members (Industrial engineer, Process specialist and supervisor) made up the core and remained throughout the project | 15 people with different backgrounds (worked on several other projects) | 7 active members (from all over the world) |

* Innov $B_3$ was a unique project that started as an improvement and later on became an innovation

### 2.4.3. Structural Ambidexterity – A Project Level Capability

Once strategic decisions are made on innovation and improvement, the next question is how can innovation and improvement coexist within the same business unit? The case analysis supports structural ambidexterity argument that allows for simultaneous management of innovation and improvement projects (O'Reilly and Tushman, 2004). Researchers have proposed "dual structures," separating the explorative (innovation) and exploitative (improvement) subunits and integrating them at the strategic level (Burns and Stalker, 1961; Volberda, 1998). Dual structures in the past meant essentially creating a physical separation between these activities (e.g., innovation or new product development takes place in the R&D area, while improvement takes place in the manufacturing facility) (Van de Ven, 1986). Such separation is hard to achieve in high technology divisions where innovation projects (both product and process innovation) coexist with improvement projects (Cole and Matsumiya, 2007; Jayanthi and Sinha, 1998). For example, process innovation projects (Innov $A_{1}$ & Innov $A_{2}$ in the PC division) took place in the manufacturing facility along with other improvement projects (Improv $A_{1}$). Recently, scholars have extended the notion of dual structures to include incentives, leadership, cultures and other sub-systems that promote internal alignment (March, 1998; O'Reilly and Tushman, 2008). This research finds three of these characteristics: project leadership styles, incentive systems and team structures that help simultaneous execution of innovation and improvement (March, 1998).

#### 2.4.3.1. Leadership Style

The cross-case analysis of the projects indicates different project leadership styles for managing innovation and improvement projects. In general, previous research has acknowledged the importance of leadership in sustaining innovation or improvement (Graebner, 2004; Crossan et al., 1999; Juran, 1995). For example, the Six Sigma literature notes the importance of leadership in improving existing practices (Schroeder et al., 2008; Waldman, 1994), while the innovation literature notes the importance of leadership in enhancing creativity during new product development activities (Amabile, 1996). In leadership theory, transactional and transformational leadership styles give a similar distinction (Burns, 1978). Transactional leaders motivate individuals through contingent reward and punishment (House and Mitchell, 1974; Avolio et al., 1999). In contrast, transformational leaders use charisma and appeal to individuals ideals' to stimulate and encourage higher levels of motivation (House and Shamir, 1993; Fielder, 1967). Transformational leaders help individuals transcend their self-interest for the sake of the larger vision of the organization (Waldman, 1994).

Cross-case comparisons indicate that the project leaders, when managing improvement projects, set explicit goals and expectations for how the teams will be rewarded and provide feedback to the project teams for their tasks - they exhibit transactional leadership (Avolio et al., 1999; Vera and Crossan, 2004). For example, in the case of Improv $A_1$, the project leader worked with the individual module leaders and coached them on a regular basis to be sure that the milestones were met. Such a leadership style is best suited for reinforcing existing practices and cementing them in the organization’s culture (Vera and Crossan, 2004). As pointed out by the project leader of Improv $A_1$:

> Well my primary responsibility with the project is more of a coordination role. It is to make sure that we are pulling together all of these different functions in the company that are responsible for Improv $A_1$; making sure that we are identifying the tasks that are responsible for improving yield and then setting the goals and the strategies as far as how are we going about attacking yield. Our project is now in the sedimentation phase where we have identified those tasks and we are following them on a weekly basis and reporting on or having the projects report, to myself and others as far as status with how we’re progressing on those different improvement activities.

Project leaders of innovation projects, however, switched back and forth between transactional and transformational leadership styles (Vera and Crossan, 2004). During certain phases of the innovation project (e.g., conceptual and design phases), project leaders functioned as transformational leaders, exhibiting charismatic behaviors and allowing team members to occasionally experiment and challenge existing routines. At other times they functioned as transactional leaders, meeting with the teams more than once a week, giving them explicit instructions and establishing timelines and targets. Maintaining dual roles of transformational and transactional leadership during innovation projects encourages creativity while also ensuring the projects to proceed through a structured development process at a reasonable speed. Table 5 illustrates the characteristics exhibited by the project leaders while working on the innovation and improvement projects.

*Proposition 2-5a: The greater the division’s emphasis on distinct project management leadership styles for innovation and improvement projects, the higher is its structural ambidexterity.*

#### 2.4.3.2. Incentive Structure

The cross-case analyses show differences in rewards and incentives for innovation and improvement projects. A key aspect to managing innovation and improvement involves creating recognition systems that can sustain innovation (March, 1998). This is because innovation projects are usually associated with mixed results and they typically require longer periods of time to yield significant results (Balkin et al., 2000; Dearden and Ickes, 1990). Improvement projects, on the other hand, require shorter time periods and often result in predictable outcomes. Poorly designed incentive structures, hence can shift the balance toward improvement at the expense of innovation, especially if the incentive structures are based on the project outcomes. Previous studies show that incentives and reward structures have a substantial effect on the extent of creativity and control of project teams (Huber and Brown, 1991; Leonard-Barton, 1992; Carrillo and Gaimon, 2004; Eisenhardt, 1989). Results from the case analysis confirm this viewpoint.

Recognition systems for improvement projects use an outcome-based incentive structure (Sarin and Mahajan, 2001). This type of incentive structure can be characterized as informal, small, and frequent and are usually given out at the completion of the project. It is ideal for activities that involve shorter time intervals and less risky outcomes. For example, during our site visits, project team members on Improv $A_3$ were rewarded with thermos containers engraved with their names and the recently completed project goals. This commemorated completion of the project.

In contrast, cross-case analysis indicate innovation projects to adopt a process-based incentive structure (Henderson and Lee, 1992). Process-based incentives are defined as "the degree to which team rewards are tied to procedures, behaviors, or other means of achieving desired outcomes (i.e., completion of certain phases in the development process)" (Sarin and Mahajan, 2001, p. 39). This type of incentive structure encourages project team members to focus on the procedures required to produce the desired outcome rather than the outcome itself. For example, the PC division at Firm A has its own product development procedure: Product Process Development (PPD) used during the innovation projects. All the innovation projects studied in this division are rewarded after the completion of major project milestones based on this procedure. Additionally, the project team members are also motivated through patents and trade secret awards which are awarded to them during annual innovation weeks or banquet celebrations. Emphasis on the process rather than the desired outcomes is given during innovation projects. Table 5 gives the incentive structures used for all the projects.

> *Proposition 2-5b: The greater the division's emphasis on distinct incentive and recognition structures for innovation and improvement projects, the higher is its structural ambidexterity.*

#### 2.4.3.3. Project Team Structure

The innovation and improvement project teams have different reporting and functioning structures. For example, all the innovation project teams operate through an X-team structure (Ancona and Bresman, 2007; Chesbrough, 2003) that consist of a core group of team members and a project leader who remains throughout the project. Characteristics of X teams include: expandable tiers, flexible team membership and extensive ties (Ancona and Caldwell, 1992). Due to the high levels of complexities involved during innovation projects, experts join the team as peripheral members, leaving the team after their task is completed. This creates an expandable team structure. Maintaining a core group of team members throughout the project facilitates the retention of tacit knowledge generated at different stages of the development process (Thompson and Choi, 2005). For example, Innov $A_1$ has a core group of fifteen members that remain throughout the project (four years and continuing), while additional team members (four members of photo-etching group) were brought in during the fabrication stage. The core group retained a majority of knowledge about the chemical treatment procedures used in the etching process and its impact on the flexure assemblies. This knowledge proved critical during the manufacturing stage even after the etching group left the team.

Improvement project teams, however, are self-managed and cross-functional, with project team members simultaneously working on several improvement projects. They function as self-managed teams with the authority to design and implement solutions without consent from senior management (Thompson and Choi, 2004). The project leaders for these improvement projects lead several similar projects; this enables the leaders to transfer knowledge across projects. For example, Improv $B_1$ and Improv $B_2$ have the same project leader and involve global project team members. In the beginning, Improv $B_1$ faced delays due to coordination failures among the team members. To overcome this problem the project leader, with management approval, decided to bring the team members together. Team members were flown in from various locations to one facility and met as a group for three weeks. This interaction sped up the problem definition process. It also helped determine the team members' strengths, weakness, expertise etc., which proved critical during the later stages of the project. A similar strategy was followed by the project leader at the beginning of Improv $B_2$ and contributed to its success.

*Proposition 2-5c: The greater the division's emphasis on distinct project team structure for innovation and improvement projects, the higher is its structural ambidexterity.*

Table 2-5 outlines the structural distinctions between innovation and improvement projects maintained across these divisions that foster their coexistence. Although previous research has identified the importance of structural ambidexterity on balancing (O'Reilly and Tushman, 2004), this research is the first empirical study to identify the specific organizational characteristics that promote structural ambidexterity.

*Proposition 2-6: The higher the level of structural ambidexterity (demonstrated by maintaining distinct rewards, project team leadership, and team structures for innovation and improvement projects), the greater is the division's ability to balance innovation and improvement activities.*

### 2.4.4. Balancing and Performance

High velocity environments are characterized by frequent product and process technology changes and intense competition (Bourgeois and Eisenhardt, 1988; Benner and Tushman, 2003). Divisions operating in these environments need to innovate in both products and processes, explore new markets and find new ways to compete and differentiate from competitors (Zahra, 1993). They also need to improve existing products and processes, reduce cost and increase their efficiency to remain competitive in the current markets (He and Wong, 2004). Simultaneous execution of innovation and improvement activities (balancing innovation and improvement activities) is critical to a division's survival in these environments (He and Wong, 2004). Hence,

*Proposition 2-7: High velocity environments positively moderate the relationship between the division's ability to balance innovation improvement activities and its performance.*

## 2.5. Discussion and Implications for Theory

Both academics and practitioners have acknowledged the importance of simultaneously pursuing innovation and improvement (He and Wong, 2004; Beinhocker, 2006; Raynor, 2007). However, an organization's ability to achieve this capability is not well understood (Smith and Tushman, 2005). How do high technology organizations balance resources between innovation and improvement demands? The purpose of this research is to understand this question using a grounded theory building approach. Figure 2-3 shows the theory developed from this study. As shown in Figure 2-3, managing the right balance of innovation and improvement is not a single level problem. Three different components contribute to the balance between innovation and improvement: resolving strategic contradiction among senior management teams by mitigating the innovation-improvement decision risks (cognitive ambidexterity); ensuring alignment and adaptability between the strategic and project levels (contextual ambidexterity); and ensuring distinct structural mechanisms at the project level (structural ambidexterity). While strategic contradiction occurs at the senior management level and structural ambidexterity happens at the project level, contextual ambidexterity connects these levels, providing a comprehensive explanation of the balancing phenomenon.

Does the presence of one or two of these ambidexterities constitute balance? The case analysis indicates that high technology organizations require *all three forms* of ambidexterity, which complement one another. Complementarities occur when having more than one thing increases the odds of having more of another (Milgrom and Roberts, 1995). A division that exhibits all three ambidexterities will have the ability to decide upon the right opportunities for innovation and improvement. It will also have the ability to align and adapt the project level characteristics to respond to these opportunities while allowing coexistence of innovation and improvement projects. This combination of all three characteristics provides the ability to balance innovation and improvement strategies. Researchers have argued for synergies arising from complementarities, because of the difficulty in simultaneously imitating all of them (Tanriverdi and Venkataraman, 2005). Results from this research indicate that the three forms of ambidexterities are present at multiple levels within the division, which makes imitation difficult and provides a competitive edge.

For instance, the ability to maintain the right levels of innovation and improvement resides at the strategic level within the division (Smith and Tushman, 2005). The first part of Figure 2-3 shows this argument. A closer examination of this portion of the model draws parallels to the sensemaking in the managerial cognition literature (Weick et al., 2005; Weick and Roberts, 1993). According to Weick, Sutcliffe and Obstfeld (2005), sensemaking originates in "disruptive ambiguity, its beginnings in acts of noticing and bracketing" (p. 413). Organizational sensemaking unfolds through a sequence of processes: scanning, interpreting, action, and outcome (Thomas et al., 1993). In this research, managers interpret the innovation-improvement decision risk by scanning customer needs (spoken and unspoken), market actions and internally examining the capabilities of their division's processes and technologies. This reduces the risk of making an incorrect decision on whether to innovate or improve. Relying on one mechanism, such as quick response to the market or customer demands can lead to failure as illustrated by the PC division's competitors. Reacting quickly to market changes or demands may not be the right approach in these environments. Rather, developing a thorough understanding of the needs and relying on information analysis and methods and involving multiple levels of information leads to better quality of decisions. This is consistent with the decision comprehensiveness literature (Talaulicar et al., 2005; Mankins and Steele, 2005) that argues for a thorough problem analysis to overcome cognitive bias among individual decision makers. Findings from this study indicate that managers look at these decision making scenarios as a continuous process and can maintain the decision making speed required for their survival.

Addressing the second research question, this study finds contextual ambidexterity as a meso level capability that is used to connect different levels within a division. Since innovation and improvement efforts take place as projects within divisions, they have to be aligned with the division's strategic intent. Alignment helps in understanding the value creation process and is critical for streamlining the process to exploit short term markets. Adaptability, however, provides the division with the capability to adjust quickly to the changing market demands coming from the market (Lewis, 2000). High technology divisions require both alignment and adaptability to meet current and future demands. Results from the case studies indicate three distinct mechanisms that provide contextual ambidexterity. Disciplined project management is one approach that facilitates aligning and adapting to market changes. This involves establishment of clear standards of performance and behavior and a system of open and quick feedback regarding the project and its contribution to the divisional goals. Creating an appropriate organizational context through this approach empowers individuals and project teams to act and respond to changes. Using a hierarchy of scorecards also develops contextual ambidexterity within a division by connecting project level metrics with the divisional metrics. This enables tracking the project performance and assists in connecting the tactical, operational and strategic goals within the division (Crewling, 2006). Additionally, evidence from the divisions at Firm A indicates that the ability to connect the planning process across different levels (referred as the “Rollover of Divisional Plans”) promotes contextual ambidexterity.

This research also supports structural ambidexterity arguments that manifests at the project level (O’Reilly and Tushman, 2008; Hayes et al., 2004). Evidence from the case studies indicate that having distinct incentive systems, team leadership and team structures for innovation and improvement projects facilitate their coexistence. Although previous research has emphasized the need for these distinctions, our study is the first attempt to specify the differences in these structural characteristics for simultaneously managing innovation and improvement projects.

### 2.6. Conclusions and Future Work from this Study

The study leads to three important implications for both academic research and practice. First, the study finds that managers interpret the strategic contradiction between innovation and improvement in the form of a decision risk. Minimizing this decision risk affects the organization’s ability to balance innovation and improvement.

Cognitive ambidexterity helps managers resolve this strategic contradiction using several mechanisms: information analysis and methods, a continuous planning process through hierarchical roadmap development, usage of inter-functional multilevel planning teams (IMP), and tapping the unspoken and spoken customer and market needs. Scanning both inward and outward for clues on these strategic choices helps make the right decision on innovation and improvement. Other high technology organizations such as Nokia, 3M and General Electric[6] (outside the scope of this study) have also begun to adopt similar scanning practices.

Second, this study examines organizational ambidexterity as a multilevel phenomenon. Although decisions about innovation and improvement occur at the strategic level, the execution of these decisions takes place as projects that coexist in high technology organizations. Academic literature has not addressed the multilevel nature of ambidexterity. Our study overcomes this limitation by considering ambidexterity at multiple levels and their influence on balancing.

Finally, this study helps inform the research on organizational ambidexterity. Emerging research suggest several forms of ambidexterity—structural, temporal, contextual—as solutions to balance innovation and improvement (O'Reilly and Tushman, 2004; Gibson and Birkinshaw, 2004). However, few scholars have investigated the antecedents to these ambidexterities (Tushman et al., 2006). Results from this study suggest that cognitive, contextual, and structural ambidexterities coexist in high technology environments. The case study analysis also provides empirical evidence about the antecedents of each of these ambidexterities. The results indicate

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[6] Based on evidence from talks on IBM lecture series (Engineering Systems Division Lecture Series). Talks by the CTO's from Nokia, 3M and GE indicate that these organizations use a multilevel planning process to integrate external and internal information..

that all three forms of ambidexterities complement each other and are required for organizations to survive in fast-paced environments.

# CHAPTER 3

# Antecedents to Organizational Ambidexterity - A Multilevel Investigation

## 3.1. Introduction

*"To survive, organizations must execute in the present and adapt to the future. Few of them manage to do both well." – Eric D. Beinhocker*

*"Tension between creativity and efficiency is bedeviling CEO's everywhere." – Interview with George Buckley, 3M Corporation*

High technology organizations operate in environments with frequent changes in product and process technologies and increased competition (Bourgeois and Eisenhardt, 1997; Benner and Tushman, 2002). To function effectively in these fast changing environments, organizations have to excel in their short term and long term performances. Short term performance in these environments focuses on competing in the existing market by *improving* product and process quality and by being efficient, while long term performances aim at exploring the future market needs through *innovation* or exploration. Hence, organizations have to simultaneously innovate and improve (referred as balancing innovation and improvement) to maintain a competitive advantage.

This is always a challenge for high technology organizations (He and Wong, 2004; Tushman et al., 2006). Recently several organizations such as Polaroid, Kodak, Motorola, Ericsson, and Samsung have failed to maintain this delicate balance and hence lost their competitive advantage (Christensen and Raynor, 2003; Gibson and Birkinshaw, 2004; Chao and Kavadias, 2008). For example, Motorola's cell phone division reported a third quarter loss of $394 million and eliminated over 3,000 jobs (in 2008) due to their inability to simultaneously dominate current and future cell phone markets (Thomson Reuters, 2008). According to business analyst reports, competitors such as Nokia, Ericsson, Samsung, Palm, and Research in Motion (RIM) performed better in exploiting the current markets and exploring future markets, which lead to the loss in Motorola's market share (Holmes, 2008). What are some of the organizational processes that allow high technology organizations to balance innovation and improvement demands is a question that has not been understood clearly (He and Wong, 2004; O'Reilly and Tushman, 2008).

**Table 3-1**: Ambidexterity versus Punctuated Equilibrium Argument – An Overview

| | **The Ambidexterity Argument** | **The Punctuated Equilibrium Argument** |
|---|---|---|
| Fundamental Assumption | Innovation and Improvement are orthogonal processes | Innovation and Improvement forms two ends of a continuum |
| Unit of Analysis | Appropriate for the divisional level (system) formed of loosely connected domains for innovation and improvement | Appropriate for single domain (individuals) where innovation and improvement are temporally separated |
| Environment Context | Appropriate for fast-paced environments where there is lack of temporal separation between innovation and improvement | Appropriate for slow paced environments or when it is feasible to temporally separate the two activities |
| Research Design | Cross Sectional | Longitudinal |
| Notable References | Benner and Tushman (2003), He and Wong (2004), Jansen et al. (2009) | Levinthal and March (1993), Burgelman (2002), Siggelkow and Levinthal (2003), Romanelli and Tushman (1994) |

Although the challenge of balancing innovation and improvement occur in diverse context, the impact becomes acute in high technology organizations due to reduced product and process lifecycles and increased competition (Bourgeois and Eisenhardt, 1988; Auh and Menac, 2005). Current theories explaining the antecedents to balancing can be categorized into two streams: The ambidexterity argument and the punctuated equilibrium argument (Gupta et al., 2006). Table 3-1 compares these theoretical streams. High technology organizations place strategic importance on innovation and improvement decisions and are beginning to incorporate ambidextrous organizational design to address their need for balance (O'Reilly and Tushman, 2008; Gilbert, 2005). This research limits its focus to understand the antecedents and consequences of organizational ambidexterity on balancing in high technology organizations.

Although scholars have articulated ambidexterity as a mechanism to balance innovation and improvement, there is lack of research studying the antecedents to organizational ambidexterity (Raisch and Birkinshaw, 2008; Tushman et al., 2006; Voss et al., 2003). This is mainly due to a piecemeal approach adopted by researchers. For example, strategic management researchers studying balancing have treated organizations as the unit of analysis and hence failed to delineate the intra-organizational processes that allow them to simultaneously pursue innovation and improvement (He and Wong, 2004; Cho and Pucik, 2005). Similarly operations management researchers studying the project level manifestation of balancing do not investigate the "Unstructured and Messy" decision making (Kavadias and Loch, 2007;

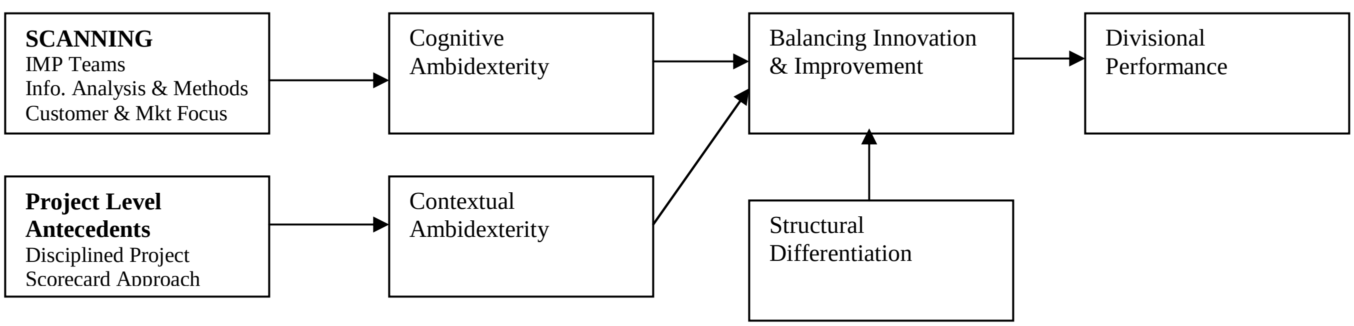
Wheelwright and Clark, 1992) at the strategic level and its impact on project level decisions. This inconsistency in the unit of analysis is a major reason the problem still remains unaddressed (Tushman et al., 2007).

In this research, we consider the strategic level, the project level, and the inter-alignment factors and their impact on the organization's ability to balance innovation and improvement. A recent empirical work by Chandrasekaran et al. (2008)[7] provides theoretical grounding to this research. Results from their multiple case studies suggest that the solution to balancing innovation and improvement manifest at multiple levels within the organization: The strategic level, the project level, and the meso level. At the strategic level, this involves resolving contradictions between innovation and improvement opportunities using a decision risk framework, defined as *cognitive ambidexterity* (Chandrasekaran et al., 2008). At the project level, this involves designing the organization's structural characteristics such as incentive systems, team structure, and the team leadership that permits coexistence of innovation and improvement projects, defined as *structural ambidexterity*[8] (O'Reilly and Tushman, 2004; Jansen et al., 2009). At the meso level, it involves aligning and adapting the project level decisions with the strategic decisions, defined as *contextual ambidexterity* (Gibson and Birkinshaw, 2004). All three forms of ambidexterity complement each other to help high technology organizations balance innovation and improvement.

[7] This work is described in detail in Chapter 2 of this dissertation.
[8] The term structural ambidexterity—"the ability to maintain distinct organizational processes, structures and cultures to innovate and improve"—was originally defined by O'Reilly & Tushman (2004). However, recent empirical work by Jensen et al. (2009) operationalizes structural ambidexterity as structural differentiation. This research uses structural differentiation and structural ambidexterity interchangeably.

Barring Gibson and Birkinshaw (2004), our study is the first empirical work that looks at ambidexterity at multiple levels within an organization. In this research, we hypothesize and measure three forms of ambidexterity at the strategic, project, and the meso level. Using multilevel data from 34 high technology divisions and from 110 projects (innovation and improvement projects), our research investigates the antecedents to cognitive, contextual and structural ambidexterities. Figure 3-1 gives the model studied in this research. The rest of the Chapter 3 is organized as follows. In section 3.2, we review the existing literature on ambidexterity and balancing and develop the hypotheses to be tested. We illustrate the research design involving the multilevel data collection process in section 3.3. The analysis and findings from this study are described in section 3.4. Finally, we discuss the implications of these results for theory and practice in section 3.5.

**Figure 3-1**: Multilevel Theory on Organizational Ambidexterity




## 3.2. Theory Development

### 3.2.1. Operations – Strategy Literature Gap

Although innovation and improvement decisions are made at the strategic level, they are executed as projects that often coexist in high technology organizations. A gap exists in the academic literature connecting the strategic level decisions on innovation and improvement and its execution at the operational level. For instance, consider the strategy buckets perspective used by the Operations Management (OM) researchers while studying portfolio balancing issues (Wheelwright and Clark, 1992; Cooper et al., 1998; Ulrich and Eppinger, 2004; Loch and Kavadias, 2007; Chao and Kavadias, 2008). OM researchers have argued the portfolio balancing problem to be "unstructured and messy" at the strategic level (Kavadias and Loch, 2007). Current research in this topic is beginning to look at the impact of external contingencies such as environmental stability and environmental complexity on the strategy bucket decisions (resource allocation toward improving existing portfolio or innovating newer portfolios of products). This stream of research suggests that a higher level of complexity shifts the balance toward innovation while a higher level of instability shifts the balance toward improvement (Chao and Kavadias, 2008). However, there is dearth of organizational processes that explain how these strategic decisions are made and how these decisions are connected with project level decisions.

A similar disconnect exists between strategy and manufacturing literature that addresses coexistence of innovation and improvement (Cole and Matsumiya, 2007; Adler et al., 1999; Victor et al., 2000). For example, OM researchers argue the need to maneuver their organizational structural and infrastructural practices to ensure coexistence of innovation and improvement (Hayes et al., 2004). Strategic Management research refers to this as structural ambidexterity or structural differentiation[9]: establishing separate project team structures, cultures and incentives to innovate and

[9] According to Jensen et al. (2009), structural differentiation is critical to achieve organizational ambidexterity.

improve (O'Reilly and Tushman, 2004; Jansen et al., 2009). Although theoretical arguments exist on structural ambidexterity, there is no empirical evidence on how structural ambidexterity manifests at the operational level. Our study is the first research to measure and relate the impact of structural ambidexterity on the ability to balance innovation and improvement.

### 3.2.2. Ambidexterity and Balancing

The term ambidexterity refers to the ability to simultaneously innovate and improve (O'Reilly and Tushman, 2004; Jansen, 2006). Nokia Corporation is an example of an ambidextrous organization; it offers a vast array of novel mobile technologies, while also maintaining its dominance in the handset franchise market (Birkinshaw and Gibson, 2004). Research has shown ambidexterity to be an effective mechanism to achieve the delicate balance between innovation and improvement in fast-paced environments (He and Wong, 2004; Rothaermel and Alexandre, 2009). Competing theories on organizational ambidexterity include *structural ambidexterity* or *structural differentiation*, which involves creation of different organizational architectures within a company in the form of physical spaces, incentives, business models, metrics and cultures (Burns and Stalker, 1961; O'Reilly and Tushman, 2004). Recently, scholars have also suggested a meso level ambidexterity capability referred to as *contextual ambidexterity* (Raisch and Birkinshaw, 2008; Gibson and Birkinshaw, 2004). This type of ambidexterity stresses alignment and adaptability across the organization to sustain superior performance. According to this argument, the ability of the individuals, teams or units to align and adapt across different levels naturally translates into sustained competitive advantage. Although both structural and contextual ambidexterity are critical to operationalize innovation and improvement, the ability to maintain the right balance of innovation and improvement efforts reside at the strategic level within an organization (Kaplan, 2008a; Smith and Tushman, 2005).

Resolving the strategic contradiction between innovation and improvement opportunities is critical to maintain this delicate balance (Smith and Tushman, 2005; Kaplan, 2008a). Current research refers to this as *cognitive ambidexterity*: the ability of the senior managers to resolve the strategic contradiction between innovation and improvement (Chandrasekaran et al., 2008). Managers develop cognitive ambidexterity, i.e., the ability to resolve strategic contradiction between innovation and improvement, using an innovation-improvement decision risk frame (Walsh, 1995; Kaplan, 2008a). Research in the managerial cognition literature suggests that cognitive frames give manager's a way to sort through ambiguities (Kaplan, 2008b; Tripsas and Gavetti, 2000). An innovation-improvement decision risk cognitive frame helps minimize the extent to which significant and disappointing outcomes are realized from an innovation or an improvement decision (Sitkin and Pablo, 1992). In this context, the outcome can be a success trap, characterized by too much innovation compared to improvement; a failure trap, characterized by too much improvement compared to innovation or a termination trap, characterized by the wrong choice in an innovation or improvement decision, leading to extinction (March, 1998). Cognitive ambidexterity helps senior managers avoid these traps and hence maintain the right balance of innovation and improvement. This is done by using a variety of organizational processes that scan externally to understand the customer and market preferences and integrate them with the organization's operational capabilities determined through rigorous information and data analysis (Soussa, 2003; Smith and Tushman, 2005; Chandrasekaran et al., 2008). In addition to these processes, senior managers adopt continuous planning forums that involve an Inter-functional Multilevel Planning approach (IMP) while making decisions on innovation and improvement opportunities (Mankins, 2007; Hollenbeck et al., 1998). Unlike strategic planning that assumes that "future is more like the present" (Hamel, 1996), continuous planning involves constantly monitoring for changes in the customer, competitor, and internal strategies and incorporating them into the organization's strategic decision making process (Grant, 2003). This is done using IMP teams that have members from various levels within the organization (Bates and Dillard, 1993). An IMP approach is both internally and externally driven and develops a shared vision and common understanding among senior managers on innovation and improvement opportunities. This helps resolve strategic contradictions, between innovation and improvement.

Incorporating information regarding customer and market changes as well as internal operational capabilities through information analysis and methods and IMP teams (collectively referred as scanning) mitigates the risk of making an incorrect decision between innovation and improvement opportunity and hence increases the cognitive ambidexterity capability among senior managers.

*Hypothesis 3-1: Higher use of scanning mechanisms (e.g., Customer and Market Focus, Information Analysis, and Methods and IMP Teams) leads to higher cognitive ambidexterity capability of the senior managers.*

Organizations with cognitively ambidextrous managers are able to use existing practices such as the IMP planning approach, information analysis and methods, customer and market focus, etc., to achieve new and innovative forms of competitive advantage (Leonard-Barton, 1992). Literature on top management decision making, barring Smith and Tushman (2005), has been particularly silent on identifying mechanisms dealing with strategic contradictions (Adner and Helfat, 2002). Cognitive ambidexterity help managers integrate and resolve opposing views over innovation and improvement. It also helps identify the right opportunities for innovation and improvement and hence overcome the inertia due to competency traps. This capability is critical for high technology organizations to simultaneously pursue innovation and improvement strategies (Brown and Eisenhardt, 1999).

> *Hypothesis 3-2: The higher the cognitive ambidexterity among senior managers, the greater is the organization's ability to balance innovation and improvement. (i.e.) Cognitive ambidexterity mediates between Scanning practices and the organization's ability to balance innovation and improvement.*

Although decisions regarding innovation and improvement take place at the strategic level, they get operationalized as projects (innovation and improvement projects). As a result, it is essential to connect decisions across the strategic and project levels to ensure that the organization has the ability to align and adapt to market changes. That is, strategy and execution need to be connected. How is this achieved? Two prominent methods used in high technology organizations to align and adapt decisions across levels are: disciplined project management approach (Chandrasekaran et al., 2008; Ghoshal and Bartlett, 1994) and metric alignment (Kaplan and Norton, 1996). Characteristics of a disciplined project management approach include: establishment and acceptance of clear performance standards, faster feedback cycles (due to constant reviews by the strategic leaders) and the involvement of strategic leadership in the project decision making processes (Ghoshal and Bartlett, 1994). For example, Ghoshal and Bartlett (1994) in their field research describe disciplined management as, “an attribute of an organization’s context that induces its members to voluntarily strive for meeting all expectations generated by their explicit or implicit commitments” (Ghoshal and Bartlett, 1994, p. 97). A disciplined project management approach allows organizations to connect strategy with the project levels decisions enabling faster adaptation to the strategic level decisions. This approach also serves as a bottom-up channel communicating the project level decisions to the higher levels which can also change the overall strategic intent of the organization (Raisch and Birkinshaw, 2008).

In addition, a scorecard approach of identifying the key performance metrics for innovation and improvement projects and connecting them with the strategic level metrics serves as another mechanism for alignment (Ittner and Larker, 2003; Bendoly et al., 2007). The use of a scorecard to link lower level operational metrics with the division’s strategies has its origins in the balanced scorecard literature (Kaplan and Norton, 1992). Advantages of using a scorecard approach include the following: articulate a common vision among the organizational members, create a strategic intent to both explore (innovate) and exploit (improve), enhance strategic feedback and learning, and to set targets and align strategic initiatives (Kaplan and Norton, 2008). In general, innovation and improvement projects have different performance metrics (e.g., improvement projects have greater priority toward quality and cost components while innovation projects have higher weights on the risk structures and innovation measures). However, alignment of these metrics with the strategic level metrics is critical to track the overall organizational performance along both innovation and improvement dimensions. Both disciplined project management and a scorecard approach allow organizations to align and adapt decisions across strategy and projects. This ability to align and adapt decisions across the strategic and project level can be called as contextual ambidexterity (Gibson and Birkinshaw, 2004; Im and Rai, 2008). Current research examining the antecedents to contextual ambidexterity resides at the individual level (Gibson and Birkinshaw, 2004), while this study extends the arguments to the project level.

> *Hypothesis 3-3: Greater use of disciplined project management and scorecards among innovation and improvement projects leads to higher contextual ambidexterity in the organization.*

Contextual ambidexterity is a meso level capability that permits alignment and adaptability of decisions across different levels of the organization (Raisch and Birkinshaw, 2008; Gibson and Birkinshaw, 2004; Baradhan, Krishnan and Lin, 2007; Im and Rai, 2008). Alignment is focused toward improving the short term performance while adaptability is geared toward the long term performance of the organization (Gibson and Birkinshaw, 2004). High technology organizations require both alignment and adaptability to meet current and future demands through innovation and improvement. Hence, contextual ambidexterity is the second form of ambidexterity required in fast-paced environments to balance innovation and improvement. Consistent with existing research, we suggest the following hypothesis.

> *Hypothesis 3-4: The higher the contextual ambidexterity achieved through alignment and adaptability, the greater is the organization's ability to balance innovation and improvement. (i.e.) Contextual ambidexterity mediates between project level practices and the organization's ability to balance innovation and improvement.*

Once strategic decisions are made on innovation and improvement and connected with the project level actions, the next question is how can innovation and improvement coexist within the same business unit? Researchers have proposed “dual structures” of separating the explorative (innovation) and exploitative (improvement) subunits and integrating them at the strategic level (Burns and Stalker, 1961; Volberda, 1998). This is referred as *structural ambidexterity* or *structural differentiation* (O’Reilly and Tushman, 2004). Literature on structural ambidexterity equates it to the spatial separation within the organization (e.g., innovation or new product development takes place in the Research & Development area, while improvement takes place in the manufacturing facility) (Christensen, 1998; Van de Ven, 1986; Duncan, 1976). Such separation is hard to achieve in high technology organizations where innovation projects (both product and process innovation) coexist with improvement projects. Structural ambidexterity, (also referred as Structural differentiation) in this context entails creation of different incentives, project leadership, and project team competencies that are internally aligned (Jansen et al., 2009; O’Reilly and Tushman, 2008; Hayes et al., 2004; March, 1998). For example, having similar incentive structures (e.g., outcome-based incentives) for both innovation and improvement projects can shift the balance toward improvement, since improvement projects have deterministic and time bounded outcomes when compared to the innovation projects. Hence there is a need for having a distinct incentive system (e.g., process based incentives versus outcome based incentives) for innovation and improvement projects (Sarin and Mahajan, 2001). Similarly, project leadership style and project team structure can differ between innovation and improvement projects. For example, project leaders leading improvement projects set explicit goals, and expectations for how teams will operate and provide feedback for their tasks – i.e., they exhibit transactional leadership characteristics (Vera and Crossan, 2004). Project leaders in innovation projects exhibit an ambidextrous leadership style (both transactional and transformational leadership). Maintaining dual roles of transactional and transformational leadership encourages creativity while also ensuring that the project proceeds through a structured development process at a reasonable speed (Jansen et al., 2009). The project team structure also vary between innovation and improvement projects (Ancona and Bresman, 2007; Thompson and Choi, 2007). Innovation project teams have an X-team structure, with expandable tiers, flexible team membership and extensive ties that accommodates higher levels of complexities. Improvement project teams are self-managed and cross functional with the team leaders leading multiple projects that enable them to transfer learning across these projects.

Achieving structural differentiation through distinct team incentives, project leadership and project team structures ensure coexistence of innovation and improvement projects in high technology environments (O'Reilly and Tushman, 2008; March, 1998). Hence we suggest,

> *Hypothesis 3-5: The higher the structural differentiation (achieved through distinct incentives, project team leadership and project team differences), the greater is the organization's ability to balance innovation and improvement.*

High technology environments are characterized by frequent product and process technology changes and intense competition (Benner and Tushman, 2003; Eisenhardt and Tabirizi, 1995; Mendelson and Pillai, 1999). The ability to simultaneously execute innovation and improvement is critical to the overall organizational performance in these environments (He and Wong, 2004; Auh and Menac, 2005), which suggests the following hypothesis.

*Hypothesis 3-6: The impact of balancing innovation and improvement activities has a positive effect on the organization's performance.*

## 3.3. Data Collection

Previous studies on organizational ambidexterity barring Gibson and Birkinshaw (2004), have either used single informants to answer the questions on behalf of the entire organization (Jansen et al., 2009), or relied on secondary data that did not capture the organizational decision making attributes (He and Wong, 2004; Cho and Pucik, 2005). This study in contrast adopts a multi-level research design involving at least three levels of respondents for the data collection process. Our data comes from 34 high technology business units and involves over 110 innovation and improvement projects. This sample is sufficient to allow statistical analysis at the division or business unit level.

### 3.3.1. Data Collection Procedure

Our procedure consists of a multiple case study approach at four high technology divisions involving over 200 participants (Fifty-three interviews conducted with the strategic and project level respondents) to understand the problem in detail, followed by a follow-up survey data collection from 34 different high technology divisions across multiple levels involving over 110 projects.

The survey data collection took place between January 2008 and March 2009. To collect multilevel survey data, we contacted over 190 divisional heads (e.g., Chief

Technology Officer, Divisional Manager and Senior Vice Presidents) by partnering with high technology agencies such as the LifeScience Alley Institute, the Minnesota High Technology Association, and the Joseph M. Juran Center for Leadership in Quality. Our first contact involved sending out an executive summary (through personalized email messages) to the divisional heads describing the research study and the potential benefits from their participation. We requested the divisional heads to contact us for more information regarding this study. Forty-one divisional representatives came back to us seeking more information on this study. We conducted phone conversations and in-person meetings with each of these representatives to explain the research design (collecting data from both the strategic and project level respondents), research method (web survey) and the time commitment from these respondents. Five divisions did not participate in this study leaving our total sample at thirty-six divisions (32 divisions in North America and 4 outside North America). We then worked closely with each of these 36 division contacts in order to sample the appropriate respondents for our study. For instance, the research team spent considerable amount of time to understand the organizational culture, innovation and improvement methods used by the division (e.g., Six Sigma, DFSS methodologies) and the nature of their business (competition, product, process, and industry lifecycles etc). This helped customize the survey to each of these divisions (e.g., use their organizational language). We excused two more divisions since they did not meet our sampling requirements (they had slower product and process clockspeed; Fine (1998)). Our final sample involved 34 high technology divisions giving us a response rate of 17.89%.

Within each division, we asked the divisional level contacts to sample a minimum of two innovation and improvement projects that were of strategic importance. We used our definitions of innovation and improvement for this sampling procedure (Innovation Projects: Projects involving product or process changes that were new to the unit of adoption [Zaltman et al., 1973]; Improvement Projects: Projects involving product or process changes that were based on existing knowledge within the unit of adoption [Zangwill and Kantor, 1991]).

A web survey was designed to collect data from these divisions. It was divided into three parts: Strategic Level, Project Leader and Project Team Member parts. The survey design required at least two respondents (e.g., divisional head, R&D Director) to complete the strategic level part of the survey. The project leaders and the project team members completed their corresponding parts of the survey. This type of survey design also reduced the number of questions per survey, which increased the response rate. At the strategic level, we had 64 respondents completing the survey on decision making regarding innovation and improvement opportunities (four divisions had just one strategic level respondent). At the project level, we collected data from 110 projects (58 innovation projects and 52 improvement projects) with the project team leader and at least one project team member as informants on these projects. Only recently completed projects (completed during the last one year) or projects close to completion were sampled to minimize the cognitive burden during recollection (Atkinson and Shriffin, 1965). Email and telephone contact information were made available to the researchers which allowed us to send reminder messages regarding the survey. We also used these channels of contact to provide feedback and benchmarking reports in return for their participation. Overall, we had 313 respondents from 34 divisions participate in this study. Table 3-2 provides a breakdown of this sample based on the industry type.

**Table 3-2**: Descriptive Statistics of the Division and Project Level Respondents

| Industry Type | No. of Divisions | Average Sales (Millions of Dollars) | No. of Strategic Respondents | No. of Projects (No. of Respondents: Leader + Team Members) |
|---|---|---|---|---|
| Semiconductor | 6 | 2541.335 | 12 | 12 (30) |
| Medical Device | 14 | 1253.3 | 24 | 58 (139) |
| Electronic Manufacturing | 2 | 18341 | 4 | 10 (24) |
| Aerospace | 5 | 7419.4 | 10 | 14 (29) |
| Other High Tech | 7 | 784.21 | 14 | 14 (27) |
| Total | 34 | 6067.84 | 64 | 110 (249) |

### 3.3.2. Common Method Bias

Our web survey consists of both objective and subjective data. For subjective data, we use multiple items that require either a five point or a seven point Likert scale responses. The stratified sampling of responses from three levels of the division provides ratings on the constructs shown in Figure 3-1. For example, the strategic level managers completed the survey questions on cognitive ambidexterity, scanning and performance constructs while the project leaders and project team members completed the disciplined project management approach and scorecard measures. Both the strategic level managers and project team leaders were informants on the contextual ambidexterity measures. To mitigate the problem of common method bias, we use different respondents for the independent and the dependent variables. That is, for the independent variables, we use only those respondents who identified themselves as R&D Managers, project leaders and project team members. For the dependent variable, we use only those respondents who identified themselves as divisional managers or directors or vice presidents. Choosing respondents based on their roles ensures that we have the best information on our measures.

### 3.3.3. Non Respondent Bias

The divisions included in our sample come from five different Industry segments (belonging to 2-digit SIC codes 33, 35, 36, 37, and 38). To check for the presence of non-response bias, we compared the basic demographics (sales, R&D expenditures and the number of employees) with the industry average for these five industries (Belonging to two-digit SIC codes: 33, 35, 36, 37 and 38). Industry average data were obtained from the COMPUSTAT database. Comparisons revealed no pattern of differences between these groups of industries minimizing concerns on non-respondent bias (Ward and Duray, 2000). In addition, we exchanged emails or telephone conversations with few non-responding divisions from the LifeScience Alley Member directory. Refusal to participate was either due to the lack of time commitment (involving multiple participants) or the reluctance to reveal confidential information.

Finally, following Li et al. (2007), we also checked for the bias that only high performing divisions were represented in our sample. Approximately, 12 divisions (a third of our sample) that performed poorly on our performance scale (based on Profitability, Return on Investment, Market Share, Profit Growth, Sales Growth and Market Share Growth—see Appendix 3-7) participated in our study minimizing concerns of high performance sample.

### 3.3.4. Measurement

Multi-item scales are used to measure the constructs. Scores on these scales are the mean value calculated across items. We ensured reliability and validity for all these constructs using appropriate procedures. For example, internal consistency of the scales is established using the Cronbach alpha coefficient. The alpha values for all these scales (except Information Analysis & Methods, Cronbach $\alpha = 0.67$) are found to be within the permissible range (0.70 and over) indicating good reliability of the constructs (Nunnally, 1978). We also established three forms of validity namely, content, construct, and criterion validity on our measures (Shadish et al., 2002). *Content validity*, the adequacy to which a specific domain of content has been sampled, is verified by mapping the construct to the existing literature (Nunnally, 1978). We used expert opinions (both managers and a panel of academics) to establish content validity. *Construct validity* assesses the extent to which all items in a scale measure the same construct. We tested for both convergent and discriminant forms of construct validity. An exploratory factor analysis method was used to establish convergent validity, when all items measuring the same construct loaded as a single factor explaining more than 50% of variance in the construct. We established discriminant validity by distinguishing items pertaining to a particular construct from items measuring other constructs. *Criterion validity* examines the extent of relationship between the items composed in a construct and the performance that it is intended to measure. This is done using a canonical correlation procedure between the independent items and the performance measures.

The survey was pre-tested at two different divisions involving over 15 projects. The pretest assessed three main characteristics of the survey: timing (Average time taken by a respondent to complete the survey), clarity (Are there any ambiguous measurement items in the survey?) and content (Does each question make sense and is it appropriate?). The appendix contains a list of the items, their factor loadings and their internal consistencies (Cronbach α).

**Performance** (PERF). The dependent variable, divisional performance is measured using a six item scale that requires divisional managers and vice presidents to reflect on the divisional performance when compared with the best competitor in their industry. All items are measured using a seven point Likert scale. The following items measure the divisional performance when compared to the Industry best: (1) Profitability, (2) Return on Investment, (3) Market Share, (4) Profit Growth, (5) Sales Growth and (6) Market Share Growth. See Appendix for EFA results.

**Balancing.** Consistent with the previous works (He and Wong, 2004; Gibson and Birkinshaw, 2006; Katila and Ahuja, 2002; Lubatkin et al., 2006; Jansen et al., 2009), we measure balancing as, (1) an interaction measure between the division's innovation and improvement capabilities and (2), the absolute difference measure between the innovation and improvement capabilities. A division that is balanced will score high on the interaction measure while also score low on the absolute difference measure.

**Innovation** (INNOV). We use the divisional manager's response to this question since they have the best knowledge about the division's innovation capability. The innovation capability is measured using a seven point Likert scale and required the divisional mangers to reflect on the division's capability on the following three items when compared to the industry average: (1) Introduce new generation of products, (2) Enter new technology fields and (3) Open up new markets.

**Improvement** (IMPROV). The improvement capability is measured using four items: (1) Extend Product Range, (2) Refine existing product quality, (3) Increase production flexibility and (4) Reduce production cost.

In the final step, we compute the multiplicative interaction between innovation and improvement capabilities, reflecting our argument that these capabilities are orthogonal (He and Wong, 2004). We also compute the absolute deviation between innovation and improvement measures. Our argument of simultaneous execution of innovation and improvement helps us hypothesize that the absolute deviation between innovation and improvement will have a negative impact on the divisional performance (He and Wong, 2004).

**Cognitive ambidexterity** (COG AMBI)**.** We measure cognitive ambidexterity **–** the ability to resolve strategic contradiction between innovation and improvement as a function of mitigating innovation – and improvement decision risks (Sitkin and Pablo, 1999; Calantone et al., 2002). Both the R&D directors and the divisional managers respond to this construct. The following four items measure this construct: (1)

Managers in this unit consistently make the right decision when catering to the needs of the future and current markets, (2) Managers in this unit accept occasional new product failures as being normal, (3) Time spent by top managers on analyzing key decisions (e.g., in-depth research alternatives) has increased substantially and (4) Choices among strategic alternatives tend to be made quickly and without precision (Reversed). We use scale development procedures (using q-sort methodology) during this scale development process.

**Scanning** (SCANNING)**.** We measure scanning as a second order factor made of IMP teams, customer and market focus and information analysis and methods. We also confirm the second order structure using a confirmatory factor analysis approach (see Appendix 3-2). The second order factor model better fits the data and is used in this research (normed $\chi^2$ =1.243, RMSEA = 0.068, GFI = 0.861, CFI = 0.927 & AGFI = 0.762). The following first order factors contribute to Scanning practices.

**IMP teams** (IMP TEAMS)**.** We measure the extent of implementation of IMP teams when making decisions on innovation and improvement using the following three items (Hollenbeck et al., 1998): (1) We involve a wide variety of functional representatives during our strategic decision process, (2) The decision making team consist of members from different organizational levels and (3) The decision making team as a whole is apprised of all the relevant information associated with the decision making process. We also collected data on the number of planning forums/ meetings held during the last two years. This was highly correlated with the IMP teams used during these planning forums.

**Customer and market focus** (CUSTOMER & MARKET FOCUS)**.** We use existing measures from Flynn and Saladin (2002) to measure customer and market focus for deciding on innovation and improvement opportunities. Four items are used to measure this construct: (1) We strive to be highly responsive to our customers' needs, (2) Our customers are actively involved in the product/process design process, (3) We regularly survey our customers' requirements and (4) Customer requirements are thoroughly analyzed in the new product/ process design process.

**Information analysis and methods** (INFO. ANALYSIS & METHODS)**.** This scale is adapted from Miller and Friesen (1982). Three items are used to measure this construct: (1) In decision making, there is great reliance on specialized technically trained staff personnel, (2) We periodically brainstorm to seek novel solutions to problems, and (3) We use techniques such as simulation to decide on major production, marketing, and financial decisions.

**Contextual ambidexterity** (CONTX AMBI) Consistent with previous research, we conceptualize ambidexterity as a multidimensional construct made of alignment and adaptability (Gibson and Birkinshaw, 2004). This measure is informed by the project team leader and the R&D director.

**Alignment** (ALIGN). This is measured by the following items: (1) The management system in this unit work coherently to support the overall objectives of the division, (2) People working in this unit are in synchronization with the product line's objectives, (3) The management systems in this unit cause us to waste resources on unproductive activities – Reversed and (4) People in this unit often end up working at cross-purposes because our management systems give them conflicting objectives - Reversed.

**Adaptability** (ADAPT). We measure adaptability using the following three items: (1) The management systems in this unit are flexible enough to allow us to respond quickly to changes in our markets, (2) The management systems in this unit allow us to identify opportunities outside the project requirements to support the strategic intent of the product line, and (3) The management systems in this unit evolve rapidly in response to shifts in our business priorities. Contextual Ambidexterity is a multiplicative factor of alignment and adaptability capability.

**Project level antecedents** (PROJ ANTE)**.** The project level antecedents are informed by the project leaders and the project team members belonging to both innovation and improvement projects. This is a second order factor comprised of the following two first order factors: disciplined project management approach and the scorecard approach. (Normed $\chi^2$ =2.72, RMSEA = 0.066, GFI = 0.926, CFI = 0.991 & AGFI = 0.840). (See appendix 3-2 for the CFA and factor structures).

**Disciplined Project Management Approach** (DISCIPLINED PROJ MANAGEMENT). We use the following four items informed by the project leader to measure the disciplined project management approach adopted by the project teams (Ghoshal and Bartlett, 1994): (1) The performance standards in our unit are pretty well established and known to all of the project team members, (2) As a project team, we get fast feedback for our work from our senior managers, (3) My team gets rewarded or punished based on the rigorous measurement of business performance against our goals and (4) Everything that we do in our project gets measured and recorded by our management staff.

**Scorecard approach** (SCORECARD APPROACH). Another project level antecedent includes the scorecard approach of connecting the project level objectives with the strategic intent of the division (Park et al., 2001; Kaplan and Norton, 2001). The following three items are informed by both the project leader and team members: (1) We use a scorecard/ dashboard approach to connect our project goals with the overall product line goals, (2) My project team performances are linked with the product line's strategies and (3) The project planning document for the team is based on the product line's plan.

**Structural differentiation** (STRUCT DIFF). Structural differentiation, defined as the creation of distinct organizational architectures in the form of incentives and metrics, is measured using three items. (1) Separate rewards and incentive systems exist in our unit for evaluating innovation projects and improvement projects, (2) The project team organization (team role, reporting system etc.,) is quite different between innovation projects and improvement projects and (3) We have distinct organizational processes, structures and cultures for innovation and improvement projects.

**Control variables.** We control for division size, measured as the natural logarithm of the sales of these divisions (LOG SALES), since larger sized divisions may have more resources to perform well along both innovation and improvement dimensions (Jansen et al., 2009). We also use dummy variables (four dummy variables) to control for the industry effect (See table 3-2).

### 3.3.5. Aggregation

Each construct in Figure 3-1 represents the overall division characteristics, but we use individuals as raters for these characteristics. Consistent with the multi-level theory development (Klein and Koslowski, 2000), our model consists of shared unit level constructs, i.e., we use individual subjects to assess the unit level characteristics. Conceptually this argument makes sense, given that individual employees are most familiar with the extent to which an organization exhibits certain attributes. However, it is critical to initially demonstrate the within-unit and between-unit differences (George, 1990; Klein and Koslowski, 2000).

In this research, we conduct several analysis to validate the within and between unit differences. First we generate intraclass correlation coefficients (ICC1) using one-way analysis of variance on the individual level data. This is done by using the division as the independent variable and scale scores as the dependent variables (Kenny and LaVoie, 1995). In all cases, the ICC(1) values are greater than zero and significant. The ICC(2) values, that represents the reliability of the unit means are computed next. All the ICC(2) values are greater than the critical value of 0.65 indicating that the means for the sets of perceptions are an accurate representation of the true score (James, 1982; Gibson and Birkinshaw, 2004).

**Table 3-3**: Discriminant Validity – Ambidexterity Measures

| | COMPONENTS | | | |
|---|---|---|---|---|
| | COG AMBI (α= 0.73) | STRUCT DIFF (α= 0.72) | ALIGN (α= 0.73) | ADAPT (α= 0.83) |
| Managers in this unit consistently make the right decision when catering to the needs of the future and current markets | **0.745** | 0.102 | 0.363 | 0.229 |
| Managers in this unit accept occasional new product failures as being normal | **0.798** | -0.166 | 0.293 | 0.185 |
| Time spent by top managers on analyzing key decisions (e.g., in-depth research alternatives) has increased substantially | **0.952** | 0.006 | 0.006 | 0.087 |
| Choices among strategic alternatives tend to be made quickly and without precision (Reversed) | **0.405** | 0.214 | -0.291 | 0.219 |
| Separate rewards and incentive systems exist in our unit for evaluating innovation projects and improvement projects | 0.059 | **0.731** | -0.305 | 0.115 |
| The project team organization (team role, reporting system etc.) is quite different between innovation projects and improvement projects | -0.273 | **0.620** | -0.138 | -0.374 |
| We have distinct organizational processes, structures and cultures for Innovation and Improvement projects | 0.038 | **0.840** | 0.343 | -0.036 |
| The management systems in this unit work coherently to support the overall objectives of the division | 0.316 | 0.064 | **0.744** | 0.020 |
| The management systems in this unit cause us to waste resources on unproductive activities (Reversed) | -0.027 | -0.409 | **0.492** | 0.331 |
| People working in this unit are in synchronization with the product line's objectives | 0.102 | -0.238 | **0.576** | 0.343 |
| People in this unit often end up working at cross-purposes because our management systems give them conflicting objectives (Reversed) | 0.162 | -0.059 | **0.760** | 0.140 |
| The management systems in this unit are flexible enough to allow us to respond quickly to changes in our markets | 0.164 | -0.135 | 0.410 | **0.751** |
| The management systems in this unit allow us to identify opportunities outside the project requirements to support the strategic intent of the product line | 0.154 | 0.112 | 0.417 | **0.657** |
| The management systems in this unit evolve rapidly in response to shifts in our business priorities | 0.059 | -0.144 | -0.005 | **0.809** |

Contextual Ambidexterity (CONTX AMBI) = Alignment x Adaptability
(Method: Principal Component Analysis, Rotation: Varimax with a Kaiser Normalization; Principal Axis Factoring also provided similar results)

### 3.3.6. Validity Checks

Table 3-3 gives the convergent and discriminant validity of the three different ambidexterities studied in this research. As seen from the results, four factors result from this analysis. The first factor comprised of four items measures cognitive ambidexterity, while the next three items load as a second factor, structural differentiation. The last two factors measure alignment (factor 3) and adaptability (factor 4) of the division. Contextual ambidexterity is a multiplicative factor comprised of alignment and adaptability. We also confirm these factor structures using a confirmatory analysis approach. Discriminant validity using a CFA approach involved a pairwise chi-square difference between the free model and the model with the correlation constrained to one (Bagozzi and Phillips, 1982). CFA results support the current factor structure (see Appendix 3-4).

One reason for using subjective performance measures instead of direct financial data is the lack of financial data for 12 of the divisions in our sample. To ensure external validity, we compare the subjective performance rating of the remaining 20 business units with the publically available financial measure of return on assets (ROA) and return on equity (ROE). These relative measures of financial performance are highly correlated with the subjective performance lending strong external validity to the performance measure.

### 3.3.7. Endogeneity Issues

A major concern in this research design is the presence of endogeneity or self-selection issues. Since our survey requires stratified sampling of high technology divisions, concerns may arise about the participation trends in this study. For example, one trend that is noticeable is the presence of a larger proportion of medical device divisions in our sample. Although our population involves other high technology divisions such as consumer electronics, semiconductor manufacturing, and high technology aerospace divisions, our sample constited of a majority of medical device divisions (Fourteen divisions with over fifty projects). This may cause concerns regarding the generalizability of these results beyond medical device divisions. We checked for self-selection issues using the Heckman two stage selection model (results not shown) (Heckman, 1979). In the first step, we computed the probability of a medical device division participating (Probit model) in our study using several predictors including organizational size and R&D expenditures. We then computed the inverse Mill's Ratio and used it as a predictor in the performance equation. The regression coefficient for this inverse Mill's ratio turned out to be non-significant indicating absence of endogeneity issues.

Also, our research sample consists of 12 divisions (one third of our sample) that performed poorly on our performance scale (based on Profitability, Return on Investment, Market Share, Profit Growth, Sales Growth and Market Share Growth). This minimizes concerns regarding self-selection issues due to performance.

### 3.4.Analysis and Results

**Table 3-4:** Descriptive Statistics and Correlation Matrix for Quantitative Variables

| | Variables | Mean | St.Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LOG SALES | 6.685 | 1.651 | 1 | 0.014 | -0.176 | -0.386* | 0.110 | 0.183 | -0.099 | 0.243 | -0.127 |
| 2 | SCANNING | 3.63 | 0.636 | | 1 | 0.611** | 0.582* | 0.451* | 0.254 | 0.453* | -0.462* | 0.281* |
| 3 | COG AMBI | 3.176 | 0.757 | | | 1 | 0.612* | 0.352* | -0.098 | 0.626** | -0.492* | 0.367* |
| 4 | CONTX AMBI | 11.24 | 5.29 | | | | 1 | 0.424* | 0.119 | 0.687** | -0.425* | 0.245 |
| 5 | PROJ ANTE | 3.22 | 0.582 | | | | | 1 | -0.116 | 0.333* | -0.298 | 0.252 |
| 6 | STRUCT DIFF | 2.889 | 0.979 | | | | | | 1 | -0.153 | 0.001 | 0.032 |
| 7 | INNOV * IMPROV | 23.16 | 10.05 | | | | | | | 1 | -0.512* | 0.554** |
| 8 | \|INNOV – IMPROV\|\| | 1.340 | 0.922 | | | | | | | | 1 | -0.582* |
| 9 | PERF | 4.601 | 1.06 | | | | | | | | | 1 |

n = 34 divisions, *$p<0.05$; **$p<0.01$

**Table 3-5:** OLS Regression Results

| Dependent Variables | Cognitive Ambidexterity | | Contextual Ambidexterity | | BALANCE INNOVATION and IMPROVEMENT | | | | PERF | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Innov * Improv | | \|Innov – Improv\| | | | |
| | Model 1a | Model 1b | Model 2a | Model 2b | Model 3a | Model 3b | Model 4a | Model 4b | Model 5a | Model 5b |
| **Independent Variables** | | | | | | | | | | |
| Constant | 3.856*** | 1.093 | 23.411*** | 10.609+ | 32.322 | -7.156 | 0.024 | 2.464* | 5.670** | 4.728** |
| Division Size (Log Sales) | -0.108 | -0.088 | -1.734** | -1.773* | -1.601 | 0.993 | 0.241* | 0.194 | -0.154 | -0.05 |
| Semiconductor[1] | 0.112 | -0.124 | 2.391 | 0.652 | 10.915 | 7.211+ | -1.072* | -1.049* | 0.713 | -0.090 |
| Electronic Mfg | 0.409 | 0.445 | 0.283 | 0.06 | -1.388 | -4.287 | -0.977 | -0.792 | 0.015 | -0.399 |
| Aerospace | 0.472 | 0.352 | -3.155 | -3.652 | 1.808 | 1.853 | -0.208 | -0.048 | 0.034 | -0.098 |
| Other High Tech | -0.468 | -0.082 | -0.4090+ | -2.275 | -2.029 | 3.785 | 0.001 | -0.325 | -0.759 | -0.654 |
| SCANNING | | 0.716*** | | | | | | | | |
| PROJ ANTE | | | | 4.026** | | | | | | |
| COG AMBI | | | | | | 4.660** | | -0.542* | | |
| CONTX AMBI | | | | | | 1.082** | | -0.113+ | | |
| STRUCT DIFF | | | | | | -1.643 | | -0.123 | | |
| INNOV * IMPROV | | | | | | | | | | 0.032* |
| \|INNOV– IMPROV\| | | | | | | | | | | -0.499** |
| $R^2$ | 0.173 | 0.473 | 0.277 | 0.445 | 0.154 | 0.681 | 0.254 | 0.441 | 0.138 | 0.482 |
| Adj.$R^2$ | 0.035 | 0.364 | 0.152 | 0.326 | 0.008 | 0.583 | 0.125 | 0.269 | 0.001 | 0.357 |
| `F-Statistic | 1.252 | 4.336** | 2.222+ | 3.741* | 1.056 | 6.931*** | 1.970 | 2.560* | 0.995 | 3.852** |

+p < 0.10; *p<0.05; **p<0.01; ***p<0.001

### 3.4.1. Discussion of the Regression Results

Table 3-4 gives the means, standard deviations and correlations among the variables used in this study. Note that these measures are informed by various informants from each of the 34 divisions. Regression assumptions of normality, heteroscadascity, presence of outliers and dependency are checked before conducting the analysis (Neter et al., 2004). To examine multicollinearity, we calculate the variance inflation factors (VIF) for each of the regression equations. All VIF are well below 3 indicating no major issues (Hair et al., 2002). Table 3-5 gives the ordinary least squares (OLS) regression results testing the research model in Figure 3-1. Results from the OLS regression are also cross checked using a three stage least squares approach. A 3SLS approach combines the two stage least squares with seemingly unrelated regression approach (Wooldridge, 2002). It is used to estimate a system of multiple equations accommodating for correlated errors between these equations. In addition, a 3SLS also corrects for endogeneity problems in the predictors using an instrumental variable approach (Heckman, 2008). The appendix has the results from the 3SLS approach that are consistent with the OLS regression results (See Appendix 3-6). We also show the statistical power of our analysis based on the regression results in the appendix (Appendix 3-10).

Division size (measured as natural logarithm of sales) and Industry type (using dummy variables) are controlled during the regression analysis since previous studies have shown their influence on divisional performance. Table 3-5 shows the results from the OLS regression. Division size has a negative effect on contextual ambidexterity.

Hypothesis 3-1 (Model 1b) examines the relationship between scanning practices and cognitive ambidexterity. Scanning (β= 0.716; p< 0.001), the ability to assess external and internal information on innovation and improvement opportunities has a significant association with the cognitive ambidexterity among senior managers. The model explains 36.4 %[10] of the variation in the cognitive ambidexterity capability supporting hypothesis 3-1.

Hypothesis 3-3 (Model 2b) examines the effect of the project level practices such as disciplined project management and scorecard approach on the contextual ambidexterity capability of the division. After controlling for division size, these project level practices (β= 4.026; p<0.01) significantly associate with the contextual ambidexterity explaining 32.6 % of variation in this construct providing support to hypothesis 3-3.

Hypotheses 3-2, 3-4 and 3-5 examine the impact of the three forms of ambidexterity on both the interaction measure and the deviation measures of balancing. i.e., the ability to simultaneously execute innovation and improvement. Model 3b indicates that both cognitive ambidexterity (β= 4.660; p<0.01) and contextual ambidexterity (β= 1.082; p<0.01) have a significant positive association with the ability to simultaneously execute innovation and improvement (interaction measure) while structural differentiation (β= -1.643; p>0.20) has no effect on this interaction measure. Both the effect size and statistical significance of the coefficients for Project level antecedents (β= 4.700; p>0.120) and Scanning (β= 0.696; p< 0.10) decreases from previous models indicating full mediation effects (Sobel's test Mediation results shown in the appendix 3-9). The overall model explains 58.3% of variability on the interaction

[10] Adjusted $R^2$ results are interpreted since they are unbiased or more likely to be replicated

measure of balancing. These results provide support to hypotheses 3-2 and 3-4 on the impact of cognitive and contextual ambidexterities on balancing while failing to support the impact of structural differentiation (Hypothesis 3-5). Similarly, Model 4b examines the association of these ambidexterities on the absolute difference measure of balancing. As seen from the results, both cognitive ambidexterity ($\beta = -0.542$; $p<0.05$) and contextual ambidexterity ($\beta = -0.113$; $p<0.10$) have a significant negative association with the absolute difference score. Structural differentiation ($\beta = -0.123$; $p>0.250$) is not related to the absolute difference failing to support hypothesis 3-5.

Hypothesis 3-6 examines the relationship between balancing and division performance (Model 5b). The ability to balance innovation and improvement (interaction measure) has a positive impact on the division's performance ($\beta = 0.032$; $p<0.05$). The absolute difference between innovation and improvement has a strong negative effect ($\beta = -0.499$; $p<0.01$) on divisional performance. The overall model explains 35.7% of the variation in the division performance. These results support hypothesis 3-6.

### 3.4.2. Post Hoc Analyses

#### 3.4.2.1. Understanding Structural Differentiaion

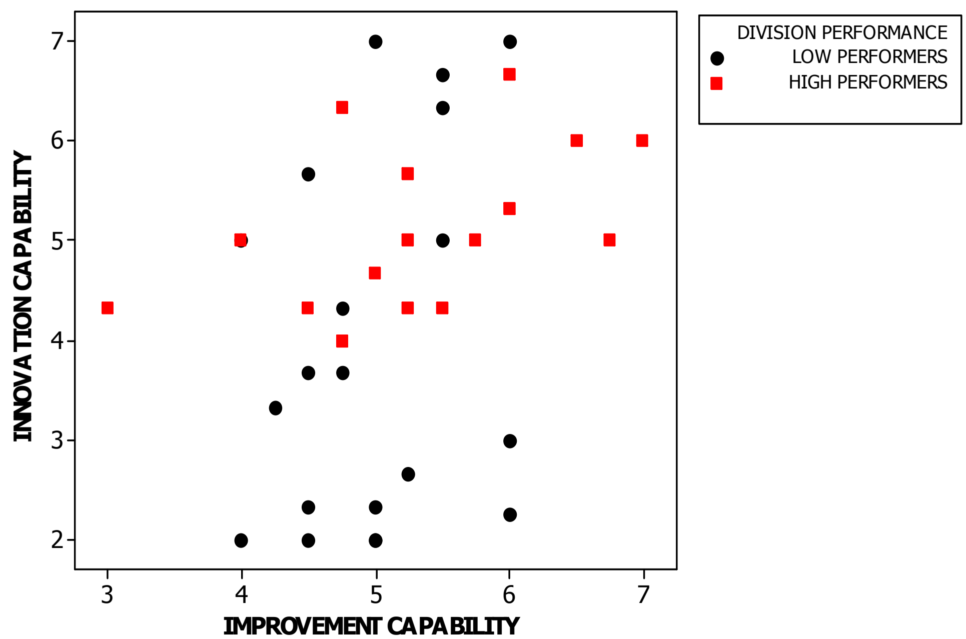
All hypotheses except the effect of structural differentiation (Hypothesis 3-5) on balancing are supported in our study. We are unable to show that structural ambidexterity, in terms of maintaining distinct rewards, project team leadership, and team structures for innovation and improvement projects, has a significant effect on the ability to simultaneously innovate and improve. One reason could be that the effect of structural differentiation is subsumed by cognitive ambidexterity capability of the senior managers (Smith and Tushman, 2005). That is, the ability to resolve the strategic contradiction between innovation and improvement at the highest level also accommodates for the need to separate innovation and improvement activities that can coexist in the form of projects. This is somewhat consistent with the theoretical work of Smith and Tushman (2005). According to these authors,

> Where structural differentiation permits to explore as well as exploit, the top management team serves as the point of integration between contrasting agendas. It is the top management team that makes the decisions regarding organizational forms, cultures, and resource allocation process. (p. 524)

So, divisions with cognitively ambidextrous managers have already designed their processes to ensure coexistence of innovation and improvement. Hence, there is minimal effect of structural differentiation on the ability to simultaneously improve and innovate. To test this case, we decided to run an OLS regression for divisions where senior managers score low on the cognitive ambidexterity scale. We still did not find any significant relationship between structural differentiation and balancing due to the small sample size (only 14 divisions scored less than the median on the cognitive ambidexterity scale).

### 3.4.2.2. Ambidexterity and Performance

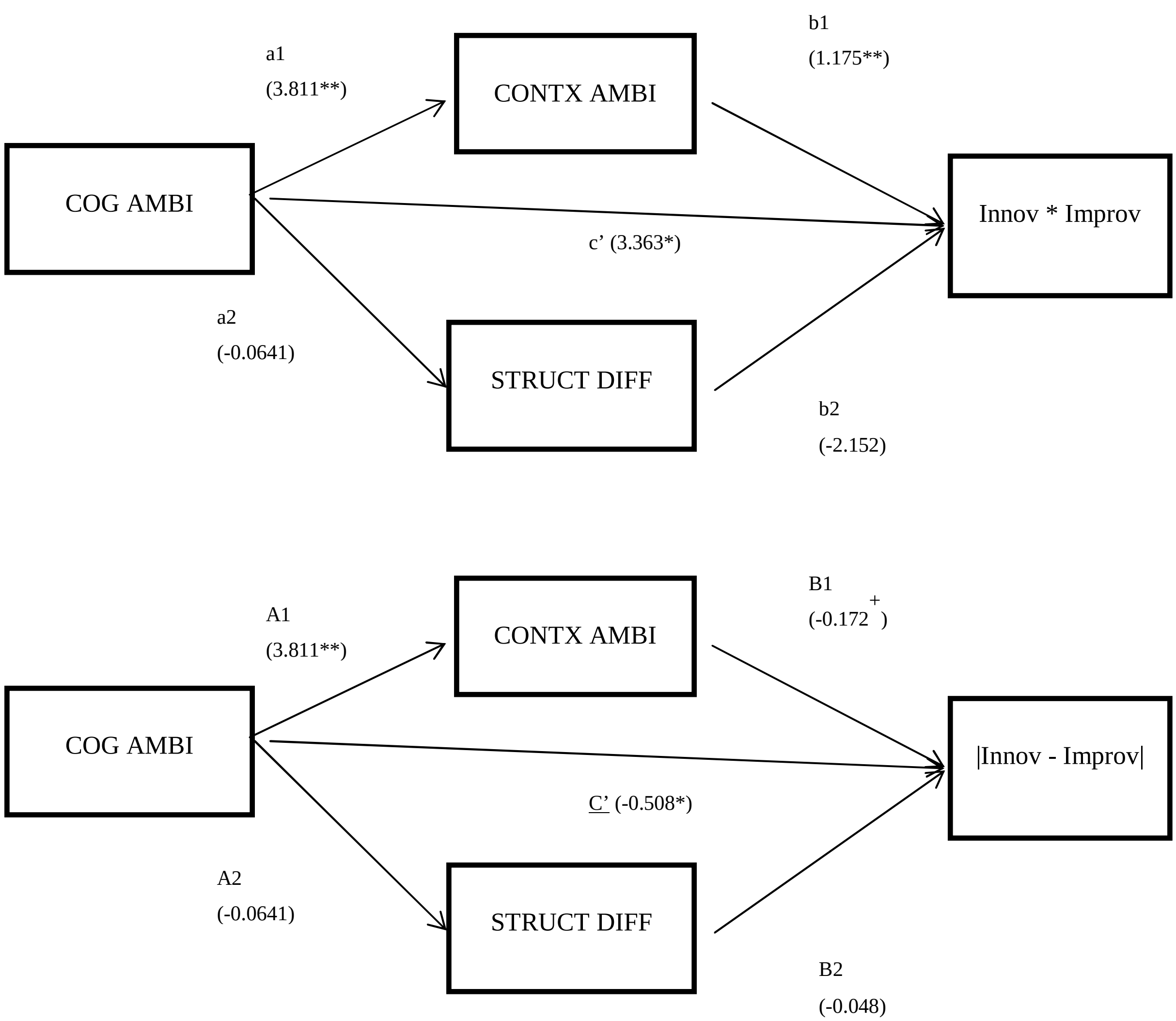
**Figure 3-2**: Ambidexterity and Performance




Do high technology divisions require channeling resources along both innovation and improvement dimensions? Figure 3-2 plots the relationship between the division's priorities on innovation and improvement strategies and divisional performance. We use the median scores in the performance scale to differentiate the high and low performers (Above the median indicate high performers; below the median indicate low performers). Figure 3-2 shows that divisions that stay along the diagonal simultaneously pursuing innovation and improvement strategies (balancing innovation and improvement) perform better than the rest. The absolute difference between innovation and improvement strategies has a negative association with the divisional performance ($\beta = -0.381$; $p<0.020$). That is, focusing too much on innovation or improvement strategies in high technology environments is negatively related to the divisional performance. How can high technology divisions simultaneously pursue both innovation and improvement strategies? Our research suggests the presence of two forms of ambidexterities that help divisions excel along both innovation and improvement.

### 3.4.2.3. Multiple Mediation among Ambidexterities

**Figure 3-3**: Multiple Mediation Effects among Ambidexterities




+ $p < 0.10$ * $p < 0.05$ ** $p < 0.01$

We also explored for multiple mediation effects among the three forms of ambidexterities (Barron and Kenny, 1981). Typically, one would expect the divisions to develop cognitive ambidexterity capability at the senior management level that would then facilitate the division to be contextually ambidextrous and structurally differentiated (Smith and Tushman, 2005). Hence, both contextual ambidexterity and structural differentiation partially mediate the effect of cognitive ambidexterity on the ability to balance innovation and improvement. We use the multiple mediation test proposed by Preacher and Hayes (2008) to test these paths. A multiple mediation test differs from the commonly used single mediation test (Sobel's test) in that it simultaneously estimates the effects of dependent variables through multiple mediators. This eliminates biasness due to omitted parameter estimates (Judd and Kenny, 1981). In addition, we also estimate the bootstrapped confidence intervals for the mediators to gain robust results (Using macro developed by Preacher and Hayes (2008)). Figure 3-3 shows the results from the multiple mediation tests. The direct effects from cognitive ambidexterity to the interaction measure of balancing ($c= 8.252$; $p< 0.0001$) are reduced in the presence of the mediators namely: structural and contextual ambidexterities. Indirect effects through contextual ambidexterity ($a_1b_1 = 4.479$; $p<0.05$) and structural differentiation ($a_2b_2 = 0.1379$; $p>0.10$) minimize the direct effects from cognitive ambidexterity to the interaction measure of balancing ($c' = 3.6359$; $p<0.05$). Similar results appear with the deviation measure of balancing ($A_1B_1= -0.0656$; $A_2B_2= 0.0031$; $C=-0.5711$; $C' = -0.508$).

These results provide support that contextual ambidexterity partially mediates the effect of cognitive ambidexterity on the division's ability to simultaneously innovate and improve. There is no mediation effect through structural differentiation. We also checked for other possible fits between the three ambidexterities but did not find any significant result.

## 3.5. Discussion and Conclusions

### 3.5.1. Implications for Theory

Scholarly work on understanding how organizations simultaneously excel along innovation and improvement has seen exponential growth (Jansen et al., 2009; He and Wong, 2004; Gibson and Birkinshaw, 2004; Smith and Tushman, 2005; Benner and Tushman, 2003; Katila and Ahuja, 2002). Ambidexterity is one approach to balance innovation and improvement (O'Reilly and Tushman, 2007). However, researchers have proposed several forms of ambidexterities: structural (O'Reilly and Tushman, 2004; Jansen et al., 2009), contextual (Gibson and Birkinshaw, 2005), and cognitive (Chandrasekaran et al., 2008; Smith and Tushman, 2005). Are all these ambidexterities equally important to balance innovation and improvement? And what are the antecedents to these different forms of ambidexterities?

This research is the first to empirically investigate both the consequence and the antecedents to ambidexterities. We argue that the three types of ambidexterities are manifested at different levels within the organization and are required to maintain the delicate balance. For example, cognitive ambidexterity – the ability to resolve strategic contradiction is present at the senior management level and is used to maintain a healthy balance of innovation and improvement activities. Organizational processes such as information analysis and methods, customer and market focus and IMP teams (all grouped as scanning practices) synthesize internal and external information and are used in deciding the right balance between innovation and improvement through a decision risk approach. Contextual ambidexterity allows for aligning and adapting decisions across the strategy and project levels to respond to frequent customer and market changes. Disciplined Project Management and metric alignment are approaches to connect innovation and improvement project level decisions with the division's strategies.

Testing this multilevel theory requires collecting data from various levels within the organization. We collected data from 34 high technology divisions and from over 110 projects. We sampled both innovation and improvement projects within these divisions to understand how these projects are aligned with the strategic intent of the division. Often these projects coexist in the same physical environment competing for similar resources. This helps us test the structural differentiation arguments.

Results from this research suggest the importance of cognitive and contextual ambidexterity on the ability to simultaneously execute innovation and improvement strategies. Contextual ambidexterity partially mediates the effect of cognitive ambidexterity on the ability to simultaneously innovate and improve. We find no support for structural differentiation arguments in this study. Although our explanation regarding cognitive ambidexterity accounting for structural differentiation seems rational, more research is required to understand this issue. For example, while we used the divisional managers' response on structural differentiation, our research also collects data on the type of incentives, project leadership and project team structures from both the project leaders and the team members. These results are discussed in the next chapter.

This study leads to three important implications for the ambidexterity literature. First, we provide empirical validation to the cognitive ambidexterity capability proposed by Chandrasekaran et al., (2008). We measure cognitive ambidexterity of the senior managers: the ability to resolve strategic contradiction between innovation and improvement, using a decision risk framework. We also relate it to the organization's ability to balance innovation and improvement.

Second, our research is the first empirical study to measure the antecedents to the organizational ambidexterities. Current literature on organizational ambidexterity proposes cognitive, contextual, and structural ambidexterities to be present at multiple levels within an organization (O'Reilly and Tushman, 2008; Raisch and Birkinshaw, 2008; Gibson and Birkinshaw, 2004). Studying them collectively requires data from informants at multiple levels within an organization. We collected such form of data which helps us examine the effects of all three ambidexterities on the ability to balance innovation and improvement.

Third, we provide support to Tushman et al., (2006) argument that balancing innovation and improvement is a multilevel phenomenon. We show how cognitive and contextual ambidexterities are simultaneously associated with the organization's ability to balance innovation and improvement. Although we did not find any effect of structural ambidexterity, researchers have shown the effect of structural ambidexterity on the ability to simultaneously innovate and improve (Jansen et al., 2009).

### 3.5.2. Implications for Practice

There are a few practical implications from this research. Results from this research indicate that high technology divisions that simultaneously pursue innovation and improvement strategies perform better in terms of Return on Investment, Profitability, Market Share Growth, Sales Growth, and Profit Growth. Results also suggest that pursuing too much innovation at the expense of improvement or vice versa lead to poorer performance.

Second, it is important for managers to understand that simultaneous execution of innovation and improvement is not a single level problem (strategic or project level) but requires synchronization across multiple levels. Findings from this research stress the importance of managing strategic contradiction at the senior management level (cognitive ambidexterity) to balance the right levels of innovation and improvement. Resolving the strategic contradiction requires senior managers to scan internally and externally to understand customer, market, and operational capabilities to consistently make the right decisions on innovation and improvement opportunities. Our research identifies methods such as IMP teams that help them do this. In addition, we identify mechanisms such as disciplined project management and scorecard approach that are required to align and adapt project level decision with the strategic level decisions (contextual ambidexterity). This is important in high technology environments characterized by frequent customer and market changes.

Our research study is limited in scope to high technology organizations. These organizations require simultaneous execution of innovation and improvement for their survival (He and Wong, 2004; Brown and Eisenhardt, 1997). This brings out the important question of whether the three forms of ambidexterity discussed in this research are required under other external contingencies. More research is required to understand these capabilities in other environmental conditions. We also note that ambidexterity is one among several approaches to balance innovation and improvement. There could be other mechanisms such as temporal separation that enable balancing both innovation and improvement demands in other external contingencies.

**Appendix 3-1:** Descriptive Statistics and Factor Loadings for the Items

| Items | Construct | Mean | Std. Deviation | Factor Loadings |
|---|---|---|---|---|
| Profitability | PERFORMANCE (Cronbach α = 0.88) Eigen Value = 3.754 | 4.8077 | 1.48243 | 0.787 |
| Return on Investment | | 5.0385 | 1.46811 | 0.791 |
| Market Share | | 4.6538 | 1.53245 | 0.732 |
| Profit Growth | | 4.5577 | 1.33451 | 0.825 |
| Sales Growth | | 4.3654 | 1.32885 | 0.845 |
| Market Share Growth | | 4.1023 | 1.45942 | 0.760 |
| Introduce new generation of products | INNOV [11] (Cronbach α = 0.83) Eigen Value = 2.252 | 4.7308 | 1.64633 | 0.893 |
| Enter new technology fields | | 4.2885 | 1.51252 | 0.896 |
| Open up new markets | | 4.4423 | 1.56448 | 0.807 |
| Extend product range | IMPROV [12] (Cronbach α= 0.71) Eigen Value = 1.956 | 5.0962 | 1.08934 | 0.631 |
| Refine existing product quality | | 5.0962 | 1.19245 | 0.804 |
| Increase production flexibility | | 4.8462 | 1.36317 | 0.729 |
| Reduce production cost | | 4.6154 | 1.34535 | 0.601 |
| Managers in this unit consistently make the right decision when catering to the needs of the future and current markets | COG AMBI (Cronbach α = 0.73) Eigen Value = 2.317 | 3.1887 | .98169 | 0.745 |
| Managers in this unit accept occasional new product failures as being normal | | 2.7547 | 1.17515 | 0.798 |
| Time spent by top managers on analyzing key decisions (e.g. in-depth research alternatives) has increased substantially | | 2.8491 | 1.09888 | 0.952 |
| Choices among strategic alternatives tend to be made quickly and without precision (Reversed) | | 2.875 | 1.0739 | 0.405 |
| The management systems in this unit work coherently to support the overall objectives of the division | ALIGN (Cronbach α = 0.73) Eigen Value = 2.058 | 3.5106 | 1.01879 | 0.744 |
| The management systems in this unit cause us to waste resources on unproductive activities (Reversed) | | 3.0000 | 1.17954 | 0.492 |
| People in this unit often end up working at cross-purposes because our management systems give them conflicting objectives | | 2.9787 | 1.11295 | 0.576 |
| People working in this unit are in synchronization with the product line's objectives (Reversed) | | 3.4043 | .99257 | 0.760 |

[11] Items INNOV and IMPROV were included in the EFA and they loaded as two factors.

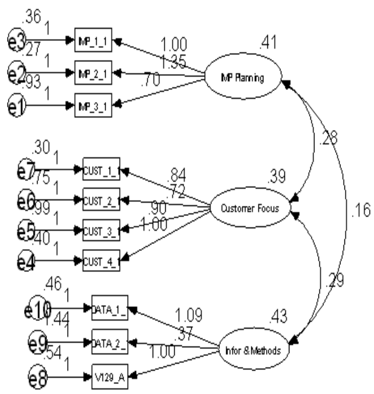
**Appendix 3-1 (Cont'd):** Descriptive Statistics and Factor Loadings for the Items

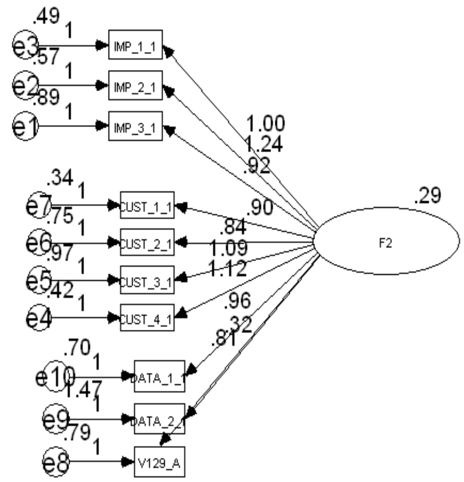
| Items | Construct | Mean | Std. Deviation | Factor Loadings |
|---|---|---|---|---|
| The management systems in this unit are flexible enough to allow us to respond quickly to changes in our markets | ADAPT (Cronbach α = 0.83) Eigen Value = 2.760 | 3.2766 | 1.17403 | 0.751 |
| The management systems in this unit allow us to identify opportunities outside the project requirements to support the strategic intent of the product line | | 3.2766 | 1.01515 | 0.657 |
| The management systems in this unit evolve rapidly in response to shifts in our business priorities | | 2.9583 | 1.11008 | 0.809 |
| Separate rewards and incentive systems exist in our unit for evaluating innovation projects and improvement projects | STRUCT DIFF or STRUCT AMBI (Cronbach α = 0.73) Eigen Value = 1.910 | 2.9375 | 1.170 | 0.731 |
| The project team organization (team role, reporting system etc.) is quite different between innovation projects and improvement projects | | 3.0625 | 1.390 | 0.620 |
| We have distinct organizational processes, structures and cultures for Innovation and Improvement projects | | 3.000 | 0.803 | 0.840 |
| The decision making team as a whole is apprised of all the relevant information associated with the decision making process | IMP TEAMS (Cronbach α = 0.70) Eigen Value = 1.820 | 3.5833 | 1.06857 | 0.662 |
| The decision making team consist of members from different organizational levels | | 3.4583 | 1.12908 | 0.662 |
| We involve a wide variety of functional representatives during our strategic decision process | | 3.9130 | 1.06606 | 0.809 |
| We strive to be highly responsive to our customers' needs | CUSTOMER & MARKET FOCUS (Cronbach α = 0.70) Eigen Value = 2.073 | 4.3125 | .80309 | 0.716 |
| Our customers are actively involved in the product/process design process | | 3.7708 | 1.03635 | 0.775 |
| We regularly survey our customers' requirements | | 3.6250 | 1.21384 | 0.693 |
| Customer requirements are thoroughly analyzed in the new product/ process design process | | 3.9167 | .94155 | 0.665 |
| In decision making, there is a great reliance on specialized technically trained line and staff personnel | INFO. ANALYSIS & METHOD (Cronbach α = 0.67) Eigen Value = 1.550 | 3.6042 | 1.04657 | 0.710 |
| We use techniques such as simulation to decide on major production, marketing and financial decisions | | 3.1250 | 1.29853 | 0.660 |
| We periodically brainstorm to seek novel solutions to problems | | 3.889 | 0.8338 | 0.472 |

**Appendix 3-1 (Cont'd):** Descriptive Statistics and Factor Loadings for the Items

| Items | Construct | Mean | Std. Deviation | Factor Loadings |
|---|---|---|---|---|
| The performance standards in our unit are pretty well established and known to all of the project team members | DISCIPLINED PROJ MANAGEMENT<br><br>(Cronbach α = 0.70)<br><br>Eigen Value = 1.997 | 3.7191 | 0.999 | 0.722 |
| As a project team, we get fast feedback for our work from our senior managers | | 3.0562 | 1.037 | 0.737 |
| My team gets rewarded or punished based on the rigorous measurement of business performance against our goals | | 2.7303 | 1.019 | 0.669 |
| Everything that we do in our project gets measured and recorded by our management staff | | 2.6404 | 1.089 | 0.706 |
| We use a scorecard/ dashboard approach to connect our project goals with the overall product line goals | SCORECARD APPROACH<br><br>(Cronbach α= 0.70)<br><br>Eigen Value = 1.784 | 2.8315 | 1.272 | 0.684 |
| My project team performances are linked with the product line's strategies | | 3.6742 | 1.008 | 0.788 |
| The project planning document for the team is based on the product line's plan | | 3.5393 | 1.034 | 0.846 |

**Appendix 3-2: Comparing the three factor correlated model and the single factor model fits for Scanning**

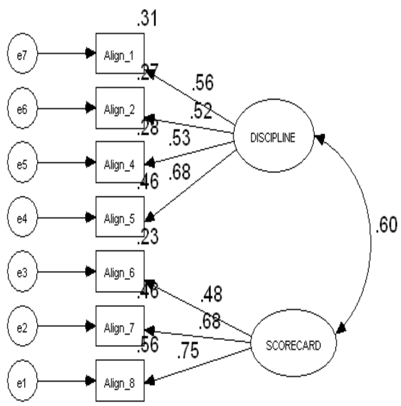


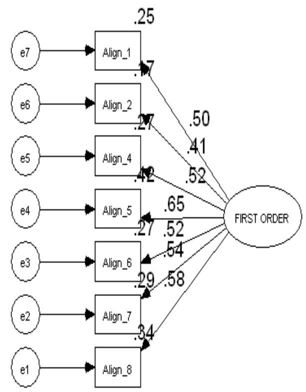




| | Three Correlated Factor | Single Factor |
|---|---|---|
| χ2 test statistic (df) | 39.783 (32) | 57.334 (35) |
| Root mean square error of approximation (RMSEA) – point estimate | 0.068 | 0.111 |
| RMSEA—90% confidence interval | 0.000 : 0.130 | 0.055: 0.161 |
| p value Ho: close fit (RMSEA_0.05) | 0.318 | 0.041 |
| Standardized root mean square residual (RMR) | 0.092 | 0.103 |
| Goodness-of-fit index (GFI) | 0.861 | 0.816 |
| Comparative fit index (CFI) Incremental fit index | 0.927 | 0.790 |
| (CFI) | 0.935 | 0.808 |
| Adjusted GFI | 0.762 | 0.710 |

The second order factor model (not shown here) has a significantly better fit when compared to the first order factor model.

**Appendix 3-3: Comparing the two factor correlated model and single factor model fits for PROJ_ANTE**




| | Two Correalted Factor | Single Factor |
|---|---|---|
| χ2 test statistic (df) | 35.370 (13) | 51.645 (14) |
| Root mean square error of approximation (RMSEA) – point estimate | 0.066 | 0.084 |
| RMSEA—90% confidence interval | 0.047: 0.126 | 0.113: 0.205 |
| p value Ho: close fit (RMSEA_0.05) | 0.061 | 0.000 |
| Standardized root mean square residual (RMR) | 0.076 | 0.084 |
| Goodness-of-fit index (GFI) | 0.926 | 0.890 |
| Comparative fit index (CFI) Incremental fit index | 0.990 | 0.981 |
| (CFI) | 0.991 | 0.982 |
| Adjusted GFI | 0.840 | 0.780 |

The second order factor model (not shown here) has a significantly better fit when compared to the first order factor model.

**Appendix 3-4**: Assessment of Discriminant Validity for Ambidexterity Measures
(Chi-square differences between the free model and the model with correlation constrained to one is shown in the table)

| | Cognitive | Structural | Alignment | Adaptability |
|---|---|---|---|---|
| Cognitive | | | | |
| Structural | 6.9 | | | |
| Alignment | 8.6 | 8.1 | | |
| Adaptability | 9.3 | 16.5 | 7.8 | |

All Chi-square differences were significant at the 0.01 level (for 1 d.f.)

**Appendix 3-5:** Sample Characteristics

| | |
|---|---|
| Average Sales (in Millions of Dollars) | 6067.84 |
| Average R&D Expenditure (in Millions of Dollars) | 334.87 (425.26) |
| Total Number of Employees (in thousands) | 7.815 |
| Training Expenditures (as a % of Sales) | 3.99% (5.553) |
| Competitive Intensity[1] | 3.5833 (on a Scale of 5) |

[1] Competitive Intensity was measured on the following items regarding the pace of change in their industry during the last five years as reported by the divisional manager (1= very slow, 5=very fast)
(Change in Industry sales, Change in Industry employment, Pace of technological change in the industry & Emergence of newer competition)

**Appendix 3-6: 3SLS Regression Results**

| | Cognitive Ambidexterity | Contextual Ambidexterity | BALANCE INNOVATION AND IMPROVEMENT | | Performance |
|---|---|---|---|---|---|
| | | | Innov * Improv | \|Innov – Improv\| | |
| Independent Variables | Model I | Model II | Model III | Model IV | Model V |
| Constant | 1.3026$^{+}$ | 12.482** | -19.174 | 3.8402 | 5.808** |
| Division Size (Log Sales) | -0.0789 | -1.7637*** | 2.832 | 0.1436 | 0.1609 |
| Semiconductor[1] | 0.0079 | 2.065 | 4.727 | -1.029 | -0.7414 |
| Electronic Mfg | 0.4150 | 0.5541 | -5.295 | -0.515 | -1.531 |
| Aerospace | 0.3840 | -3.305 | 4.020 | 0.258 | -0.266 |
| Other High Tech | -0.1225 | -2.272 | 8.457 | -0.697 | -0.766 |
| SCANNING | 0.6172*** | | | | |
| PROJ_ANTE | | 3.216** | | | |
| COG AMBI | | | 5.682* | -0.602$^{+}$ | |
| CONTX AMBI | | | 1.19586** | -0.110* | |
| STRUCT AMBI | | | -1.5192 | -0.137 | |
| Innov * Improv | | | | | 0.0800* |
| \|Innov – Improv\| | | | | | -0.8419** |
| $R^2$ | 0.4542 | 0.4356 | 0.4262 | 0.1408 | 0.4654 |
| $\chi^2$ | 25.52*** | 22.81*** | 45.57** | 37.22* | 34.98** |

+p < 0.10; *p<0.05; **p<0.01; ***p<0.001

**3SLS Regression Results**

A three stage least squares (3SLS) regression is an improvement over the 2SLS procedure and is used to estimate a system of simultaneous equations (Kennedy, 2001). The 3SLS procedure can be summarized as follows:

**Stage 1**: calculate the 2SLS estimates of the identified equations
**Stage 2**: use the 2SLS estimate to estimate the structural equations' errors and then use these to estimate the contemporaneous variance – covariance matrix of the structural equations' errors
**Stage 3**: apply GLS to the large equation representing all the identified equations of the system.
The system of simultaneous equations in the Figure 3-1 can be represented as follows:

COG AMBI = SCANNING Industry_1 Industry_3 Industry_4 Industry_5 LOG_SALES (Equation 1)

CONTX AMBI = PROJANTE Industry_1 Industry_3 Industry_4 Industry_5LOG_SALES (Equation 2)

INNOV*IMPROV = COG AMBI CONTX AMBI STRUCT DIFF (Equation 3)

|INNOV-IMPROV| = COG AMBI CONTXAMBI STRUCT DIFF (Equation 4)

PERFORMANCE = INNOV*IMPROV |INNOV-IMPROV| (Equation 5)

Where, SCANNING and PROJ_ANTE are treated as Instrumental variables (IV). That is, our theory argues for SCANNING and PROJ_ANTE to be related to COGAMBI and CONTX AMBI. They only affect INNOV*IMPROV and |INNOV – IMPROV| through these ambidexterity measures.

For example, the following two step procedure is used to check whether PROJ_ANTE is a good Instrumental Variable for the affect of CONTXAMBI on say the interaction measure of balance (INNOV * IMPROV).

**Step 1:**

Regress PROJ_ANTE on CONTX AMBI with all the other predictors in the model, and save the predicted values. That is,

$$\text{CONTX\_AMBI} = \beta_0 + \beta_1 PROJ\_ANTE + \hat{\beta}(INDUSTRY) + \hat{\beta}(LOG\_SALES) + \varepsilon$$

The predicted values are saved as $\overrightarrow{\text{CONTX\_AMBI}}$

**Step 2:** In the second step, regress the predicted values on the interaction measure (INNOV*IMPROV). The following table shows the Beta coefficients from the IV method and the OLS procedure.

**Results from the Instrumental Variable (IV) Method (Two Step):**

**Coefficients**[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 30.171 | 8.111 | | 3.720 | .001 | | |
| | LOG_SALES | -1.208 | 1.166 | -.198 | -1.036 | .308 | .788 | 1.270 |
| | Industry_1 | 9.937 | 5.879 | .310 | 1.690 | .101 | .853 | 1.173 |
| | Industry_3 | 1.121 | 5.326 | .039 | .210 | .835 | .857 | 1.167 |
| | Industry_4 | 1.791 | 5.814 | .056 | .308 | .760 | .872 | 1.147 |
| | Industry_5 | -2.191 | 4.910 | -.081 | -.446 | .659 | .867 | 1.153 |
| 2 | (Constant) | -23.160 | 18.066 | | -1.282 | .210 | | |
| | LOG_SALES | 2.816 | 1.618 | .461 | 1.741 | .092 | .315 | 3.176 |
| | Industry_1 | 4.175 | 5.459 | .130 | .765 | .450 | .760 | 1.315 |
| | Industry_3 | .733 | 4.672 | .025 | .157 | .876 | .856 | 1.168 |
| | Industry_4 | 8.816 | 5.548 | .275 | 1.589 | .123 | .736 | 1.358 |
| | Industry_5 | 6.900 | 5.153 | .256 | 1.339 | .191 | .606 | 1.651 |
| | Unstandardized Predicted Value | 2.255 | .702 | .792 | 3.211 | .003 | .363 | 2.755 |

a. Dependent Variable: BALANCE

**Results from the OLS Regression Procedure**

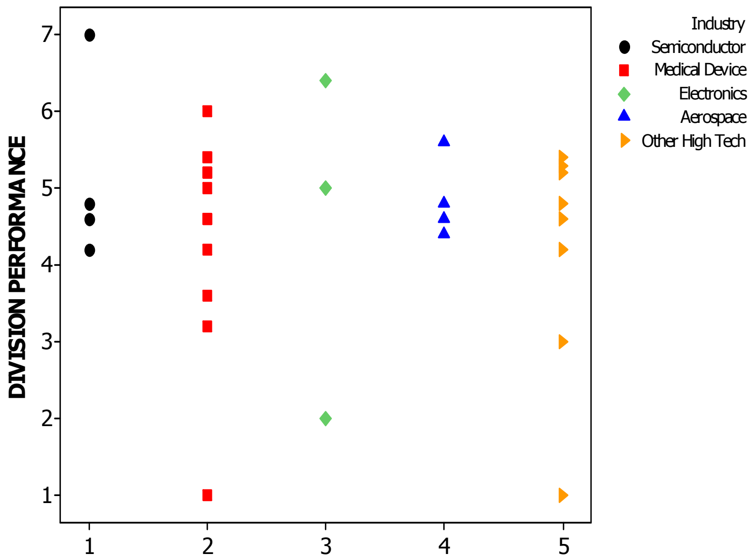
**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 32.322 | 8.128 | | 3.977 | .000 | | |
| | LOG_SALES | -1.601 | 1.182 | -.258 | -1.354 | .186 | .805 | 1.243 |
| | Industry_1 | 10.915 | 5.881 | .346 | 1.856 | .074 | .839 | 1.192 |
| | Industry_3 | -1.388 | 5.726 | -.044 | -.242 | .810 | .885 | 1.130 |
| | Industry_4 | 1.808 | 5.763 | .057 | .314 | .756 | .874 | 1.145 |
| | Industry_5 | -2.029 | 4.876 | -.076 | -.416 | .680 | .870 | 1.150 |
| 2 | (Constant) | -2.356 | 8.686 | | -.271 | .788 | | |
| | LOG_SALES | .968 | .971 | .156 | .997 | .327 | .609 | 1.642 |
| | Industry_1 | 7.373 | 4.253 | .234 | 1.734 | .094 | .819 | 1.221 |
| | Industry_3 | -1.807 | 4.092 | -.057 | -.442 | .662 | .885 | 1.130 |
| | Industry_4 | 6.482 | 4.208 | .206 | 1.540 | .135 | .836 | 1.196 |
| | Industry_5 | 4.030 | 3.662 | .151 | 1.100 | .281 | .787 | 1.271 |
| | CONTX AMBI | 1.481 | .276 | .770 | 5.368 | .000 | .723 | 1.383 |

a. Dependent Variable: BALANCE

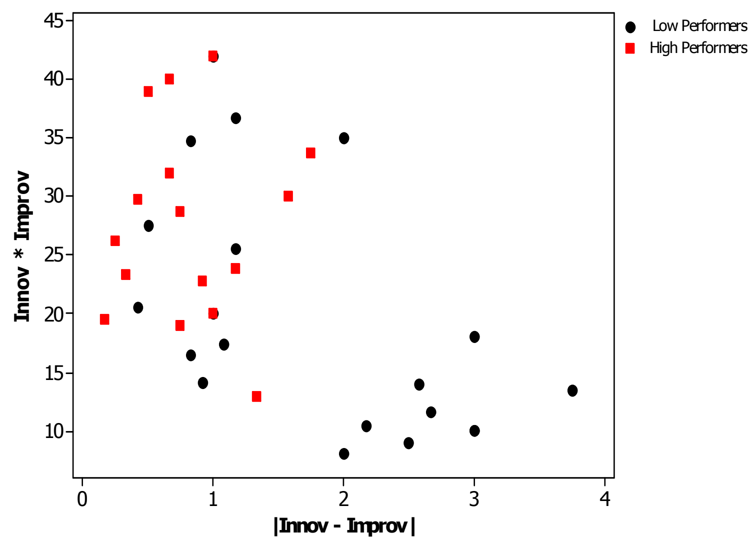
It is seen that the OLS estimate for CONTX AMBI ($\beta$ = 1.481) has an effect smaller than the IV procedure ($\beta$ = 2.255). The standard error on the OLS estimate is also considerably smaller. Wider confidence interval is the price we pay to get a consistent estimator of CONTX AMBI, if we believe that the above estimate is biased.

**Appendix 3-7:** Industry type and Divisional Performance




Note: Appendix 3-7 indicate absence of trend between Industry on Divisional Performance

**Appendix 3-8:** Measures of Balance – Multiplicative & Absolute Difference




Note: Appendix 3-8 indicate that divisions that score high on the multiplicative measure and low on absolute difference measure outperform the rest ($\rho = -0.512$, $p<0.01$)

## Appendix 3-9: Sobel's Test

| | Independent Variable | Mediator Variable | Dependent Variable | Sobel Test Statistic |
|---|---|---|---|---|
| 1 | SCANNING | COG AMBI | Innov * Improv | 2.124** |
| 2 | SCANNING | COG AMBI | \|Innov – Improv\| | 1.759* |
| 3 | PROJ_ANTE | CONTX AMBI | Innov * Improv | 2.268** |
| 4 | PROJ_ANTE | CONTX AMBI | \|Innov – Improv\| | 1.654* |

*p < 0.05; **p<0.01

## Appendix 3-10: Post Hoc Statistical Power Analysis for Multiple Regression Models

To determine the statistical power of the OLS Regression results, the following power analysis is performed based on Cohen's (1988) Statistical Power Analysis criteria. An interactive software[12] is used to compute the statistical power of the test results. This is based on the (1) type I error (0.05), (2) number of predictors (n=7) in the final model, (3) observed $R^2$ (0.482 for the final model) and (4) the sample size (34 divisions). The observed power is found to be 0.9704 (well above the cutoff 0.8 suggested by Cohen 1988).

[12] http://www.danielsoper.com/statcalc/calc09.aspx
http://www.danielsoper.com/statkb/topic09.aspx

# CHAPTER 4

# Explaining Structural Ambidexterity in High Technology Organizations

## 4.1. Introduction

> *"You know it's tough to manage innovation and improvement projects especially when your management tells you to be efficient and structured in both." –Project Leader 1 (Case Study from Firm A)*

> *"I can't stand this. One minute the management team is telling us to innovate, and the next minute they are giving us our marching orders in deploying Six Sigma. It's crazy to tell people they should be focused on becoming more efficient while at the same time you want them to explore untapped growth potential. This is making me nuts" –Jeneanne Rae, Business Week (June 2007)*

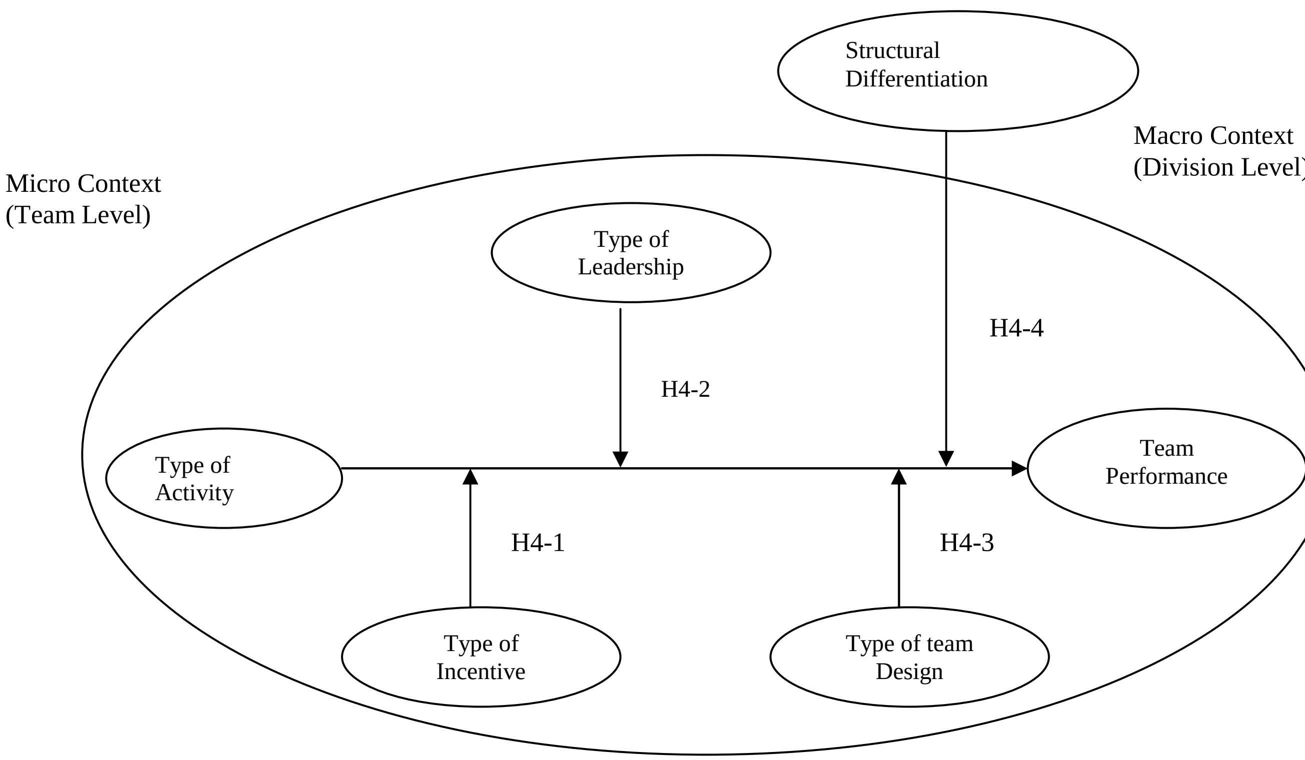
Structural ambidexterity (or structural differentiation), which involves creating distinct organizational structures and cultures for exploring and exploiting is one approach to ensure that organizations simultaneously innovate and improve (O'Reilly and Tushman, 2004; Jansen et al., 2009). Organizational structures in the past meant spatial separation between innovation and improvement (Duncan, 1976). However, such spatial separation is not possible in high technology organizations where innovation and improvement projects need to coexist (Burgelman et al., 2008; Cole, 2001; Cole and Matsumiya, 2007; Jayanthi and Sinha, 1998). Reduced product and process lifecycles and increased competition requires high technology organizations use similar resources (project teams, project leaders) to accelerate the learning rates between innovation and improvement activities (Jansen et al., 2009; Brown and Eisenhardt, 1997; Bettis & Hitt, 1995). This is accompanied by numerous outcries and agonies expressed by the project leaders and the project team members working on innovation and improvement projects

(Rae, 2007; Creveling, 2007). The quotes in the beginning of this chapter describe the plights of project managers who lead Improvement and Innovation projects. Innovation projects are long term oriented and have less predictable outcomes when compared to improvement projects which are short term and more predictable. Adopting similar project management techniques for these projects can be detrimental. For instance, a recent study by Burgleman et al. (2008) shows that 3M rewards its project leaders (Black Belts) and its project team members (Green Belts) based on the project outcomes that fostered improvement at the expense of innovation. This was against the innovation culture at 3M and resulted from the change in top management leadership.

Structural ambidexterity in this context entails creation of distinct rewards, team leadership, team structures, and organizational processes that can promote coexistence of innovation and improvement. In fact, structural ambidexterity can be broken down into organizational macro and micro contexts. For example, the team rewards, team leadership, and project team structures collectively represent the organizational micro context that vary across the teams within a division or a firm and are influenced by the project teams (Zellmer-Bruhn and Gibson, 2006). Organizational processes, cultures and structures that are invariant across the teams within a division or a firm constitute the macro context (Gladstein, 1984). Both organizational micro and macro context influence how innovation and improvement projects are managed.

Although ambidexterity researchers have argued about the importance of organizational and team level differences, there is lack of research exploring the specific factors that permit simultaneous deployment of innovation and improvement (Adler et al., 2009; Raisch and Birkinshaw, 2008; Jansen et al., 2009). This research is the first attempt to empirically examine how innovation and improvement projects that coexist are managed. Drawing from the organizational learning and the leadership theories, we investigate the effects of macro context (organizational level, e.g., project reporting structures, organizational processes) and micro context (project team leadership, project incentives, and project team structures) on innovation and improvement project performance. Data for this research comes from 110 innovation and improvement projects that belong to 34 high technology divisions. Our study theorizes and examines the presence of a cross level relationship between organizational context and the project level characteristics (Zellmer-Bruhn and Gibson, 2006). In addition, we theorize and measure the project team leadership, the project team incentives, and the project team structures required for innovation and improvement. Figure 4-1 gives the research model investigated in this paper.

**Figure 4-1:** Moderation Effects on Team Performance



The next section presents the literature review and hypothesis underlying our research model shown in Figure 4-1. Then, we discuss our research design to collect both the organizational and project level data from 34 high technology divisions. This follows with a discussion of the results, implications for theory, practice, and future research.

### 4.2. Structural Ambidexterity – A Theoretical Framework

The major question among management scholars is how can a few organizations survive and even flourish in the face of change while others cannot? The central tenet behind this question is the ability to exploit existing assets in a profitable way and simultaneously explore newer technologies, competencies, and markets (O'Reilly and Tushman, 2008; Holmqvist, 2004; March, 1991; Teece, 2006). To simultaneously explore and exploit, organizations are required to maneuver and adapt their operational capabilities. The Strategic Management literature refers to this as *dynamic capability* (Teece et al., 1997; Zahra and George, 2002). A vast array of operation management literature argues for the tradeoff between long term and short term dynamic capabilities (Adler et al., 1999; Eisenhardt and Tabrizi, 1995; Hayes and Pisano, 1996; Hayes, 2002; Sitkin et al., 1994; Juran, 1988). For example, Eisenhardt and Tabrizi (1995) illustrate tradeoffs between two different types of product innovation strategies: a compression strategy model which assumes well-known, rational process and which relies on squeezing together the sequential steps in product development, and an experiential strategy, which assumes an uncertain process and dynamic environment and relies on improvisation, flexibility and real-time experience. Similarly, Adler et al. (1999), from their study in the NUMMI automobile plant, report tradeoffs between flexibility and efficiency. Sitkin et al. (1994), in their theoretical work, contrast quality control practices that are aimed at the current markets from quality learning practices aimed at the future markets. They further emphasize the need for changing organizational characteristics such as incentives, leadership, etc. that are contingent with the practices deployed. Another relevant work in the field of product development proposes a tradeoff between “project firmness” and “project flexibility” (Tatikonda and Rosenthal, 2000).

Nevertheless, recent research in operations management has shown that successful organizations are able to overcome this tradeoff by maneuvering their structural and infrastructural practices (see Lapre and Scudder, 2004; Adler et al., 1999; Hayes and Pisano, 1996). This capability is referred as *ambidexterity* in the organizational literature (Duncan, 1976; Burgleman et al., 2008). Ambidextrous organizations consist of multiple internally inconsistent architectures that have collective capability of simultaneously pursuing short term efficiency as well as long term innovation (O’Reilly and Tushman, 2004). Theoretical arguments to explain ambidexterity include: (1) *temporal ambidexterity*, which assumes that the rate of change in markets and technologies proceeds at a pace that permits organizations to innovate and improve sequentially (Volberda, 2004); (2) *structural ambidexterity* or Structural Differentiation of having separate subunits, business models, processes, incentives, and cultures to innovate and improve simultaneously that are internally aligned (O’Reilly and Tushman, 2004); (3) *contextual ambidexterity*, the ability to align and adapt the organization to frequent changes (Gibson and Birkinshaw, 2004) and (4), *cognitive ambidexterity,* the ability of the senior management to manage strategic contradiction between innovation and improvement (Chandrasekaran et al., 2008).

While temporal ambidexterity is feasible in many circumstances, this approach of sequential deployment of innovation and improvement may not work well in high technology organizations. Rapid changes in product and process lifecycles and increased competitive pressures require high technology organizations to pursue innovation and improvement simultaneously (Brown and Eisenhardt, 1997; He and Wong, 2004). Clearly, structural ambidexterity of simultaneous execution of innovation and improvement is a better approach under this contingency. In the past, structural ambidexterity meant spatial separation. That is, focusing on innovation in the R&D units while improvement takes place in the manufacturing units (Van de Ven, 1986; Duncan, 1976). Spatial separation is hard to achieve in dynamic environments. For example, Cole and Matsumiya (2007) attribute the Japanese loss of the DRAM (Dynamic Random Access Memory) chip industry to Korean firms due to their inability to simultaneously improve and innovate.

Other recent studies have also supported the argument that innovation activities (especially process innovation) coexist with improvement activities in the manufacturing and R&D units (Jayanthi and Sinha, 1998; Adler et al., 2009; O'Reilly et al., 2007). Structural ambidexterity in fast paced envrionemnts entails differences in the infrastructural practices (e.g., rewards, team structures, team decision making, and leadership) that permit coexistence of innovation and improvement. Consistent with the current literature, we refer to these as *micro contextual practices* (Mathieu et al., 2008). In addition, the *organizational context* (the overarching structure and systems external to the team) influences innovation and improvement project performance (Sarin and McDermott, 2003). Little is known about how both macro and micro level practices relate with innovation and improvement projects. Our research addresses this limitation and develops a theoretical explanation connecting the macro and micro contexts.

## 4.3. Unraveling Structural Ambidexterity

### 4.3.1. The Role of Incentives

Several scholars have studied the effects of rewards and incentives on motivation and performance (Stewart et al., 1993; Dearden and Ickes, 1990). A key aspect to simultaneous execution of innovation and improvement involves designing incentive structures that can sustain innovation. This is because innovative activities typically require a longer duration to bestow significant results (Balkin et al., 2000; David et al., 2001; Dearden and Ickes, 1990). Improvement activities, on the contrary, require a shorter duration to provide the necessary results. Previous studies have shown that incentives and reward structures have substantial effects on the extent of creativity and control (Sarin and Mahajan, 2001; Huber and Brown, 1991; Leonard-Barton, 1992; Carrillo and Gaimon, 2004; Sitkin et al., 1994). For example, Carrillo and Gaimon (2004) have analytically shown that an ideal incentive system for a target-goal activity (improvement) emphasizes the realization of predictable and consistent performance and is outcome-driven, while the incentive system for a threshold-goal activity (innovation) emphasizes the importance of uncertainty and risks and is process-driven. An outcome-based incentive structure stresses reducing errors and is tied to the bottom-line profitability of the project (Sarin and Mahajan, 2001) while a process-based incentive (threshold) structure provides high tolerance for errors, thereby creating opportunity to learn in uncertain situations and is associated with long term project success (Thompson, 2004).

Project leaders that adopt an outcome-based incentive structure reward their team members based on short term results and can discourage the teams from experimenting and learning (Levinthal and March, 1993). Instead they should encourage innovation by rewarding team members for exploring or knowledge seeking activities. This provides a safety net in cases of failures. Safety nets imply the need to disregard failures that occur in the path toward innovation. Hence, project leaders should adopt an outcome-based incentive structure for improvement activities and incorporate a process-based incentive structure that fosters exploration and learning for innovation. The type of incentive structure adopted while monitoring an innovation or improvement project can influence its impact on the overall project performance, which suggests the following hypothesis.

*Hypothesis 4-1: The effect of innovation or improvement activities on project performance is moderated by the type of incentive structures adopted when working on these projects. That is,*

*H4-1a: The effect of improvement activities on the project performance is moderated by an outcome-based incentive structure*

*H4-1b: The effect of innovative activities on the project performance is moderated by a process-based incentive structure*

### 4.3.2. Strategic Leadership Theories

In general, researchers have acknowledged the importance of leadership in sustaining improvement or innovation (Jansen et al., 2009; Anderson et al., 1994; Juran, 1995). For example, process management literature argues for the importance of leadership in improving existing processes (Schroeder et al., 2008; Hahn et al., 1999) while Amabile (1996) in her work supports the importance of leadership in enhancing creativity in the R&D laboratory.

Burns (1978) provides a well-established classification of leadership style: *transactional leadership* and *transformational leadership*. Transactional leadership motivates individuals primarily through rewards and goals (Avolio et al., 1999). "Transactional leaders set goals and articulate explicit agreements regarding what leaders expect from organizational members and how they will be rewarded for their efforts, commitment and provide constructive feedback to keep everybody on task" (Vera and Crossan, 2004, p.224). Such a leadership style would be best suited for reinforcing existing practices and embedding them into the individual organization's culture. Since this type of leadership style promotes goals through contingent rewards, they enhance improvement activities that have faster returns and are focused on short term goals (Vera and Crossan, 2004). Transformational leadership, in contrast, is charismatic, intellectually stimulating and individually considerate (Avolio et al., 1999). These types of leaders aid individuals to transcend their self interest for the sake of the larger vision of the organization (Waldman, 1994). Transformational leadership behavior reflects the openness of the organization and promotes innovative abilities of the individuals in the organization (Vera and Crossnan, 2004). Such a leadership style will aid in institutionalizing newer routines that challenge existing routines.

It is common for high technology organizations to have project leaders lead both innovation and improvement projects (Rae, 2007). Project leaders, while monitoring improvement projects, should adopt a transactional leadership style which promotes feedback flows of learning that take advantage of existing learning stored in the firm's culture, structure, strategy, and procedures (Vera and Crossan, 2004). The contingent reward behavior reflected in transactional leadership provide the focus and discipline that the team members need to concentrate efficiently and to become consistently better at performing current routines (Jansen et al., 2009). Innovation projects, however, require *both* transactional and transformational leaderships for effective performance. A recent case study by Chandrasekaran et al., (2008) indicates that project leaders exhibit transformational leadership during the conceptual and design phases of an innovation project. They function as a transactional leader, meeting with the teams more than once a week, giving them explicit instructions and providing timelines and targets during the deployment phase.

In general, innovation project leaders exhibit an ambidextrous leadership style. Maintaining dual roles of transactional and transformational leadership during innovation projects encourages creativity while also ensuring the projects to proceed through a structured development process at a reasonable speed. Inconsistency in the project team leadership while leading these projects may result in poor project performance. Hence we suggest,

*Hypothesis 4-2: The effect of innovation or improvement activities on project performance is moderated by the leadership style of the project leader.*

*H4-2a: The effect of improvement activities on project performance is moderated by the transactional leadership style employed by the project leader*

*H4-2b: The effect of innovative activities on project performance is moderated by the ambidextrous leadership style employed by the project leader*

### 4.3.3. Project Team Differences

Most of the innovation and improvement opportunities occur in the form of projects. Using similar project teams for innovation and improvement can be detrimental since these tasks require different team autonomy, team composition, and supporting structures (Stewart, 2006). Previous research has shown that these task differences moderate between the project team structures and performance (Stuart and Barrick, 2000; Campian et al., 1997). For example, if one were to categorize project teams in the order of increasing autonomy, then project teams range from quality circles to self managing and self designing teams (Hackman, 1987; Thomson, 2004).

Self managing project teams are more substantive in nature as they are able to design and implement their solutions without authorization from senior levels of management. These types of project team structures are found to be effective especially when the team tasks are unclear and involve substantial conceptual work (Manz and Stewart, 1997; Stewart and Barrick, 2000). Similarly, research has also shown that for activities that involve clearly defined goals and those that are based on existing knowledge, self-managed team structures have lesser impact on project performance (Stewart, 2006; Stewart and Barrick, 2000). Higher autonomy during these activities can sometime result in the project teams searching for complex solutions to simple problems causing project delays and poor performance (Adler and Cole, 1992). For these types of activities, a hierarchical organizational structure with the leadership outside the team or an assigned team leader can lead to increased efficiency and superior performance (Adler and Cole, 1992). Hence, innovation projects that involve high amounts of creativity and idea generation procedures will benefit from a self-managed team structure, while this type of team structure will have significantly less impact during improvement projects. Improvement projects can benefit if the project team members and project leader work on multiple projects that share similar knowledge. This enhances learning and knowledge transfer across these projects which in turn can benefit their project performance (Ellis et al., 2003).

Innovation project teams focus on creating new knowledge and have an *X-team* structure, with expandable tiers, full time core team membership and extensive ties that accommodates higher levels of complexities (Ancona and Caldwell, 1999; Chesbrough, 2003). In X-teams, project team members and leaders have almost full time responsibility while working on these projects and seldom work on multiple projects at a given point in time. Clearly, innovation and improvement projects have differences in their team structures that can influence their project outcomes. Hence we suggest,

*Hypothesis 4-3: The effect of innovation or improvement activities on project performance is moderated by the type of project team structure*

> *H4-3a: The effect of self-managed team structure on project performance will be more pronounced during innovation projects when compared to improvement projects.*
>
> *H4-3b: The effect of X-Team structure on project performance will be positive for innovation projects and negative during improvement projects.*

### 4.3.4. Structural Differentiation – An Organizational (Macro) Context

There have been theoretical arguments proposed on the importance of structural differentiation, or the subdivisions of organizational tasks by maintaining distinct cultures to innovate and improve (Benner and Tushman, 2003; Jansen et al., 2009).

Structural differentiation is critical to structural ambidexterity that argues for having separate organizational processes and cultures to innovate and improve (O'Reilly and Tushman, 2004). It protects ongoing improvement projects that are deterministic and short term from interfering with the innovation projects that are uncertain and long term (Jansen et al., 2009). Structural differentiation – a macro level context (organizational) – is invariant across project teams and is less influenced by the project teams (Zellmer-Bruhn and Gibson, 2006; Mathieu et al., 2008). Usually championed by the senior levels of the management, it facilitates an organization wide recognition toward innovation and improvement differences.

Little is known about the effect of organizational level context on project performance. One key reason for this is the difficulty of data collection across multiples levels within an organization (Mathieu et al., 2008). Most large samples of teams come form either a single division or a single organization offering no variance in these macro contexts. Structural differentiation – one such macro level context – can significantly impact innovation and improvement project performance especially in the fast-paced organizations (Rothaermel and Alexandre, 2009). Divisions that have separate organizational cultures, reporting structures, and incentives for innovation and improvement projects, avoid undue preference among the project team members to one of these activities and ensure better project performance on both fronts. That is, innovation and improvement projects perform better in divisions that have higher structural differentiation, which suggests the following hypothesis.

*Hypothesis 4-4: The higher the structural differentiation (separate organizational cultures, processes and structures) within a division, the higher is the innovation and improvement project performance.*

Figure 4-1 summarizes these hypotheses. The project team incentives, project team leadership, and project team structures represent the micro-level context while structural differentiation represents the macro-level context. Both micro and macro level contexts influence project performance.

## 4.4. Research Design

### 4.4.1. Data Collection Procedure

Our procedure consists of a multiple case study approach at four high technology divisions involving over 200 participants (53 interviews conducted with the strategic and project level respondents) not reported here to understand the problem in detail, followed by a survey data collection from 34 other high technology divisions involving over 110 innovation and improvement projects (313 respondents).

The survey data collection took place between January 2008 and March 2009. Project leaders and project team members responded on the project team constructs. We also collected data from strategic level respondents (Vice Presidents, Chief Technology Officers and Divisional Managers) from the 34 divisions on the organizational attributes (e.g., structural differentiation) that can influence innovation and improvement projects. Our research design to collect this type of multilevel data involved partnering with high technology agencies such as the LifeScience Alley Institute, the Minnesota High Technology Association and the Joseph Juran Center for Leadership in Quality.

Our first contact involved sending out an executive summary (through personalized email messages) to over 190 divisional heads (CTO’s & Vice Presidents) describing the research study and the potential benefits from their participation. Divisions were sampled based on their industry clockspeed, competitive intensity, and R&D expenditures (Fine, 1998). We requested the divisional heads to contact us for more information regarding this study. Forty-one divisional representatives came back to us seeking more information on this study. We conducted phone conversations and in-person meetings with each of these representatives to explain the research design (collecting data from both the strategic and the project level respondents), research method (web survey) and time commitment from these respondents (7-10 minutes to complete the survey).

Five divisions refused to participate in our study, leaving our total sample at 36 divisions (32 divisions in the North America and 4 divisions outside North America). We worked closely with each of these 36 division contacts in order to sample the appropriate respondents for our study. For instance, the research team spent considerable time to understand the organizational culture, innovation and improvement methods used by the division (e.g., Six Sigma, DFSS methodologies) and the nature of their business (competition, product, process, and industry lifecycles, etc.). This helped customize the survey to each of these divisions (e.g., use their organizational language). We excused two more divisions since they did not meet our sampling requirements (they had slower product, and process clockspeed; Fine (1998)). Our final sample involved 34 high technology divisions, giving us a response rate of 17.89%.

Within each division, we asked the divisional level contacts to sample a minimum of two innovation and improvement projects that were of strategic importance. We used our definitions of innovation and improvement for this sampling procedure (Innovation Projects: Projects involving product or process changes that were new to the unit of adoption [Zaltman et al., 1973]; Improvement Projects: Projects involving product or process changes that were based on existing knowledge within the unit of adoption, [Zangwill and Kantor, 1991]).

A web survey was designed to collect data from these divisions. It was divided into three parts: Strategic Level, Project Leader, and Project Team Member. The survey design required at least two respondents (e.g., Divisional head, R&D Director, or Vice President) to complete the strategic level part of the survey. The project leaders and the project team members completed their corresponding parts of the survey. This type of survey design also reduced the number of questions per survey, which increased the response rate. At the strategic level, we had 64 respondents completing the survey on decision making regarding innovation and improvement opportunities (Four divisions had just one strategic level respondent). At the project level, we collected data from 110 projects (58 Innovation projects and 52 Improvement projects), with the project team leader and at least one project team member as informants on these projects. Only ongoing or recently completed projects (completed during the last one year) were sampled to minimize the cognitive burden during recollection (Atkinson and Shriffin, 1965). Email and telephone contact information were made available to the researchers which helped send reminder messages regarding the survey. We also used these channels of contact to provide feedback and benchmarking reports in return to their participation. Overall, we had 313 respondents from 34 divisions participate in this study. Table 4-1 provides a breakdown of the projects from these divisions.

**Table 4-1**: Description of the Projects and Division Sample

| Divisions* | Total Number of Projects | Project Level Respondents (Project leader + Team Member) |
|---|---|---|
| Division 1[a] | 8 | 20 |
| Division 2[a] | 3 | 7 |
| Division 3 | 2 | 4 |
| Division 4 | 4 | 8 |
| Division 5[b] | 4 | 14 |
| Division 6[b] | 4 | 9 |
| Division 7 | 2 | 4 |
| Division 8 | 4 | 8 |
| Division 9 | 2 | 4 |
| Division 10 | 3 | 5 |
| Division 11 | 2 | 4 |
| Division 12 | 2 | 4 |
| Division 13[d] | 2 | 4 |
| Division 14[c] | 2 | 4 |
| Division 15[c] | 3 | 5 |
| Division 16 | 2 | 4 |
| Division 17[b] | 4 | 8 |
| Division 18 | 2 | 5 |
| Division 19 | 3 | 7 |
| Division 20 | 2 | 5 |
| Division 21 | 2 | 6 |
| Division 22[g] | 4 | 9 |
| Division 23[g] | 3 | 6 |
| Division 24 | 2 | 4 |
| Division 25 | 2 | 5 |
| Division 26 | 3 | 7 |
| Division 27 | 3 | 9 |
| Division 28[d] | 5 | 10 |
| Division 29 | 5 | 15 |
| Division 30[f] | 4 | 7 |
| Division 31[e] | 9 | 19 |
| Division 32[f] | 2 | 4 |
| Division 33[e] | 4 | 10 |
| Division 34 | 2 | 5 |
| **Total** | **110** | **249** |

*(a,b,c…..e) Superscripts indicate divisions from the same firm
All divisions except Divisions 9, 16, 20 and 24 had multiple respondents at the strategic level

### 4.4.2. Sample Characteristics

At the project level, 110 project team members and project leaders completed our survey. The average time taken to complete the survey was seven minutes. The number of projects from each division varied between two (one innovation and one improvement) to nine (four improvement, five innovation projects). We asked the project team leaders to identify the type of project (innovation or improvement), and also used a scale to measure the amount of innovation and improvement activities performed by the project teams.

To deal with the potential problems associated with single informant bias and common method bias, we separated the measurement of the independent, dependent variables, and the moderators, and collected data through multiple respondents. For example, we used the project team performance, project incentive systems as reported by the project leader while we used the project team structure and project leadership styles information as reported by the project team members. R&D Directors reported on the structural differentiation adopted in the division. All constructs were measured using multi-item Likert scales. We used a five point and a seven point Likert scale for the independent and dependent variables. The mean scores of all the items on these constructs were used.

Non respondent bias at the divisional level is examined by comparing the basic demographics (sales, R&D expenditures, and the number of employees) with the industry average (See Section 3.3.3 for more details). We received close to 100% response rate at the project level (one project leader and one project team member) since we had management commitment from all the 34 divisions. We also ensured high response rate at the project level by sending reminder requests through emails to the project team participants.

### 4.4.3. Measurement and Validation of Constructs

We ensured reliability and validity for all these constructs using appropriate procedures. For example, internal consistency of the scales is established using the *Cronbach's alpha coefficient*. The alpha values for all scales (except X-Teams (Cronbach $\alpha$ = 0.67)) are found to be within the permissible range (0.70 and over) indicating good reliability of the constructs (Nunnally, 1978).

Three forms of validity (namely, content, construct and criterion validity) were established on our measures (Shadish et al., 2002). *Content validity* referred to the adequacy to which a specific domain of content has been sampled is verified by mapping the construct to the existing literature (Nunnally, 1978). We used expert opinions (both managers and panel of academics) to establish content validity. *Construct validity* assesses the extent to which all items in a scale measure the same construct. We tested for both convergent and discriminant forms of construct validity. An exploratory factor analysis is used to establish convergent validity, when all items measuring the same construct loaded as a single factor explaining more than 50% of variance in the construct. We established discriminant validity by distinguishing items pertaining to a particular item from items measuring other constructs. *Criterion validity* examines the extent of the relationship between the items composed in a construct and the performance that it is intended to measure. This is done using a canonical correlation procedure between the independent items and the performance measures.

The survey was pre-tested at two different divisions involving over 15 projects. The pretest assessed three main characteristics of the survey: timing (average time taken by a respondent to complete the survey), clarity (Are there any ambiguous measurement items in the survey?) and content (Does each question make sense and is it appropriate?). Appendix 4.1 contains a list of the items used in the survey, factor loadings and their internal consistencies (Cronbach α).

**Project Performance** (PROJECT PERF). The dependent variable, project performance is measured using five items that required the project leaders to report on a seven point Likert scale. The following items measured the overall project performance: (1) Adherence to Schedule, (2) Adherence to Budget, (3) Adherence to Quality, (4) Technical Performance and (5) Overall Satisfaction (Alpha =0.827). We also used an objective measure of project performance based on Kekre et al., (2004). The objective measure of performance (PERF_OBJECTIVE) is measured as

$$\text{PERF\_OBJECTIVE} = \frac{\text{Time ahead of schedule of completion of the project (Enter negative if delayed)}}{\text{Overall time alloted to the project}} * 100$$

However, objective performance is available only for 67 projects (43 projects had missing data) and so it is not used in the analysis. The correlation between the objective performance and project performance is 0.4532 ($p<0.001$) for the 67 projects.

**Type of Project.** To decide whether the project is focused on an innovation or an improvement task, we used both the project leader's categorization (Project leader reported on the type of the project: Innovation or Improvement) and the project team members' response to the following items regarding their project priorities: (1) Reducing variation in existing processes, (2) Increasing production flexibility in existing process, (3) Reducing production cost, (4) Introducing new generation of products, (5) Redesigning the process for producing new generation products, (6) Entering new technology fields, and (7) Opening up new markets. EFA results indicate that the first three items load as Improvement activity (IMPROVEMENT) while the last four items load as Innovation activity (INNOVATION). Our analysis is based on both the project leader's categorization **(Method 1)** and the project team member's response to the innovation and improvement scales **(Method 2)**. More details follow.

**Incentive Structures.** The following seven items are informed by the project leader on the team incentive structure used during the project: (1) The team receives incentives based on increased performance against predetermined targets, (2) Rewards to the team members are related entirely to the profit contribution attributed to the team, (3) Rewards to the teams are deferred until bottom line results of the project are available, (4) The team is rewarded for completing major milestones/ phases accomplished in their project, (5) Teamwork behavior is taken into account when evaluating/ rewarding the team, (6) Team learning is one of the top priorities of our project, and (7) The performance evaluation procedures takes into consideration the suggestions given by the team members. EFA results indicate two factors where items 1-3 measures the outcome-based incentives structure (OUTCOME INCENTIVE) and items 4-7 measures the process-based incentive structure (PROCESS INCENTIVE). The scale is adapted from Sarin and Mahajan (2001). Appendix 4.1 has details regarding the factor loadings.

**Leadership.** The following seven items are adapted from the work of Vera and Crossan (2004) and are informed by the project team members regarding their project leader. (1) My project leader is able to get others committed to his/her vision of the future, (2) My project leader leads by "doing" rather than simply by "telling," (3) My project leader enables me to think about old problems in new ways, (4) My project leader challenges me to reexamine some of my basic assumptions, (5) My project leader only tells me what I have to know to do my job, (6) My project leader would indicate his or her disapproval if I performed at a low level, and (7) It is all right if I take initiatives, but my project leader does not encourage me to do so. Items 1-4 measure transformational leadership style (TRANSFORM LEADER) while items 5-7 measure transactional leadership style (TRANSACT LEADER). Ambidextrous leadership (AMBIDEXT LEADER) is the product of transactional and transformational leadership styles (Jansen et al., 2009). Multiplication of the scores for the styles insures that both types of leadership are being followed on the same project. Centering is done before computing the product term to avoid multicollinearity issues (Aiken and West, 1981).

**Self-Managed Team** (SELF – MANAGED)**.** We used the following five items to measure the extent of decision making and leadership controls that reside within the team (Zellmer-Bruhn and Gibson, 2006; Thompson, 2004). Items are informed by the project team members on a five point Likert Scale (1=Very little input, 5= A lot of input): (1) Planning and Determining Goals, (2) Who will be on the team, (3) Decisions concerning leadership inside the team, (4) Performance evaluation of the team, and (5) Task assignments within the team. This scale measured the extent of self-managed team structure adopted during the project.

**X-Team Structure** (X-TEAM)**.** We used the following three items informed by the project team member regarding the type of team structure adopted (Chesbrough, 2003): (1) The core member of our team remained on the project until completion, (2) The project manager who started this project remained on until completion, (3) The work load was full time while working on this project. Higher scores on this scale indicate adopting an X-team structure during the project.

**Structural Differentiation** (STRUCT DIFF)**.** This is a divisional level construct that measures the presence of distinct organizational cultures, processes and structures for innovation and improvement projects. It is measured using three items: (1) Separate rewards and incentive systems exist in our unit for evaluating innovation projects and improvement projects, (2) The project team organization (team role, reporting system etc.,) is quite different between innovation projects and improvement projects, and (3) We have distinct organizational processes, structures and cultures for innovation and improvement projects. R&D directors respond to this construct .

**Control Variables.** We controlled for project team size (TEAM SIZE), measured as the natural logarithm of the number of team team members, since bigger project teams are likely to have more resources than samller project teams, and in turn, better performance (Boh et al., 2007).

Project complexity (PROJ COMPLEX) is measured using the following four items, (1) It took time to understand the project's necessary task and objectives, (2) The project required a lot of different skills and knowledge from team members, (3) The project required a lot of analysis, and (4) The project was relatively simple (reversed). Prior research has shown that complexity can have significant impact on project performance (Tatikonda and Rosenthal, 2000). We included project complexity in our initial model but later dropped it due to insignificant effects.

### 4.5. Results

### 4.5.1. Method 1 – Project Leader's Categorization

Our hypotheses suggest the presence of a moderation fit between the type of activity administered by the project teams and the micro and macro level contexts (namely team structure, leadership, incentive structure, and structural differentiation) on the project performance. To test the structural differences between innovation and improvement teams, we employ a subgroup analysis by dividing the data into innovation and improvement projects[13]. Both project leader response (project leaders identified innovation or improvement projects based on our definitions) and the project team member responses on innovation and improvement scales are used to categorize these subgroups. The 110 projects are nested within 34 high technology divisions and hence can be treated as an unbalanced panel. A random effects regression, also known as Hierarchical Linear Modeling, Mixed effects regression or Latent trajectory modeling, is used for testing the cross level interactions (Greene, 2002). This approach models the effect of structural differentiation (divisional level construct) on the project performance (Wooldridge, 2002).

The following two-step procedure determined the type of model used in the study (Kennedy, 2008). First, we examined whether our intercepts for all the projects (i.e., innovation and improvement projects) are same across divisions. Results from our analysis indicate differences of these intercepts for both the improvement (Wald Z =24.57, $p<0.001$) and innovation subgroups (Wald Z =40.87, $p<0.001$) (See Appendix 4-3).

[13] The appendix has details regarding the pooled results wherein we use a binary variable to categorize innovation and improvement projects. As shown in the appendix, testing the hypothesis is complex for the pooled model. Results were consistent across both these approaches.

Second, we performed a Hausman test to check if the random effects estimator is unbiased (Appendix 4-4). A Hausman test is used to check whether the assumption of independence between the random effects and the predictors is justified (Hausman, 1978). If the test is not rejected, then the random effect model is a better one compared to the fixed effect model. In general, a random effect is used for controlling for unobserved heterogeneity since it uses fewer degrees of freedom relative to the fixed effects model (Richard et al., 2007). Results from the Hausman test comparing both the fixed and random effects models show the random effects model to be a more efficient estimator model for both the improvement ($\chi^2(8)=8.63$, $p>0.375$) and innovation ($\chi^2(8)=2.53$, $p>0.950$) subgroups. Based on these results, we use a random effects procedure in our analysis.

**Table 4-2:** Descriptive Statistics for the Improvement Subgroup (N=52)

| | Variables | Mean | St.Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TEAM SIZE | 2.305 | 0.796 | 1 | 0.2616* | -0.01 | 0.300* | 0.1631 | -0.124 | 0.2148 | 0.061 | 0.2396 | -0.271* |
| 2 | PROJECT PERF | 4.447 | 1.162 | | 1 | 0.3372** | 0.1539 | 0.3618* | 0.2277 | 0.1570 | 0.0723 | 0.4016*** | 0.030 |
| 3 | STRUCT DIFF | 3.174 | 0.859 | | | 1 | 0.2111 | 0.2810* | 0.0600 | 0.0568 | -0.0516 | 0.5610** | 0.0954 |
| 4 | OUTCOME INCENTIVE | 2.306 | 0.912 | | | | 1 | 0.2235 | -0.1813 | 0.0504 | 0.0226 | 0.0145 | 0.0533 |
| 5 | PROCESS INCENTIVE | 3.103 | 0.649 | | | | | 1 | -0.1169 | 0.2049 | 0.1288 | 0.3154* | -0.1309 |
| 6 | TRANSACT LEADER | 2.422 | 1.026 | | | | | | 1 | -0.2371 | -0.2155 | 0.1381 | -0.0217 |
| 7 | TRANSFORM LEADER | 3.724 | 0.686 | | | | | | | 1 | 0.5496** | 0.1706 | 0.2610 |
| 8 | AMBIDEXT LEADER | -0.161 | 1.051 | | | | | | | | 1 | -0.1892 | 0.0522 |
| 9 | SELF-MANAGED | 3.626 | 0.833 | | | | | | | | | 1 | 0.1783 |
| 10 | X-TEAM | 3.319 | 0.967 | | | | | | | | | | 1 |

*p<0.05; **p<0.01; ***p<0.001

**Table 4-3:** Descriptive Statistics for the Innovation Subgroup (N=58)

| | Variables | Mean | St.Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TEAM SIZE | 2.519 | 0.729 | 1 | -0.0497 | -0.1848 | 0.1126 | 0.1838 | -0.01 | 0.1795 | 0.0111 | 0.0001 | -0.0776 |
| 2 | PROJECT PERF | 4.645 | 0.912 | | 1 | -0.2446* | 0.1399 | 0.1193 | -0.1395 | 0.2314 | 0.0042 | 0.3496* | 0.2035 |
| 3 | STRUCT DIFF | 3.229 | 0.930 | | | 1 | 0.0551 | 0.0282 | -0.0988 | -0.0690 | -0.0260 | 0.0755 | 0.2326 |
| 4 | OUTCOME INCENTIVE | 2.189 | 0.868 | | | | 1 | 0.2789* | -0.2224 | -0.2414 | 0.0873 | -0.0741 | 0.1190 |
| 5 | PROCESS INCENTIVE | 3.306 | 0.807 | | | | | 1 | -0.0572 | 0.0604 | -0.0436 | 0.2289 | 0.0673 |
| 6 | TRANSACT LEADER | 2.258 | 1.031 | | | | | | 1 | -0.2537* | -0.3071** | -0.2721* | -0.1561 |
| 7 | TRANSFORM LEADER | 3.672 | 0.877 | | | | | | | 1 | 0.0623 | 0.5418*** | 0.1575 |
| 8 | AMBIDEXT LEADER | -0.223 | 1.204 | | | | | | | | 1 | -0.0740 | -0.0520 |
| 9 | SELF - MANAGED | 3.33 | 0.664 | | | | | | | | | 1 | 0.3000** |
| 10 | X-TEAM | 3.385 | 0.982 | | | | | | | | | | 1 |

*p<0.05; **p<0.01; ***p<0.001

Tables 4-2 and 4-3 give the means, standard deviations and correlations among these variables for the innovation and improvement projects. Both innovation and improvement projects serve as a context that changes the predictive ability of the structural characteristics (i.e., incentives, leadership, team structures) on the project performance. This corresponds to strength of moderation type of fit (Venkataraman, 1989). Testing the strength of moderation is done using a subgroup analysis[14]. The random effects model examined across both the subgroups is as follows:

$$\begin{aligned}\text{PROJECT PERF}_{ij} = {} & \underline{u} + \alpha_i + \beta_0 \text{ Ln(TEAM SIZE)} \\ & + \beta_1 \text{ OUTCOME INCENTIVE}_{ij} + \beta_2 \text{ PROCESS INCENTIVE}_{ij} \\ & + \beta_3 \text{ TRANSACT LEADER}_{ij} + \beta_4 \text{ TRANSFORM LEADER}_{ij} + \beta_5 \text{ AMBIDEXT LEADER}_{ij} \\ & + \beta_6 \text{ SELF-MANAGED}_{ij} + \beta_7 \text{ X-TEAM}_{ij} \\ & + \beta_8 \text{ STRUCT DIFF}_{.j} + \varepsilon_{ij}\end{aligned}$$

In this formula, the intercept consists of a deterministic component $\underline{u}$ and a random component $\alpha_i$ which is assumed to be normally distributed. The intercept parameter captures all the division specific effects that are omitted in the model other than structural differentiation (STRUCT DIFF), leaving only the project level differences to be explained by the covariates (Greene, 2002).

A subgroup analysis is done based on the innovation and improvement subgroups. Support for H4-1a requires coefficient $\beta_1$ to be significantly different from zero for the improvement subgroup while support for H4-1b requires coefficient $\beta_2$ to be significantly different than zero for the innovation subgroup. Similarly, support for H4-2a and H4-2b means the coefficients $\beta_3$ is significantly different from zero for the improvement subgroup and the coefficient $\beta_5$ is significantly different from zero for the innovation subgroup (consistent with the strong hereditary property, we have

[14] We also checked these results using a pooled data sample – See Appendix 4-2 for more details

transformational leadership in the model, Neter et al. [2004]). H4-3a is supported if $\beta_6$ is statistically different across the innovation and improvement subgroups while H4-3b is supported if the coefficient $\beta_7$ is negative in the improvement subgroup and positive in the innovation subgroup. Finally, support for H4-4 implies that the coefficient $\beta_8$ (structural differentiation) is significant for both the subgroups.

**Table 4-4:** Random Effects Regression Results (Robust Standard Errors in parentheses)

| **Variables** | **Improvement Projects (52 Projects)** | **Innovation Projects (58 Projects)** |
|---|---|---|
| Model | Model 1 | Model 2 |
| DV: PROJECT PERF | re (Division) | re (Division) |
| Group Variable | Divisions (34) | Divisions (34) |
| TEAM SIZE | 0.2124<br>(0.2427) | -0.1856<br>(0.1338) |
| STRUCT DIFF | 0.4752*<br>(0.2410) | -0.3578**<br>(0.1545) |
| OUTCOME INCENTIVE | 0.2788*<br>(0.1340) | 0.1526<br>(0.1954) |
| PROCESS INCENTIVE | 0.3289<br>(0.3066) | -0.1018<br>(0.1598) |
| TRANSACT LEADER | 0.3165**<br>(0.1436) | 0.00899<br>(0.1627) |
| TRANSFORM LEADER | -0.2854<br>(0.3339) | 0.0683<br>(0.1413) |
| AMBIDEXT LEADER | 0.2318<br>(0.1907) | 0.0076<br>(0.1143) |
| SELF-MANAGED | 0.1064<br>(0.2175) | 0.5496***<br>(0.2228) |
| X-Team | 0.1103<br>(0.2482) | 0.6894*<br>(0.3467) |
| Constant | 0.2806<br>(1.4523) | 3.856***<br>(1.1621) |
| $\chi^2$ | 31.15*** | 19.39** |
| $R^2$ | 0.3595 | 0.3012 |
| Intraclass Correlation (ρ) | 0.3205 | 0.0810 |

*p<0.05; **p<0.01; ***p<0.001

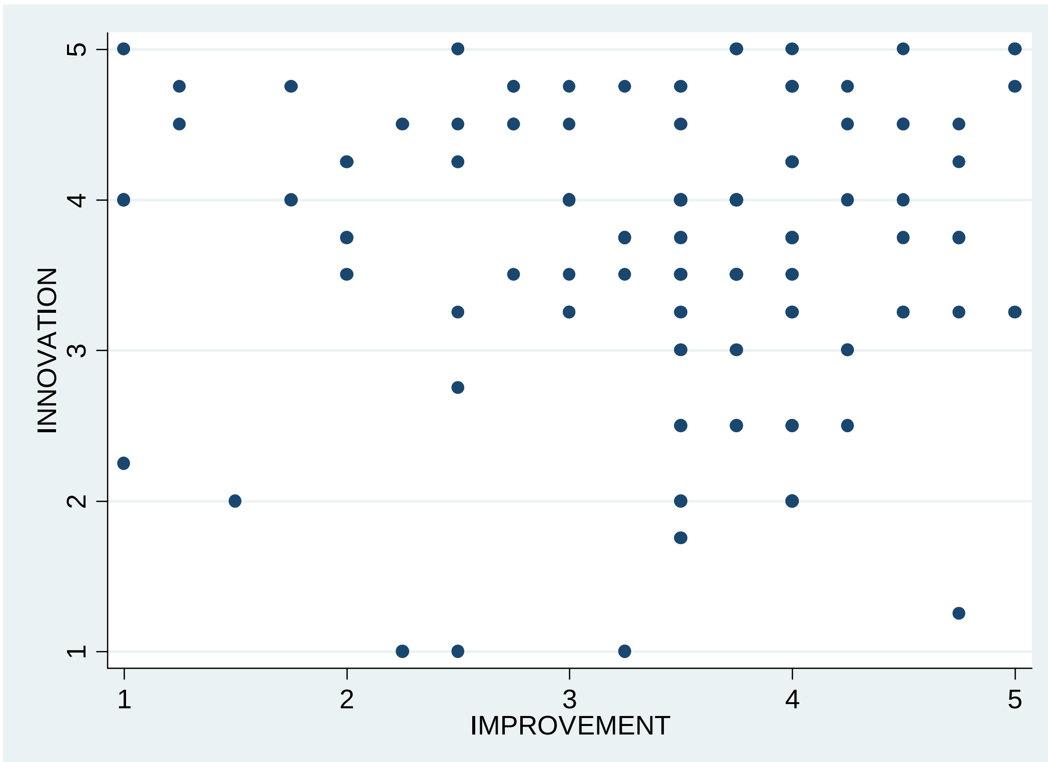
Table 4-4 shows the random effect regression results for the sub group analysis performed using the project leader's response. That is, we divided the project level data based on the project leader's identification of innovation and improvement projects. The subgroups consist of 58 innovation and 52 improvement projects nested within 34 divisions (Appendix 4-5 show the results of these projects nested in 24 firms). We used the Huber-White sandwich estimator, which corrects for heteroscedasticity and provides robust standard errors, and is thus considered to be a more conservative estimation procedure especially in a clustered data sample (Rabe-Hesketh and Skrondal, 2005; Greene, 2002). Chow tests indicate significant differences in the regression coefficients across the subgroups ($F_{Chow}$ = 2.27, p<0.03). We controlled for the project team size (natural logarithm of team size) since research has shown significant effects of the team size on project performance (Thompson and Choi, 2005; Manz and Stewart, 2000).

Model 1 shows the random effect regression results for the Improvement subgroup. Both the transactional leadership style ($\beta_3$ = 0.3165, p<0.01) and outcome-based incentive structure ($\beta_1$ = 0.2788, p<0.05) have a significant positive effect on the project performance. This result supports H4-1a and H4-2a. To test H4-3a, we compared the coefficients of self-managed teams between innovation and improvement subgroups ($\beta_{7\ INNOV} - \beta_{7\ IMPROV} > 0$) using a Wald's Chi-square test procedure. Results indicate that the effect of self-managed teams is more pronounced for the innovation subgroup when compared to the improvement subgroup supporting H4-3a (Wald $Z_{diff}$ = 4.83, p=0.028). However, the coefficient of X-teams for the improvement subgroup is not significant (and negative) and hence does not support H4-3b. The divisional level construct, structural differentiation ($\beta_8$ = 0.4752, p<0.05), has a significant positive effect on the project performance providing support for H4-4. That is, the ability of senior management to maintain distinct cultures and organizational structures for innovation and improvement positively impacts improvement project performance (we also tested the effects of these infrastructural characteristics without modeling for structural differentiation and found that results become less significant – See Appendix for more discussion). All other micro contextual practices do not impact project performance. The overall model explains 35.95% of the variation in the project performance.

Model 2 represents the random effect regression results for the Innovation subgroup. X-Team structure ($\beta_7$ = 0.6894, $p<0.05$) and self managed team structures ($\beta_6$ = 0.5496, $p<0.001$) have a positive impact on the project performance supporting H4-3a & H4-3b. Both the process-based incentives ($\beta_2$ = -0.1018, $p>0.120$) and ambidextrous project leadership style ($\beta_5$ = 0.0076, $p>0.659$) have no effect on the project performance failing to support H4-1b & H4-2b. In addition, the divisional level construct, structural differentiation ($\beta_8$ = -0.3867, $p<0.05$) has a negative effect on project performance. That is, the ability of senior management to maintain distinct cultures and organizational structures for innovation and improvement negatively influence innovation project performance. This result not only rejects H4-4, but also suggests that creating distinct organizational structures for innovation and improvement hurts innovation projects. On the contrary, structural differentiation benefits improvement projects. We discuss this managerial dilemma in detail in the next section. The overall model explains 30.12% of the variation in the innovation project performance.

### 4.5.2. Method 2 – Project Team Member's Categorization

**Figure 4-2:** Projects Classified Based on the Team Member's Response




Analyzing our project team member data in detail suggests differences in categorizing innovation and improvement projects by the project leaders. There were 28 projects that scored high on both innovation and improvement scales but were categorized either as improvement projects or innovation projects by the project leader. Figure 4-2 plots the 110 projects based on the Project team member's responses to innovation and improvement goals. Projects that scored high on both these scales were unique since they defied the existing exploration-exploitation theories (March, 1998;

Gupta et al., 2006). According to Gupta et al. (2006), "within a single domain or subsystem, exploration-exploitation will generally be mutually exclusive" (pg. 697). However, exploration and exploitation goals coexist within the same project. An example of this is the Innov $A_2$ (from the case study described in Chapter 2) that introduces a new generation of process for manufacturing a radically different hard drive component (new product) that reduces the cost by 50%.

To understand the structural differences among these projects, we divided the 110 projects based on the project team members' responses on innovation and improvement scales. We used the median scores on these scales to split our project sample. Table 4-5 represents the three categories of projects based on the scale.

**Table 4-5:** Project Team Member Categorization and Descriptive Statistics

| | IMPROVEMENT (N=34) | INNOVATION (N=44) | HYBRID (N=28) |
|---|---|---|---|
| INNOV Score[1] | 2.72 (0.908) | 4.034 (0.702) | 4.47 (0.387) |
| IMPROV Score[1] | 3.934 (0.604) | 2.369 (0.761) | 4.125 (0.488) |
| Project Duration (in months) | 12.20 (6.879) | 17.79 (10.489) | 11.47 (8.634) |
| Project Complexity[1a] | 3.953 (0.549) | 4.14 (0.750) | 4.197(0.530) |
| PROJECT PERF[2] | 4.347 (1.072) | 4.559 (0.808) | 4.807 (1.300) |

Standard Deviations in parentheses
1 : Measured on a 5-point Likert Scale , 2: Measured on a 7-point Likert Scale
a: Complexity is measured through the following items (Alpha: 0.773):

1. It took time to understand the project's necessary task and objectives
2. The project required a lot of different skills and knowledge from team members
3. The project required a lot of analysis
4. The project was relatively simple (reversed)

There were 34 projects that scored high on the improvement scale and low on the innovation scale. We classified them as *improvement projects*. Similarly, 44 projects scored high on the Innovation scale and low on the Improvement scale and were classified as *innovation projects*. Twenty-eight projects scored high on both the scales and were classified as *hybrid projects.* Four Projects scored low on both the innovation and improvement scales (below the median) and were dropped from the analysis**.** Our theory suggest that both innovation and improvement projects comply with our theories suggested in the hypotheses, H4-1a-H4-3b while hybrid projects have no previous theoretical explanation on how they are managed.

Table 4-6 shows the OLS regression results for these three subgroups after controlling for the project size (Models 3a, 4a, 5a &6a). Due to the smaller number of clusters at the divisional level, we were unable to use a random effects regression approach in our project team member analysis. However, we used clustered standard errors estimator, which adjusts for the correlations in error terms across observations coming from the same divisions (Rabe-Hesketh and Skrondal, 2008). It also corrects for heteroscedasticity and normality issues and provides robust standard error estimates in our analysis (Greene, 2002). To be consistent with Method 1, we use the same predictors in this model although structural differentiation (a divisional level predictor) conveys little meaning since our clusters do not include all the 34 divisions.

**Table 4-6:** OLS Regression Results (Clustered Standard Errors in Parentheses)

| **Variables** | **IMPROVEMENT PROJECTS (N=34)** | **INNOVATION PROJECTS (N= 44)** | **HYBRID PROJECTS (N= 28)** |
|---|---|---|---|
| DV = PROJ PERF | Model 5 | Model 6 | Model 7 |
| | | | |
| TEAM SIZE | -0.1878<br>(0.2368) | -0.0334<br>(0.2264) | 0.4770<br>(0.3832) |
| STRUCT DIFF | -0.2396<br>(0.3693) | -0.2844*<br>(0.1382) | 0.1342<br>(0.2583) |
| OUTCOME INCENTIVE | 0.5002**<br>(0.2035) | -0.4797**<br>(0.2202) | -0.04805<br>(0.2383) |
| PROCESS INCENTIVE | 0.1641<br>(0.3853) | 0.1257<br>(0.1209) | (0.3279<br>(0.3451) |
| TRANSACT LEADER | 0.4740***<br>(0.1514) | -0.1406<br>(0.1663) | -0.7820<br>(0.2565) |
| TRANSFORM LEADER | 0.2995<br>(0.3200) | 0.2133<br>(0.2349) | -1.3113**<br>(0.4133) |
| AMBIDEXT LEADER | -0.1039<br>(0.2557) | -0.1060<br>(0.1791) | 0.5022***<br>(0.2534) |
| SELF-MANAGED | 0.3480<br>(0.3018) | 0.2652<br>(0.3373) | 1.2207***<br>(0.2282) |
| X-Team | -0.0974<br>(0.1974) | 0.2474*<br>(0.1221) | 0.4508<br>(0.3832) |
| Constant | 1.2040<br>(1.5806) | 5.4783***<br>(1.2712) | 2.4137<br>(2.4555) |
| F-Statistic | 5.47** | 5.70** | 48.09*** |
| $R^2$ | 0.3896 | 0.3675 | 0.6946 |

*p<0.05; **p<0.01; ***p<0.001

Model 5 shows the regression results for the improvement projects. The outcome-based incentive ($\beta_1$ = 0.5002, p<0.01) and transactional leadership ($\beta_3$ = 0.474, p<0.001) have a significant positive impact on the project performance consistent with the results from Method 1. These results strengthen support for H4-1a and H4-2a. Model 6 gives the results for the innovation projects. Outcome-based incentives have a negative impact on project performance ($\beta_1$ = -0.4797, p<0.01) while process-based incentives do not have a significant impact on project performance ($\beta_2$ = 0.1257, p>0.180). There is no effect of ambidextrous leadership on the project performance, but adopting an X-team structure ($\beta_7$ = 0.2474, p<0.05) impacts innovation project performance. These results suggest that micro level context barring team structure has no effect on the innovation project performance, which is consistent with the results from Method 1.

Model 7 gives regression results for the hybrid projects – projects that scored high on both the innovation and improvement scales (these projects were nested within 19 divisions). Pairwise comparisons with the other two groups indicate these projects have similar duration and project team size. Regression results indicate the importance of self-managed team structures ($\beta_6$ = 1.2207, $p<0.001$) and ambidextrous leadership styles during these projects ($\beta_5$ = 0.5022, $p<0.001$). That is, project leaders leading hybrid projects are transformational at times providing support for experimentation and learning and transactional at times providing explicit directions and driving projects toward completion. They juggle between these leadership styles to ensure effective completion of these projects. Results from an earlier case study (Chandrasekaran et al., 2008) indicate that these projects can also have dual leadership styles: transactional, setting the right time and milestones for the projects, or transformational, providing opportunities to experiment. Our results also indicate no influence of rewards and incentives for motivating these projects.

### 4.5.3. Post Hoc Analysis

**Figure 4-3:** Impact of Structural Separation on Innovation and Improvement projects (Cross Level Interaction)

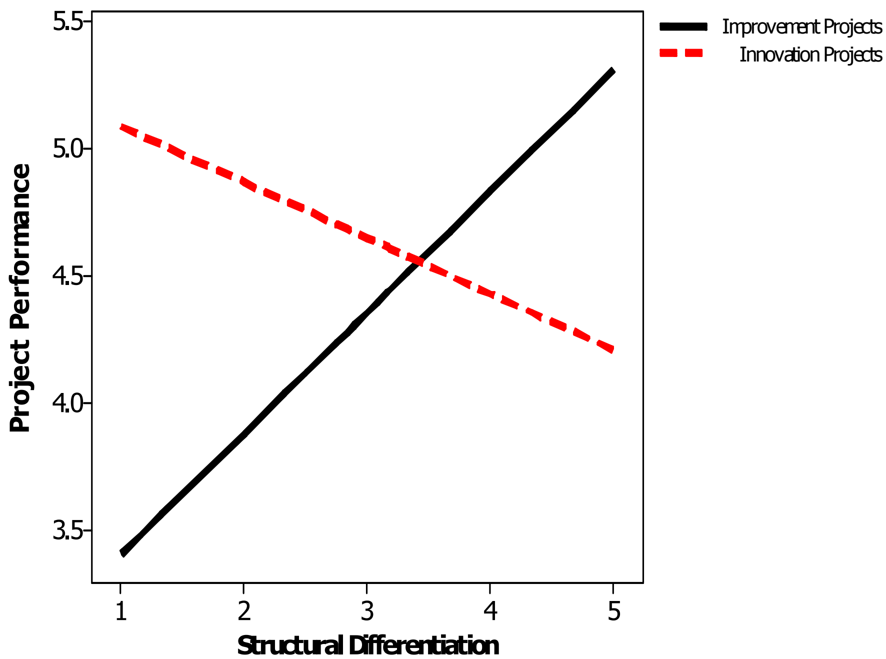


**Figure 4-4:** Interactions Plot of Outcome Incentives and Self-Managed Team Structure for Improvement Subgroup

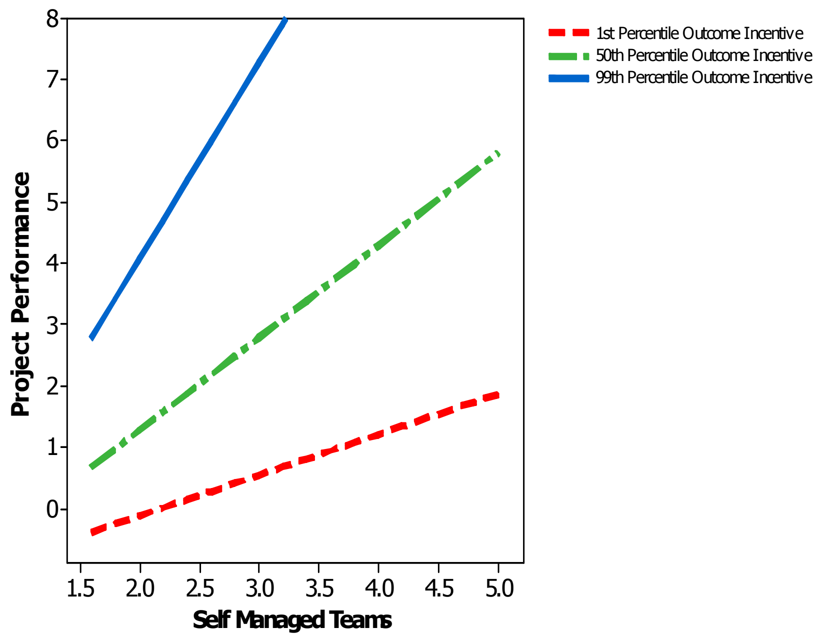
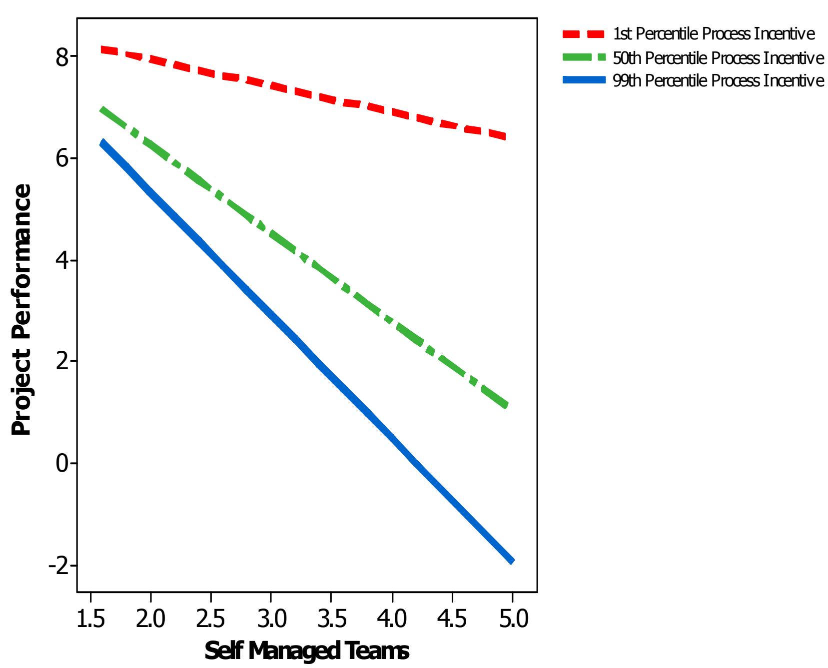



**Figure 4-5:** Interactions Plot of Process Incentives and Self-Managed Team Structure for Improvement Subgroup



We also checked for second order effects, both cross level interactions (between Structural differentiation and micro-level practices) and among the micro-level practices (rewards, leadership, and team structures) to examine the presence of reinforcing or negative interactions. Mean centering is done before testing for interaction effects to avoid multicollinearity problems (Aiken and West, 1991; Irwin and McClelland, 2001). We arrived at similar conclusions from both the project leader and project team member subgroups. Results from the project leader's subgroup are reported below.

Figure 4-3 confirms the presence of a cross level interaction between structural differentiation and the type of projects. This plot shows the predicted project performance as a variant of structural differentiation. As structural differentiation within a division increases, improvement projects perform better while innovation projects perform worse. We also checked for cross level interactions between structural differentiation and other micro-level practices (team leadership, team structures, team incentives). None of these interactions were significant in our model.

Figures 4-4 and 4-5 give the conditional effects plot among the micro level contexts. Adopting a wrong choice of incentive structure, namely process-based incentive (e.g., $\beta_{\text{Process x Self-Managed}} = -0.6452$, $p<0.01$) structure during improvement activities has a negative effect on the project performance while an outcome-based incentive structure positively impacts improvement project performance (e.g., $\beta_{\text{Outcome x Self-Managed}} = 0.6651$, $p<0.05$). The conditional effects plot provides a way to interpret the regression results in the presence of an interactions effect. They plot E[PROJ PERF] as a function of Self-Managed team structure conditioned on the Incentive structures. The plot considers values between the 1st and 99th percentile ranking for Self-Managed teams conditioned on the 1st, 50th, and 99th percentile ranking of Process and Outcome Incentives. These interactions plot indicate a positive reinforcing effect for using outcome-based incentives while a negative antagonistic effect occurs for using process-based incentives during improvement activities. These results strengthen support for our previous results about improvement projects. We do not find any significant interactions effects for the innovation subgroup.

In general, results from our analysis suggest three interesting implications. First, Structural differentiation, separating innovation and improvement in high technology divisions benefit improvement projects but it hurts innovation projects. Second, improvement projects benefit from infrastructural characteristics such as leadership (transactional) and incentives (outcome) but innovation projects mainly depend on team decision making and project team structures. Third, high technology divisions have a lot of overlap between innovation and improvement opportunities (hybrid projects) that cannot be explained using existing structural differentiation theory and require refinement in existing theories. We discuss this in detail in our next section.

## 4.6. Discussion and Conclusion

### 4.6.1. Understanding Structural Ambidexterity Results

Structural ambidexterity entails creation of distinct organizational structures and infrastructural elements that permit coexistence of innovation and improvement projects in high technology organizations. Although theoretical arguments are present on structural ambidexterity, there is lack of specificity on the structural characteristics that permit simultaneous deployment of innovation and improvement (O'Reilly and Tushman, 2008). In addition, there is almost no empirical support to the project level manifestation of this capability.

Our study addresses these limitations and refines existing theories on structural ambidexterity. In this research, we measure and investigate the effects of structural differentiation on separating innovation and improvement projects in high technology organizations. Using organizational learning theories and leadership theories, we argue the importance of team incentives, team leadership and team decision making (infrastructural) differences between innovation and improvement projects. Current theories on structural ambidexterity suggest that these projects would benefit if the organizations were to adopt different cultures for innovation and improvement. We examine these arguments by collecting both project level and divisional level data from over 110 projects and 34 divisions.

Results from our research suggest that structural differentiation of distinct project teams, incentives and cultures benefit improvement projects but hurts innovation projects in high technology divisions. There are at least three specific reasons for this to be the case. First, although innovation projects cater to introducing new products, new technologies and new markets, they branch out of current generation of products and technologies (Chesbrough, 2003). That is, improvement activities form the foundation, on which innovation can exist (March, 1991). Hence, innovation projects require connection with improvement projects and can benefit sharing organizational structures, processes, and cultures with improvement initiatives.

Second, competition in high technology industries has forced drastic reduction in the product and process development times (Creveling et al., 2003). This requires innovation projects to work at the same pace as improvement and hence the structural differentiation of creating more tolerance to failures (experimentation) can hurt innovation under these circumstances.

Third, innovation projects studied in this research also have a considerable amount of improvement goals embedded in them (average improvement score = 2.814 out of 5). Having dual goals within the same project requires a lot of knowledge crossover between innovation and improvement project teams, and hence maintaining distinct structures can hurt innovation project performance.

Structural differentiation, on the contrary, is good for improvement projects. These projects have well-defined objectives and are based on existing knowledge. Hence they require minimum overlap with innovation (knowledge seeking) activities and can benefit from structural isolation. Our project level results suggest that improvement projects depend heavily on the micro-contextual characteristics such as team incentives and team leadership styles. That is, improvement projects require a transactional leader and are motivated using an outcome incentive structure. Our post hoc results also suggest that adopting the wrong combination of micro-contextual characteristics lead to poor project performance in the case of improvement projects.

Innovation projects are not influenced by incentives and leadership characteristics, but depend mostly on the project team decision making and project team structures. Results from this study also find support for the significance of X-team structure during innovation projects (Ancona and Caldwell, 1992; Chesbrough, 2003).

That is, innovation projects benefit from having a core team structure with flexible and expandable team memberships.

We also find the presence of hybrid projects – those with the dual goals of innovation and improvement. These projects benefit from the presence of ambidextrous project leaders who switch between transactional and transformational leadership styles ensuring better project performance. Metaphorically, this leadership style has been compared to the Roman god Janus, who had two faces that looked in opposite directions (O'Reilly and Tushman, 2004). The manager's ability to look in two directions at once ensures that both the goals of innovation and improvement can be met by the project teams. In an earlier case study, we found ambidexterity to be achieved by the presence of two distinct project leaders – one performing the role of a "pusher" and the other performing the role of an "explorer" – providing opportunities to search and experiment during the project. The following quote, gleaned from the case study described in Chapter 3, describes this statement.

> [When asked about their role during the project X] Steve and I come in. He is a little more analytical and I am a little more of a pusher. And between the two of us, I mean here is the right time, milestones and bills, we put in daily updates, projects, we chose 2/3 projects on an ongoing process that were to be frequently reported on. There were timelines out there, there were deadlines but along with that we put a lot of systems in place to motivate people to make a decision.

To our knowledge, this is the first research that looks within the black box of structural ambidexterity. Current research mostly deals with structural ambidexterity as an organization level phenomenon (Raisch and Birkinshaw, 2008). For example, USA today separates its online business from the existing newsprint business maintaining distinct organizational cultures, reporting structures, and processes to evaluate these businesses (O'Reilly and Tushman, 2004). Another example would be the analog and digital photography divisions at Kodak (Gibson and Birkinshaw, 2004). However, even within the same business unit (e.g., online businesses, digital photography division) there are opportunities catering to the current and future generation of markets. Current theories of organizational separation provide little or no explanation on how to manage these subsystem level differences (Gatignon et al., 2002). Our research adopts a granular investigation at the lower level task environments (projects) and their interrelations with the concept of ambidexterity. We argue the importance of cross-functional linkages between innovation and improvement project teams at the subsystem level that can accelerate innovation in fast-paced environments (Westerman et al., 2006). To some extent, our results are consistent with the recent study by Jansen et al., (2009) that argues for organizational integration mechanisms such as cross-functional interfaces and connectedness that permit knowledge transfers between explorative and exploitative sub-units. We also go beyond their study and identify the specific infrastructural (team leadership, team structures, team incentives) that permit simultaneous deployment of improvement and innovation.

### 4.6.2. Implications for Practice

There are some important implications from this study for practice. First, results from this research suggest high technology organizations have projects that go beyond the dichotomy of Improvement and Innovation. They have some projects that emphasize both innovation and improvement at the same time. It is common for organizations to prescribe to a structured project management approach based on whether the project serves current or future needs (George, 2002; Pyzdek, 2003), and thus categorize as either pure innovation or pure improvement. The business press illustrates numerous examples of organizations (e.g., 3M, Motorola) that have suffered by the current classification of projects into these dichotomous portfolios (Rae, 2007). Our study suggests a third classification of projects that have high innovation and improvement goals. These projects (referred to as hybrid projects) require minimal organizational interventions through incentives and benefit from self-managed team and ambidextrous leadership styles. Presence of these projects in high technology divisions suggests the need for managers to develop a third portfolio to monitor these projects. Second, our multilevel results suggest the importance of innovation projects to have similar reporting structures, processes to that of improvement projects. This helps transfer knowledge across these projects that facilitate innovation project performance.

### 4.6.3. Limitation of Study Results and Future Research Suggestions

Our research study is based on both the project and divisional level data from fast-paced organizations. The research findings regarding structural separation hurting innovation is only valid in these contingencies where there is minimal temporal separation between existing and future customer needs. These results suggest a possible contingency perspective on structural ambidexterity arguments (O'Reilly and Tushman, 2004). That is, structural ambidexterity of separating innovation and improvement might be useful in slower paced environments as seen from the case evidence from *USA Today* and Ciba Vision. However, fast-paced organizations require less spatial separation and more loosely coupled organizational structures that facilitate social and technical relations between innovation and improvement units (Gilbert, 2006). Less structural separation is required in these organizations. Since our research does not involve divisional and project level data from slow paced organizations, more research is required at the granular level to test this contingency perspective.

Another limitation to this study is the small sample size available for the hybrid project group. The overall explanatory power ($R^2$ = 69.4%) is high, owing to this small sample size (28 projects). However, these projects came from 19 different divisions, which mitigate concerns regarding the infrequent occurrence of these types of projects.

This research also represents a first step toward uncovering the relationship between macro level organizational characteristics and innovation and improvement project performance. Collecting data from both the division and project levels, we show the direct effects of both macro (structural differentiation) and micro (infrastructural team practices) on the project performance. We did not find any statistical significance to the cross level interactions between micro and macro variables (Mathieu et al., 2008), and more research is required to understand the alignment between micro-macro level factors and their influence on project performance.

We hope this research has contributed to a greater understanding of structural ambidexterity in high technology environments. While we have found some important and interesting results, this study is a first step in many respects. Future research should build on the results presented here.

## Appendix 4-1: Descriptive Statistics and Factor Loadings for the Items

| Items | Construct | Mean | Std. Deviation | Factor Loadings |
|---|---|---|---|---|
| Introducing new generation of products | **INNOV**[15] (Cronbach α = 0.76) Eigen Value = 2.243 | 4.064 | 1.180 | 0.778 |
| Redesigning the process for producing new generation products | | 3.467 | 1.309 | 0.502 |
| Entering new technology fields | | 3.660 | 1.355 | 0.910 |
| Opening up new markets | | 3.706 | 1.383 | 0.892 |
| Reducing variation in existing processes | **IMPROV**[15] (Cronbach α = 0.76) Eigen Value = 2.757 | 3.266 | 1.372 | 0.712 |
| Refining existing product quality | | 3.403 | 1.414 | 0.725 |
| Increasing production flexibility in existing process | | 3.091 | 1.330 | 0.831 |
| Reducing Product Cost | | 3.596 | 1.277 | 0.709 |
| Adherence to Schedule | **PROJECT PERF** (Cronbach α = 0.83) Eigen Value = 2.978 | 3.872 | 1.4914 | 0.650 |
| Adherence to Budget | | 4.220 | 1.2424 | 0.690 |
| Adherence to Quality | | 4.825 | 1.3460 | 0.840 |
| Technical Performance | | 5.045 | 1.300 | 0.792 |
| Overall Satisfaction | | 4.798 | 1.3661 | 0.863 |
| The team receives incentives based on increased performance against predetermined targets | **OUTCOME INCENTIVE**[16] (Cronbach α = 0.69 ) Eigen Value = 1.716 | 2.467 | 1.231 | 0.577 |
| Rewards to the team members are related entirely to the profit contribution attributed to the team | | 1.915 | 1.019 | 0.891 |
| Rewards to the teams are deferred until bottom line results of the project are available | | 2.345 | 1.213 | 0.791 |
| The team is rewarded for completing major milestones/ phases accomplished in their project | **PROCESS INCENTIVE**[16] (Cronbach α = 0.70) Eigen Value = 2.405 | 3.028 | 1.111 | 0.749 |
| Teamwork behavior is taken into account when evaluating/ rewarding the team | | 3.205 | 0.988 | 0.746 |
| Team learning is one of the top priorities of our project | | 3.336 | 1.140 | 0.688 |
| The performance evaluation procedures takes into consideration the suggestions given by the team members | | 3.028 | 1.111 | 0.749 |

[15] Items of INNOV and IMPROV were included in the EFA and they loaded as two factors.
[16] Items of OUTCOME and PROCESS INCENTIVE were included in the EFA and they loaded as two factors

## Appendix 4-1 (Cont'd): Descriptive Statistics and Factor Loadings for the Items

| Items | Construct | Mean | Std. Deviation | Factor Loadings |
|---|---|---|---|---|
| My project leader only tells me what I have to know to do my job | **TRANSACT LEADER**[17] (Cronbach α = 0.69) Eigen Value = 1.423 | 2.394 | 1.154 | 0.764 |
| My project leader would indicate his or her disapproval if I performed at a low level | | 4.036 | 0.881 | 0.512 |
| It is all right if I take initiatives but my project leader does not encourage me to do so | | 2.275 | 1.282 | 0.840 |
| My project leader is able to get others committed to his/her vision of the future | **TRANSFORM LEADER**[17] (Cronbach α = 0.77) Eigen Value = 2.618 | 3.697 | 1.084 | 0.786 |
| My project leader leads by "doing" rather than simply by "telling" | | 3.624 | 1.086 | 0.722 |
| My project leader enables me to think about old problems in new ways | | 3.624 | 0.998 | 0.841 |
| My project leader challenges me to reexamine some of my basic assumptions | | 3.844 | 0.9445 | 0.653 |
| Planning and Determining goals | **SELF-MANAGED** (Cronbach α = 0.74) Eigen Value = 2.118 | 3.921 | 1.083 | 0.688 |
| Who will be on the team | | 3.198 | 1.191 | 0.718 |
| Decisions concerning leadership inside the team | | 3.346 | 1.117 | 0.803 |
| Performance evaluation for the team | | 2.920 | 1.197 | 0.598 |
| Task Assignments within the team | | 3.94 | 0.8224 | 0.677 |
| The core members of our team remained on the project until completion | **X-TEAM** (Cronbach α = 0.66) Eigen Value = 1.633 | 3.494 | 1.350 | 0.888 |
| The project manager who started this project remained on until completion | | 3.7576 | 1.333 | 0.897 |
| The work load was full time while on this project | | 3.303 | 1.351 | 0.518 |
| Separate rewards and incentive systems exist in our unit for evaluating innovation projects and improvement projects | **STRUCT DIFF** (Cronbach α = 0.73) Eigen Value = 2.405 | 2.9375 | 1.170 | 0.731 |
| The project team organization (team role, reporting system etc.) is quite different between innovation projects and improvement projects | | 3.0625 | 1.390 | 0.620 |
| We have distinct organizational processes, structures and cultures for Innovation and Improvement projects | | 3.000 | 0.803 | 0.840 |
| It took time to understand the project's tasks and objectives | **PROJ COMPLEX** (Cronbach α = 0.77) Eigen Value = 2.405 | 3.813 | 1.025 | 0.599 |
| The project required a lot of different skills and knowledge from team members | | 4.237 | 0.678 | 0.614 |
| The project required a lot of analysis | | 4.033 | 1.066 | 0.741 |
| The project was relatively simple | | 1.810 | 0.887 | 0.749 |

[17] Items TRANSACTIONAL and TRANSFORMATIONAL LEADER were included in the EFA and loaded as two factors.

## Appendix 4-2: Pooled Random Effects Regression Results (Robust Standard Errors in parentheses)

| Variables | DV = Project Performance |
|---|---|
| Structural Differentiation ($\beta_A$) | 0.4100* (0.2494) |
| Innovation Improvement Binary (I) ($\beta_B$) | 0.39166* (0.1877) |
| Log Team Size ($\beta_C$) | -0.04954 (0.1454) |
| Outcome Incentive ($\beta_D$) | 0.2899* (0.1475) |
| Process Incentive ($\beta_E$) | 0.2694 (0.3036) |
| Transactional Leader ($\beta_F$) | 0.2862* (0.1479) |
| Transformational Leader ($\beta_G$) | -0.1681 (0.3409) |
| Ambidextrous Leader ($\beta_G$) | 0.2528 (0.1930) |
| Self-Managed Team ($\beta_H$) | 0.2312 (0.2216) |
| X-Team ($\beta_I$) | -0.0007 (0.2391) |
| I * Structural Differentiation (Cross Level Interaction) ($\beta_J$) | -0.7656*** (0.2795) |
| I*Outcome ($\beta_K$) | 0.1629 (0.2452) |
| I*Process ($\beta_L$) | -0.39887 (0.3426) |
| I* Transactional Leader ($\beta_M$) | -0.2318 (0.2100) |
| I * Transformational Leader ($\beta_N$) | 0.17088 (0.3724) |
| I* Ambidextrous Leader ($\beta_P$) | 0.3059 (0.226) |
| I* Self-Managed Team ($\beta_Q$) | 0.3059 (0.226) |
| I* X-Team ($\beta_R$) | 0.1929+ (0.1007) |
| Constant ($\beta_0$) | 0.8733 (1.3622) |
| | |
| Overall $R^2$ | 0.3314 |
| Chi Square | 46.60**** |
| Intra Class Correlation ($\rho$) | 0.08020 |

+p < 0.10; *p<0.05; **p<0.01; ***p<0.001

Note:
H1a is supported if $\beta_D > 0$
and H1b is supported if $(\beta_E + \beta_L) > 0$

H2a is supported if $\beta_F > 0$ and H2b is supported if $(\beta_G + \beta_P) > 0$

H3a is supported if $(\beta_H + \beta_Q) > 0$ and H2b is supported if $\beta_I < 0$ & $(\beta_I + \beta_H) > 0$

H4 is supported if $\beta_A > 0$ and $(\beta_A + \beta_J) > 0$

**Appendix 4-3:** Random intercepts across subgroups

| Subgroups (DV: Project Performance) | Intercepts ($\gamma_{00}$) | Wald Z | Intraclass Correlation |
|---|---|---|---|
| Improvement (52 Projects) | 4.371 | 21.39 | 0.36652 |
| Innovation (58 Projects) | 4.606 | 40.87 | 0.1336 |

**Note:** The following null hypothesis (i.e., Ho: $\gamma_{00}$ =0; Ha: $\gamma_{00} > 0$) is examined to see if the intercepts differ across divisions.
Results indicate that there is variability in project performance across divisions for both the innovation and improvement subgroups which allows us to go for a hierarchical model

**Appendix 4-4: Hausman Test**

The Hausman test is used to compare the fixed effect estimator ($\beta'^{W}$) and the GLS estimator ($\beta'^{R}$) to determine the most efficient estimator between the two. The Hausman test statistic takes the form

$$h = \frac{(\hat{\beta}^{W} - \hat{\beta}^{R})\ \{Cov(\hat{\beta}^{W}) - Cov(\hat{\beta}^{R})\}^{-1}(\hat{\beta}^{W} - \hat{\beta}^{R})'}{}$$

The h statistic has a $\chi^2$ null distribution with degrees of freedom given as the number of overlapping estimated regression coefficients from the two approaches, that is the number of covariates with both between and within cluster variation. The following results summarize the Hausman test for both the subgroups.

## Hausman Test for the Pooled Model

```
. estimates store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
 LN_TEAMSIZE |     .019363    -.0105263        .0298893        .1677049
OUTCOME_IN~E |    .2361919     .2250234        .0111684        .0995881
PROCESS_IN~E |    .0383749     .0395142       -.0011392        .1131439
TRANSACTIO~R |    .0954449     .1333555       -.0379105        .0838116
TRANSFORM_~R |    .0868475     .0928254       -.0059779        .1132957
 AMBI_LEADER |    .1022201     .0743026        .0279175        .0743018
SELF_MANAG~M |     .427108     .4419138       -.0148058        .1120851
     XTEAM_2 |    .0326389     .0102794        .0223595        .1075166
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.61
                Prob>chi2 =      0.9997
```

## Hausman Test for the Improvement Subgroup

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
 LN_TEAMSIZE |    .4038895     .2124085         .191481        .5691985
OUTCOME_IN~E |    .5835326     .2788027        .3047299        .2967535
PROCESS_IN~E |    .1815402     .3287491       -.1472089        .9847054
TRANSACTIO~R |    .5050895     .3164984        .1885911        .2784457
TRANSFORM_~R |     .321363    -.2854236        .6067866        .5182784
 AMBI_LEADER |   -.6231622     .2317694       -.8549316        .5337769
SELF_MANAG~M |   -.0420628     .1064301       -.1484929        .3907757
     XTEAM_2 |    .1998908     .1103214        .0895694        .2980946
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        8.63
                Prob>chi2 =      0.3744
```

### Hausman Test for the Innovation Subgroup

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
 LN_TEAMSIZE |   -.2575085    -.1856268       -.0718817        .3812818
OUTCOME_IN~E |   -.0753154     .1526362       -.2279516        .2759039
PROCESS_IN~E |   -.2792037    -.1017726       -.1774311        .2132215
TRANSACTIO~R |   -.0119674     .0682855       -.0802529        .2698841
TRANSFORM_~R |     .076788     .0089952        .0677928        .2880985
 AMBI_LEADER |    .1468243     .0076977        .1391266        .2078327
SELF_MANAG~M |    .3943091     .5496911        -.155382        .5573849
     XTEAM_2 |    .2402815     .1296436        .1106379        .3035475
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        2.73
                Prob>chi2 =      0.9501
```

A significant Hausman test means that the random-intercept model should be abandoned in favor of a fixed effects model. Hausman test results indicate that a random effects model is a better predictor for our data.

## Appendix 4-5: Random Effects Regression with Firm Level Clustering (N=24 Firms)

| Variables | Improvement Projects (52 Projects) | Innovation Projects (58 Projects) |
|---|---|---|
| DV: PROJ PERF | | |
| Group Variable | Firm (24) | Firm (24) |
| TEAM SIZE | 0.0823<br>(0.2148) | -0.1878<br>(0.1814) |
| STRUCT DIFF | 0.4744**<br>(0.2316) | -0.3186**<br>(0.1343) |
| OUTCOME INCENTIVE | $0.2410^{+}$<br>(0.1287) | 0.06558<br>(0.1644) |
| PROCESS INCENTIVE | 0.3296<br>(0.2999) | -0.0899<br>(0.1650) |
| TRANSACT LEADER | 0.2767*<br>(0.1370) | 0.0402<br>(0.1324) |
| TRANSFORM LEADER | -0.2203<br>(0.3552) | -0.03504<br>(0.1746) |
| AMBIDEXT LEADER | 0.1722<br>(0.1984) | 0.0345<br>(0.1185) |
| SELF-MANAGED | 0.1102<br>(0.2420) | 0.53002***<br>(0.2239) |
| X-TEAM | 0.07312<br>(0.2388) | 0.6836*<br>(0.3267) |
| Constant | 0.9103<br>(1.3119) | 2.9048*<br>(1.1923) |
| $\chi^2$ | 25.64*** | 23.10*** |
| $R^2$ | 0.3523 | 0.3533 |
| Intraclass Correlation (ρ) | 0.3960 | 0.0310 |

*p<0.05; **p<0.01; ***p<0.001

# Chapter 5

# Conclusion

## 5.1. Introduction

This dissertation research informs both practitioners and academics on the concept of ambidexterity – the ability to simultaneously execute innovation and improvement strategies. Recent years have seen a growing interest among scholars studying ambidexterity; a quick web search in the top tier management and operations management journals[18] turns up a dozen articles published on this topic during the last three years (2006-2009). Researchers have urged each other to perform more granular investigations into ambidexterity (Tushman et al., 2006; Raisch and Birkinshaw, 2009; Adler et al., 2009), but the understanding of this concept remains inconsistent. As described by Tushman et al., (2006),

> The current debate [on ambidexterity] is almost exclusively dedicated to questions of organizational design. However, ambidexterity requires aligned activities across multiple organizational levels, including organizational culture, firm strategy, and corporate leadership. (p. 773)

This research is focused on clarifying and refining the existing debate on ambidexterity. Although scholars have identified ambidexterity as a mechanism to simultaneously innovate and improve, very little research has studied the antecedents to organizational ambidexterity (Raisch and Birkinshaw, 2008; Tushman et al., 2006; Voss et al., 2003). This is mainly due to the piecemeal approach adopted by researchers. For example, strategic management researchers tend to study ambidexterity as an

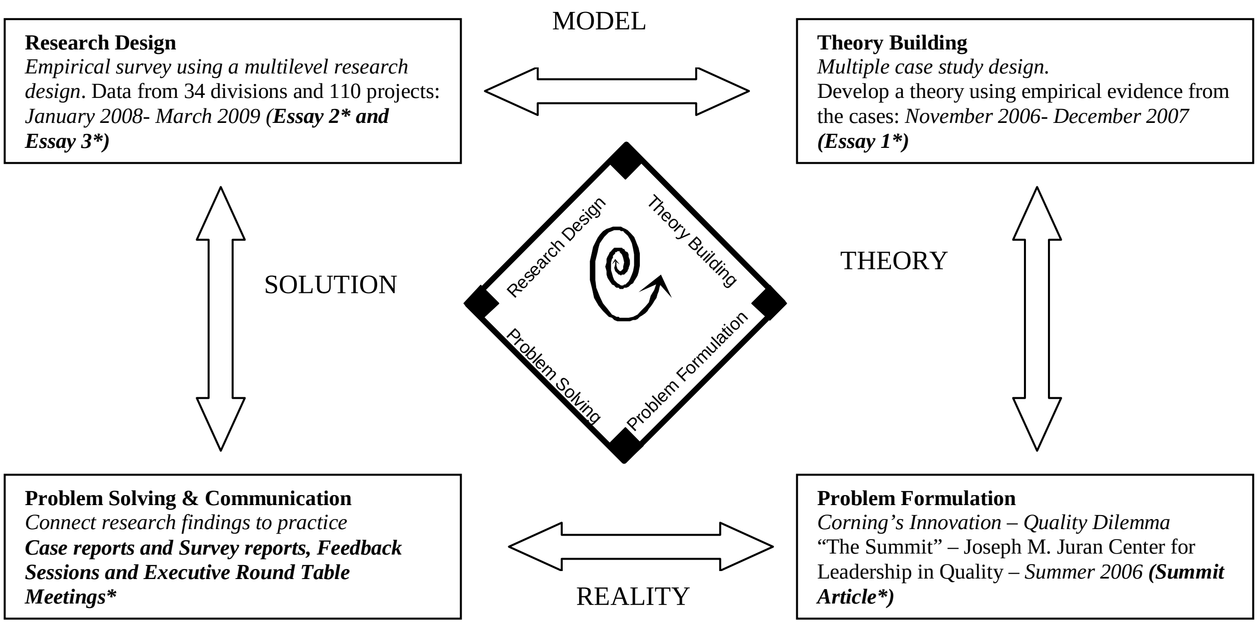
[18] *Journal of Operations Management*, *Management Science*, *Organization Science*, *Strategic Management Journal* and *Academy of Management Journal* were searched with the key word "ambidexterity" between the years 2006 and 2009

organizational level phenomenon and fail to delineate the intra-organizational processes that allow firms to simultaneously pursue innovation and improvement (He and Wong, 2004; Cho and Pucik, 2005). Similarly, operations management researchers studying the project level manifestation of innovation and improvement capabilities do not investigate the "unstructured and messy" decision making (Kavadias and Loch, 2007; Wheelwright and Clark, 1992) that takes place at the strategic level and its impact on the project level decisions. This inconsistency in the unit of analysis is a major reason that an over arching conception of ambidexterity and its antecedents has remained elusive.

## 5.2. Theoretical Implications from this Research – An Engaged Scholarship Approach

In this dissertation research, I look at the concept of ambidexterity at multiple levels within an organization. I adopt a diamond model research philosophy of advancing knowledge for science and profession. This involves traversing the four research bases: *problem formulation, theory building, research design,* and *problem solving and communication*. Figure 5-1 summarizes my dissertation research design (consisting of three essays, case study and survey reports) based on this philosophy.

**Figure 5-1:** The Diamond Model Research Philosophy (Adapted from Engaged Scholarship)




**** Indicates explicit outcomes from these phases***

As illustrated by this figure, my research began with a summary article based on a research talk by Don McCabe on Corning Incorporated's struggle to simultaneously excel on innovation and quality during a Juran summit for Quality in Leadership held in summer 2006. This was followed by my semi-structured interviews with the top management team at Corning to understand their problem and ground it in reality. Current theories on ambidexterity – namely structural ambidexterity (having distinct units to innovate and improve) and temporal ambidexterity (pursuing innovation and improvement sequentially) – failed to completely explain Corning's difficulty in simultaneously excelling at both innovation and quality. Chapter 3 of this dissertation addresses this limitation through a case study research design. Data for this study was collected from four high technology divisions and involved 11 projects. Both qualitative data (gathered through 53 semi-structured interviews) and quantitative data (e.g., project reports, division reports, IP documents etc.) were collected and analyzed in this study. A grounded theory building approach was used in this research.

Results from this study argue for multiple levels of ambidexterity: resolving strategic contradiction among senior management teams by mitigating the innovation-improvement decision risks (*cognitive ambidexterity*); ensuring alignment and adaptability between the strategic and project levels (*contextual ambidexterity*); and ensuring structural and infrastructural differences at the project level (*structural ambidexterity*). While strategic contradiction occurs at the senior management level and structural ambidexterity happens at the project level, contextual ambidexterity connects the two, providing a comprehensive theory on ambidexterity. Although theoretical arguments have been advanced as to senior management's ability to manage strategic contradictions (see Smith and Tushman, 2005; Lewis, 2009), this study is the first to measure and identify the antecedents and consequences of cognitive ambidexterity. In addition, I extend the concept of contextual ambidexterity and identify the project level antecedents to this capability. I also identify the organizational macro and micro contexts that promote structural ambidexterity. This case study is the first empirical examination of ambidexterity at multiple levels within an organization.

Testing the multilevel model developed in Chapter 3 required collecting data from several high technology organizations and at multiple levels. Studies collecting data from multiple levels within an organization are scarce (Mathieu et al., 2008) due to the difficulty in the data collection process (one key exception is Gibson and Birkinshaw [2004]). To gather the information needed for this dissertation, I partnered with high technology agencies such as the Life Sciences Alley and the Minnesota High Technology Association to collect multilevel data. Survey data collection took place between January 2008 and March 2009. Thirty-four divisions participated in the second phase of my dissertation research, and survey data was collected from both strategic level respondents and from 110 innovation and improvement projects within these divisions. Multiple respondents were used to collect survey data in order to avoid common method bias.

In Chapter 3, I test some of the theories developed from Chapter 2 on the effects of cognitive, contextual, and structural ambidexterities on organizations' ability to simultaneously innovate and improve. Results from this research suggest that organizational processes such as information analysis and methods, customer and market focus and inter-functional multilevel planning teams (grouped as scanning practices) synthesize internal and external information and predict cognitive ambidexterity. Disciplined project management and scorecard approach connect innovation and improvement project level decisions with the division's strategies and promote contextual ambidexterity. Both cognitive and contextual ambidexterity impact the division's ability to simultaneously pursue innovation and improvement strategies.

Interestingly, I find no support for structural ambidexterity arguments in this study. One reason for this could be that the effect of structural ambidexterity is subsumed by the cognitive ambidexterity capability of the senior managers (Smith and Tushman, 2005). That is, senior managers' ability to resolve the strategic contradiction between innovation and improvement at the highest level also accommodates for the need for structural separation between innovation and improvement activities. More research is required to understand how structural ambidexterity is operationalized (Jansen et al., 2009).

In addition to these results, I also show in Chapter 3 that high technology divisions that are able to simultaneously excel on both innovation and improvement outperform the rest. This research study is the first to measure the antecedents and performance implications of three distinct ambidexterities within an organization. It also provides empirical support to Tushman et al.'s (2006) argument that ambidexterity is a multilevel phenomenon and shows how cognitive and contextual ambidexterities simultaneously impact the organization's ability to balance innovation and improvement.

In my third essay, Chapter 4, I look within the "black box" of structural ambidexterity. Organizations use project teams to execute innovation and improvement goals. In fact, they use similar resources (project teams, project leaders) to accelerate the learning rates between innovation and improvement activities (Jansen et al., 2009; Brown and Eisenhardt, 1997; Bettis and Hitt, 1995). This is accompanied by numerous outcries and agonies expressed by the project leaders and the project team members working on innovation and improvement projects (Rae, 2007; Creveling et al., 2007). In this essay, I argue that structural ambidexterity has two facets: organizational macro and micro contexts. For example, the team rewards, team leadership, and project team structures collectively represent the organizational micro contexts that vary across the teams within a division or a firm and are influenced by the project teams (Zellmer-Bruhn and Gibson, 2006). Organizational processes, cultures, and structures that are invariant across the teams within a division or a firm constitute the macro context

(Gladstein, 1984). Both organizational micro and macro contexts influence how innovation and improvement projects are managed. Using organizational learning and strategic leadership theories, I argue for moderation by the strength fit between the type of activity (innovation, improvement) and the micro (project team structures, project team leadership, and project team incentives) and macro (structural differentiation) contexts. Data for this study was collected as a part of the multilevel survey. I usee both the project leaders' and project team members' responses to identify the innovation and improvement priorities on a given project. Results from this research suggest that the structural differentiation (macro level context) of distinct project teams, incentives, and cultures benefit improvement projects but hurt innovation projects in high technology divisions. Improvement projects also benefit from having a transactional leader and an outcome-based incentive structure, while innovation projects depend mainly on team structures. Analysis also suggests the presence of *Hybrid projects* with dual goals of both innovation and improvement. Hybrid projects benefit from the presence of ambidextrous project leaders who switch between transactional and transformational leadership styles, ensuring better project performance. They also benefit from having self-managed teams that design and implement their own solutions. This essay represents the first empirical investigation into the antecedents to structural ambidexterity arguments. It is also one of the few studies that look at the interaction between organizational macro and micro contexts.

### 5.3. Implications for Practice

This dissertation research informs practitioners on several facets of ambidexterity. Results from my research indicate that high technology organizations that simultaneously pursue both innovation and improvement strategies (ambidextrous organizations) perform better in terms of return on investment, profitability, market share, sales growth, and profit growth. The results also suggest that pursuing too much innovation at the expense of improvement (or vice versa) leads to poor performance. This result is consistent with the work of He and Wong (2004) and Jansen et al. (2006). Finally, my research unravels the antecedents to organizational ambidexterity.

Results from this research indicate that ambidextrous organizations have three different capabilities at multiple levels that enable them to simultaneously excel on innovation and improvement. First, managers of ambidextrous organizations resolve strategic contradictions between innovation and improvement using a decision risk approach. Referred to as cognitive ambidexterity, this requires senior managers to scan externally and internally to understand the customer and market preferences and integrate them with their operational capabilities. This ambidexterity allows managers to consistently make the right decision on innovation and improvement opportunities. My research identifies processes such as using inter-functional multilevel planning teams (IMP Teams), information analysis and methods, and customer and market focus which managers use in their decision making.

Ambidextrous organizations also have systems that permit alignment and adaptability across strategic and operational levels. Alignment is focused on improving short term performance while adaptability is geared toward the long term performance of the organization (Gibson and Birkinshaw, 2004). Referred to as contextual ambidexterity, my research finds that this type of ambidexterity grows out of organizational mechanisms such as disciplined project management and scorecard approach to connect goals and strategies across levels. Disciplined project management requires managers to establish clear standards of performance and behavior and a system of open and quick feedback regarding the project and its contribution to the organizational goals. Creating an appropriate organizational context this way empowers individuals and project teams to act and respond to changes. A scorecard approach also develops contextual ambidexterity by connecting project level metrics with the overall organizational metrics. This enables tracking of project performance and assists in connecting the tactical, operational and strategic goals of the organization (Crewling, 2006).

Ambidextrous organizations have distinct infrastructural and structural characteristics that permit simultaneous execution of innovation and improvement projects. Results from my dissertation indicate that the spatial separation of having innovation in R&D units and improvement in manufacturing units is less common in high technology organizations when compared to organizations operating in other external contingencies (also shown in the works of Cole, 2007; Cole and Matsumiya, 2007; Jayanthi and Sinha, 1998). These organizations use similar resources (project teams, project leaders) to accelerate the learning rates between innovation and improvement activities (Jansen et al., 2009; Brown and Eisenhardt, 1997; Bettis & Hitt, 1995). Recent articles in the business press illustrate agonies among project leaders and team members if they are all evaluated on a similar basis while working on these projects. My results indicate that both organizational and project level differences are required to ensure the coexistence of innovation and improvement. For example, improvement projects benefit from having a transactional leader who sets explicit agreements regarding expectations for the project team members and how team members will be rewarded for their efforts. These projects also require an outcome-based incentive structure focused on reducing errors and tied to the bottom-line profitability of the project. Innovation projects, on the contrary, are *least* influenced by the leadership or incentive designs. These projects benefit from a self-managed team structure which plans and designs its own goals and an X-team design with a core project team membership.

In addition to this dichotomy of projects (innovation and improvement), ambidextrous organizations also have a third classification of projects – hybrid projects – that have dual goals to innovate and improve. These projects require minimal organizational intervention through incentives and benefit from self-managed team and ambidextrous leadership styles. This suggests the managerial need to go beyond the dichotomy of improvement and innovation projects. While it is common for organizations to subscribe to a structured project management approach based on whether the project serves current or future needs (George, 2002; Pyzdek, 2003), The business press holds numerous examples of organizations (e.g., 3M, Motorola) that have suffered from the classification of projects into these dichotomous portfolios (Rae, 2007). The presence of hybrid projects suggests the need for managers to develop a third portfolio to successfully monitor these projects.

The final step of the diamond model research philosophy pictured in Figure 5-1 involves communicating my research results back to practice. A summary of this dissertation research has been compiled as case study reports and provided to the participating organizations. I have also presented my results in the round table meetings conducted by the Minnesota High Technology Association and other high technology organizations. Connecting research results back to practice helps inform the managerial community on the implications of current research and creates opportunities for continuous engagement with future research.

### 5.4. Limitations

Several limitations of this study merit discussion. First, the scope is limited to high technology organizations. Divisions were sampled based on the industry clockspeed (Fine, 1998), R&D expenditures, and competitive intensity. Results regarding organizational ambidexterities and their antecedents cannot be extended beyond this contingency. For instance, a core premise of my research is that high technology organizations are devoid of temporal separation between innovation and improvement activities (Voldberda, 1998). Temporal ambidexterity (pursuing innovation at one point in time, then improvement at the next instance) may be a viable alternative in slow-paced environments (Gupta et al., 2006). Data from other industries can test my theories in other contingencies.

Second, the sample of projects from each of the thirty-four divisions varied between two (one innovation and one improvement project as identified by the project leader) and nine (five innovation and four improvement) projects. These projects were not randomly sampled but were identified by the senior management as “projects of strategic importance.” This may cause some bias in the results at the project level.

Third, there were only thirty-four divisions participating in this study. The small sample size is due to the research design which required data from both the strategic level (e.g., vice presidents and R&D directors) and the project level (e.g., project team members and project leaders) respondents. Several divisions also declined to participate in this study because of the time and resource commitments. This small sample size at the divisional level is consistent with other studies involving multilevel research design (see Gibson and Birkinshaw, 2004). But, future studies may benefit from collaborative efforts among researchers working in this area, which might increase the sample sizes during multilevel research studies.

Fourth, the data collected at the strategic and at the project level represented the perceptual and self-reported assessments of the respondents. I also collected certain objective data (e.g., divisional sales, R&D spending, objective project performance). Missing values were an issue with the objective data. For example, forty-three projects had missing data on the objective project performance. The research design did utilize multiple respondents to avoid common method bias. I also used reliable and valid measurement instruments to collect perceptual data. Future studies, though, may benefit from gathering more objective performance data that can increase the validity of the study results.

Finally, both the case study and the survey research involved cross sectional design. To some extent, longitudinal data *was* collected during the case study, but the survey examined the concept of ambidexterity at a given instance in time. Future research may benefit from gathering data that spans more than one year. Longer term data might also address the question of sustainability – that is, whether ambidexterity helps organizations sustain competitive advantages over time.

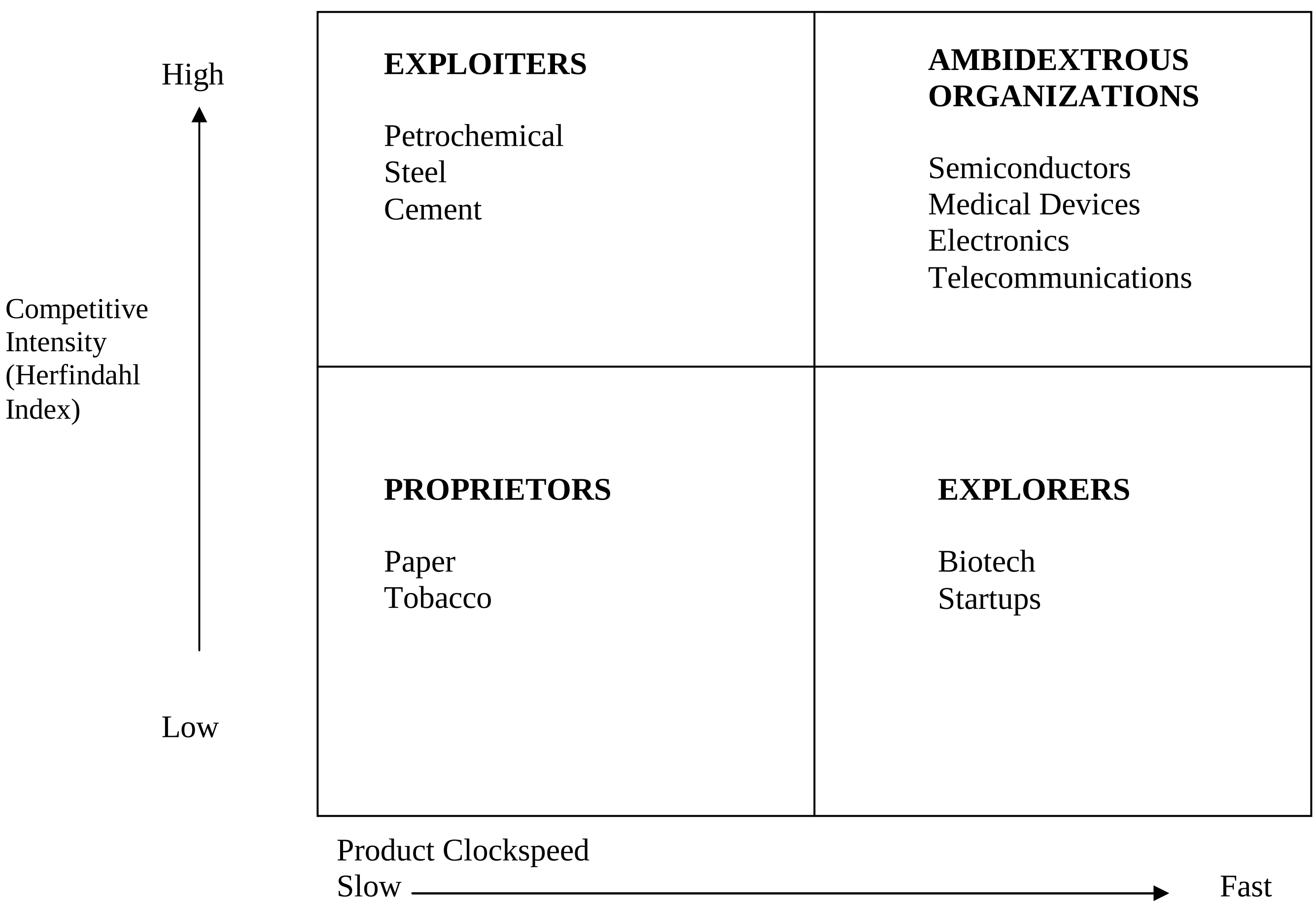
## 5.5. Future Research Directions

There are at least two possible extensions to this dissertation research: one at the organizational level and one at the project level.

### 5.5.1. Contingency Perspective toward Organizational Ambidexterity

This dissertation research shows that organizational ambidexterity – the ability to simultaneously innovate and improve – leads to better performance in fast-paced environments. Do all organizations need to be ambidextrous? Or is there a contingency perspective to organizational ambidexterity? An extension to this dissertation research could develop a contingency theory on organizational ambidexterity depending on product clockspeed and competitive intensity. Figure 5-2 shows a rough classification of industries based on secondary data from the COMPUSTAT database and Global Market Industry Database.

**Figure 5-2:** Contingency Perspective on Ambidexterity



Organizations that operate in external contingencies of fast product clockspeed and high competitive intensity are required to simultaneously excel at both innovation and improvement. Ambidexterity leads to superior performance for these organizations. Organizations functioning in slower product clockspeed but higher competitive intensity require more focus on improvement strategies (referred to as *exploiters*), while organizations functioning in fast product clockspeed but low competitive intensity are required to focus on innovation (referred to as *explorers*). Finally, organizations functioning in slow product clockspeed and low competitive environments generate rents through other possible means (e.g., patents, trade secrets, etc.). They are referred *proprietors*. Testing this taxonomy is currently underway as a part of an extension to the dissertation research.

### 5.5.2. Understanding Knowledge Creation and Knowledge Transfer across Innovation and Improvement Projects

A project level extension to this dissertation research is to understand the extent of tacit and explicit knowledge generated from these projects. Explicit knowledge is easy to codify, document, and transfer across organizational members while tacit knowledge is personal and is very difficult to extract from individuals (Nonaka and Takeuchi, 1995). Preliminary results from the case study suggest that project leaders utilize both macro (e.g., reporting structures) and micro contexts (e.g., team composition, team interactions) to minimize tacit knowledge generated from the projects. As an extension to this research, I plan to investigate the effect of macro and micro contexts on both the generation and transfer between the two kinds of knowledge.

Using theories from organizational cognition literature (Ocasio, 2001) and social context of creativity (Amabile et al., 1996), I plan to validate the following two research questions in future research:

1. *What is the effect of method and organizational context on knowledge created from innovation and improvement projects?*

and

2. *What are mechanisms that minimize the generation of tacit knowledge from innovation and improvement projects?*

### 5.6. Conclusion

Overall, the consequences of ambidexterity on organizational performance and its manifestation at multiple levels within an organization offer intriguing insights for both research and practice. I acknowledge that this dissertation research has only scratched the surface on this important topic. More research is required to understand the concept of ambidexterity. Future work will also help replicate the results from this dissertation research.

**References:**


Adler, P., M. Benner, J. Brunner, J.P. McDuffie, E. Osone, R. Staat, H. Takeuchi, M. Tushman, and S. Winter, 2009. “Perspectives on the Productivity Dilemma,” *Journal of Operations Management*. Published in *Articles in Advance* Jan. 2009.

Adler, P., B. Goldoftas, and D. Levine, 1999. “Flexibility versus Efficiency? A Case Study of Model Changeovers in Toyota Production System,” *Organization Science*. 10: 43-69.

Ahuja, G. and C.M. Lampert, 2001. “Entrepreneurship in the Large Corporation: A Longitudinal Study of How Established Firms Create Breakthrough Inventions,” *Strategic Management Journal*. 22: 521-543.

Aiken, L.S. and S.G. West, 1991. *Multiple Regression: Testing and Interpreting Interactions*. Newbury Park, CA: Sage Publications.

Akao, Y., 2004. *Quality Function Deployment: Integrating Customer Requirements into Product Design*. New York: Productivity Press.

Amabile, T., 1996. “Creativity and Innovation in Organizations.” Harvard Business School Case #396239.

Amason, A.C., 1996. “Distinguishing the Effects of Functional and Dysfunctional Conflicts on Strategic Decision Making: Resolving a Paradox for Top Management Teams,” *Academy of Management Journal*. 39: 123-148.

Ancona, D. and H. Bresman, 2007. *X-Teams: How to Build Teams that Lead, Innovate and Succeed*. Boston, MA: Harvard Business School Press.

Anderson, J., J. Rungtusnatham, and R.G. Schroeder, 1994. “A Theory of Quality Management Underlying the Deming Management Method,” *Academy of Management Review*. 19(3): 472-509.

Argyris, C. and D. Schon, 1978. *Organizational Learning: A Theory of Action Perspective*. Boston, MA: Addison Wesley.

Auh, S. and B. Menac, 2005. “Balancing Exploration and Exploitation: The Moderating Role of Competitive Intensity,” *Journal of Business Research*. 58: 1652-1661.

Avolio, B.J., B.M. Bass, and D. Jung, 1999. “Re-examining the Components of Transformational and Transactional Leadership using the Multifactor Leadership Questionnaire,” *Journal of Occupational Health and Organizational Psychology*. 72: 441-462.

Bagozzi, R.P. and L.W. Phillips, 1982. "Representing and Testing Organizational Theories: A Holistic Construal," *Administrative Science Quarterly*. 27: 459-489.

Baradhan, I., V. Krishnan, and S. Lin, 2007. "Project Performance and Enabling Role of Information Technology: An Exploratory Study on the Role of Alignment," *Manufacturing and Service Operations Management*. 9: 579-595.

Balkin, d.B., G.D. Markeman, and L.R. Gomez-Mejia, 2000. "Is CEO Pay in High Technology Firms Related to Innovation?" *Academy of Management Journal*. 43: 1118-1129.

Bates, D.L. and J.E. Dillard, 1993. "Generating Strategic Thinking through Multi-level Teams," *Long Range Planning*. 26: 103-110.

Beinhocker, E.D., 2006. "The Adaptable Organization," *The McKinsey Quarterly*. 2: 76-87.

Bendoly, E., E.D. Rosenzweig, and J.K. Stratman, 2007. "Performance Metrc Portfolios: A Framework and Empirical Analysis," *Production and Operations Management*. 16: 257-276.

Benner, J.M. and M. Tushman, 2002. "Process Management and Technological Innovation: A Longitudinal Study of Photography and Paint Industries," *Administrative Science Quarterly*. 47: 676-707.

——, 2003. "Exploitation and Exploration and Process Management: The Productivity Dilemma Revisited," *Academy of Management Review*. 28: 238-256.

Bettis, R.A. and M.A. Hitt, 1995. "The New Competitive Landscape," *Strategic Management Journal*. 16: 7-19.

Bhattacharya, S., V. Krishnan, and V. Mahajan, 1998. "Managing New Product Definition in Highly Dynamic Environments," *Management Science*. 44: 50-64.

Birkinshaw, J. and C. Gibson, 2004. "Building Ambidexterity into an Organization," *California Management Review*. Summer: 47-55.

Boer, H., A. Berger, and F. Gersten, 2000. *CI Changes from Suggestion Box to Organisational Learning*. Surrey, UK: Ashgate.

Boh, W. F., Ren, Y., Kiesler, S., and Bussjaeger, R. 2007. "Expertise and Collaboration in the Geographically Dispersed Organization," *Organization Science*, 18: 595-612.

Bourgeois, L.J. and K. Eisenhardt, 1988. "Strategic Decision Processes in High Velocity Environments: Four Cases in the Microcomputer Industry," *Management Science*. 34: 816-835.

Brown, S.L. and K.M. Eisenhardt, 1997. "The Art of Continuous Change: Linking Complexity Theory and Time-paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly*. 42: 1-34.

——, 1999. *Competing on the Edge: Strategy as Structured Chaos*. Boston, MA: Harvard Business School Press.

Burns, J., 1978. *Leadership*. New York: Harper and Row.

Burns, T. and G.M. Stalker, 1961. *The Management of Innovation*. New York: Oxford University Press.

Burt, R., 1992. *Structureal Holes: The Social Structure of Competition*. Boston, MA: Harvard Business School Press.

Campbell, D. and D.W. Fiske, 1959. "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," *Psychological Bulletin*. 56: 81-105.

Carrillo, J. and C. Gaimon, 2004. "Managing Knowledge Based Resource Capabilities Under Uncertainty," *Management Science*. 50: 1504-1518.

Chandrasekaran, A., K. Linderman, and R.G. Schroeder, 2008. "Managing Innovation and Improvement in High Technology Organizations: Evidence from Multiple Case Studies," *Academy of Innovation and Entrepreneurship Proceedings*. 297-303.

Chao, R. and S. Kavidias, 2008. "A Theoretical Framework for Managing the New Product Development Portfolio: When and How to Use Strategic Buckets," *Management Science*. 54(5): 907-921.

Chesborough, H., 2003. "Environmental Influences Upon Firm Entry into New Sub-markets: Evidence from the Worldwide Hard Disk Industry Conditionally," *Research Policy*. 32: 659-679.

Cho, H. and V. Pucik, 2005. "Relationship Between Innovativeness, Quality, Growth, Profitability and Market Value," *Strategic Management Journal*. 26: 555-575.

Christensen, C.M. and M.E. Raynor, 2003. *The Innovator's Solution: Creating and Sustaining Successful Growth*. Boston, MA: Harvard Business School Press.

Cohen, J., 1988. *Statistical Power Analysis for the Behavioral Sciences*, $2^{nd}$ Edition. Hillsdale, NJ: Lawrence Earlbaum Associates.

Cohen, S.G. and D.E. Bailey, 1997. "What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite," *Journal of Management*. 23(3): 239-290.

Cole, R.E., 2001. “From Continuous Improvement to Continuous Innovation,” *Administrative Science Quarterly*. 7-21.

Cole, R.E. and T. Masumiya, 2007. “Too Much of a Good Thing? Quality as an Impediment to Innovation,” *California Management Review*. 50: 77-84.

Collins, J. and J. Porras, 2002. *Built to Last: Successful Habits of Visionary Companies*. New York: HarperCollins Publishers.

Cooper, L.P., 2003. “A Research Agenda to Reduce Risk in New Product Development through Knowledge Management: A Practitioner Perspective,” *Journal of Engineering and Technology Management*. 20: 117-140.

Creveling, C.M., 2007. *Six Sigma for Technocal Processes: An Overview of R&D Executives, Technical Leaders and Engineering Managers*. Upper Saddle River, NJ: Prentice Hall.

Crossan, M.M., H.W. Lane, and R.E. White, 1999. “An Organizational Learning Framework: From Intuition to Institution,” *Academy of Management Review*. 24: 522-537.

Davis, I., 2005. “How to Escape the Short-Term Trap,” *The McKinsey Quarterly*. 29(April): 2005.

Dearden, J. and B.W.S. Ickes, 1990. “To Innovate or Not to Innovate: Incentives and Innovation in Heirarchies,” *American Economic Review*. 80: 1105-1125.

Devan, J., A. Millan, and S. Pranav, 2005. “Balancing Short and Long Term Performance,” *The McKinsey Quarterly*. 1: 31-33.

Dobbs, R., K. Leslie, and L. Mendonca, 2005. “Building the Healthy Corporation,” *The McKinsey Quarterly*. 3: 62-71.

Duncan, R.B., 1976. “The Ambidextrous Organization: Designing Dual Structures for Innovation,” *The Management of Organization*. 1: 167-188.

Ellis, A.P.J., Hollenbeck, J.R., Porter, C., West, B.J., and Moon, H., 2003. Team Learning: Collectively connecting the dots,” *Journal of Applied Psychology*, 88: 821-835.

Eisenhardt, K.M., 1989a. “Building Theories from Case Study Research,” *Academy of Management Review*. 14: 532-551.

——, 1989b. “Making Fast Strategic Decisions in High Velocity Environments,” *Academy of Management Journal*. 32: 543-576.

Eisenhardt, K.M. and B.N. Tabirizi, 1995. “Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry,” *Administrative Science Quarterly*. 40: 84-110.

Eisenhardt, K.M. and J.A. Martin, 2000. “Dynamic Capabilities: What are They?” *Strategic Management Journal*. 21: 1105-1121.

Fine, C.H., 1998. *Clockspeed: Winning Industry Control in the Age of Temporary Advantage*. New York: Perseus Books.

——, 2000. “Clockspeed-based Strategies for Supply Chain Design,” *Production and Operations Management*. 9(3): 213-221.

Flynn, B.N. and B. Saladin, 2001. “Further Evidence on the Validity of the Theoretical Models Underlying the Baldrige Criteria,” *Journal of Operations Management*. 19: 617-652.

Gatignon, H., M.L. Tushman, W. Smith, and P. Anderson, 2002. “A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type and Characteristics,” *Management Science*. 48: 1103-1112.

George, J., 1990. “Personality, Affect and Behavior in Groups,” *Journal of Applied Psychology*. 75: 107-116.

George, M., 2002. *Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed*. New York: McGraw Hill.

Ghoshal, S. and C. Bartlett, 1994. “Linking Organizational Context and Managerial Action: The Dimensions of Quality Management,” *Strategic Management Journal*. 15: 91-112.

Gibson, C.B. and J. Birkinshaw, 2004. “The Antecedents, Consequences and Mediating Role of Organizational Ambidexterity,” *Academy of Management Journal*. 47: 209-226.

Glaser, B. and A. Strauss, 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* Aldine Transaction.

Goll, I. and A. Rasheed, 1997. “Rational Decision Making and Firm Performance: The Moderating Role of Environment,” *Strategic Management Journal*. 24: 491-517.

Graebner, M.E., 2004. “Momentum and Serendipity: How Do Acquired Leaders Create Value in the Integration of Technology Firms?” *Strategic Management Journal*. 25: 771-777.

Greene, W.H., 2002. *Econometric Analysis,* 5th Edition. Upper Saddle River, NJ: Prentice Hall.

Gupta, A.K., K. Smith and C.E. Shalley, 2006. “The Interplay Between Exploration and Exploitation,” *Academy of Management Journal*. 49; 693-706.

Hackman, J.R., 1987. *The Design of Work Teams: Handbook of Organizational Behavior*. Englewood Cliffs, NJ: Prentice Hall. 315-342.

Hahn, G., W. Hill, R. Hoerl, and S. Zingraf, 1999. “The Impact of Six Sigma Improvement: A Glimpse into the Future of Statistics,” *American Statistical Association*. 53(3): 208-215.

Hamel, G., 1996. “Strategy as Revolution,” *Harvard Business Review*. July-August.

Hayes, R. and G. Pisano, 1996. “Manufacturing Strategy: At the Intersection of Two Paradigm Shifts,” *Production and Operations Management*. 5: 25-41.

Hayes, R., G. Pisano, D. Upton and S. Wheelwright, 2004. *Operations, Strategy, and Technology: Pursuing the Competitive Edge*. New Jersey: John Wiley & Sons.

He, Z.L. and P.K. Wong, 2004. “Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis,” *Organization Science*. 15: 481-494.

Heckman, J., 1979. “Sample Selection Bias as Specification Error,” *Econometrica*. 47: 153-161.

Henderson, J. and S. Lee, 1992. “Managing I/S Design Teams: A Control Theories Perspective,” *Management Science*. 38: 757-777.

Hitt, M., P. Beamish, S. Jackson, and J. Mathieu, 2007. “Building Theory and Empirical Bridges Across Levels: Multilevel Research in Management,” *Academy of Management Journal*. 50: 1385-1399.

Hollenbeck, J.R., D.R. Ilgen, J.A. LePine, J. Colquitt and J. Hedlund, 1998. “The Multilevel Theory of Team Decision-Making: Explaining and Controlling the Decision Accuracy of Leaders and Staff,” *Academy of Management Journal*. 21: 269-282.

Holmes, R., 2008. “RIM, Apple May Gain from Motorola Split,” *The Street.com (http://www.thestreet.com/newsanalysis/techtelecom/10409509.html)*

Holmqvist, M., 2004. “The Experiential Learning Process of Exploitation and Exploration Within and Between Organizations: An Empirical Study of Product Development,” *Organization Science*. 15: 70-81.

House, R.J. and T.R. Mitchell, 1974. "Path-Goal Theory of Leadership," *Journal of Contemporary Business*. 3: 81-97.

House, R.J. and B. Shamir, 1993. "Towards the Integration of Transformational, Charismatic and Visionary Theories." In M.M. Chemers and R. Ayman (Eds.), *Leadership Theory and Research: Perspectives and Directions*. San Diego, CA: Academic Press. 81-207.

Huber, V.L. and K.A. Brown, 1991. "Human Resource Issues in Cellular Manufacturing: A Sociotechnical Analysis," *Journal of Operations Management*. 10: 138-159.

Im, G. and A. Rai, 2008. "Knowledge Sharing Ambidexterity in Long Term Interorganizational Relationships," *Management Science*. 54: 1281-1296.

Ittner, C.D. and D.F. Larcker, 2003. "Coming Up Short on Nonfinancial Performance Measurement," *Harvard Business Review*. 81: 88-95.

Ittner, C.D., D.F. Larcker and M.W. Meyer, 2003. "Subjectivity and the Weighting of Performance Measures: Evidence from a Balanced Scorecard," *The Accounting Review*. 78: 725-758.

Jansen, J., M.P. Tempelaar, F.A.J. Van de Bosch and H.W. Volberda, 2009. "Structural Differentiation and Ambidexterity: The Mediating Role of Integrating Mechanisms," *Organization Science*. Forthcoming.

Jansen, J., F.A.J. Van de Bosch and H.W. Volberda, 2006. "Explorative Innovation, Exploitative Innovation and Performance: Effects of Organizational Antecedents and Environmental Moderators," *Management Science*. 52: 1661-1674.

Jansen, J., D. Vera and M. Crossan, 2009. "Strategic Leadership for Exploration Exploitation: The Moderating Role of Environmental Dynamism," *The Leadership Quarterly*. 20: 5-18.

Jayanthi, S. and K.K. Sinha, 1998. "Innovation Implementation: A Chaos Theoretic Empirical Analysis," *Journal of Operations Management*. 16: 471-495.

Judge, W. and A. Miller, 1991. "Antecedents and Outcomes of Decision Speed in Different Environmental Contexts," *Academy of Management Journal*. 34: 449-463.

Juran, J., 1988. *Quality Control Handbook.* Texas: McGraw Hill.

Juran, J., 1995. *Managerial Breakthrough*, 2nd Edition. New York: McGraw Hill.

Kano, N., 1984. "Attractive Quality Must Be Quality," *The Journal of the Japanese Society for Quality Control*. 38-39.

Kaplan, R. and D.P. Norton, 1992. “The Balanced Scorecard Measures that Drive Performance,” *Harvard Business Review*. 71-80.

——, 1996. “Using the Balanced Scorecard as a Strategic Management System,” *Harvard Businses Review*. 74: 75-85.

——, 2004. “Measuring the Strategic Readiness of Intangible Assets,” *Harvard Business Review*. 82: 52-63.

——, 2004. *The Execution Premium: Linking Strategy to Operations for Competitive Advantage.* Boston, MA: Harvard Business School Press.

Kaplan, S., 2008a. “Framing Contests: Strategy Making Under Uncertainty,” *Organization Science*. 19: 729-752.

——, 2008b. “Cognition, Capabilities and Incentives: Assessing Firm Response to the Fibre-Optic Revolution,” *Academy of Management Journal*. 51(4): 672-695.

Katila, R. and G. Ahuja, 2002. “Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction,” *Academy of Management Journal*. 45(6): 1183-1194.

Kavidas, S. and C.H. Loch, 2007. “Managing New Product Development: An Evolutionary Framework.” In *Handbook of New Product Development*. Oxford, UK: Butterworth-Heinemann.

Kennedy, P., 2008. *A Guide to Econometrics*, 6th Edition. Malden, MA: Blackwell Publishing.

Klein, K.J. and S.W.J. Kozlowski, 2000. *Multilevel Theory, Research and Methods in Organizations: Foundations, Extensions and New Directions*. Society for Industrial and Organizational Psychology Frontier Series. San Francisco, CA: Jossey-Bass.

Knight, D., C.L. Pearce, K. Smith, J. Olian, H.P. Sims, K.A. Smith and P. Flood, 1999. “Top Management Team Diversity, Group Processes and Strategic Consensus,” *Strategic Management Journal*. 20: 455-465.

Lapre, M. and D. Scudder, 2004. “Performance Improvement Paths in the U.S. Airline Industry: Linking Tradeoffs to Asset Frontiers,” *Production and Operations Management*. 13: 123-134.

Leonard-Barton, D., 1992. “Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development,” *Strategic Management Journal*. 13: 111-125.

Levinthal, D. and J. March, 1994. “The Myopia of Learning,” *Strategic Management Journal*. 14: 95=112.

Lewis, M., 2000. “Exploring Paradox: Toward a More Comprehensive Guide,” *Academy of Management Review*. 25: 760-776.

Li, H., J.B. Bingham and E.E. Umphress, 2007. “Fairness from the Top: Perceived Procedural Justice and Collaborative Problem Solving in New Product Development,” *Organization Science*. 18: 200-216.

Loch, C. and S. Kavadias, 2007. *Handbook of New Product Development Management*. Oxford, UK: Butterworth-Heinemann.

Mankins, C.M. and R. Steele, 2005. “Turning Grate Strategy into Great Performance,” *Harvard Business Review*. 83: 64-72.

——, 2006. “Stop Making Plans. Start Making Decisions.” *Harvard Business Review*. 84: 76-84.

March, J. 1991. “Exploration and Exploitation in Organizational Learning,” *Organization Science*. 2: 71-78.

——, 1998. *The Pursuit of Organizational Intelligence*. Boston, MA: Harvard Business School Press.

Martin, R.L., 2004. *The Opposable Mind: How Successful Leaders Win through Integrative Thinking*. Boston, MA: Harvard Business School Press.

Matson, E. and L. Prusak, 2003. “The Performance Variability Dilemma,” *Sloan Management Review*. 39-44.

Mathieu, J., M.T. Maynard, T. Rapp and L. Gilson, 2008. “Team Effectiveness 1997-2007: A Review of Recent Advancements and a Glimpse into the Future,” *Journal of Management*. 34(3): 410-476.

McCall, M.W. and R.E. Kaplan, 1985. *Whatever it Takes*. New York: Prentice Hall.

Mendelson, H. and R.R. Pillai, 1999. “Industry Clockspeed: Measurement and Operational Implications,” *Manufacturing and Service Operations Management.* 1(1): 1-20.

Michelman, P., 2005. “Balancing the Future Against Today’s Needs,” Harvard Business School Working Paper.

Miles, M.B. and M. Huberman, 1994. *Qualitative Data Analysis*. New York: Sage Publications.

Milgrom, O. and J. Roberts, 1995. “Complementarities and Fit: Strategy, Structure and Organizational Change in Manufacturing,” *Journal of Accounting and Economics*. 19: 179-208.

Morse, J.M., 1997. “Perfectly Healthy, But Dead: The Myth of Inter-Rater Reliability,” *Qualitative Health Research*. 7: 445-447.

Nadkarni, S. and V.K. Narayanan, 2007. “Strategic Schemas, Strategic Flexibility, and Firm Performance: The Moderating Role of Industry Clockspeed,” *Strategic Management Journal.* 28: 243-270.

Naveh, E. and M. Erez, 2004. “Innovation and Attention to Detail in the Quality Improvement Paradigm,” *Management Science*. 50: 1576-1586.

Neter, J., M. Kutner, C. Nachtsheim, and W. Li, 2004. *Applied Linear Statistical Models*, 5th Edition. New York: McGraw Hill.

Nonaka, I. and H. Takeuchi, 1995. *The Knowledge Creating Company*. New York: Oxford University Press.

Nunnally, J.C., 1978. *Psychometric Theory*. New York: McGraw Hill.

Ocasio, W., 2001. “How do Organizations Think?” in T. Lant and Z. Shapira (Eds.), *Organizational Cognition: Computation and Interpretation*. NJ: Lawrence Erlbaum Associates. 39-60.

O’Reilly, C. and M. Tushman, 2004. “The Ambidextrous Organization,” *Harvard Business Review*. April: 74-81.

——, 2008. “Ambidexterity as a Dynamic Capability: Resolving the Innovator’s Dilemma,” Harvard Business School Working Paper.

Park, S., Hartley, J., and Wilson, D., 2001. “Quality management practices and their relationship to buyer’s supplier ratings: a study in the Korean automotive industry,”*Journal of Operations Management.* 19: 695-712.

Pyzdek, T., 2003. *The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels*. New York: McGraw Hill.

Rabe-Hesketh, S. and A. Skrondal, 2005. *Multilevel and Longitudinal Modeling Using Stata*. TX: Stata Press.

Raisch, S. and J. Birkinshaw, 2008. “Organizational Ambidexterity: Antecedents, outcomes and Moderators,” *Journal of Management*. 34(3): 375-409.

Raynor, M.E., 2007. *The Strategy Paradox: Why Committing to Success Leads to Failure (and What to Do about It)*. New York: Doubleday.

Romanelli, E. and M. Tushman, 1994. "Organizational Transformation as Punctuated Equilibrium: An Empirical Test," *Academy of Management Journal*. 37: 1141-1166.

Rothaermel, F.T. and M.T. Alexandre, 2009. "Ambidexterity in Technology Sourcing: The Moderating Role of Absorptive Capacity," *Organization Science*. Forthcoming. Articles in Advance.

Sarin, S. and V. Mahajan, 2001. "The Effects of Reward Structures on the Performance of Cross Functional Product Development Teams," *Journal of Marketing*. 65: 35-53.

Sarin, S. and C. McDermott, 2003. "The Effect of Team Leader Characteristics on Learning, Knowledge Applications and Performance of Cross Functional New Product Development Teams," *Decision Sciences*. 34: 707-740.

Schroeder, R.G., K. Linderman, C. Leidtke and A. Choo, 2008. "Six Sigma: Definition and Underlying Theory," *Journal of Operations Management*. 26: 536-554.

Schwab, A., 2007. "Incremental Organizational Learning from Multilevel Information Sources: Evidence for Cross Level Interactions," *Organization Science*. 18: 233-251.

Shadish, W.R., T.D. Cook and D.T. Campbell, 2002. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. New York: Houghton Mifflin Company.

Shane, S. and K. Ulrich, 2004. "Technology Innovation, Product Development and Entrepreneurship in Management Science," *Management Science*. 50: 133-144.

Sitkin, S. and A.L. Pablo, 1992. "Reconceptualizing the Determinants of Risk Behavior," *Academy of Management Review*. 17: 9-38.

Sitkin, S., K. Sutcliffe and R.G. Schroeder, 1994. "Distinguishing Control from Learning in Total Quality Management: A Contingency Perspective," *Academy of Management Review*. 19: 446-471.

Smith, W. and M.L. Tushman, 2005. "Managing Strategic contradictions: A Top management Model for Managing Innovation Streams," *Organization Science*. 16: 522-536.

Strauss, A.L. and J. Corbin, 1998. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, CA: Sage Publications.

Stewart, G., 2006. "A Meta Analytic Review of Relationships between Team Design features and Team Performance," *Journal of Management*. 20: 503-550.

Stewart, G., E. Applebaum, M. Beer, A. Lebby and T. Amabile, 1993. “Rethinking Rewards,” *Harvard Business Review*. 71: 37-49.

Stewart, G. and M.R. Barrick, 2000. “Team Structure and Performance: Assessing the Mediating Role of Intra Team Proces and the Moderating Role of Task Type,” *Academyof Management Journal*. 43: 135-148.

Stieglitz, N. and K. Heine, 2007. “Innovation and the role of Complementarities in a Strategic Theory of the Firm,” *Strategic Management Journal*. 28: 1-15.

Suddaby, R., 2006. “From the Editors: What Grounded Theory is Not,” *Academy of Management Journal*. 49: 633-642.

Tatikonda, M.V. and S. R. Rosenthal, 2000. “Successful Execution of Product Development Projects: Balancing Firmness and Flexibility in the Innovation Process,” *Journal of Operations Management*. 18: 401-425.

Talaulicar, T., J. Grundei and A. Werder, 2005. “Strategic Decision Making in Start-ups: The Effect of Top Management Team Organization and Processes on Speed and Comprehensiveness,” *Journal of Business Venturing*. 20: 519-541.

Teece, D.J., G. Pisano and G. Shuen, 1997. “Dynamic Capabilities and Strategic Management,” *Strategic Management Journal*. 18: 509-533.

Thomas, J.B., M. Clark and D. Gioia, 1993. “Strategic Sensemaking and Organizational Performance: Linkages Among Scanning, Interpretation, Action and Outcomes,” *Academy of Management Journal*. 36: 239-270.

Thompson, L.L., 2004. *Making the Team: A Guide for Managers*, 2nd Edition. Upper Saddle River, NJ: Pearson Prentice Hall.

Thompson, L. and H.S. Choi, 2005. *Creativity and Innovation in Organizational Teams*. NJ: Lawrence Erlbaum Associates.

Tushman, M.L. and P. Anderson, 1986. “Technology Discontinuities and Organizational Environments,” *Administrative Science Quarterly*. 31: 439-465.

Tushman, M.L., J. Birkinshaw, G. Probst and S. Raisch, 2006. “Call for Papers in Organization Science – Special Issue on Ambidextrous Organizations,” *Organization Science*. 17: 773.

Ulrich, K. and S. Eppinger, 2004. *Product Design and Development*. Boston, MA: McGraw-Hill/Irwin.

Utterback, J.M. and W.J. Abernathy, 1975. "A Dynamic Model of Process and Product Innovation," *Omega, International Journal of Management Science*. 3: 639-656.

Van de Ven, A.H., 1986. "Central Problems in the Management of Innovation," *Management Science*. 32: 590-607.

Van de Ven, A.H., 2007. *Engaged Scholarship: A Guide for Organizational and Social Research*. New York: Oxford University Press.

Venkataraman, N., 1989. "The Concept of Fit in Strategy Research: Toward Verbal and Statistical Correspondence," *Academy of Management Review*. 14: 423.

Vera, D. and M. Crossnan, 2004. "Strategic Leadership and Organizational Learning," *Academy of Management Review*. 29(2): 222-240.

Victor, B., A. Boynton and S. Theresa-Jahng, 2000. "The Effective Design of Work Under Total Quality Management," *Organization Science*. 11: 102-118.

Voberda, H.W., 1998. "Toward the Flexible Form: How to Remain Vital in Hypercompetitive Environments," *Organization Science*. 7: 359-374.

Waldman, D.A., 1994. "The Contributions of Total Quality Management to a Theory of Work Performance," *Academy of Management Review*. 19: 510-536.

Walsh, J.P., 1995. "Managerial and Organizational Cognition: Notes from a Trip Down Memory Lane," *Organization Science*. 6: 280-321.

Ward, P. and R. Duray, 2000. "Manufacturing Strategy in Context: Environment, Competitive Strategy and Manufacturing Strategy," *Journal of Operations Management.* 18: 123-138.

Weick, K.E., 1992. "The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster," *Administrative Science Quarterly*. 38: 628-652.

Weick, K.E. and K. H. Roberts, 1993. "Collective Mind in Organizations: Heedful Interrelating on Flight Decks," *Administrative Science Quarterly*. 38: 357-382.

Weick, K.E., K.M. Sutcliffe and D. Obstfeld, 2005. "Organizing and the Process of Sensemaking," *Organization Science*. 16: 409-421.

Westerman, G., M. Iansiti and W. McFarlan, 2006. "Organizational Design and Effectiveness Over the Innovation Life Cycle," *Organization Science*. 17: 230-238.

Winter, S., 2003. "Understanding Dynamic Capabilities," *Strategic Management Journal*. 24: 991-995.

Zaltman, G., R. Duncan, and J. Holbeck, 1973. *Innovation and Organizations*. New York: Wiley-Interscience.

Zangwill, W. and P. Kantor, 1991. “Theoretical Foundation of a Learning Rate Budget,” *Management Science*. 37: 315-330.

——, 1996. “Toward a Theory of Continuous Improvement and the Learning Curve,” *Management Science*. 44: 910-920.

Zellmer-Bruhn, M. and C. Gibson, 2006. “Multinational Organization Context: Implications for Team Learning and Performance,” *Academy of Management Journal*. 49(3): 501-518.