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New product development system fit for innovative performance

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NEW PRODUCT DEVELOPMENT SYSTEM FIT FOR INNOVATIVE PERFORMANCE

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DEDICATION

I would like to dedicate this to my wife, Shelly, and my children, Rachel, Griffin, and Ryan. Your support, love, encouragement, and patience during my academic journey has been remarkable. Thank you for helping me realize this goal.

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VITA

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ABSTRACT

Innovation is an imperative for long-term health and shareholder returns in firms dependent on product development. Yet, most companies struggle with the tension between creative ideation and implementation. Effectively finding new sources of revenue and improving and profiting from existing products and services reflects a product development ambidexterity challenge. Surveys were collected from 212 development team members representing 31 teams from the transportation, aerospace, and chemical sectors to understand if a new product development (NPD) system's ambidexterity supported team level innovation performance. When NPD systems are perceived by development team users as ambidextrous structures, their combined ideation and implementation strength contributes directly to team innovation performance. This research supports past findings in contextual ambidexterity and provides a new measure for assessing the ideation and implementation characteristics of NPD systems.

Keywords: contextual ambidexterity, product development, team innovation

CHAPTER 1: INTRODUCTION

The pressure is on. Stakeholders of product development processes and manufacturing firms including customers, investors, and financial analysts, are demanding excellence in new product launches and other major innovations. Timeliness, launch cost control, profitability targets, quality metrics, and last-minute customer changes must be delivered properly to keep up with the competition and meet overall financial performance goals.

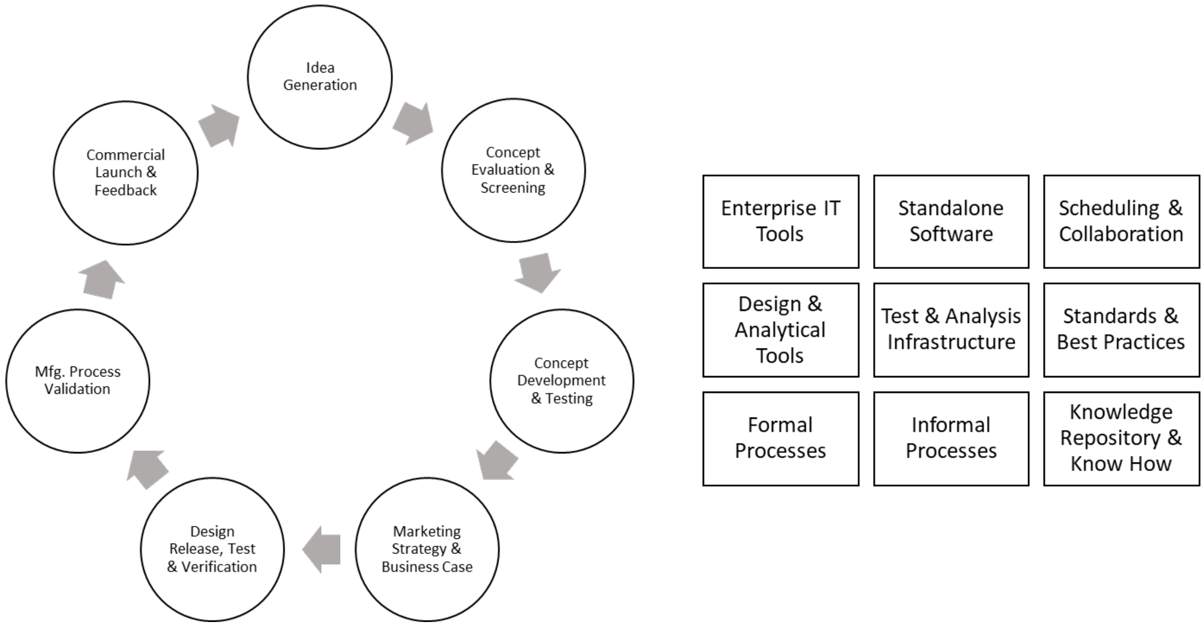
New product innovation is the lifeblood for many firms and imperative for long-term organization health and shareholder returns (Cefis & Marsili, 2005; Rubera & Kirca, 2012). How to best design and deliver the most innovative products to customers is quite contextual; theory and empirical evidence provide no easy-to-digest, one-size-fits-all approach (Simsek, 2009). Depending on their market environment and internal capabilities, companies can be successful with products that span the spectrum from radical innovation, such as products with totally new features or discontinuous production capability improvements, to incremental improvements, such as refining current products and internal production processes (Hoonsopon & Ruenrom, 2012). Simply outspending competitors on R&D is not necessarily a winning strategy either (Rosenbusch et al., 2011). Yet, firms struggle with the tension between ideation and implementation activities, often referred to as ambidexterity (O'Reilly & Tushman, 2013). Finding a suitable balance is a common but difficult objective (Andriopoulos & Lewis, 2009; Beretta et al., 2018; Birkinshaw et al., 2011).

On the implementation side, being fast in total development speed and efficient in practice is certainly intuitive to most leaders and managers. Research supports that these qualities lead to success measured by cost, market timing, product quality, competitiveness, and financial outcome (Cankurtaran et al., 2013). One solution is *process formalization*, or the establishment of documented routines, rules, concurrency, and the simultaneous coordination between separate functional departments. Such coordination is an antecedent of new product development speed (Chen et al., 2010) and increasing speed and efficiency are natural targets of automation through information system (IS) technology that extends to the enterprise level. Originally, the domain of engineering disciplines, the integration of upstream and downstream processes like marketing, customer relations, warranty support, and end of life decommission or recycling associated with new product development (NPD) can also be described as Product Lifecycle Management or PLM (Grieves, 2005; Terzi, 2005).

However, certain aspects of highly efficient, automated PLM systems could be inadvertently degrading the balance between effective ideation and implementation in NPD processes. Strict process controls that guide employees, providing oversight to help ensure accuracy and prevent wasteful errors, can also create rigidity and impediments to creativity and fully vested problem solving (Cooper & Sommer, 2016). The research reported here takes a broad strategic viewpoint, defining the enterprise level NPD system as the control architecture encompassing PLM and other related formal and informal systems. Together, these systems contribute to the definition and execution of the firm’s overall new product development process regardless of implementation depth, formality, or IT automation complexity. For example, a loosely controlled market development or voice of the customer data stream that supports early product ideation but lacks IT enabled knowledge dissemination tools is still part of an NPD system. A feedback loop from field service technicians to manufacturing is still part of an NPD system even if formalized tracking may not make this information readily available to product development teams. Typical operational phases and the components that may be used collectively to operate the new product development system are shown in Figure 1.

Figure 1

New Product Development System: Typical Phases and Component Structure



The term NPD will be used synonymously with innovation. NPD is a system and management process that enables innovation in an organization. NPD processes govern innovation, but do not mandate that a successful benefit has been achieved, which is required in most definitions of innovation. The processes a company employs do not change state or name based on a retrospective application of a success measure. For the purposes of this research, it can be assumed that successful NPD is equal to innovation.

Problem Addressed

This research contends that questions about the overall effectiveness of NPD systems plague team leaders and front-line managers not because the systems are technically inefficient or narrowly applied, but because they lack a method to understand whether their exploitive and explorative characteristics are appropriate for the organization's strategic and developmental needs. Inadequate or infrequent ideation processes risk new products that are not truly innovative or may be too far outside the firm's capability; inadequate implementation capabilities risk not being able to deliver on a high-potential product (Ahuja & Lampert, 2001; Volberda & Lewin, 2003). Research suggests that rigidity and maturity of NPD and PLM implementations can create problems regarding creativity, team process flexibility, and even solution response times (Barari & Pop-Iliev, 2009; Hachani et al., 2013). If an NPD system can encourage ideation while providing necessary oversight and control at all points in the process, it can achieve contextual ambidexterity (Gibson & Birkinshaw, 2004). Firms must ask, "How are these processes affecting the development teams that use them on a day-to-day basis?" and "Do they promote an appropriate balance between creativity and implementation for our particular challenges?"

Research Question

The research question addressed concerns the extent to which the ambidexterity of an NPD system influences team innovation. Specifically, does an NPD system's ambidexterity, as perceived by the development teams using it, positively affect team innovative output as judged by peers? In addition, is the relationship between NPD system ambidexterity and team innovativeness moderated by the organization's strategic orientation and leadership behavior?

Significance and Purpose of the Proposed Research

Ignoring failures in the development and ideation process, products introduced to the marketplace have an average failure rate of 40% across industries, with the best companies missing the mark 25% of the time and the worst 50% of the time (Castellion & Markham, 2012). Recognizing that learning also occurs in failures, there is still significant waste in the form of financial, human, and fixed capital resources which could be spared by improving firms' product innovation processes. Ambidexterity is a managerial capability and multi-level construct requiring all levels of the organization to participate in solving the explore and exploit dilemma

(Birkinshaw & Gupta, 2013; March, 1991). While research into structural design and management processes have fostered practical guidance for NPD, little is understood about how organizational systems enable or hinder ambidexterity within a firm.

The objective of this study was to explore how enterprise-level NPD system characteristics influence team innovation performance. By defining NPD system ambidexterity and quantifying its relationship to team innovative performance, an important gap in academic literature will be filled. For example, Anderson et al. (2014) note that much of the empirical research on innovation spans individual, team, organization, and multi-level approaches and they call for future research at the organization-team interface "where organizational-level processes and phenomena impinge upon teams" (p. 1324) and the team-individual interface "where work group processes and phenomena impinge upon individual team members" (p. 1324). Currently, no analytical tools exist to evaluate this characteristic of NPD systems and the literature suggests that NPD systems may be biased toward efficiency. In addition to advancing the study of ambidexterity, the fields of management and organizational design will benefit from understanding how these systems affect the teams utilizing them.

Practitioners will benefit having an additional tool for evaluating NPD system installation characteristics above that of installation maturity which exists today. This tool and the associated diagnostic analysis of the relationship between NPD system ambidexterity and team innovative performance will enable practitioners to formulate and guide prescriptive change to improve firms' new product development results. Increasing effectiveness in a firm's overall NPD process will preserve valuable resources and improve firm health (Rubera & Kirca, 2012). Leaders and managers that install, modify, or utilize NPD systems without this perspective could be suboptimizing their overall innovative potential and output. This research posits that understanding NPD system ambidexterity will enable improvements in team innovative output beyond that of the insights and resulting guidance already provided in leadership and strategic orientation related literature.

How Aims Were Accomplished

The overall research process consisted of two phases. In the first phase, a psychometric measurement tool for NPD system ambidexterity was developed, refined, and validated. This established NPD system ambidexterity as a characteristic of an organizational structure which can be discerned as separate from product development strategic orientation and leadership processes. In the second phase, the NPD system ambidexterity measurement tool was used to test a hypothesized relationship between the NPD system ambidexterity and team innovation performance as measured by observers who are not part of the development team. Using additional, existing ambidexterity measurement instruments, hypothesized moderating effects of product development strategic orientation and leadership behavior were tested as well.

Chapter 2 addresses the existing literature relevant to organizational innovation, NPD, the theory of ambidexterity, and the gaps that exist in its application to the study of NPD system characterization. Chapter 3 outlines the justification for a quantitative research approach and the two-phase design used in the study. Chapter 4 describes the successful validation of a new measure necessary to study NPD system ambidexterity and then follows with the quantitative studies required to test the hypotheses in phase two of the research design. Chapter 5 discusses the implications of the results on theory advancement and practitioner application before outlining study limitations and recommending further research.

CHAPTER 2: LITERATURE REVIEW

Innovation is a broadly researched topic. Garcia and Calantone (2002) proposed: "Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, marketing, and production tasks striving for the commercial success of the invention" (p. 112). Baregheh et al. (2009) distilled 60 definitions into "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service, or processes… to advance, compete, and differentiate themselves successfully in their marketplace" (p. 1334). Both definitions convey important concepts that are relevant to this research. First, ideation (a new idea) is transformed into success through an implementation process. Second, the process is iterative and embraces both newness and incremental changes or fixes.

The enterprise level systems which are the focus of this research, like any internal organizational system, are subject to process innovation or continuous improvement. To avoid ambiguity, the term *innovation* will be used to describe the outcome of a process intended to introduce new products by a firm and/or the manufacturing processes by which these products are made. Innovation will not refer to the modification of management processes or organizational structures that achieve these end goals. Services are differentiated from products as an output (Nijssen et al., 2006) and will not be considered under these terms.

Organizational Innovation

Despite a 10x publication growth factor in the 20 years following 1990 compared to the 20 preceding years, publication of an integrative and widely accepted innovation framework has yet to emerge (Anderson et al., 2014). In addition to traditional theories that give R&D expenses a driving role (Segerstrom & Dinopoulos, 1990), one of the most widely cited frameworks is the

Dynamic Componential Model of Creativity and Innovation in Organizations (Amabile, 1988; Amabile & Pratt, 2016). It posits that innovation is partly a function of team and individual interactions. A central relationship in the theory suggests that leadership creates strategies and structures that affect creativity at the team and individual levels by continuously influencing the dyadic interactions between team members and team leaders. Although this theory focuses heavily on the creativity (i.e., ideation, exploration) side of the innovation process, it illustrates the parallelism between individual and small group creativity and organizational innovation processes. It asserts that "true organizational motivation to innovate is marked by a bias toward clear-eyed risk-taking (versus clinging to the status quo)" (Amabile, 1988, p. 161).

Amabile and Pratt (2016) recognized that other theories were compatible with and were encompassed within their model. For example, the Interactionist Theory of Organizational Creativity stresses that team creativity is affected by contextual influences from organizational characteristics and the environment (Woodman et al., 1993). Similarly, a Dialectic Perspective on Innovation suggests that active management and self-regulating processes across organization levels resolves the dynamic and changing demands of creative yet accurate and efficiently implemented product and process solutions and that multiple pathways to success exist within and between development projects. The focus on dialectic thinking at the individual, team, and process design level has been suggested as the key to innovation success (Bledow et al., 2009). These existing multi-level theories recognize that ideation and implementation penetrate the organization-team boundary and suggest that organizational processes or structures have an effect on the development teams that make use of them (Anderson et al., 2014).

New Product Development Process Management

The mid to late 20th century witnessed a shift in innovation focus from project management efficiency to the advent of concurrent engineering principles that addressed communication, discipline, and accuracy as a means of increasing product development success (Laufer et al., 1996). In the case of the project management approach, a design or project goal was typically fixed in stone and competitive advantage was gained by optimizing execution scheduling and cost outlays. This was typical in simple linear tasks but also highly complex projects that required many disparate parties to work together in unison. The project management methods evolved to appreciate the fact that designs often changed during dynamic projects or large complex undertakings.

Unfortunately, for product developers in dynamic and competitive markets, relying on a stable design or goal is a rare luxury. The concepts of project management naturally extended to a development management concept tasked with integrating team efforts around this goal uncertainty. The next evolutions aimed to manage the risk of unstable propositions, and to do both things as quickly as possible with many organizational functions working concurrently. For instance, a disc brake producer will often win a product contract for an application that is slightly larger or more demanding that they have in the past. To meet these evolving customer demands and market pressures, several internal company disciplines must establish and validate new methods of design, manufacturing, service, and fulfillment in parallel, synchronized to codependent due dates to meet the promised goal.

Utterback and Abernathy (1975) recognized the importance and complexity of creativity and efficiency while adapting innovation processes to changing market conditions and increasing product maturity. The focus could no longer remain on program management's implementation efficiency and accuracy alone to explain product development success. They forwarded the theory of dynamic product development and observed that firms naturally shifted focus from less structured new product solutioning to more structured incremental process-based solutions as markets matured and product cost efficiency needs began to dominate. They hypothesized that firms with less structured processes and a higher product performance focus would result in more innovative products compared to firms with highly structured, efficiency maximizing processes.

Subsequent research built on Utterback and Abernathy's (1975) model but varied on how best to react to the need for more creative products or more rapid introduction. Andreasen and Hein (2000) stressed the importance of interfaces between functional areas in their integrated product development approach in which an initial investigation of need precipitated a product design prior to execution. Cooper (1990) stressed execution quality, market orientation, and resource optimization while still advocating for the early establishment of a fixed design target in his Stage-Gate® methodology. Prasad (1996) placed importance on the concurrent alignment of the downstream production related resources to the early product design activities, but still saw the process as linear; product design was established early and production implementation dominated the latter activities.

Inspection of these various approaches reinforces that new product development process management, like organizational innovation theory, acknowledges coordination between different ideation and implementation tasks is required.

NPD Systems as Innovation Support

The process of how innovation takes place changes little in these management-based theories. Each recognizes that once an idea is created it must be efficiently implemented and each proposes that a variety of organizational systems and structures provide control. However, under increased environmental uncertainty and dynamism, these evolutionary theory refinements increase the time pressure placed on the individuals and development teams from a design and problem-solving redesign perspective. Not coincidentally, general market conditions have evolved such that customers are demanding more rapid product evolution in most product segments and this significant stressor continues to increase (Williamson & Yin, 2014).

In response, practitioners and scholars began to develop methods for controlling the process. An innovation management or NPD system is defined for the purposes of this research as the collection of formal and informal processes and technologies employed by any or all organizational disciplines to monitor the market or business environment, translate an idea or request into a delivered product or process, and then assess its functional life as a means of knowledge acquisition.

An NPD system is an integral part of an organization's strategy, structure, and processes; it cannot be viewed in a vacuum. For example, Chen et al. (2010) suggested that NPD system-related factors of formalization (i.e., explicit rules and standards), concurrency (i.e., simultaneous work between functions), iteration (i.e., build, test, repeat), and learning (i.e., resulting knowledge generation and acquisition) had a significant positive effect on product development speed. Cankurtaran et al. (2013) show product development speed positively relates to product success, reduced development costs, better market timing, and an overall competitive advantage. Interestingly, they find no adverse effect from speed on product technical quality. These characteristics are all expected strongpoints of NPD processes being increasingly employed at the Information Systems level (Terzi, 2005).

Stage-Gate® processes (Cooper, 1990) became prevalent in the initial industry uptake of IS augmented NPD systems and focused on up front project justification, market screening, and periodic review gates to ensure accurate management involvement and cost-efficient execution during new product implementation. By using disciplined decision points to stop projects when required parameters were not met, overall project risk was managed and expenditure waste was minimized (Cooper, 1998). Not surprisingly, managers attempted to further embed their enterprise level NPD systems by maximizing their implementation maturity or the extent to which it was adopted, formalized, and automated across organizations (Batenburg et al., 2006).

Reflection on this efficiency focus and other shortfalls of early Stage-Gate® success shows that companies adapted a spiral development approach to address Ottosson's (2004) call for a more dynamic product development (DPD) approach and improvements in redesign speed (Cooper, 2014). Ottosson (2004) claimed that the existing methods of integrated product development (IPD) were only optimized for incremental improvements and needed to become more dynamic in response to customer demands for faster product evolution. This framework modifies IPD to loop faster by removing review formality and anchoring decision making at the development team level.

NPD system research has been active for several decades but has focused primarily on product development efficiency management and associated marketing processes (Page & Schirr, 2008). Page and Schirr's (2008) review of the research indicates that strategy, teams, and integration were the dominant subjects. For example, leadership created a strong market-oriented vision for product strategy based on the competitive landscape and the firm's resources believing this approach would clarify the difficult "fuzzy front end" of the innovation process (Reid & de Brentani, 2012). In addition to market orientation, some generalizable factors were positively related to overall NPD system process performance, including group level launch proficiency (i.e., a firm's capability to introduce the product to market efficiently), a structured approach to managing NPD (i.e., employing formalized procedures), and cross functional integration (i.e., degree of multi-department participation) (Evanschitzky et al., 2012). Placing emphasis on creating and supporting strong cross-functional teams is well warranted as these serve as the locus of innovation (Sethi et al., 2001).

Most quantitative measures focused on NPD systems do not attempt to measure their performance. Several measures exist that share the primary objective of making NPD systems or PLM implementation processes more widely integrated and accepted within an organization (Vezzetti et al., 2014). Batenburg et al.'s (2006) model is the most complete implementation of the concept and note that maturity analysis systems typically focus on the business function dimensions, tool integration, and employee engagement from an assigned maturity level point of view without regards to project effectiveness or project orientation suitability.

A known outcome from NPD systems implementation maturity progression, according to Batenburg et al. (2006), is an increased focus on efficiency and control through broader and deeper automation, functional integration, and process definition (Vezzetti et al., 2014). Implementing an NPD system efficiently with maximum depth and breadth may be desirable, however doing so with a system unsuited for an organization's strategic product development objectives can create more harm than benefit (Barari & Pop-Iliev, 2009; Hachani et al., 2011).

My practical experience indicates that managers struggle with the extent to which their NPD systems help them ensure that their concepts are practical and realistic, but also have enough profit potential for successful implementation. Simply integrating significant focus on market orientation and creativity up front in an innovation process is not sufficient. When solving unexpected problems, tools do not exist to evaluate how NPD systems encourage or inhibit re-engineering to improve functionality and cost during these reactive periods. Current

NPD system solutions may not be addressing the imperative of ensuring that the overall firm NPD process works well delivering a range of products along the creative and radical to incremental implementation spectrums. Recent suggestions of philosophy modifications, including the addition of agile methods like increased team empowerment and process control latitude through sprints and scrums, are testament to the shortfalls of traditional systems which evolved with a bias towards change reduction and cost-efficient implementation (Cooper, 2019; Cooper & Sommer, 2016).

While NPD system management is evolving, it is still largely dominated by a linear thought process of creating a new concept using market-oriented knowledge followed by a fast and efficient, well controlled implementation process. The new influence of Agile techniques is a logical reaction to the insufficiency of relatively long time-loop linear development. Agile importantly reduces the temporal separation between periods of creative design change and disciplined implementation. A reality of new product development is its uncertainty and control processes must accommodate failures and iterations at multiple points from initial ideation to final implementation (Paulus, 2002).

Ambidexterity and the NPD Process

Organizational innovation theories consistently illustrate that tension between creativity and practical implementation pressures exist. They suggested that a basic challenge facing organizations is focusing enough attention on creativity to ensure a successful future while also exploiting current capabilities to remain viable in the near term (Levinthal & March, 1993). The ability to manage these conflicting requirements is defined as a firm’s capability to be ambidextrous (Duncan, 1976).

The literature supports a significant positive relationship between ambidexterity at the organization level and both innovative output and firm performance (O'Reilly & Tushman, 2013). In contrast, NPD systems research has focused on an organization's goal of fast and efficient implementation and the structures and processes to support it once an idea is put forth as a guidepost. Here, I present theories of ambidexterity that tie the organization's strategic orientation, structure, and leadership characteristics to performance across multiple levels while appreciating contextual complexity. Measures exists that can be leveraged by practitioners to assess ambidexterity of an organization's strategy, structure, and leadership characteristics, but many organizational processes have not been afforded this same treatment.

Ambidexterity has been conceived as a paradox (Eisenhardt, 2000) and a balance of tensions and activities (Tushman & O'Reilly, 1996). Most ambidexterity definitions equate ideation (the creation and adoption of products and manufacturing processes that are new to an organization) to exploration and implementation (the refinement or improvement of existing products and processes) to exploitation (Birkinshaw & Gupta, 2013; Tushman & O'Reilly, 1996). However, achieving ambidexterity is not an easy proposition, and 80% of firms that are suboptimized are biased too far from exploration towards exploitation (Uotila et al., 2008). Ambidexterity can be achieved through serialization of efforts through a separation in organizational design (Benner & Tushman, 2003; Duncan, 1976), or the creation of contextual, simultaneous capabilities (Gibson & Birkinshaw, 2004, Tushman & O'Reilly, 1996). Serialization temporally separates efforts, allowing common resources to focus on exploration or ideation then exploitation or implementation, while the structural approach resolves these product development tensions by isolating separate tasks between resources to achieve simultaneous competency (O'Reilly & Tushman, 2013). The contextual approach embraces the tensions, creating an environment within the firm that allows a direct appreciation of the opposing factors within the decision process at the individual and team level in a fluid and continuous manner (Gibson & Birkinshaw, 2004).

Instead of reinforcing a dichotomous, sequential understanding of innovation (i.e., ideate then implement) as in the creativity and management-based theories, contextual ambidexterity recognizes this dichotomy but also recognizes that organizations can create supportive contexts through processes that allow individuals to adjust continuously to some preferred simultaneous balance. Gibson and Birkinshaw (2004) defined *contextual ambidexterity* as a balance between adaptability and alignment at the organizational level which is fostered by the organizational context, or the systems, beliefs, and processes that influence team member behavior. They put forth that this context is shaped by Ghosal and Bartlett's (1994) claim that a balance is necessary between the soft attributes of trust and support which foster a cooperative environment and the hard attributes of stretch and discipline which enable goal attainment. Relevance to NPD systems can be seen in Gibson and Birkinshaw's (2004) explanations of these attributes: Trust is fostered by fairness, business decision inclusivity, and supportive staff; Support results from sharing mechanisms, initiative freedom, and management help. Stretch incentives induce team members to reach for more ambitious goals and discipline, or meeting all commitments, is established through clear performance standards, feedback, and sanctions. Gibson and Birkinshaw (2004) showed that an increase in the combined presence of these organizational context attributes led to an increase in the ambidexterity combination of adaptability and alignment in the organization. They then showed a positive connection between this ambidexterity and organizational unit performance (e.g., achieves potential, satisfies customers, encourages employee performance) as rated by senior managers and leaders. In addition, they illustrate that the ambidexterity mediates the relationship between these contextual attributes and unit performance. The measures used in this study encompass perceptions of general management cues and organization performance attributes. This leaves open the opportunity for research to consider a more focused analysis of the systems that create the overall management context perceived by team members and measure performance at a team rather than organizational unit level.

Under any approach to ambidexterity, the organization must identify the environmental and strategic contexts and the structures, systems, and processes required to support it. Contingency theory, specifically structural contingency theory, suggests that environmental demands and a firm's strategic orientation will influence the characteristics of structure and processes a firm needs for successful operation (Donaldson, 2001; Galbraith, 1977).

In terms of the firm's strategic orientation (Miles & Snow, 1978; Porter, 1980), Miles and Snow (1978) identified four types. *Prospectors* have a strong exploration orientation, actively seeking out new ideas, customers, feature sets, and methods. *Defenders* have a strong exploitation orientation, actively seeking to protect existing customers and refine product efficiency and value. *Analyzers* choose to carefully explore or judiciously exploit based on market observation, and *Reactors* display no consistency in behavior based on market observations. Research suggests that prospectors, defenders, and analyzers outperform the reactors (Sabherwal & Chan, 2001).

The processes and structures put in place by a firm are an important complement to leadership in navigating the paradox of ideation and implementation which is solved at the senior manager and team level (Smith & Tushman, 2005). Rosing et al. (2011) noted that a team's exploratory and exploitive behavior require increases and decreases in the variation of their behavior based on the situational context (Gupta et al., 2006; March, 1991). They theorized that leadership behavior could foster this variation in team behavior and output using opening (variance encouraging) or closing (variance depressing) cues and pressures. In the context of this research, an opening leader behavior could be a manager shifting resources and encouraging a development team member to solve an implementation problem by redesigning for a new cost mitigating manufacturing technique. This is opposed to the closing behavior of encouraging a faster, less resource consuming fix which relies on increased cycle time through existing processes and degrading product margin.

The Rosing et al. (2011) theory received empirical support linking a combined proficiency in opening and closing leader cues to team innovative performance (Zacher & Rosing, 2015). In addition, opening cues were positively related to team innovation, which could indicate support for contingency theory in that leadership opening behaviors are counteracting the supported historical bias of NPD systems towards implementation and rigidity.

The concept of fit among these distinct but complementary organizational features (Drazin & Van de Ven, 1985) is important for understanding the moderating effects of an organization's strategic and leadership orientation. According to structural contingency theory, external environments that drive needs for high ambidexterity or even a bias towards ideation or implementation in new product development will require complementary characteristics from its organizational processes and structures.

Due to the underpinnings of contextual ambidexterity at all levels, the Dialectic Perspective on Innovation is well suited as the theoretical lens for this research (Bledow et al., 2009). This theory has underlying properties that apply to the conceptualization of an effective NPD system. It recognizes tensions are created through conflicting demands of creation/exploration vs. implementation/exploitation, illustrates that demands can and should be managed simultaneously at a team and individual level, recognizes that management and organizational processes affect the team and individual actions, and suggests that the preferred balance between exploration and exploitation is not necessarily equal and will depend on several contextual conditions.

Creating Ambidexterity for Innovation Performance

Simultaneously differentiating and exploring new solutions to limit the inertia of current product and technology offerings while also efficiently mining and profiting from existing capability is the product development ambidexterity paradox. The successful balancing of this paradox rests squarely on the shoulders of senior leaders and development teams (Smith & Tushman, 2005). They argue that team design, leader coaching, firm architecture, and task formality are important in the resolution of these cognitive paradoxes. Meta-analysis supports this view noting that an inward focus on product development processes and team orientation is more effective than simply spending more money on R&D, focusing on net outputs, or garnering external cooperation (Rosenbusch et al., 2011). Raisch and Birkinshaw (2008) summarize that several research areas have emerged, including organizational learning, organizational adaptation, technological innovation, strategic management, and organizational design, to explain how organizations achieve ambidexterity. Meta-analytic studies of ambidexterity have examined the antecedents from structural and contextual points of view and tied the concept to innovation performance across organizational and team levels of analysis (Fourne et al., 2019; Junni et al., 2013). Junni et al. (2013) suggest positive effects of ambidexterity on innovation performance across organizational levels and note that ambidexterity was most appropriate as a strategic objective in dynamic environments. Moreover, the linkages between levels are important since “Individual and team-level [ambidexterity] may not result in significant benefits unless they are supported by firm-level structures, processes, and incentives" (Junni et al., 2013, p. 310). A firm's strategic and leadership orientation have received significant attention in ambidexterity research, but characterizing the ambidexterity of the systems and processes associated with the innovation process have been largely overlooked (Birkinshaw & Gupta, 2013; Hulsheger et al., 2009; Kwak et al., 2020).

Using Ambidexterity to Evaluate NPD Systems

While enterprise level IS system alignment, fit concepts, and methods of measurement have significant coverage in the literature (Strong & Volkoff, 2010; Tallon et al., 2016), these approaches have not appreciated the concepts of ambidexterity. Marzi et al. (2020) assert that better tools are required to measure relative NPD system performance differences between NPD process philosophies and call for research to explain the "how" and "to what extent" aspects of culture, ambidexterity, and idea generation affect the NPD process (p. 17).

Swink et al. (2006) surveyed US manufacturers and analyzed project output performance metrics, like development time, costs, and quality, to categorize projects by efficiency. They then associated process related antecedents like management support, experience, collaboration, and colocation to these performance parameters. It was not intended to be a study of ambidexterity characterization, but their observations highlight the ideation/implementation paradox in that the fastest, most efficient projects lacked innovative features and the most innovative projects took longer and consumed more research capital.

Regarding the shortfalls of linear NPD management systems, the ambidexterity afforded by temporal or structural separation of creativity followed by accurate implementation is problematic. Kim et al. (2016) use failure analysis to characterize why NPD systems perform well or fail and build their analysis around the traditional Stage-Gate® process pattern calculating failure ratios at each traditional gate point. They note that the predominant shortfall of the studied NPD systems was a lack of front-end marketing and project scope planning input. This resulted in a lack of grounding for the designs leading to a high project failure ratio.

A significant theme of this research implies that contextual ambidexterity present at the beginning of the process should provide better bounding for the designs carried through to execution. Likewise, more support for pragmatic, disciplined venturing in problem solving during the typically rigid implementation phase should result in more effective solutions. There is little to no performance analyses that grade the overall NPD systems on how well they foster the ideation and implementation facets of innovation from a team perspective nor any measurement tool for characterizing an NPD system's ambidexterity. An ambidextrous NPD system will be defined as one that encourages embracing the ideation and implementation tension throughout product development cycles in a pragmatic fashion as opposed to an NPD system which demands a fixed product design, or one that stresses a single early creative design period transitioning into a rigid implementation phase.

The implementation bias of many NPD systems can be tempered with process structures or planned reviews that stress early identification and repair of product design flaws or performance risks. Deficiencies found may trigger aggressive corrective actions and enable a formal controlled recovery phase that diverts specialized resources to the development team. The development system may also stress reporting on product functionality goals at the end of a development phase thereby relaxing perceived consequences of intermediate development missteps and promoting venturing in problem solving.

Ideation can be stressed in all phases by a system that promotes alternative design and development pathways. This may happen through process templates that require formal meetings and reviews with internal expert departments or outside technology suppliers at various phases of a product design cycle. An IT based tool may effectively connect the team member with internal and external best practices databases or expert systems that extend ideation beyond a team member's creative ability. A system may encourage calculated risk taking by codifying a process that assesses venturing risk to relieve the team members of the risk or no risk decision burden. Technology or intelligent archiving may help employees access internal and external solution options rather than promoting narrow best practice pathways which may be too restrictive for some design problems.

Hypothesis Development

The ambidexterity to performance link has been established at the team level by research that investigates processes and strategies. The NPD system affects and shapes team decisions on a day-to-day basis through its influences on individual members. It is a structure that may employ formal and informal controls that stress discipline and support when formalized activities are required and tracked, as well as stretch and trust when activities are allowed or encouraged without tracking or oversight. These characteristics are posited to create the context that leads to ambidexterity and facilitating positive performance (Gibson & Birkinshaw, 2004).

NPD systems have been analyzed for efficiency and connectivity, but not for suitability of purpose based on an organization's strategic orientation or level of ambidexterity. Rather, scholars have focused on innovation output metrics (e.g., project time, project cost, review gate success rates) and implementation maturity (Hertsenstein & Platt, 2000), but not ambidexterity. A common thread in performance measurement studies ties NPD system performance to the contextual nature of project requirements, so the lens of ambidexterity should be well suited for this purpose.

NPD System Ambidexterity and Team Innovative Performance

Early creativity combined with rigid, accurate implementation may create an ambidextrous condition, but not a condition of contextual ambidexterity. Structural separation of the ideation and implementation functions or a large temporal separation reinforced by most NPD systems do not necessarily create the contextual ambidexterity that embraces a more continuous appreciation for the tension between ideation and implementation in daily work activity.

Knowing that development challenges and unpredicted problems are the daily and weekly reality for development team members, creativity during the implementation phase can avoid design stagnation, product cost creep, or cost inefficiency in production processes. Teams will perceive a lack of support for creative problem solving or an over emphasis on schedule rigidity as a bias toward implementation during these periods.

The opposite problem is also true. When early concepts and creative ideas are not grounded in the technical competencies of the firm and its production capabilities, development cost overruns, late market introduction, and performance problems may result due to overreaching. These are common issues cited in the observed, high overall NPD process failure rates (Castellion & Markham, 2012). Shortfalls in competency will affect the performance NPD system negatively regardless of which side of the ideation or implementation classification they fall and regardless of phase timing. Thus:

H1: High levels of NPD system ambidexterity will be positively related to team innovative performance.

The Moderating Influence of Leadership Behavior

In addition to the direct influence of NPD system ambidexterity on team innovative performance, leader behavior is likely to influence the relationship. Past research indicates leadership combined ambidexterity leads to team innovative performance (Zacher & Rosing, 2015). In concert with H1, an NPD system high in both ideation and implementation will require a leader to be fluent in prompting both behaviors and have the temporal ability to switch appropriately based on situational context. They will align with an NPD system strong in ambidexterity when they also display strength in both opening and closing behavior. The leader must support creativity early, but also foster creativity during implementation heavy tasks with opening behavior so the team members have the confidence to stretch. Likewise, they must support implementation accuracy and efficiency during implementation, but help temper early creative ideation with closing cues that ensure the risk taking has the highest chance of success and is efficient from a resource consumption point of view.

> H2a: The relationship between NPD system ambidexterity and team innovativeness will be moderated by the leader's opening and closing behaviors; this relationship will be stronger the more that the leader engages in both behaviors.

Another approach to leadership's contribution is to consider the directionality of the balance between opening and closing behaviors. Although combined strength is established as important, the possibility exists that firms adjust their capabilities and constrained resources to find a localized maximum point for performance. That is, they may prefer closing over opening behaviors or vice versa. The relationship between NPD system ambidexterity and team innovative performance will be stronger when the leader emphasizes opening or closing cues that match and complement surrounding processes. Zacher and Rosing (2015) recommend increasing “practitioners’ awareness of the complexities of the innovation process and that this complexity needs to be matched with an equally complex leadership approach” (p. 64). Harmony between the NPD system and leaders’ behavior will reinforce team effectiveness while conflict between the two will send mixed signals that, when taken together, are less effective in supporting team innovativeness. If an NPD system is biased towards exploration and ideation performance, then the leadership cues must also support this to maximize overall performance. When stretch is required during early concept design, or under time pressure to fix and implement problem fixes, the team members will sense whether they have this risk support from their direct supervisors and the firm leadership, and the strength of this support should influence follower’s interpretation of the NPD system requirements. When the team has this support, they will be more apt to exercise creativity consistent with the NPD system. Likewise, when biased towards efficiency and implementation accuracy, team members will understand that they are expected by their managers and leaders to forego potential new solutions regardless of the development phase and maintain a focus on time and cost optimization, and the strength of these leader closing cues will affect their NPD system interactions. Thus:

> H2b: The relationship between NPD system ambidexterity and team innovativeness will be positively moderated by leadership’s opening and closing behaviors when the NPD system and leadership match in their relative orientation towards ideation or implementation.

The Moderating Influence of Strategic Orientation

Development team members do not operate in a vacuum and strategic orientation forms a context that is compared by the team members to the command-and-control cues that are provided by the guidance, tracking, organizational integration, and knowledge control features of an NPD system. Through reinforcement of a consistent message regarding this support for stretch or discipline, ideation, or implementation, an NPD system in harmony with the firm's strategic orientation will foster team execution more effectively than an NPD system that contradicts the firm's strategy.

Prospectors are entrepreneurial and actively monitor the environment for conditions, trends, and events (Miles & Snow, 1978). They require flexibility in support to adapt this new information by evaluating many alternative options (Slater et al., 2006). If a firm has broadcast to its stakeholders that it is a prospector, having a bias towards ideation, its creative push will be more apt to be executed in the case where the NPD system allows and encourages significant latitude through early creativity and exploration. While any new product must be implemented effectively to reach the market, these firms will focus on significant latitude for additional creativity during the implementation phase. New concepts require continuous flexible problem solving not only to deliver on functional promises but also to do so without creating untenable product cost structure. Prospectors may suboptimize their NPD system ambidexterity in favor or ideation freedom.

Defenders resolve their entrepreneurial, engineering, and administrative pressures by narrowing focus. A company that limits product development and tenaciously holds on to customers or expands market penetration by making improvements to quality and cost will require an NPD system that is biased towards implementation. To achieve cost efficiency in a stable and commodity biased market, the NPD system must support continuous improvement and incremental gains in low deviation, low error manufacturing and product delivery. If the firm has an NPD system that does not promote delivery accuracy, cost efficiency during implementation, and an intelligent re-use of core designs in the concept phase, cost creep or misguided product features may result and create underperformance to customer expectations. If the NPD system allows too much latitude for creativity in up front screening, design, or during implementation, focus is lost on the prime objective of current product and process improvement. Defenders may suboptimize overall NPD system ambidexterity in favor of implementation strength.

Reactors do not establish a consistent pattern of behavior regarding strategy response to the firm capabilities or market context. They typically underperform, have a short-term response cycle, and may not show a consistent process or leadership to performance relationship (Sabherwal & Chan, 2001).

Analyzer firms scan market conditions and carefully capitalize on demonstrated product successes or learn from and exploit other's failures while also defending their market position. This dual focus often leads to an excess of development opportunity (Slater et al., 2006). It requires an NPD system that is accommodating to new ideas at the beginning of the NPD process but has a strong screening function to preserve resources for continuous improvement activities. To efficiently implement an unfamiliar product, the implementation speed and accuracy focus must allow some flexibility and creative latitude to resolve unpredictable development issues typical in an unfamiliar product or design. However, when these same firms decide to exploit and defend their current products, the NPD system must be able to draw on a deep connection to existing processes and current product design knowledge. They must have a system that can comprehend ideation and implementation at all phases of development, without one capability being achieved at the expense of the other. An NPD system strong in ambidexterity should benefit analyzers needs in both explorative and exploitive pursuits.

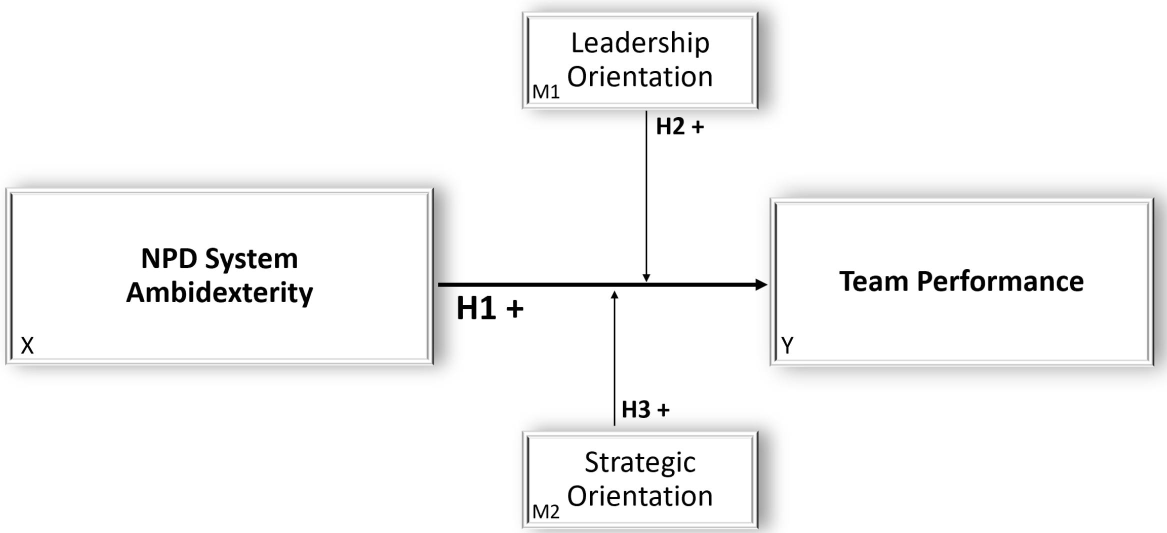
Considering these strategic orientation types, an NPD system with strong ambidexterity characteristics would be most appropriate in analyzer firms that have to display both creative ideation and fast implementation depending on their market environment context at any given time. Thus:

H3: The analyzer orientation will make a unique and significant contribution to team innovative performance after accounting for NPD system ambidexterity.

The hypothesized relationships are summarized in Figure 2:

Figure 2

Proposed Model of Team Innovation Performance



CHAPTER 3: RESEARCH DESIGN AND METHODS

This chapter presents the methods used in this research. First, the research design and approach are stated and justified. Next, the population and sampling process is outlined followed by an explanation of the data collection methods and procedures. After a detailed definition of ambidexterity measurement, other measures and controls used in this study are defined and summarized. Lastly, the analysis procedures are explained.

Research Design and Approach

This study employs a mono method, survey-based, quantitative research design. It utilized validated measures from previous research, a modification of existing measures, and the creation of a new measure for NPD system ambidexterity. This design is appropriate in areas of mature theory that relies heavily on existing constructs and measures and standard statistical analyses (Edmondson & McManus, 2007). Innovation, NPD, and ambidexterity are well developed domains, with a history of reviews, meta-analyses, and empirical studies.

Epistemologically, a survey-based quantitative research design, aligns with a positivist philosophical approach which is deductive in its methodology (Saunders et al., 2012). This effort can be further described as a single (mono) method multi-source effort (Gibson, 2017) since survey inputs will come from development team members as well as their managers, leaders, and other associates within each organization, representing a strength of the design.

Institutional Review Board (IRB) approval for this project was granted on October 12, 2021 and can be found in Appendix A.

Population and Sampling Methods

The sample frame for this study was development teams, related managers, and team observers from public and private companies that were involved in manufacturing, product development, and process development. English was their primary language for conducting their team-based development tasks. Initial targets consisted of North American manufacturers. All participants were required to be at least 19 years old and employed in their relevant position for more than one year.

Convenience and purposive sampling techniques were used to gain study participants. Warm contacts from my personal network, either existing or through requests for introduction, proved to be the most successful path to gaining company participation. All but one company were recruited through the warm contact method. The other company was recruited through a purposive sampling method consisting of cold approaches to companies using two data sources:

(1) Publicly available data for North America firms with revenues greater than $100 million and more than 250 employees in SIC codes likely to yield the proper activity.

(2) A private phone and e-mail contact database of mid to high-level engineering contacts at North American product development firms obtained and used with permission from personal contacts who actively operated among development companies across diverse industry sectors.

A total of 761 companies were initially identified from the publicly available data. The data were sorted by company revenue and every Nth company was selected to create a pseudo random sample representing different revenue categories. Internet web page and LinkedIn searches generated potential participants. Efforts were suspended after 106 companies were researched and contacted with no success.

The private contact lists provided direct paths to 137 unique companies across industries. In total, 260 contacts were approached with a cold e-mail followed by a phone call approximately one week later. This effort generated one company participant. In addition, a social media messaging strategy using general, non-targeted postings on LinkedIn and posts to relevant LinkedIn groups, such as Operational Excellence, generated no participants.

The sample outreach method was refined during the process but followed a consistent pattern. Where e-mail addresses were available, e-mails were sent through my e-mail and included brief paragraphs outlining the research, potential company benefits, and a request for a conversation or introduction to the most appropriate company decision maker or champion. The potential company benefits included advanced access to study results in addition to company specific team data as well as insights from me regarding the data’s implications from a diagnostic and prescriptive viewpoint.

The goal of initial outreach was to identify a company decision maker/champion with the authority to support participation in the research survey. This was typically initiated in a phone call between me and the internal champion. In all cases, phone and video calls or follow-on e-mail exchanges were preceded by e-mail delivery of an outreach letter (Appendix B). Phone and video calls clarified that participation was confidential and online survey based, involved the selection of team groups within the company as respondents, and required a small amount of administrative assistance from a company liaison. Upon request, approvers and reviewers were given the survey questions in a PDF. In the case where approvers previewing the survey questions were respondents, they were asked to wait at least three weeks prior to participating.

A total of 11 companies participated in the study encompassing 16 unique divisions/locations. Eight companies represented various product solutions in the transportation industry and there was one company each from the chemical, aerospace, and medical devices sector. All firms were both developers and manufacturers. In general, the sample is biased toward the transportation industry.

Data Collection Methods

A web-based survey application was used for data collection. All participants received anonymous links to the voluntary surveys and were required to consent to participate. The consent form is shown in Appendix C. The survey was administered as a cross sectional effort with most companies participating between January and July of 2022. A typical company or team unit would complete responses within a two-to-three-week period.

Survey administration required me to complete several steps with one or more company liaisons. The first step involved helping the company identify relevant team groups and compile the team group participant lists. The concept of what constituted a valid team data point was explained. Instructions clarified that a team data point required at least five active team members be invited to participate. In addition, the team member data had to be matched with at least one peer level observer familiar with the environment, activity, and performance of the team and one senior manager or leader level observer also familiar with team's environment and performance. Senior managers or leaders were also qualified to respond as peer observers. To meet the requirement of having at least one of each observer type for each team, it was recommended that more than one peer observer and senior manager/leader observer be invited to participate.

Final team definition and count was left to the discretion of the participating company, but discussions indicated that team definition could follow formal or informal internal company designation and be functional or cross-functional. A spreadsheet was exchanged with the company liaison that documented their contact information, allowed them to list their teams along with arbitrary identifying names for each team, provided a count of team members, and listed each observer type that would receive survey invitation links. This method enabled me to avoid collecting participant identifying e-mails.

After teams were defined, I generated a separate anonymous survey link containing two pseudo-random embedded codes. Each was five alphanumeric characters, with one code unique to the participating company and one code unique to the team group within that company. The company specific tracking spreadsheet with an example of these links is shown in Appendix D. This method permitted team-based data aggregation and company identification for analysis and reporting without the need for collection and storage of personal identifying information from the participants. These instructions and the tracking sheet were also accessible through a link to a liaison instruction document in the general invitation letter.

After the consent form acceptance, qualifying questions required that the participants were at least 19 years of age and in their current position of employment at least one year prior to taking the survey. Partial responses that failed to qualify or reach the final exit page of the survey were discarded. Respondents could typically complete the questions in three to eight minutes and intentional attention check questions were not included.

After the consent and qualification questions, a demographic question asked the respondents to identify themselves as either a team member, a peer observer, or a senior manager/leader observer. Depending on the answer, they were routed to the appropriate survey for their respondent type. Team groupings were established by each organization at the outset of the survey participation and didn't necessarily follow strict organization chart boundaries, but followed what management believed was the best definition for the proximal team.

A total of 371 participant invitations resulted in 311 completed surveys for a response rate of 83.8%. These members represented 39 teams. The rates by respondent classification are shown in Table 1.

Table 1

Survey Response Rate Statistics by Respondent Type

	Team Members	Sr. Mgr./Leader Observer	Peer Observer	Total Respondents
Invited	268	54	49	371
Responses	212	54	45	311
Response Rate	79.10%	100.00%	91.84%	83.83%
Response Per Team	5.44	1.38	1.15	7.97
SD (response per team)	2.89	1.09	0.84	

Prior to aggregating individual data into team data, a sufficiency analysis was conducted to verify that enough responses were received from each team to assume representation, based on the total team size the organization contact had indicated. Rather than rely on a team response percentage or absolute count, Dawson's (2003) selection rate provides a formula that predicts true scores by considering number of responses per group (n) and the group size (N). Using a selection ratio of .32 or lower as defined by ([N – n]/N*n) will generally correlate to true scores at .95 or higher (Richter et al., 2006). In addition, a minimum respondent count of three was established. Four of the 39 teams that participated in the survey failed to meet this requirement. A total of 35 teams proceeded to team level aggregation statistical analysis.

To meet the requirements of this research, team data points required that at least one peer level observer and one senior manager/leader level observer be matched with qualified, aggregated team-level data. Of 35 teams used in the team level aggregation analysis, four did not meet the data qualification standard for observer count minimum and were not used in team level analyses regardless of the aggregation results. In total, 31 teams, represented by 189 members, were eligible for final consideration pending successful team level aggregation analysis

Variables and Measures

Ambidexterity

Several measures of ambidexterity were used in this research. Ambidexterity is typically measured by multiplying or subtracting the perceived explorative and exploitive qualities or tendencies of a given concept (e.g., leadership) at the organizational, group, team, or meso levels of analysis (Cao et al., 2009; He & Wong, 2004, Zacher & Rosing, 2016). For example, at the group level, Gibson and Birkinshaw (2004) multiplied alignment (exploitation) and adaptability (exploration) measures to represent overall ambidexterity. By operationalizing ambidexterity with a multiplicative measure, also known as the combined dimension (CD) (Cao et al., 2009), Gibson and Birkinshaw (2004) implied that both characteristics are separate but necessary dimensions rather than ends of a spectrum (Bierly & Daly, 2001; Katila & Ahuja, 2002).

At the strategy level, He and Wong (2004) tested this multiplicative measure on performance and introduced the concept of a *balance dimension* (BD), defined as the absolute value of the exploration measure minus the exploitation measure. It indicates whether explore and exploit capabilities are roughly equal or not and explains results differently than the multiplicative orthogonal approach. Their combined measure was positively related to sales growth and the balance measure was negatively related to sales growth, suggesting that strategies with stronger exploration or exploitation emphases depressed revenue growth.

Cao et al. (2009) proposed that the CD and BD measures were not competing for evaluation as a best measure, but that both were important dimensions influencing organizational success through different effect pathways. The implication is that achieving both high levels of exploration and exploitation as well as a balance between them is important.

As an absolute difference, the balance concept in ambidexterity provides no clue about whether exploration/ideation is more or less operative than exploitation/implementation. He and Wong (2004) created a precedent that removes the ability to understand if a firm's capabilities lean toward one pole or the other. For this research, a lack of directionality in the balance measure, given the arguments in line with structural contingency theory, is problematic.

NPD System Ambidexterity

The primary IV in this study, NPD System Ambidexterity Combined (tNPDCD), is measured using a scale adapted from existing measures. Lubatkin et al.'s (2006) validated scale assessing a firm's strategic development orientation ambidexterity (exploitation, $\alpha = .83$; exploration, $\alpha = .84$) was adapted by changing the referent to the NPD system. For instance, instead of asking respondents to assess if their firm "actively targets new customer groups," the new item asks team members their opinion on the statement "our NPD system helps us target new customer groups." A more difficult adaptation was changing the question whether the firm "fine-tunes what it offers to keep its current customers satisfied" to asking team members if "our NPD system encourages improving current products and/or processes to keep customers satisfied." Because these items did not address the breadth of NPD system ambidexterity, additional items were sourced from measures developed by Zacher and Rosing (2015) (exploitation, $\alpha = .85$; exploration, $\alpha = .89$). Probing these perceptions regarding the NPD system required a referent change.

Fifteen items relating to the Exploit/Implement dimension and 15 items relating to the Explore/Ideate dimension were pooled as a starting point for developing a new scale to assess NPD system ambidexterity (Carpenter, 2018; Worthington & Whittaker, 2006). Some items were split to account for double-barreled characteristics. Respondents were primed with a definition and typical examples of the NPD system in organizations prior to commenting on the items. The initial researcher adaptations are shown in Table 2 and their relations to donor scales can be cross referenced to Appendix E. In a pre-test phase to check for item clarity and face/content validity, subject matter experts (SMEs) drawn from my personal network were provided the purpose of their participation, introduced to the term NPD System with the same text the eventual respondents would receive, and briefed on the definition implementation/exploitation and ideation/exploration dimensions. They were then asked to rate each explore/ideate and exploit/implement statement in terms of its clarity/understandability and relevance. Clarity was measured on a three-point scale: (1) Confusing, Ambiguous; (2) Reasonable, Can be improved; and (3) Clear, Understandable. Relevance was measured on a five-point scale: Irrelevant (1); Not Very Relevant (2), Somewhat Relevant (3); Relevant (4); and Highly Relevant (5). They were also asked to comment on the items that were confusing or not relevant.

Table 2

Item Pool for NPD System Ambidexterity Scale Development

Please give your opinion about your organization's NPD System… Strongly Disagree (1) to Strongly Agree (5)		
Item #	Item Text	*Donor Scale Item #
	Implement (Exploit) Dimension	
NPDP1	Our NPD System stresses minimizing product and/or process cost	LS7
NPDP2	Reliability improvement of our products and/or mfg. processes is prioritized by our NPD system	LS8
NPDP3	Our NPD System prioritizes maximizing product and/or process quality	LS7
NPDP4	Our NPD System focuses our team on existing customers' satisfaction	LS10/11
NPDP5	Our NPD System encourages improving current products and/or processes to keep customers satisfied	LS11
NPDP6	Our NPD System prioritizes keeping projects on track	ZR14
NPDP7	Accurate information on customer needs and requirements is available in our NPD System	LS10
NPDP8	Our NPD System monitors goal attainment	ZR8
NPDP9	When development problems occur, our NPD System ensures we take corrective action	ZR10
NPDP10	Manufacturing processes provide data thorugh the NPD system that helps problem solving	LS8/11
NPDP11	Our NPD System monitors/encourages uniform task accomplishment	ZR12
NPDP12	Our NPD system has well defined routines for project executions	ZR9
NPDP13	Our NPD system requires that we follow process rules	ZR11
NPDP14	Our NPD system encourges designs for automation	LS9
NPDP15	Errors in execution or product design are highlighted in our NPD system	ZR13
	Ideate (Explore) Dimension	
NPDP16	Our NPD System promotes "outside the box" solutions and designs	LS1
NPDP17	We are encouraged by our NPD system to incorporate technologies outside of our current capabilities	LS2
NPDP18	Our NPD System prioritizes products or mfg. process improvements that are new to our firm	LS3
NPDP19	Our NPD System encourages finding alternative paths to satisfy customer needs	LS4
NPDP20	Our NPD System highlights gaps in competitor's product/process offerings	LS4
NPDP21	Our NPD System helps us identify new customers and/or markets to pursue	LS5/6
NPDP22	Our NPD System motivates us to take calculated risks	ZR3
NPDP23	Our NPD System encourages manufacturing involvement in new concept development	LS8mod
NPDP24	We can quickly test new product concepts and/or mfg. processes using our NPD system	ZR2
NPDP25	Our NPD System incorporates errors effectively as lessons learned	ZR7
NPDP26	We can more effectively partner with outside technology suppliers during development using our NPD syster	LS3
NPDP27	We can work around our NPD system to solve unexpected problems	ZR4
NPDP28	Our NPD system allows us to solve problems in our own preferred manner	ZR1
NPDP29	Team members individual ideas are supported by our NPD system	ZR5
NPDP30	Our NPD system helps us target new customer groups	LS6

Note. * See Appendix E

Following scale development, individual scores for ideate and implement dimensions were calculated by taking the mean of the items for each dimension. To arrive at team level scores, individual scores for ideate and implement dimensions were aggregated with equal weighting across items. Just as with individualized data, the CD or BD form of ambidexterity was calculated from the dimension scores. The directional BD composite was calculated by subtracting the implement score from the ideate score.

Following NPD system ambidexterity scale development, the team's perception of combined NPD system ambidexterity (tNPDCD) was calculated as the product of the explore and exploit dimensions. It is used directly as a predictor for the main hypothesis (H1), in the Leadership Orientation hypothesis (H2), and in the strategic orientation hypothesis (H3). The NPD system ambidexterity balance dimension composite (BD) is calculated by subtracting the implementation dimension from the ideation dimension.

Leadership Orientation

The IV Leadership Orientation (LO) was measured using the Zacher and Rosing (2015) scale. It examines individuals' perceptions of the opening and closing behaviors of their leadership using Likert-type scale items. Example statements include, "Our leadership motivates us to take risks" (opening) and "Our leadership controls adherence to rules" (closing). One item, "Our leadership reacts negatively to or penalizes errors," was reverse scored (Appendix E). In the case of more than one respondent per team, the average score was calculated and used in hypothesis testing. The LO CD composite was calculated by multiplying the exploitation score by the exploration score, and the LO BD composite dimension was calculated by subtracting the exploitation score from the exploration score.

For the LO hypothesis (H2a), the Leadership Orientation Combined Dimension (tLOCD) score was used. For the alternate LO hypothesis (H2b), the concept of ambidexterity alignment was introduced. This alignment variable (tLOALI) was created by taking the absolute value of the LO BD subtracted from the NPD System BD. When both leadership and NPD system ambidexterity are leaning to explore or exploit identically, they will be aligned and this difference calculation will be zero. A positive number indicates that the NPD System BD is leaning towards ideation compared to the LO BD. It should be noted that this requires that the input terms (i.e., LO BD and NPD System BD) retain their directionality rather than be treated as an absolute value term as found in some prior research. The absolute value requirement is applied to the resulting difference. Since the hypothesis proposes that aligned or being close to zero is optimal, using the absolute value of this alignment term is appropriate. It is also noted that difference scores, and the fact that they have an increased variance over measuring these differences directly in the construction of survey items, may need different treatment in quantitative analysis (Edwards, 2001). The introduced alignment term compounds this issue.

Strategic Orientation Type and Match

The IV firm strategic orientation type (SOType) was represented as a categorical variable established with a self-typing paragraph approach (Slater & Olson, 2000) (Appendix F). Senior Managers/Leaders were requested to identify the paragraph best describing their firm as prospector, defender, analyzer, or reactor.

Team Innovative Performance

The DV team innovative performance (tPERF) was assessed by senior managers/leaders. Likert-type items identified by Atuahene-Gima and Ko (2001) as relevant product development success performance factors were used in this study. The overall measure is represented by three dimensions: product quality, product performance, and product launch performance.

The three-item launch proficiency subscale was modified to focus on the development team's launch performance rather than the performance of the launch activity directly. For instance, instead of rating "Effectiveness of tests of the product with customers before launch," respondents were asked to agree or disagree with the statement: "Regarding launch performance, the development team…tests the product before launch with customer involvement."

The three-item product quality subscale was used directly with clarification that the statements applied to new products and/or processes rather than simply products. One sample question from this scale included, "The development team delivers products (and/or manufacturing processes) that… provide unique benefits superior to competitors."

Their four-item product performance subscale was adapted to five items to avoid ambiguity in a double-barreled question. As an example, senior managers/leaders were asked to agree or disagree with the statement: "The development team delivers products (and/or manufacturing processes) that… 'meet profit objectives'" (Appendix G).

To compute the NPD Performance score for an individual rater, the scales were combined and the items are treated with equal weighting to calculate a mean. In the case of more than one respondent per team, the average score is calculated and used in hypothesis testing.

Strategic Orientation

Strategic Orientation (SO) was measured using the Lubatkin et al. (2006) scale which measures firms' ambidexterity around their product and technology development orientation. Examples of the statements are "Our organization has success measures that reward exploring new technologies" and "Our organization continuously improves the reliability of our products and manufacturing processes." The item "commits to improve quality and lower cost" was split to avoid a double-barreled question (Appendix E).

The respondent's SO scores are calculated by taking the mean of the items for each dimension (exploration/exploitation) independently. In the case of more than one respondent per team, the average score is calculated and used in hypothesis testing. The SO BD composite was calculated by subtracting the exploitation score from the exploration score. This orientation bias was used as a robustness check against the leader strategic orientation typing.

Process Ambidexterity

As a validity check for the newly developed NPD System Ambidexterity scale, Kwak et al. (2020) provides a measure for team assessment of a firm's innovation process ambidexterity (PROC). Rather than measuring the ideate/implement ambidexterity concept central to this study, it measures the relative emphasis on development process agility ($\alpha = .98$) and development process standardization ($\alpha = .98$). These scales were used directly with two items from the agility scale combined prior to data collection. "Our team effectively performs the changing business requirements" is ambiguously worded, and "Our team makes effective decisions to cope with business changes" is redundant and unclear with the NPD system as a referent. They were combined into "Our team effectively performs under changing business requirements." The measure scores are calculated by taking the mean of the scale items for each dimension separately. Team aggregation is not required since this variable was used only in individual form as a validity check for the NPD system Ambidexterity scale. The scale is shown in Appendix H.

Control Variables

Team size (tSZ) and team tenure (tTEN) can play a role in team innovative performance (Ancona & Caldwell, 1992; Stewart, 2006). Team size is defined by the number of team members invited to participate. The research guideline set the minimum team size by invitation at five and the maximum at 19. In total, 39 teams participated ($M = 6.97$, $SD = 3.07$).

Team tenure was defined as the mean of individual team member tenures (Chan, 1998). Team members were asked "How many years have you been on this development team?" In this study, 40% of the team members reported specific team experience at one to two years, while 25% reported tenure of eight or more years. The average values of the categorical responses were used to calculate a team value, with a value of 10 years assigned to the eight or more category. Estimated team tenure (tTEN) ranged from 1.5 to 10.0 years (*M* = 4.61, *SD* = 2.22.

Organization size (ORGSZ) (Voss & Voss, 2013) is also a factor that influences innovation in firms. Publicly available corporate demographic data was used to establish employee count and was verified against survey responses from the senior manager/leader observer. As weighted by teams (some organizations have multiple teams), the organization size by employee count ranged from 43 to 18,500 with a median size of 930 (*M* = 5,157, *SD* = 5,921). This variable was log transformed for regression calculations.

Since market environment can have an impact on preferred operating structure (Davis et al., 2009), environment technology turbulence (ENVT) was measured using a scale from Jaworski and Kohli (1993). The four-item scale asked senior managers and leaders to provide insight about market technology conditions the development team encounters when providing solutions. Questions such as "The technology in our industry is changing rapidly" were answered on a five-point scale anchored Strongly Disagree (1) to Strongly Agree (5) with one item, "Technological developments in our industry are relatively minor," reverse scored. Scores ranged from 1.5 to 5.0 (*M* = 3.19, *SD* = 0.79, *n* = 54). When multiple respondents were available as team observers, an average score was calculated.

Table 3 displays the primary variables and their codes. Additional validation and robustness check variables are shown in Table 4. In the case where a variable measurement represents individual data, the prefix (i) was used, and where a variable represents team level data, the prefix (t) was used.

Table 3

Primary Analysis Variable & Dimension Summary

Variable/Measure	Subdimensions	Code	Analysis Level (Code Prefix*)	Calculation
Team Performance		PERF	t	Survey
NPD System Ambidexterity	explore/ideate	NPDid	i, t	Survey
NPD System Ambidexterity	exploit/implement	NPDim	i, t	Survey
Leadership Orientation	explore/opening	LOid	t	Survey
Leadership Orientation	exploit/closing	LOim	t	Survey
Strategic Orientation Type	(categorical)	SOType	t	Survey
Team Size		tSZ		Invite Count
Organization Size		ORGSZ	t	Public data
Team Tenure		tTEN	t	Survey
Environment: Tech Turbulence		ENVT	t	Survey
NPD System Ambidexterity	Combined Strength	NPDCD	i, t	NPDid * NPDim
NPD System Ambidexterity	Balance Dimension	NPDBD	i, t	NPDid - NPDim
Leadership Orientation	Combined Strength	LOCD	t	tLOid * tLOim
Leadership Orientation	Balance Dimension	LOBD	t	tLOid - tLOim
NPD to Leadership Alignment		LOALI	t	ABS(tNPDBD - tLOBD)

Note. * The prefix will denote if data was calculated/used at individual level (i) or team level (t)

Table 4

Additional Variables & Dimensions

Variable/Measure	Subdimensions	Code	Analysis Level (Code Prefix*)	Calculation
Process Ambidexterity	explore/agility	PROC	i	Survey
Process Ambidexterity	exploit/standardization	PROC	i	Survey
Strategic Orientation	explore/ideate	SO	t	Survey
Strategic Orientation	exploit/implement	SO	t	Survey
Process Ambidexterity	Combined Strength	PROCCD	i	iPROCid * iPROCim
Process Ambidexterity	Balance Dimension	PROCBD	i	iPROCid - iPROCim
Strategic Orientation	Balance Dimension	SOBD	t	tSOid * tSOim

Note. * The prefix will denote if data was calculated/used at individual level (i) or team level (t)

Table 5 indicates the survey flow assignment of the significant variable measures to the respondent type for both the prime source as well as source for robustness and validity checks.

Table 5

Measurement Instrument to Respondent Assignment Matrix

	NPD System Ambidexterity (New Scale)	Leadership Orientation Ambidexterity (Zacher & Rosing, 2015)	Strategy Type (Slater & Olson, 2000)	Strategic Orientation Ambidexterity (Lubatkin et al., 2006)	NPD Performance (Atuahene-Gima & Ko, 2001)	Process Ambidexterity (Kwak et al, 2020)
Team Members	**IV**					IV
Observer (peer)		**IV**		IV		
Observer (mgr./leader)			**IV**		**DV**	

Note. **Bold** IV/DV = Variables for Primary Hypothesis Testing, Not Bold IV = Alternate Testing

NPD System Ambidexterity Scale Refinement and Validation Method

The NPD System Ambidexterity scale was developed for this study using the procedures outlined in Worthington and Whittaker (2006), Wieland et al. (2016), and Carpenter (2018). The initial pool of items described above were initially refined in a pre-pilot phase with SMEs (DeVellis, 2012). SMEs with experience in product and process development were identified from my personal network and asked to participate in quantitative and qualitative survey analysis. In total, 21 invitations were sent by e-mail with a link to a survey. The invitation established that their confidential help as "experts or knowledgeable in the field of product or process development" was needed to refine questions that may be included in subsequent research. Of the 11 SMEs that completed the survey, all had both manufacturing and product development experience. To be more specific, seven were from the automotive industry, three were from primary metals production, and one was from biotechnology.

In the second phase, the survey invitation was given to 268 development team members. This data was used to establish item and scale reliability as well as construct validity of the new

NPD System Ambidexterity measure. Worthington and Whittaker (2006) generally recommend a sample size to item ratio above 5:1; this study had a ratio of 7.57:1.

Principal Axis Factoring was utilized with Direct Oblimin rotation, Kaiser normalization, and pairwise deletion of items. Per Worthington and Whittaker (2006) and Gorsuch (1997), exploratory factor analysis (EFA) using principal-axis factoring is most closely aligned with the development of new scales and understanding the shared variance of latent constructs. Since the factors are suspected to be correlated based on prior theory, an oblique rotation method was used to prevent overestimation of the factor loadings.

Worthington and Whittaker (2006) summarize several techniques for justifying item deletion and retention and suggest the researcher focus on an item's contribution rather than scale length. General guidelines include items with loadings above 0.32, no cross loading, and no cross-loadings with a differential less than 0.15 (Tabachnick & Fidell, 2007). However, Worthington and Whittaker (2006) caution that cross loadings as a deletion criterion can be problematic in that loadings may clarify as other items are removed. For this reason, the communalities after rotation are recommended as useful in evaluating specific items until a factor structure that relates to theory is clarified. The Tabachnick and Fidell (2007) guidance, that communalities below 0.40 indicate an item is not highly correlated with one or more factors in the solution, was used with the other item retention methods as an a priori criteria set.

Zwick and Velicer (1986) caution that factor retention methods may be more important than the selection of factoring or rotation techniques in EFA analysis for scale development and suggest that parallel analysis (Horn, 1965) may be a preferred and most robust method for factor retention guidance. Parallel analysis is a method whereby random answers are generated for the scale items (and factored as if they were genuine) to represent the concept of random error. This can be compared to actual factoring results to verify that factors were chosen other than those which would result had the scale item data resulted purely from random error.

Scale reliabilities were verified with Cronbach's alpha. Nunnally (1978) indicates values above 0.70 are acceptable in exploratory research, while George and Mallery (2019) advise that values above 0.80 is good and above 0.90 is excellent.

The $r_{wg(j)}$ index (James et al., 1984, 1997), a measure of inter-rater agreement, was calculated to support aggregation of individual measures to a team level variable. Calculation results above 0.70 indicate strong agreement and above 0.92 indicate very strong agreement (LeBreton & Senter, 2008). Guidance for aggregation suggests that teams with $r_{wg(j)}$ index below 0.70 be excluded from analysis unless the mean $r_{wg(j)}$ is above 0.70 and less than 5% of the team values fall below 0.70 (LeBreton et al., 2003).

In addition to internal consistency, the new NPD System Ambidexterity scale should demonstrate convergent and discriminant validity (Cohen, 1982; Fornell & Larcker, 1981). The exploit/implementation and explore/ideation dimensions in an ambidexterity measure have been demonstrated to be functional as separate concepts, rather than two ends of a competing spectrum. However, correlation can be observed between dimensions. Cao et al. (2009) report a correlation of 0.47 between organizational exploration and exploitation. Similarly, the two dimensions of ambidextrous leadership have shown correlation. Zacher and Rosing (2015) report 0.21, although this was a non-significant correlation, and Turnalar-Cetinkaya (2022) report 0.71, with significance not mentioned. Kwak et al. (2019) report correlation between the dimensions of process agility and process standardization at 0.56 with no significance mentioned.

The same respondents completed both the Kwak et al. (2019) Process Ambidexterity measure and the new NPD System Ambidexterity measure. These responses were used to assess convergent and divergent validity of the new scale. Cohen (1992) guidelines that medium to large correlations (>|.30|) indicate convergent validity, while small correlations (<|.20|) indicate divergent validity between measures.

Hypothesis Testing

Using data from the refined NPD ambidexterity measurement scale and existing scales for strategic orientation type, leadership orientation, and team innovative performance, the second phase of this research quantitatively tested the hypothesized relationships. The primary analysis method was hierarchical moderated multiple regression analysis. Aiken et al. (1991) suggest this ordinary least-squared (OLS)-based analysis technique is appropriate for relationship description, prediction modeling, and explanatory theory testing. Dawson (2014) provided practical guidance for this exercise.

The analyses used the tNPDCD measure to understand the overall ambidexterity strength for testing the main effect between the NPD system characteristics and team innovative performance (H1) and successive hypotheses. Variables were not transformed except for mean centering during the calculation of interaction products for moderation testing in the H2a and H2b testing (Dawson, 2014). The H3 hypothesis test was related to the strategy type categorization and relied on a binary category variable. The moderation hypotheses were tested independently, and the regression analysis sequence proceeded as follows:

0. Baseline model: Regress Team Innovative Performance (tPERF) on team size (tSZ), team tenure (tTEN), organization size (ORGSZ), and environmental turbulence (ENVT) controls.
1. Regress Team Innovative Performance (tPERF) on NPD System Ambidexterity CD (tNPDCD) (direct H1 test)

2. H2a) Regress Team Innovative Performance (tPERF) on NPD System Ambidexterity CD (tNPDCD) and Leadership Orientation ambidexterity (tLOCD) (main effects with moderator included).

   H2b) Repeat with NPD System to Leader Orientation alignment (tLOALI) as the moderator in place of (tLOCD).

3. H2a) Regress Team Innovative Performance on NPD System Ambidexterity CD, Leader Orientation ambidexterity (tLOCD), and the NPD System CD * Leader Orientation ambidexterity interaction (tNPDCD*tLOCD).

   H2b) Repeat with Leadership Orientation ambidexterity alignment (tLOALI) as the moderator and interaction component in place of (tLOCD).

For the H3 hypotheses test, the binary categorical variable ANALYZER was used to test the direct effect of the difference between the analyzer and non-analyzer strategy types.

0. Baseline model: Regress Team Innovative Performance (tPERF) on team size (tSZ), team tenure (tTEN), organization size (ORGSZ), and environmental turbulence (ENVT) controls.
1. Regress Team Innovative Performance (tPERF) on NPD System Ambidexterity CD (tNPDCD).
2. Regress Team Innovative Performance (tPERF), the NPD System Ambidexterity CD (tNPDCD), and the binary categorical variable (ANALYZER).

CHAPTER 4: ANALYSIS AND FINDINGS

The analysis and findings are separated into two phases. Phase 1 describes the development and validation of the new NPD System Ambidexterity measure. This consists of a qualitative and quantitative subject matter expert pre-pilot refinement followed by a pilot survey phase and quantitative reliability and validity analysis. Phase 2 utilizes this new measure with existing measures to quantitatively test the hypotheses.

Phase 1: NPD System Scale Refinement and Validation

Subject Matter Expert Review and Content Validity Refinement

New scale item face validity and content validity were refined through an SME survey.

For the exploit/implement dimension items, one rater gave items NPDP10-14 a ranking of “Confusing;” all other raters judged all the items to be “Reasonable” or “Clear.” Items NPD10 and NPD11 were “Clear” to less than half of the raters. These items had average relevancy scores between “Relevant” and “Highly Relevant” with the lowest scores on all items being “Somewhat Relevant” except for item NPDP14 which received one “Irrelevant” score. Based on this feedback, I judged that the items were relevant to the construct but refined wording to address clarity concerns and deletion to address redundancy for some items.

The response summary for the exploit/implement dimension items, NPDP01-NPDP15, in terms of clarity and relevance is shown in Table 6.

Table 6

SME Rating Summary for NPD System Exploit/Implement Pooled Items

Item #	Pooled NPD System Exploit/Implement Items	Item Clarity* (1=not clear, 3=clear) % scored "Clear"	Item Relevance** (1=not, 5=relevant) n	*Mean*	*SD*
NPDP01	Our NPD system stresses minimizing product and/or process cost.	91%	11	4.55	0.69
NPDP02	Reliability improvement of our products and/or mfg. processes is prioritized by our NPD system.	73%	11	4.64	0.67
NPDP03	Our NPD System prioritizes maximizing product and/or process quality.	91%	11	4.82	0.40
NPDP04	Our NPD System focuses our team on existing customers' satisfaction.	91%	11	4.27	0.90
NPDP05	Our NPD System encourages improving current products and/or processes to keep customers satisfied.	91%	11	4.36	0.67
NPDP06	Our NPD System prioritizes keeping projects on track.	82%	10	4.50	0.71
NPDP07	Accurate information on customer needs and requirements is available in our NPD System.	82%	11	4.36	0.81
NPDP08	Our NPD System monitors goal attainment.	91%	11	4.45	0.52
NPDP09	When development problems occur, our NPD System ensures we take corrective action.	64%	11	4.45	0.52
NPDP10	Manufacturing processes provide data through the NPD system that helps problem solving.	45%	11	4.45	0.52
NPDP11	Our NPD System monitors and encourages uniform task accomplishment.	36%	11	3.73	0.79
NPDP12	Our NPD system has well defined routines for project executions.	64%	11	3.91	0.83
NPDP13	Our NPD system requires that we follow process rules.	73%	11	3.73	0.65
NPDP14	Our NPD system encourages designs for automation.	73%	11	3.82	1.08
NPDP15	Errors in execution or product design are highlighted in our NPD system.	64%	11	4.64	0.67

Note. Definitions are provided for Item Clarity and Item Relevance.

* How clear and understandable are these statements in describing a feature of the NPD system that applies to the concept of Implementation/Exploitation?

** How relevant are these statements to the concept of Implementation/Exploitation?

No items were judged “Irrelevant” and scores for relevancy were like the exploit dimension. Based on this feedback, I judged the items were relevant to the construct but determined that refined wording was required for some items to address clarity. Based on SME feedback, NPDP04 was removed and judged to be redundant with NPDP05. Items NPDP08 and NPDP11 were also redundant, but combination and rewording resolved the redundancy and improved clarity. Two items, NPDP10 and NPDP12, required editing for clarity improvement. This effort resulted in 13 items put forward to the pilot study for the exploit dimension.

For the explore/ideate dimension items, all items received a "Clear" rating from more than half of the raters. One rater was generally low compared to others and rated several items as confusing. Three items, NPDP20, NPDP26, and NPDP27, included a low rating of "Confusing" from at least one other rater. The response summary for the explore/ideate dimension items, NPDP16-NPDP30, in terms of clarity and relevance is shown in Table 7.

Table 7

SME Rating Summary for NPD System Explore/Ideate Pooled Items

		Item Clarity* (1=not clear, 3=clear)	Item Relevance** (1=not, 5=relevant)		
Item #	Pooled NPD System Explore/Ideate Items	*% scored "Clear"*	n	*Mean*	*SD*
NPDP16	Our NPD System promotes "outside the box" solutions and designs.	91%	10	4.80	0.42
NPDP17	We are encouraged by our NPD system to incorporate technologies outside of our current capabilities.	82%	11	4.45	0.69
NPDP18	Our NPD System prioritizes products or mfg. process improvements that are new to our firm.	82%	11	4.00	0.89
NPDP19	Our NPD System encourages finding alternative paths to satisfy customer needs.	82%	11	4.36	0.67
NPDP20	Our NPD System highlights gaps in competitor's product/process offerings.	64%	11	4.45	0.69
NPDP21	Our NPD System helps us identify new customers and/or markets to pursue.	73%	11	4.45	0.52
NPDP22	Our NPD System motivates us to take calculated risks.	55%	11	4.36	0.67
NPDP23	Our NPD System encourages manufacturing involvement in new concept development.	82%	11	4.45	0.69
NPDP24	We can quickly test new product concepts and/or mfg. processes using our NPD system.	82%	11	4.64	0.50
NPDP25	Our NPD System incorporates errors effectively as lessons learned.	82%	11	4.55	0.69
NPDP26	We can more effectively partner with outside technology suppliers during development using our NPD system .	73%	11	4.36	1.03
NPDP27	We can work around our NPD system to solve unexpected problems	55%	11	3.82	0.87
NPDP28	Our NPD system allows us to solve problems in our own preferred manner	73%	11	4.00	0.63
NPDP29	Team members individual ideas are supported by our NPD system.	82%	10	4.50	0.53
NPDP30	Our NPD system helps us target new customer groups.	82%	10	4.00	1.05

Note. Definitions are provided for Item Clarity and Item Relevance.

* How clear and understandable are these statements in describing a feature of the NPD system that applies to the concept of Exploration/Ideation?

** How relevant are these statements to the concept of Exploration/Ideation?

With respect to the explore dimension, feedback regarding redundancy was less compelling than for the exploit items and did not result in any concerns that merited item deletion or combination. Based on review of the feedback and re-inspection of the content, four items required word choice and phrasing editing to improve clarity. These were NPDP20 and NPDP25-27. This effort resulted in 15 items put forward to the pilot study for this dimension.

Pilot Phase Refinement of the NPD System Ambidexterity Scale

In total, 212 team members served as respondents for the pilot phase of scale development. Descriptive statistics for the individual items data are shown in Table 8.

Table 8

NPD System Ambidexterity Scale Item Descriptive Statistics

Item ID	Please give your opinion about your organization's NPD System… [Answered on scale of 1 (Strongly Disagree) to 5 (Strongly Agree)]	Mean	*SD*
NPD01_1	Our NPD system stresses minimizing product and/or process cost.	3.59	1.06
NPD01_2	Reliability improvement of our products and/or mfg. processes is prioritized by our NPD system.	3.12	1.10
NPD01_3	Our NPD System prioritizes maximizing product and/or process quality.	3.48	1.07
NPD01_4	Our NPD System encourages improving current products and/or processes to keep customers satisfied.	3.47	1.03
NPD01_5	Our NPD System prioritizes keeping projects on track.	3.50	1.12
NPD01_6	Accurate information on customer needs and requirements is available in our NPD System.	3.33	1.14
NPD01_7	When development problems occur, our NPD System ensures we take corrective action.	3.54	1.09
NPD01_8	Our NPD system uses manufacturing guidelines as inputs to design and problem solving.	3.69	1.04
NPD01_9	Our NPD System effectively monitors task completion performance.	3.283	1.15
NPD01_10	Our NPD system uses established and consistent routines for project execution.	3.60	1.09
NPD01_11	Our NPD system requires that we follow process rules.	3.68	1.10
NPD01_12	Please give your opinion about your organization's NPD System. - Our NPD system encourages designs for automation.	3.14	1.09
NPD01_13	Errors in execution or product design are highlighted in our NPD system.	3.05	1.10
NPD01_14	Our NPD System promotes "outside the box" solutions and designs.	3.17	1.05
NPD01_15	We are encouraged by our NPD system to incorporate technologies outside of our current capabilities.	2.90	1.12
NPD01_16	Our NPD System prioritizes products or mfg. process improvements that are new to our firm.	2.93	1.08
NPD01_17	Our NPD System encourages finding alternative paths to satisfy customer needs.	3.35	1.06
NPD01_18	Our NPD System contains information about our competitors' products.	2.71	1.11
NPD01_19	Our NPD System helps us identify new customers and/or markets to pursue.	2.82	1.11
NPD01_20	Our NPD System motivates us to take calculated risks.	3.08	1.09
NPD01_21	Our NPD System encourages manufacturing involvement in new concept development.	3.53	1.08
NPD01_22	We can quickly test new product concepts and/or mfg. processes using our NPD system.	3.14	1.13
NPD01_23	Our NPD system tracks development failures as lessons learned.	3.31	1.23
NPD01_24	Our NPD system encourages us to partner with outside technology suppliers during development.	3.25	1.11
NPD01_25	We can easily "do a work around" of our NPD system if needed to solve problems.	3.59	1.01
NPD01_26	Our NPD system allows us to solve problems in our own preferred manner	3.50	0.86
NPD01_27	Team members individual ideas are supported by our NPD system.	3.67	1.02
NPD01_28	Our NPD system helps us target new customer groups.	2.88	1.02

The Pearson correlation matrix for this data is shown in Table 9. Correlations above 0.30 between items indicate that there is sufficient correlation to associate the items as a construct. Having no correlations above 0.80 indicates there were no issues of multicollinearity in the analysis (Tabachnik & Fidel, 2001). According to criteria proposed by and Tabachnick and Fidell (2007), the correlation matrix can be factor analyzed. Initial factoring with all 28 items resulted in five factors. There was little consistency regarding the explore/ideation items. The rotated factor matrix is shown in Table 10 with factor loadings less than |0.25| suppressed. To improve the overall solution, items were deleted one item at a time, taking the lowest communality underperforming item and running the factor analysis in each step to inspect the clarifying effects on subsequent communalities and loadings. Once communalities were above 0.40, item deletion was guided by non-loading items and largest cross-loading. When multiple low performing items presented an unclear situation, maximum-likelihood factoring was run to assist in item deletion selection and qualitative judgement was used to ensure the factor structure was moving towards a simple structure that does not contradict with the theoretical grounding (Worthington & Whittaker, 2006).

Table 9

NPD System Ambidexterity Scale Item Correlation Matrix

NPD Ambidexterity Pilot Scale Items - Pearson Correlations (n=212)

	NPD01_1	NPD01_2	NPD01_3	NPD01_4	NPD01_5	NPD01_6	NPD01_7	NPD01_8	NPD01_9	NPD01_10	NPD01_11	NPD01_12	NPD01_13	NPD01_14	NPD01_15	NPD01_16	NPD01_17	NPD01_18	NPD01_19	NPD01_20	NPD01_21	NPD01_22	NPD01_23	NPD01_24	NPD01_25	NPD01_26	NPD01_27	NPD01_28
NPD01_1	--																											
NPD01_2	.374**	--																										
NPD01_3	.394**	.582**	--																									
NPD01_4	.357**	.574**	.644**	--																								
NPD01_5	.357**	.525**	.454**	.434**	--																							
NPD01_6	.254**	.559**	.548**	.468**	.511**	--																						
NPD01_7	.349**	.538**	.603**	.566**	.504**	.513**	--																					
NPD01_8	.478**	.445**	.609**	.460**	.462**	.376**	.549**	--																				
NPD01_9	.139*	.364**	.482**	.405**	.538**	.486**	.502**	.303**	--																			
NPD01_10	.332**	.462**	.587**	.441**	.582**	.538**	.543**	.483**	.547**	--																		
NPD01_11	.378**	.517**	.623**	.435**	.534**	.487**	.615**	.464**	.477**	.589**	--																	
NPD01_12	.420**	.353**	.477**	.477**	.318**	.313**	.354**	.452**	.300**	.362**	.338**	--																
NPD01_13	.250**	.443**	.445**	.447**	.480**	.422**	.590**	.376**	.410**	.436**	.471**	.315**	--															
NPD01_14	.195**	.338**	.444**	.456**	.253**	.465**	.453**	.355**	.355**	.352**	.259**	.317**	.322**	--														
NPD01_15	.278**	.395**	.336**	.342**	.298**	.382**	.362**	.222**	.362**	.286**	.267**	.380**	.313**	.509**	--													
NPD01_16	.275**	.457**	.447**	.412**	.433**	.462**	.348**	.295**	.407**	.312**	.315**	.469**	.389**	.400**	.554**	--												
NPD01_17	.237**	.434**	.515**	.405**	.355**	.448**	.455**	.451**	.404**	.340**	.340**	.321**	.313**	.473**	.473**	.458**	--											
NPD01_18	.226**	.377**	.294**	.283**	.289**	.360**	.347**	.264**	.330**	.233**	.310**	.301**	.332**	.243**	.390**	.329**	.350**	--										
NPD01_19	.261**	.425**	.348**	.365**	.395**	.450**	.343**	.302**	.337**	.329**	.358**	.346**	.471**	.388**	.498**	.467**	.486**	.464**	--									
NPD01_20	.199**	.430**	.435**	.412**	.407**	.440**	.367**	.348**	.339**	.422**	.346**	.228**	.396**	.518**	.463**	.412**	.429**	.251**	.407**	--								
NPD01_21	.312**	.419**	.506**	.384**	.317**	.410**	.278**	.485**	.338**	.316**	.298**	.363**	.155*	.284**	.216**	.372**	.352**	.261**	.215**	.304**	--							
NPD01_22	.227**	.359**	.443**	.484**	.452**	.413**	.375**	.383**	.427**	.394**	.344**	.343**	.417**	.361**	.257**	.370**	.395**	.244**	.325**	.471**	.326**	--						
NPD01_23	.294**	.586**	.500**	.528**	.622**	.585**	.591**	.434**	.451**	.515**	.575**	.317**	.559**	.348**	.416**	.422**	.357**	.415**	.468**	.435**	.296**	.420**	--					
NPD01_24	.356**	.366**	.422**	.439**	.331**	.430**	.419**	.433**	.348**	.424**	.328**	.343**	.297**	.448**	.510**	.400**	.479**	.373**	.434**	.427**	.357**	.327**	.306**	--				
NPD01_25	.219**	.300**	.284**	.254**	.231**	.243**	.210**	.232**	.215**	.226**	.139*	0.134	.176*	.271**	.241**	.227**	.311**	.257**	.218**	.293**	.244**	.299**	.193**	.320**	--			
NPD01_26	.268**	.220**	.304**	.323**	.213**	.273**	.287**	.288**	.155*	.221**	.136*	0.127	.141*	.311**	.264**	.147*	.325**	.153*	.249**	.349**	.193**	.196**	.215**	.373**	.411**	--		
NPD01_27	.315**	.388**	.476**	.429**	.356**	.465**	.421**	.456**	.310**	.386**	.285**	.284**	.310**	.515**	.380**	.280**	.480**	.277**	.285**	.449**	.440**	.375**	.379**	.448**	.215**	.368**	--	
NPD01_28	.247**	.462**	.423**	.438**	.432**	.464**	.374**	.326**	.420**	.356**	.341**	.359**	.424**	.393**	.528**	.509**	.463**	.458**	.695**	.463**	.326**	.305**	.512**	.464**	.240**	.264**	.381**	--

Table 10

NPD System Ambidexterity: Initial Rotated Factor Solution

Pattern Matrix[a]

	Factor				
Please give your opinion about your organization's NPD System...	1	2	3	4	5
NPD01_1 Our NPD system stresses minimizing product and/or process cost.			-0.298	0.531	
NPD01_2 Reliability improvement of our products and/or mfg. processes is prioritized by our NPD system.	0.475				
NPD01_3 Our NPD System prioritizes maximizing product and/or process quality.	0.484			0.393	
NPD01_4 Our NPD System encourages improving current products and/or processes to keep customers satisfied.	0.381			0.266	
NPD01_5 Our NPD System prioritizes keeping projects on track.	0.712				
NPD01_6 Accurate information on customer needs and requirements is available in our NPD System.	0.515				
NPD01_7 When development problems occur, our NPD System ensures we take corrective action.	0.694				
NPD01_8 Our NPD system uses manufacturing guidelines as inputs to design and problem solving.	0.322			0.488	
NPD01_9 Our NPD System effectively monitors task completion performance.	0.581		0.256		
NPD01_10 Our NPD system uses established and consistent routines for project execution.	0.705				
NPD01_11 Our NPD system requires that we follow process rules.	0.792				
NPD01_12 Our NPD system encourages designs for automation.		0.272		0.618	
NPD01_13 Errors in execution or product design are highlighted in our NPD system.	0.637				
NPD01_14 Our NPD System promotes "outside the box" solutions and designs.			0.384		0.336
NPD01_15 We are encouraged by our NPD system to incorporate technologies outside of our current capabilities.		0.624			
NPD01_16 Our NPD System prioritizes products or mfg. process improvements that are new to our firm.		0.527		0.256	
NPD01_17 Our NPD System encourages finding alternative paths to satisfy customer needs.		0.275			0.283
NPD01_18 Our NPD System contains information about our competitors' products.		0.460			
NPD01_19 Our NPD System helps us identify new customers and/or markets to pursue.		0.726			
NPD01_20 Our NPD System motivates us to take calculated risks.	0.262		0.258		0.336
NPD01_21 Our NPD System encourages manufacturing involvement in new concept development.				0.464	
NPD01_22 We can quickly test new product concepts and/or mfg. processes using our NPD system.	0.384				
NPD01_23 Our NPD system tracks development failures as lessons learned.	0.752				
NPD01_24 Our NPD system encourages us to partner with outside technology suppliers during development.		0.289			0.380
NPD01_25 We can easily "do a work around" of our NPD system if needed to solve problems.					0.434
NPD01_26 Our NPD system allows us to solve problems in our own preferred manner					0.739
NPD01_27 Team members individual ideas are supported by our NPD system.					0.411
NPD01_28 Our NPD system helps us target new customer groups.		0.661			

Note. Extraction Method: Principal Axis Factoring.

a. Rotation converged in 20 iterations. Direct Oblimin Rotation; Bartlett's $\chi 2 = 3048.63$, $df = 378$, $p \leq 0.000$, KMO = 0.94

Construct validity was initially demonstrated with the refined and reduced items loading onto two factors. Factor 1 represented the exploit or implementation dimension, and Factor 2 represented the explore or ideate dimension. In addition to the two items dropped from the original pool of 30 items due to redundancy observations, seven were dropped for low communalities or insufficient loading. Two items were dropped due to cross loading concerns, and two were dropped due to cross loading and loading on off factors from theoretical expectations. Item NPD01_6 cross loaded marginally on the ideation factor but was retained due to theoretical relevancy. The refined NPD System Ambidexterity scale items factor matrix and communalities are shown in Table 11 with factor loadings less than |0.25| suppressed.

Table 11

NPD System Ambidexterity: Pilot Optimized Factor Solution and Communalities

Pattern Matrix[a]	Factor		Communalities	
Please give your opinion about your organization's NPD System...	1	2	Initial	Extraction
NPD01_2 Reliability improvement of our products and/or mfg. processes is prioritized by our NPD system.	0.532		0.519	0.491
NPD01_3 Our NPD System prioritizes maximizing product and/or process quality.	0.642		0.621	0.589
NPD01_5 Our NPD System prioritizes keeping projects on track.	0.719		0.538	0.521
NPD01_6 Accurate information on customer needs and requirements is available in our NPD System.	0.482	0.312	0.526	0.534
NPD01_7 When development problems occur, our NPD System ensures we take corrective action.	0.704		0.615	0.588
NPD01_9 Our NPD System effectively monitors task completion performance.	0.566		0.460	0.432
NPD01_10 Our NPD system uses established and consistent routines for project execution.	0.780		0.562	0.574
NPD01_11 Our NPD system requires that we follow process rules.	0.902		0.566	0.623
NPD01_13 Errors in execution or product design are highlighted in our NPD system.	0.554		0.478	0.410
NPD01_14 Our NPD System promotes "outside the box" solutions and designs.		0.731	0.500	0.495
NPD01_15 We are encouraged by our NPD system to incorporate technologies outside of our current capabilities.		0.855	0.507	0.563
NPD01_16 Our NPD System prioritizes products or mfg. process improvements that are new to our firm.		0.567	0.483	0.426
NPD01_17 Our NPD System encourages finding alternative paths to satisfy customer needs.		0.642	0.487	0.492
NPD01_19 Our NPD System helps us identify new customers and/or markets to pursue.		0.547	0.469	0.405
NPD01_20 Our NPD System motivates us to take calculated risks.		0.562	0.438	0.439
NPD01_24 Our NPD system encourages us to partner with outside technology suppliers during development.		0.618	0.428	0.441
NPD01_27 Team members individual ideas are supported by our NPD system.		0.506	0.442	0.377

Note. Extraction Method: Principal Axis Factoring.

a. Direct Oblimin Rotation with Kaiser Normalization; Bartlett's $\chi 2$ = 1761.85, *df* = 136, $p \leq$ 0.000, KMO = 0.93

NPD System Ambidexterity Scale Reliability

The internal consistency (Cronbach's alpha) for the nine-item exploit/implement dimension was 0.90 and 0.87 for the eight-item explore/ideate dimension. Inspection of the items revealed that there is conceptual clarity within and between the dimensions included (Podsakoff et al., 2016), retained items represented the original strategic development and leadership orientation scales, and the item-total statistics indicate that further item deletion would not positively affect the internal consistency of either dimension.

Criterion Validity

Kwak et al.'s (2019) process ambidexterity measure was used to assess convergent and divergent validity. Comparison with the developed measure should be useful since, on face value, Kwak et al.'s (2019) flexibility/agility and discipline appear closely related to the new NPD System Ambidexterity dimensions of ideation and implementation. For criterion validity testing, the NPD System BD and NPD System CD measures were used. In Table 12, the NPD System and Kwak et al.'s (2019) scale composite measure correlations are shown.

Table 12

NPD System Ambidexterity and Process Ambidexterity Composite Variable Validity

Ambidexterity Measure Correlations				
	iPROCCD	iPROCBD	iNPDSyCD	iNPDSyBD
iPROCCD	--			
iPROCBD	0.043	--		
iNPDSyCD	.734**	0.043	--	
iNPDSyBD	-.202**	0.101	-0.071	--

Note. **Correlation is significant at the 0.01 level (2-tailed).

Supporting convergent validity, Process CD and NPD System CD were significantly and positively correlated ($r = 0.73$, $p < .000$). The NPD System BD showed a small and significant negative correlation to Process BD ($r = -0.20$, $p = .003$). This demonstrates that the individual dimensions of the NPD System Ambidexterity scale deconstruct the same target in a different manner than the Kwak et al. (2019) scale. This was the desired outcome for the new scale. Cohen (1992) suggests that a correlation lower than |.2| is desired for divergent validity but greater than |.3| is required to suggest convergent validity. The data support that the new NPD System Ambidexterity scale displays convergent validity measuring a high overall ambidexterity of the NPD process, and divergent validity in being able to deconstruct ambidexterity into different dimensional subcomponents compared to the Kwak et al. (2019) scale.

Phase 2: Team Level Hypothesis Testing

Survey Measures, Reliability, and Aggregation

The individual survey response data, prior to team aggregation or composite variable construction is summarized for all measures in Table 13. Pearson correlations are shown, and Cronbach reliability coefficients are included in the diagonal. Individual NPD System implementation scores ranged from 1.33 to 5.00 (*M* = 3.40, *SD* = 0.83) and individual NPD System ideation scores ranged from 1.00 to 4.88 (*M* = 3.15, *SD* = 0.78).

Table 13

Survey Scales Correlations and Reliabilities: Individual Data

Survey Scale Descriptives, Correlations & Cronbach's Alpha summary (Alpha in diagonal)													
Scale	Mean	*SD*	N	iPERF	ENVT	iNPDid	iNPDim	iLOid	iLOim	iSOid	iSOim	iPROCid	iPROCim
iPERF	3.70	0.52	54	***0.83***									
ENVT	3.19	0.79	54	0.065	***0.79***								
iNPDid	3.15	0.78	212	.[a]	.[a]	***0.87***							
iNPDim	3.40	0.83	212	.[a]	.[a]	.698**	***0.90***						
iLOid	3.57	0.49	45	.[a]	.[a]	.[a]	.[a]	***0.72***					
iLOim	3.28	0.65	45	.[a]	.[a]	.[a]	.[a]	.369*	***0.84***				
iSOid	3.19	0.70	44	.[a]	.[a]	.[a]	.[a]	0.160	0.053	***0.78***			
iSOim	3.46	0.63	44	.[a]	.[a]	.[a]	.[a]	0.129	0.127	.656**	***0.75***		
iPROCid	3.62	0.81	212	.[a]	.[a]	.602**	.673**	.[a]	.[a]	.[a]	.[a]	***0.81***	
iPROCim	3.71	0.79	212	.[a]	.[a]	.567**	.699**	.[a]	.[a]	.[a]	.[a]	.734**	***0.79***

Note. * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.

a. Cannot be computed because respondents are different.

Aggregating NPD System Ambidexterity to a Shared Team Perception

Supporting aggregation of individual scores to the team level, the NPD System Implementation (NPDim) dimension exhibited a mean $r_{wg(j)}$ 0.77 (*Mdn* = 0.88, *SD* = 0.27) and the ideation (NPDid) dimension a mean $r_{wg(j)}$ = 0.81 (*Mdn* = 0.87, *SD* = 0.18) (Klein & Koslowski, 2000). While these means are above the minimum mean threshold of 0.70 suggested by Lebreton et al. (2003), six teams (17.1%) and five teams (14.2%) fell below $r_{wg(j)}$ = 0.70 for the implementation and ideation dimension measures, respectively. When more than 5% of the team values fail to meet this threshold, Lebreton et al. (2006) recommend that these teams be deleted from the sample set due to lack of inter-rater agreement.

When a bimodal distribution is present rather than general disagreement, excluding team data can be avoided if a pooled mean variance of the disparate groups, r_{wg_p}, is sufficient (LeBreton et al., 2006). The r_{wg_p} were observed to be above 0.70 on both subdimension scales for six of seven unique teams and these were included in the hypothesis analysis.

Further support that the aggregates of the individual ratings are reliable and valid as a team level construct is shown by significant intraclass correlation coefficient calculations with ICC(1) = 0.11 and 0.11 and ICC(2) = 0.41 and 0.43 for NPDim and NPDid dimensions, respectively. ICC(1) indicates that the score is reliable and is not attributed to team membership and ICC(2) suggests that the team mean scores reliably differentiate from one another (Bliese, 2000; Lebreton & Senter, 2008; McGraw & Wong, 1986).

Eligibility requirements of observer count minimums eliminated four teams for consideration in hypothesis testing. The team that did not pass r_{wg} aggregation standards for the NPD System team shared perception were one of the teams eliminated for observer count. In total, 31 teams were eligible for hypothesis testing. Team level scores for each of the variables were calculated by averaging individual scores. Team averaged scores for NPD System implementation ranged from 2.22 to 4.23 (M = 3.42, SD = 0.47) and NPD System ideation scores ranged from 1.79 to 3.70 (M = 3.11, SD = 0.46). All team level survey measure scores are shown in Appendix I.

Leadership Orientation

In total, 45 peer observer responses to the Leadership Orientation scales demonstrated reliability of α = 0.84 and α = 0.72 for the Leadership Orientation exploit/closing (iLOim) and explore/opening (iLOid) dimensions, respectively. Scores were calculated by taking the mean of the items for each dimension. iLOim scores ranged from 1.14 to 4.57 (M = 3.28, SD = 0.65) and iLOid scores ranged from 2.43 to 4.71 (M = 3.57, SD = 0.49).

The team level scores were created by averaging multiple responses when necessary. tLOim scores ranged from 1.86 to 4.57 (M = 3.33, SD = 0.57) and tLOid scores ranged from 2.71 to 4.71 (M = 3.56, SD = 0.45).

Team Innovative Performance

In total, 54 senior manager/leader observers rated Team Innovative Performance (iPERF). The combined 11-item scale demonstrated a reliability of α = 0.83. The sub-scales performed as follows: product performance (α =0.78), launch proficiency (α =0.59), and product quality (α =0.82). iPERF scores, or the average of the three scales, ranged from 1.64 to 4.55 (M = 3.70, SD = 0.52).

From these individual senior manager/leader responses, scores were averaged when necessary, and team product development performance (tPERF) scores ranged from 3.18 to 4.55 (M = 3.81, SD = 0.36). One outlier was noted during the data inspection. The company liaison was approached and asked to inquire about the response. It was determined by the liaison that the senior leader answered the performance measure questions with the company's development teams in general as the referent rather than answering with perceptions about their particular team. They re-submitted the survey, and their data was updated prior to these analyses.

Strategic Orientation Type

In total, 54 senior manager/leader observers, representing 39 teams, were asked to type their organization using the Slater and Olson (2000) paragraph protocol. Where disagreement occurred between managers responding for the same team, the mode value or nearest aggregate type rating was selected. Six were typed as prospector, 16 as analyzer, 14 as defender, and only one as a reactor. Two teams did not meet the respondent requirement for this variable. Ultimately, two prospectors, one analyzer, and three defenders were eliminated due to the team response count and observer count requirements.

Strategic Orientation Ambidexterity

In total, 44 peer observers responded regarding the firm's development Strategic Orientation. The implementation dimension reliability was 0.75 and the ideation dimension reliability was 0.78. Individual exploitation/implementation scores ranged from 2.00 to 5.00 ($M = 3.46$, $SD = 0.63$) and individual exploration/ideation scores ranged from 1.83 to 4.50 ($M = 3.19$, $SD = 0.70$).

The team level scores were created by averaging multiple responses when necessary. tSOim scores ranged from 2.00 to 4.57 ($M = 3.41$, $SD = 0.55$) and tSOid scores ranged from 1.83 to 4.55 ($M = 3.12$, $SD = 0.70$).

Team Level Survey Data Dimension Review

Edwards and Parry (1993) caution that information may be lost when combining two or more measures into one index. For robustness purposes, inspection of the team level survey dimensions prior to composite calculations was warranted to understand how subcomponents relate to predicting outcomes as compared to the final index. There was a positive and significant zero-order correlation between the ideation dimension of the NPD System Ambidexterity (tNPDid) and the DV of Team Innovative Performance (tPERF) (r = 0.38, p = .035) and a positive correlation between team leadership orientation ideation and team innovative performance (r = 0.54, p = .002). The correlations between the ambidexterity dimensions of the NPD system and strategic orientation are present in both individual and team level. The leadership orientation dimension correlation to performance present in the individual data is not present in the team averaged data.

Composite Variable Construction

Descriptive statistics and correlations for the constructed ambidexterity related variables, dependent, and control variables are shown in Table 14.

Table 14

Team Level Composite and Analysis Variable Descriptives and Correlations

Team Level Variables - Descriptives & Correlations															
Variable	Mean	*SD*	Min.	Max.	tPERF	tSZ	lnORGSZ	ENVT	tTEN	tNPDCD	tNPDBD	tLOCD	tLOBD	tSOBD	tLOALI
tPERF	3.81	0.36	3.18	4.55	--										
tSZ	7.45	3.27	5.00	19.00	0.172	--									
lnORGSZ	7.37	1.62	3.76	9.83	-0.250	0.030	--								
ENVT	3.12	0.78	1.00	4.75	-0.011	-0.162	-0.198	--							
tTEN	4.56	2.25	1.50	10.00	0.338	0.130	-0.037	-0.147	--						
tNPDCD	10.76	2.60	3.98	15.14	.370*	0.111	-0.247	0.230	-0.302	--					
tNPDBD	-0.32	0.40	-1.11	0.68	0.095	-0.031	0.018	-0.093	0.085	-0.039	--				
tLOCD	11.94	2.97	6.63	18.29	0.340	-0.043	-0.211	0.123	-0.260	.400*	-0.250	--			
tLOBD	0.23	0.59	-0.86	1.71	0.341	-0.061	-0.259	-0.002	0.285	0.145	0.110	-0.240	--		
tSOBD	-0.29	0.54	-1.74	0.64	-0.005	0.005	0.158	-0.053	-.365*	0.044	0.022	0.221	-0.087	--	
tLOALI	0.66	0.56	0.01	2.21	.378*	-0.142	-0.283	0.089	0.195	0.172	-.423*	0.041	.784**	-0.092	--

Note. n = 31. * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.

Based on 31 qualifying teams, there was a significant positive correlation between Team Innovative Performance and NPD System CD (r = 0.37, p = .041) and the hypothesized moderating variable, tLOALI (r = 0.38, p = .036). It should be noted that the NPD System CD dimension was positively correlated to Leadership Orientation CD (r = 0.40, p = .026) and Team

Tenure (tTEN) was negatively correlated to the Strategic Orientation BD (r = -0.37, p = .043). There were no excessive correlations which would indicate collinearity issues besides the expected correlations within the variable compositions (Tabachnick & Fidell, 2007).

Main Hypothesis Testing (H1)

Ordinary least squares regression analysis was used to test if the NPD System CD ambidexterity predicted the Team Innovative Performance (tPERF). The baseline model including the control variables of Team Size, Team Tenure, Technology Dynamism, and Company Size is shown as Model 0 in Table 15.

Table 15

The Effect of NPD System Ambidexterity on Team Innovative Performance

DV Team Performance (tPERF)	Model 0	Model 1
Team Size (tSZ)	0.140	0.049
ln Company Employees (lnORGSZ)	-0.240	-0.127
Env. Technolgy Turbulence (ENVT)	0.010	-0.073
Team Tenure (tTEN)	0.313†	0.465*
NPD Sys. Ambidexterity CD (tNPDCD)		0.490*
ΔR^2	0.190	0.190*
Total R^2	0.190	0.379
ΔF	1.521	1.533
Total F	1.521	3.054*

*p < .05, †p < .1 ; df = 26 Model 0, 25 Model 1

Note. There were no concerns for autocorrelation, multicollinearity, or in the analysis of residuals.

The control variables were not a significant predictor of Team Innovative Performance. The addition of NPD System Ambidexterity CD in Model 1 accounted for a significant increase in Team Innovative Performance (ΔR^2 = .190, df = 1,25, p = .011). Model 1 was a significant predictor of Team Performance, explaining 37.9% of the observed variance (df =5,25, p = .028).

Hypothesis 1, high levels of NPD system ambidexterity will be positively related to increases in team innovative performance, is supported.

In a post hoc analysis, per Edwards and Parry (1993), the individual ambidexterity subdimension effects of the NPD system (ideation and implementation) were investigated. While both were significant in their explanatory power individually, they do not surpass the effect of NPD System Ambidexterity CD. The only variable with a stronger main effect on the team's innovative performance was the ideation dimension of Leadership Orientation.

Leadership Orientation Moderation Hypothesis Testing (H2a & H2b)

Hypothesis 2a proposed that the Leadership Orientation (tLOCD) would moderate the effect of NPD System CD on Team Innovative Performance. Table 16 illustrates the results from the hierarchical moderated regressions.

Table 16

Leadership Orientation Ambidexterity Moderation of Team Innovation Performance

DV Team Performance (tPERF)	Model 0	Model 1	Model 2a.1	Model 2a.2
Team Size (tSZ)	0.140	0.049	0.066	0.069
ln Company Employees (lnORGSZ)	-0.240	-0.127	-0.085	-0.048
Env. Technolgy Turbulence (ENVT)	0.010	-0.073	-0.069	-0.088
Team Tenure (tTEN)	0.313†	0.465*	0.514**	0.512**
NPD Sys. Ambidexterity CD (tNPDCD)		0.490*	0.388*	0.456*
Leadership Orientation Ambidexterity CD (tLOCD)			0.311†	0.210
Interaction Effect (Int_tNPDCDxtLOCD)				0.321*
ΔR^2	0.190	0.190*	0.077	0.091
Total R^2	0.190	0.379	0.456	0.547
ΔF	1.521	1.533	0.305	0.616
Total F	1.521	3.054*	3.359*	3.975**

$^{**}p < .01$, $^{*}p < .05$, †$p < .1$; df = 26 Model 0, 25 Model 1, 24 Model 2a.1, 23 Model 2a.2

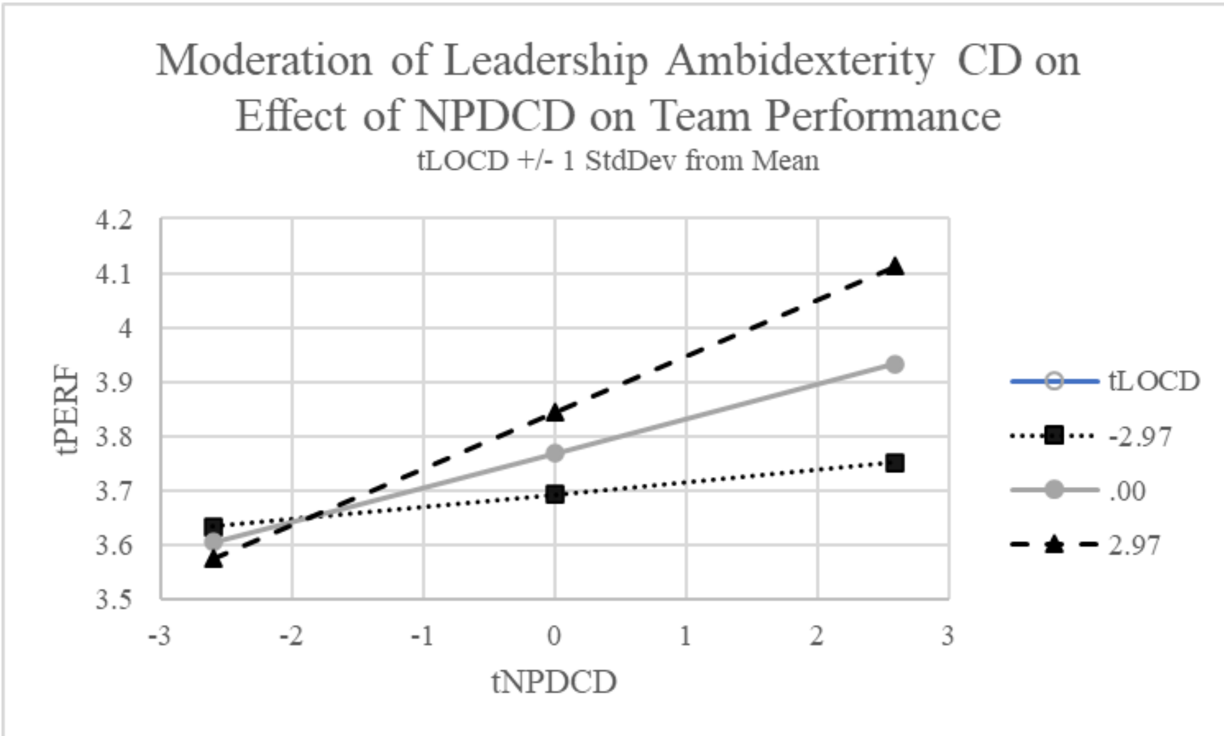
Note. There were no concerns for autocorrelation, multicollinearity, or in the analysis of residuals.

Model 2a.1 and Model 2a.2 show the addition of the Leadership Orientation ambidexterity predictor (tLOCD) and the interaction term between the Leadership Orientation and NPD System ambidexterity combined (CD) dimensions. The addition of the interaction term was significant on Team Innovative Performance (ΔR^2 = .091, *df* =1,23, *p* = .042). Model 2a.2 was a significant predictor of Team Performance, explaining 54.7% of the observed variance (*df* =7,23, *p* = .006). The 13 teams with leadership orientation ambidexterity (tLOCD) above the mean had a correlation between NPD system ambidexterity (tNPDCD) and team innovative performance (tPERF) (*r* = .68, *p* = .011) while the 18 with tLOCD below mean did not have a significant correlation.

Hypothesis 2a, that Leadership Orientation combined ambidexterity positively moderates the relationship between NPD system combined ambidexterity and team innovation performance, is supported. As the ambidexterity of the leadership increases, the moderation effect increases as illustrated in Figure 3. Using the Johnson-Neyman technique (Johnson & Fey, 1950), a simple slopes analysis indicates that the effect is significant over the entire anticipated range of Leadership Orientation ambidexterity CD.

Figure 3

Moderation Effects of Leadership Orientation Ambidexterity



Hypothesis 2b was tested using OLS linear regression techniques as applied to ambidexterity balance dimension constructs in past research. However, the operationalization of the alignment score, involving the absolute value of a difference between to balance scores (which are themselves differences) results in a rather untenable and uninterpretable measure. Edwards (2001) recommends that a polynomial regression and commensurate modeling technique be applied to properly evaluate congruence in higher order terms. These results are presented in Appendix J.

Strategic Orientation Hypothesis Testing (H3)

Hypothesis 3 proposed that the analyzer strategic orientation would benefit more from NPD System Ambidexterity CD (combined dimension) than non-analyzers. The binary categorical variable of ANALYZER was added to the H1 model and tested as a predictor as can be seen in Table 17.

Table 17

NPD System to Strategic Type Analyzer Effect on Team Innovative Performance

DV Team Performance (tPERF)	Model 0	Model 1	Model 3
Team Size (tSZ)	0.140	0.049	0.029
ln Company Employees (lnORGSZ)	-0.240	-0.127	-0.129
Env. Technolgy Turbulence (ENVT)	0.010	-0.073	-0.074
Team Tenure (tTEN)	0.313†	0.465*	0.503*
NPD Sys. Ambidexterity CD (tNPDCD)		0.490*	0.554*
(ANALYZER)			0.180
ΔR^2	0.190	0.190*	0.028
Total R^2	0.190	0.379	0.408
ΔF	1.521	1.533	-0.303
Total F	1.521	3.054*	2.751*

*p < .05, †p < .1 ; df = 26 Model 0, 25 Model 1, 24 Model 3

Note. There were no concerns for autocorrelation, multicollinearity, or in the analysis of residuals.

In Model 3, the addition of the binary variable contrasting analyzer firms to non-analyzer firms (ANALYZER) was not significant in its effect on Team Innovative Performance. Thus, Hypothesis 3, that possessing the analyzer orientation would make a unique contribution to team innovative performance after accounting for NPD system ambidexterity, is not supported.

In exploring this result post hoc, the correlation between NPD system ambidexterity (tNPDCD) and team performance in analyzer firms (n = 15) was significant (r = .54, p = .039) while the same correlation in non-analyzer firms was not significant.

Phase 2 Summary Findings

Phase 2 of this research provided support that the NPD System Ambidexterity measure, reliable and valid at the individual level, also reliably reflects the shared perception of development teams. The first research question, does an NPD system's ambidexterity positively affect team innovative output, was supported. As anticipated, average team tenure was a significant covariate in this relationship; however, team size, organization size, and environmental technology turbulence did not have significant effects.

The second question regarding if the relationship between NPD system ambidexterity and team innovativeness was moderated by the organization's strategic orientation and leadership behavior was answered with partial support. The combined dimension of Leadership Orientation ambidexterity does moderate the relationship between the NPD system ambidexterity and team innovation performance and adds significant explanatory power to the relationship model.

Though the alignment between the ambidexterity of the NPD system and leadership orientation showed significant positive correlation to team innovative performance, there was no support for it as a significant covariate or moderator of the relationship between NPD system ambidexterity and team innovation performance. The same was true of the alignment or match between NPD system ambidexterity and strategic orientation. Analyzer firms did not show a preference towards a strong NPD system ambidexterity.

The summary of hypotheses support is shown in Table 18.

Table 18

Hypothesis Support Summary

	Hypothesis	Direction	Predictor	Supported	β	t	*p*	ΔR^2
H1	NPD System Ambidexterity influences team innovation performance	+	tNPDCD	Yes	0.490	2.763	0.011	0.190
H2a	Leadership Orientation Ambidexterity Moderates H1	+	Int tLOCD x tNPDCD	Yes	0.321	2.151	0.042	0.091
H2b	NPD System to Leadership Orientation Ambidexterity Alignment Moderates H1	+	Int tLOALI x tNPDCD	No	0.096	0.576	0.570	0.008
H3	Strategic Type Analyzers have increased NPD System Ambidexterity to Performance	+	ANALYZER	No	0.180	1.071	0.295	0.028

CHAPTER 5: DISCUSSION

This research reviewed the existing literature on organizational innovation and NPD management against the backdrop of the research question: “Does an NPD system’s ambidexterity positively affect team innovation performance?” That review established a positive relationship between NPD management processes control, accuracy, and speed and innovation performance. These same NPD systems have come under criticism for rigidity, creativity suppression, and lack of rapid redesign cycle support. Additionally, NPD systems have not received significant interest in theoretical or practitioner study regarding fitness for purpose. The concept of ambidexterity, specifically contextual ambidexterity, had been applied to an organizational leadership, structure, and strategic orientation with positive links to performance, but not to the organizational processes that organizations use to manage and promote innovative new products and associated manufacturing processes. A set of hypotheses linking NPD system ambidexterity, team innovation performance, and related variables were proposed.

To test these hypotheses, I first created a practical measure of NPD system ambidexterity. The proposed measure was based on prior theory and refined using input from 11 SMEs and 212 active development team members. In the second phase of this study, the utility of this scale was established and quantitatively linked to team innovative performance.

This new measure extends contextual ambidexterity theory to other dimensions of organization design and provides new direction for the concept of fit in evaluation of information systems. This research introduces the first ambidexterity-based measure for evaluating the ideation and implementation performance characteristics of an organization’s new product development process. Following the theoretical contributions discussion, I review methodological contributions, illustrate implications for practice, discuss research limitations, and finally suggest future research directions.

Implications for Advancing Theory

The findings of this research support the contribution of a firm's new product development system's ambidexterity to team innovative performance. The strength of leadership ambidexterity is a moderator of the NPD system ambidexterity to team innovative performance relationship; however, firm strategic orientation type cannot be shown as playing a role between NPD system ambidexterity and team innovative performance.

This new measurement tool can facilitate better understanding of the antecedents that shape the characteristics of an NPD system's ambidexterity, as well as the outcomes that an NPD system influences from a firm performance or team and individual behavior and climate perspective.

The Influence of NPD System's Combined Ambidexterity on Team Performance

Prior research suggested that organizations can create conditions that allow employees to preferentially and simultaneously navigate conflicting tensions present at the organization level (Gibson & Birkinshaw, 2004). The measure of NPD system combined ambidexterity and its significant and positive influence on team innovative performance illustrate that organizational processes are an important part of the conditions that employees perceive as influencing their behavior during innovation.

Bledow et al. (2009) in their Dialectic Perspective on Innovation put forth several claims regarding contextual ambidexterity and its relation to innovation at the individual and team level. Their contention that management and organizational processes affect team and individual actions is directly supported by this research. The NPD system ambidexterity measure (an organization level issue) affected innovative performance at the individual and team level.

The quantification of the NPD system's combined ambidexterity effect on the development team's innovation performance makes sense. Team members' creative thinking should benefit from prompting at the early, "fuzzy front end" of a project. If they sense that their NPD system is inhibiting or will penalize over-reaching, they will not venture to provide impactful product and process improvements. Likewise, if an NPD system is constructed in a way that promotes early ideation, then team members' creativity may be amplified over a natural level. However, an NPD system that encourages boundaries to this early creative solutioning is required. The system should encourage mindfulness of risk level in selecting designs or processes too far outside the operational ability of the firm. This prevents wasted time and resources on product development that has a low probability of future success. An NPD system with a strong implementation discipline cannot reverse the damage of these actions.

Whether a firm has a well-defined gate process to define when ideas are translated into an implementation phase, or whether it is a continuous fuzzy spectrum from the team members' viewpoint, the system has as much of an influence on implementation decisioning as it does on ideation. When a team is implementing, problems occur, whether they have intentionally ventured to solve these open issues or are doing so because of unexpected occurrences. During the solutioning process, the team members can react to unexpected problems or unsolved tasks with varying degrees of creativity and risk. The NPD system that has strict and overt rules for perfection regarding implementation timing and cost reduction may not encourage team members' selection of the optimum problem solution. They may select the easier and cheaper path. This may be the correct choice for short term metrics, but the wrong choice for long term product success. Likewise, if an NPD system affords too little control over timing, risk, and cost, team members may venture too far in problem solving and create market introduction delays, manufacturing production inefficiencies, or product quality and warranty problems. These long-term inefficiencies may dominate over increases gained from the more creative solution.

An NPD system's ambidexterity is vital to performance and must be achieved through a continuous appreciation of the ideation vs. implementation tensions, rather than a temporal split due to a project's phase change or gate passage.

Innovative Performance, NPD System Ambidexterity, and Leadership Orientation

The ambidexterity theory of leadership for innovation (Rosing et al., 2011) prompted the second hypothesis of this research. The theory suggested that the interaction between leaders' opening and closing behaviors must occur in a way that matches the complexity of the innovation activities being managed. It maintained that both behaviors were required to promote team performance. The data from this research did support that leadership ambidexterity is important to team innovation performance. New insight is provided that illustrates leaders' behaviors moderates the ability of the NPD system ambidexterity to promote team innovation. The ability of the leaders to coach team members at certain points may be amplifying their ability to resolve the ideation and implementation tensions, although this study cannot define where in the process this may be happening. The direct effect of Leadership Orientation combined ambidexterity was significant but weak in combination with the NPD system ambidexterity, and in the presence of the moderation interaction, the direct effect of leadership orientation becomes insignificant. This could suggest that the leader ambidexterity is more effective at guiding team members' work through the organizational processes in place than it is at directly fostering the innovation success.

In addition, this research extends the results of Zacher and Rosing (2015) using a different measure of team performance and stronger design (team peer observers rather than team members) as raters of leadership ambidexterity. The measure of team performance used in this study encompasses a broad range of product, quality, and launch performance characteristics which gives a different perspective than the performance measure previously tied to leadership ambidexterity. It evaluated the newness or improvement of solutions across the ambidexterity dimensions of ideate and implement (Welbourne et al., 1998).

Innovative Performance, NPD System Ambidexterity, and Strategic Orientation

Bledow et al. (2009) proposed that the relative emphasis of processes and support for teams and individuals should depend on several contextual conditions, including the firm's strategy. This research did not find evidence that a preferred match between NPD system ambidexterity and the analyzer orientation had a positive effect on innovative performance when NPD system ambidexterity was accounted for. The observation that teams from analyzer firms exhibited a positive correlation between the NPD system ambidexterity (CD) bias and team innovative performance provides directionality that would support Miles and Snow's (1978) description of analyzers as adept at monitoring, fast following, and execution of improved or enhanced solutions. The regression lacks significance though since the non-analyzer group correlation is not significant or significantly different than the analyzer group. This directionality could imply that analyzers cannot afford to be dominant in their implementation focus at the expense of their ability to synthesize new solutions quickly while emulating competitive product offerings that they pursue. This lack of support may be due to the low sample size in the study.

NPD System Ambidexterity, IT Alignment, and Methodology

Information technology alignment theory can make use of this new approach in understanding NPD systems which are increasingly dominated by automated IT processes. Venkatraman et al. (1993) illustrate that one embodiment of the Strategic Alignment Model, the technology transformation alignment perspective, requires an evaluation of fit between a firm's strategy for a given operational process and the implementation of an IT based tool. An IT initiative that recognizes the link between NPD system ambidexterity and team performance would demand that IT tools and processes maintain or support this strategy. The new NPD system ambidexterity measure adds to the evaluation measures that are currently available for characterizing IT systems. By adding this new perspective to how IT system fit can be interpreted, the Venkatraman et al. (1993) call for expanding assessment across operational and strategic perspectives beyond typical cost and service considerations is satisfied.

An additional contribution of this research is methodological. I argued that an ambidexterity balance dimension calculation should not make use of absolute value in all instances. There is a theoretical case for asking whether some firms emphasize exploration over exploitation (or vice versa) and why. A sense of alignment around a zero point should not necessarily be a given in the consideration of NPD system ambidexterity. However, the moderation hypotheses that made most use of this recommendation were not supported. The reasons for this lack of support are unclear and will require the attention of future research.

Implications for Business Practice

Practitioners now have evidence that enterprise-level processes governing new product development can have ambidextrous ideation and implementation characteristics. Measuring these NPD systems diagnostically through the perceptions of the users provides a new way for managers and leaders to shape and improve them. Importantly, the establish link between combined ambidexterity and team innovation performance gives clear directional guidance on how to evaluate NPD system or team focused changes for success. Currently, practitioners may either evaluate their system maturity for breadth and depth of installation, but they cannot gain significant insight into the performance or perceived characteristics of their NPD system (Vezetti et al., 2013).

For instance, practitioners heeding the advice of Barari and Pop-Iliev (2009) and introduce agility through rapid closed-loop redesign capability provisions in response to a perceived dissatisfaction with fixed design stage processing have no reliable way to understand these effects. Waiting to see if the NPD system is more accurate or efficient at delivering programs or better at solving problems that result in competitive advantage could take a year. By using this research's new measure of system ambidexterity, the practitioner will only have to wait long enough for the users to gain a reasonably informed perception of the system change. Because this new measure of system ambidexterity has been linked to team innovative performance, the practitioner has incentive to measure the system before and after the changes to have a better appreciation for the total effects of the change.

As an illustration, introducing the capability to have fast, unstructured design loops may create an aspect of agility to reduce rigidity. The users of the system may perceive this freedom to solve problems as both a gain in product reliability improvement and an increase in their ability to address unexpected development concerns. At the same time, they may perceive a reduction in system accountability and execution quality parameters. They will likely perceive this new NPD system process path to increase their outside the box creative solutioning and a way to find alternative solutions for the customer more rapidly. But, they may also feel rapid, unstructured design loops do not allow enough development runway to take some larger calculated risks.

A practitioner implementing a change to a perceived problem with the NPD system will now have a way to quantify these complex effects. They will be able to evaluate the change's effect on the ideation and implementation dimensions of ambidexterity separately to provide richer insight in their comparison to intention and they will have an overall directional performance indicator by calculating the ambidexterity CD of their system before and after the changes. As importantly, they will be able to do this and evaluate the effect of the NPD system changes with reliability, and as quickly as the team members can perceive their changes.

Further, this evaluation measure could be employed on a routine basis over time to understand if a team's perceptions about their system are changing. A relationship between team tenure and the NPD system was noted by this research, and although it cannot inform on this relationship, the relationship suggests that an increase in average tenure can suppress the strength of the NPD system to team innovative performance relationship. This could be because more experienced team members rely less on the system for guidance than newer members. The NPD system ambidexterity measure can track temporal changes and inform a practitioner as to their magnitude and direction. Although causality cannot be inferred, changes can alert the practitioner to unanticipated or inadvertent system effects that may be affecting overall performance.

Lastly, since this measure can reliably represent a shared team perception under appropriate sampling conditions, a practitioner may use this measure within an organization to understand if different teams are perceiving the same NPD system with significant differences. A post hoc review of the six teams within the same company location showed that a team's perception of the NPD system balance bias (BD) could be identified as significantly different compared to the company location mean.

The NPD ambidexterity measure will not resolve completely where differential effects are coming from, but it may serve as a starting diagnostic to evaluate the suitability of an enterprise system to different user groups. For instance, if several groups have near identical product development functionality goals regarding their product, customer, and market, then the practitioner may look inward to the teams to understand the variability in their perceptions about the NPD system. However, when multiple teams that have different product focus, customer environment, and competitive pressure are illustrating differences, then this evaluation becomes useful as impetus to understand if certain features of the NPD system can or cannot accommodate diverse user groups. Subsequent system changes can be evaluated for their overall performance effect as well as their ability to reduce perceived performance variance.

An unexpected insight during this research indicates that there may be another use of the NPD system as a diagnostic measure. This measure displayed a sensitivity that may expose important differences in perception within the team unit. When bimodal distributions were noted within teams during aggregation analysis, I reached out to the company liaisons to inquire about the possibility that the teams were formed from multiple sub-units. Six teams illustrated a clear bimodal tendency in both the ideation and implementation dimensions of the measure. Of the four liaisons that returned calls, one had no suggestion for the variance, but three quickly rationalized that company mergers within the last year had likely created a team of two disparate groups. Based on this observation, I would say that using the NPD system ambidexterity measure to look for internal team variation can also be a diagnostic exercise useful for managers and leaders. Remedies, if necessary, may or may not be informed by the exact content of the measure response data, but the fact that knowing the variance exists may be useful.

Independent of the NPD system consideration, previous studies have illustrated the importance of leadership ambidexterity. This research creates more impetus for leaders to focus on that characteristic in their diagnostic and continuous improvement efforts. Leadership ambidexterity does have a positive effect on team innovation performance, however it may not be as straightforward as previously thought. It may be that the leaders' ambidexterity is more valuable as a coaching function supplementing the NPD system than it is as an independent motivator of innovation performance when it comes to team output.

Limitations

This research comes with limitations. First, from a sampling perspective, a larger number of teams may resolve weak relationships between leadership orientation, strategic orientation, and NPD system ambidexterity. Polynomial regression techniques were not employed. Additional team count and these regression techniques may reveal relationships not discovered in this research. Post hoc analysis on the alignment variables comparing leadership and strategic orientation ambidexterity to the NPD system ambidexterity indicated that influential cases were having a sizeable effect. This weakness, an issue of statistical power, is partially offset by the strength of the design. Having independent observations of NPD system ambidexterity and team performance avoid common method variance and increase confidence on the results.

The demographics of the industry distribution would benefit from additional team count. With seven teams in the hypothesis analyses coming from non-transportation, and 24 teams from the transportation sector, the generalizability of the results may be limited. This also means that the individual demographics shared roughly the same proportional bias. The survey measure of performance may vary due to industry specific influence on the team members regarding their needs and use profile of an NPD system.

Although a robust sampling strategy helped to reduce common-methods variance, measurement error is still a concern. Single respondents were allowed for the DV, team innovative performance, and for the leadership and strategic orientation ambidexterity measures. These data could benefit in accuracy by engaging multiple external observers for each team participating in the survey.

This study was cross-sectional in nature. There could be temporal effects on each team from several factors that contribute to variation in the team members' perceptions about the NPD system they are using at any given point in time. These could be current project load, recent organizational changes, and NPD system changes just to name a few. For instance, in the cases where a team member is working on several projects simultaneously, it is more than likely that the temporal phases of each project are not aligned. Longitudinal studies could also be combined with a separation between concurrent projects that occupy the given team member's time. This would appreciate project phase-based effects that program sequence may have on perceptions about the NPD system, but it would also remove the constructive and destructive interference that simultaneous project engagement causes. From an NPD system change point of view, a temporal study design would be necessary to appreciate the effect of system design changes. The fact that the NPD systems could have changed during the data collection period was not appreciated in this study design.

Recommendations for Future Research

Given the findings of this research, several avenues for future research can be recommended. Adding to the current research by increasing team count as well as industry and strategic typing variation is straightforward based on the limitations mentioned. An increase in team participation count could help answer if there a preferred NPD system alignment based on strategic typing. Directional indicators related to the results aimed at the isolated analyzer group support that this study extension is justified. This could also answer the question, "Do prospectors and defenders benefit from an implementation biased product development strategy due to the clarity of their scanning and front-end development selection processes?" A temporal experiment design could begin to answer the question of whether individual and team perceptions of the NPD system ambidexterity change over time in the absence of actual changes to the target. In addition, respondents could be queried for each project separately to ensure temporal project phase-based perception effects are appreciated. Team tenure effects were observed to be significant, and these have presented empirically to be complex (Koopman et al., 2016). The questions of how team tenure affects user's perceptions of the NPD system and how team tenure affects innovative performance using NPD systems are worthy of investigation.

Another methodological avenue should be investigated. To resolve the issues of congruence, more explanatory power should be gained through sample size to enable the use of polynomial regression techniques. An alternative or complement to this would be to operationalize the first and second order balances with direct survey measures to avoid the impact on error variance from the subtraction compositions.

Research into leadership ambidexterity to understand its moderating or mediating role in the NPD system to team innovative performance should help understand the continued observation that ideation of leaders is strongly correlated to performance. In addition, the question could be raised, "How does leader ambidexterity, specifically ideation strength, influence development team implementation strength and team perception of the NPD system implementation characteristics?"

The new NPD measurement scale opens avenues for many areas of research. Initial targets could be gaining understanding of what factors create a perceived ideation and implementation strength in an NPD system? In addition to breaking down antecedents of NPD system ambidexterity, researchers could also begin to clarify how these systems affect team performance by investigating how the ideation and implementation characteristics of an NPD system affect the team climate for innovation.

Conclusion

NPD systems have received recent criticism for their lack of flexibility and inability to meet the demands of innovation performance under dynamic market conditions. It has been speculated that their rigidity and focus on accuracy may be inhibiting their user's need to put forth the most creative and beneficial problem solutions. This research has shown that NPD systems indeed act as ambidextrous organizational structures. They contribute to overall team performance through strength of combined ambidexterity which is positively moderated by ambidextrous leadership behavior. User perceptions are a reliable assessment of an NPD system's ideation and implementation characteristics at both the individual level and as a shared team perception. The observation that the NPD system's ambidexterity strength leads to performance parallels previous findings in the areas of strategic and leadership ambidexterity. The new ability to measure ambidexterity of an NPD system provides an avenue for continued learning in the academic community and provides practitioners a diagnostic tool with which they can better understand and improve their NPD systems.

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APPENDIX A: IRB APPROVAL LETTER

Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263
TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: October 12, 2021

Protocol Investigator Name: Ted Mackiewicz

Protocol #: 21-08-1690

Project Title: Is your New Product Development System fit for Innovation performance?

School: Graziadio School of Business and Management

Dear Ted Mackiewicz:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

cc: Mrs. Katy Carr, Assistant Provost for Research

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APPENDIX B: OUTREACH LETTER

PEPPERDINE
Graziadio Business School

Thank you for your interest in innovation! My name is Tad Machrowicz and I'm researching product development and manufacturing process innovation as part of my doctoral dissertation. Data from companies like yours is crucial to the success of my research.

First, let me point out how easy this is for you to contribute confidentially to my research and gain insight about your company:

- You define one or more development teams within your company
- You give me the number of teams, and number of respondents for each team
- I give you a confidential survey link(s), one per team, that you distribute internally
- Team members spend 6-10 minutes taking the confidential online survey
- You receive data about your company/teams in 2022

I am looking for North American companies or subsidiaries with over 50 employees or over $50M in annual revenue to complete a short, 10-minute survey. The survey will be given to product and process development team members and their leaders. In exchange, I provide your organization insight about how your product development and innovation processes compare to industry trends in a data summary that will not be available in any publication.

The survey consists of general questions about systems, procedures, and the perceived performance of product and process development efforts. No one will be asked about any specific or proprietary project or performance information. Your company or its employees will not be referenced in any summarized data used in final reporting and research publication.

I will help you identify the types of people we need for the survey, walk through the procedures for maintaining confidentiality, and distribute the internet-based survey links through email. If you'd rather just get going, send this link to your liaison and ask them to start the process as your internal gatekeeper.
https://drive.google.com/file/d/1Q3tchtzSVeNOYtJ86KX2tX_dSy4e_XuP/view?usp=sharing

If you have any questions about the details of this study or its association with Pepperdine University, please feel free to call me, or contact my project advisor Dr. Chris Worley at chris.worley@pepperdine.edu or the leader of our EDBA program Academic Director, Dr. John Mooney at john.mooney@pepperdine.edu .

Sincerely,

Tad Machrowicz
EDBAc – Pepperdine University
tad.machrowicz@pepperdine.edu
248-854-5469

Pepperdine University | 6100 Center Drive | Los Angeles, CA 90045
310.568.5500 | bschool.pepperdine.edu

APPENDIX C: CONSENT FORM

Study Title: Is Your New Product Development System Fit for Innovative Performance?

Dear Potential Participant,

My name is Tad Machrowicz. I am a doctoral student at Pepperdine University's Graziadio Business School and I am conducting a study on the effects of business systems on innovation.

If you are at least 19 years old and have been at your current company for at least one year, you may participate in this research.

What is the reason for doing this research study? Enterprise-level information systems contribute to effective operations, management, and the development of new products and processes. This research is designed to understand how those systems can better help product and process development.

What will be done during this research study? If you agree to participate, it should take less than 10 minutes of your time to complete an on-line survey, but may take up to 30 minutes. You will be asked about the new product development processes at your company. You may complete the survey whenever and wherever you prefer.

What are the possible risks of being in this research study? The risk of participating in this study is minimal. You are being asked to think about business processes and will not be required to disclose proprietary information.

What are the possible benefits to you? There are likely no personal benefits to you for participating in this study beyond knowing that you may be contributing to an overall gain in our knowledge of innovation. The results of this study will be published in the form of a research paper or article.

How will information about you be protected? Your answers to the survey will not be shared with your company and only summaries of the data will be published. All responses are confidential and can be accessed only by the researchers. Any individual information will be removed from your responses prior to data analysis. Data will be maintained in encrypted form.

What are your rights as a research subject? You may ask any questions concerning this research and have those questions answered before agreeing to participate in or during the study.
For study related questions, please contact the investigator: Tad Machrowicz • Phone: 1(248)854-5469 • Email: tad.machrowicz@pepperdine.edu
For questions concerning your rights or complaints about the research contact the Institutional Review Board (IRB): • Phone: 1(310)568-2305 • Email: gpsirb@pepperdine.edu

What will happen if you decide not to be in this research study or decide to stop participating once you start? You can decide not to be in this research study or you can stop participating ("withdraw") at any time before, during, or after the research begins for any reason. Deciding not to be in this research study or deciding to withdraw will not affect your relationship with your company, the investigator, or with Pepperdine University. You will not lose any benefits to which you are entitled.

Documentation of Informed Consent: You are voluntarily making a decision whether or not to participate in this research study. By clicking on the I Agree button below, your consent to participate is implied. You should print a copy of this page for your records.

APPENDIX D: COMPANY TRACKING FORM

Research Survey Distribution Organizer

"Is Your New Product Development System Fit for Performance?"

introduction letter

Principal Investigator: Tad Machrowicz tad.machrowicz@pepperdine.edu 248-854-5469

consent information

DOWNLOAD/SAVE THIS FILE BEFORE EDITING - Email completed form to tad.machrowicz@pepperdine.edu

Your Company Contact Info *(Company name and primary contact info is required)*

Company Name		Division/Group	
Primary Contact Name		Secondary Contact Name	
Primary email		Secondary email	
Primary phone		Secondary phone	

How many People will receive the survey link? *Fill in the blue area, a separate row for each team (add rows if necessary)*

Team Name	Team Member Count	Peer Observer Count	Mgr/Leader Observer Count	Survey Link

APPENDIX E: LEADERSHIP AND STRATEGIC ORIENTATION SCALES

Leadership Orientation Measurement (Zacher & Rosing, 2015)

Answered on scale of 1 (not at all) to 5 (frequently, if not always)

Dimension	**Item #**	**Item Text**
Explore/Opening	ZR1	Our leadership allows different ways of accomplishing a task
Explore/Opening	ZR2	Our leadership encourages experimentation with different ideas
Explore/Opening	ZR3	Our leadership motivates us to take risks
Explore/Opening	ZR4	Our leadership gives possibilities for independent thinking and acting
Explore/Opening	ZR5	Our leadership gives room for our own ideas
Explore/Opening	ZR6	Our leadership allows errors
Explore/Opening	ZR7	Our leadership encourages learning from errors
Exploit/Closing	ZR8	Our leadership monitors and controls goal attainment
Exploit/Closing	ZR9	Our leadership establishes routines
Exploit/Closing	ZR10	Our leadership ensures we take corrective action
Exploit/Closing	ZR11	Our leadership controls adherence to rules
Exploit/Closing	ZR12	Our leadership pays attention to uniform task accomplishment
Exploit/Closing	ZR13	Our leadership sanctions errors
Exploit/Closing	ZR14	Our leadership sticks to plans

Firm Strategic Orientation Measurement (adjusted from Lubatkin, Simsek, Ling & Veiga, 2006)

Answered on scale of 1 (strongly disagree) to 5 (strongly agree)

Dimension	**Item #**	**Item Text**
Explore/Product & Tech	LS1	Our organization provides support for "outside the box", novel designs and solutions
Explore/Product & Tech	LS2	Our organization has success measures that reward exploring new technologies
Explore/Product & Tech	LS3	Our organization encourages the creation of products or mfg. process improvements that are innovative to our firm
Explore/Customer & Mkt	LS4	Our organization encourages finding new ways to satisfy our customer's needs
Explore/Customer & Mkt	LS5	Our organization encourages aggressive venturing into new markets
Explore/Customer & Mkt	LS6	Our organization encourages actively targeting new customer groups
Exploit/Product & Tech	LS7	Our organization commits to improve quality and lower cost
Exploit/Product & Tech	LS8	Our organization continuously improves the reliabilty of our products and mfg. processes
Exploit/Product & Tech	LS9	Our organization increases the level of automation in our operations
Exploit/Customer & Mkt	LS10	Our organization constantly surveys existing customers' satisfaction
Exploit/Customer & Mkt	LS11	Our organization encourages fine-tuning current offerings and processes to keep our current customers satisfied
Exploit/Customer & Mkt	LS12	Our organization encourages us to penetrate more deeply into our current customer base

APPENDIX F: STRATEGIC ORIENTATION TYPING PARAGRAPHS

Prospectors	These businesses are frequently the first-to-market with new product or service concepts. They do not hesitate to enter new market segments where there appears to be an opportunity. These businesses concentrate on offering products that push performance boundaries. Their proposition is an offer of the most innovative product, whether based on dramatic performance improvement or cost reduction.
Analyzers	These businesses are seldom ‘first-in’ with new products or services or to enter emerging market segments. However, by carefully monitoring competitors’ actions and customers’ responses to them, they can be ‘early-followers’ with a better targeting strategy, increased customer benefits, or lower total costs.
Defenders*	These businesses attempt to maintain a relatively stable domain by aggressively protecting their product–market position. They rarely are at the forefront of product or service development. They generally focus on increasing share in existing markets.
Low-Cost Defenders**	These businesses attempt to maintain a relatively stable domain by aggressively protecting their product–market position. They rarely are at the forefront of product or service development; instead, they focus on producing goods or services as efficiently as possible. These businesses generally focus on increasing share in existing markets by providing products at the best prices.
Differentiated Defenders**	These businesses attempt to maintain a relatively stable domain by aggressively protecting their product–market position. They rarely are at the forefront of product or service development; instead, they focus on providing superior levels of service and/or product quality. Their prices are typically higher than the industry average.
Reactors	These businesses do not appear to have a consistent product–market orientation. They primarily act to respond to competitive or other market pressures in the short term.

Note. Slater and Olson (2000). *This answer choice requires follow up selection of either ** item

APPENDIX G: PERFORMANCE DEPENDENT VARIABLE

Team Performance
(Modified from Atuahene-Gima & Ko, 2001)
Answered on scale of 1 (rarely) to 5 (almost always)

Dimension	Item #	Item Text
Performance	PP1	The development team delivers products (and/or manufacturing processes) that meet sales objectives
Performance	PP2	The development team delivers products (and/or manufacturing processes) that meet growth objectives
Performance	PP3	The development team delivers products (and/or manufacturing processes) that meet customer use objectives
Performance	PP4	The development team delivers products (and/or manufacturing processes) that meet market objectives since product launch
Performance	PP5	The development team delivers products (and/or manufacturing processes) that meet profit objectives
Quality	PQ1	The development team delivers products (and/or manufacturing processes) that provide unique benefits superior to competitors
Quality	PQ2	Customers perceive the team's product (and/or manufacturing processes) as giving superior performance outcomes relative to the competition
Quality	PQ3	The development team delivers products (and/or manufacturing processes) that provide higher quality than the competitors' product.
Launch	PL1	The development team executes a formal post-launch evaluation procedure
Launch	PL2	The development team launches products (and/or manufacturing processes) to meet customer timeline requirements
Launch	PL3	The development team effectively tests the product (and/or manufacturing processes) with customer involvement before launch

APPENDIX H: ADDITIONAL SCALES

Enivronment Technology Dynamism (Jaworski & Kohli, 1993)

Answered on scale of 1 (strongly disagree) to 5 (strongly agree)

Dimension	Item #	Item Text
Env. Tech Turbulence	ETD1	The technology in our industry is changing rapidly.
Env. Tech Turbulence	ETD2	Technological change provides big opportunities in our industry.
Env. Tech Turbulence	ETD3	A large number of new product ideas have been made possible through technological breakthroughs in our industry.
Env. Tech Turbulence	ETD4	Technological developments in our industry are rather minor

Innovation Process Ambidexterity (Kwak, Lee & Lee, 2020)

Answered on scale of 1 (strongly disagree) to 7 (strongly agree)

Dimension	Item #	Item Text
Process Agility	PA1	Our team is able to sense user requirements changes effectively.
Process Agility	PA2	Our team is able to strategize its response to user requirements changes effectively.
Process Agility	PA3	Our team makes effective decisions to cope with business changes.
Process Standardization	PS1	Our team consistently use common task processes across the team.
Process Standardization	PS2	Our team consistently use common planning methods/techniques across the team.
Process Standardization	PS3	Our team consistently use common communication methods/technologies across the team.
Process Standardization	PS4	Our team consistently use common performance review methods/processes across the team.

APPENDIX I: NON-COMPOSITE TEAM LEVEL MEASURES

Team Aggregated Scale Descriptives & Correlations

Scale	Mean	*SD*	tPERF	ENVT	tNPDid	tNPDim	tLOid	tLOim	tSOid	tSOim
tPERF	3.81	0.36	--							
ENVT	3.12	0.78	-0.011	--						
tNPDid	3.11	0.46	.380*	0.164	--					
tNPDim	3.42	0.47	0.289	0.241	.618**	--				
tLOid	3.56	0.45	.536**	0.119	0.353	.489**	--			
tLOim	3.33	0.57	0.074	0.097	0.088	0.300	0.347	--		
tSOid	3.12	0.70	-0.115	-0.144	0.088	0.131	0.099	0.083	--	
tSOim	3.41	0.55	-0.141	-0.130	0.092	0.166	-0.008	-0.090	.656**	--

n=31; *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

APPENDIX J: HYPOTHESIS H2B RESULTS AND DISCUSSION

Hypothesis 2b proposed that aligned Leadership Orientation and NPD system Ambidexterity (tLOALI, and Int_tNPDCD x tLOALI) would moderate the effect of NPD System CD on Team Innovative Performance. The unused table below illustrates the results from the hierarchical moderated regressions.

Unused Table

NPD System/Leadership Alignment Moderation of Team Innovative Performance[1]

DV Team Performance (tPERF)	Model 0	Model 1	Model 2b.1	Model 2b.2
Team Size (tSZ)	0.140	0.049	0.092	0.110
ln Company Employees (lnORGSZ)	-0.240	-0.127	-0.081	-0.063
Env. Technolgy Turbulence (ENVT)	0.010	-0.073	-0.074	-0.074
Team Tenure (tTEN)	0.313†	0.465*	0.402*	0.418*
NPD Sys. Ambidexterity CD (tNPDCD)		0.490*	0.440*	0.447*
NPD Sys. To Leadership Alignment (tLOALI)			0.220	0.218
Interaction Effect (Int_tNPDCDxtLOALI)				0.096
ΔR^2	0.190	0.190*	0.040	0.008
Total R^2	0.190	0.379	0.419	0.427
ΔF	1.521	1.533	-0.170	-0.433
Total F	1.521	3.054*	2.884*	2.451*

**p* < .05, †*p* < .1 ; *df* = 26 Model 0, 25 Model 1, 24 Model 2b.1, 23 Model 2b.2

[1] No concerns were noted concerning autocorrelation, multicollinearity, or in the analysis of the residuals.

In Model 2b.1 and 2b.2, neither the addition of the NPD System to Leadership Alignment predictor (tLOALI) nor the interaction term were significant in their effect on Team Innovative Performance (ΔR^2 = .040, df =1,24, p = .212) and (ΔR^2 = .008, df =1,23, p = .570), respectively.

Hypothesis 2b, that the NPD system ambidexterity and team innovativeness relationship will be positively moderated by leadership's opening and closing behaviors when the NPD system and leadership match in their relative orientation towards ideation or implementation, is not supported. Though the alignment between the ambidexterity of the NPD system and leadership orientation showed significant positive correlation to team innovative performance, there was no support for it as a significant covariate or moderator of the relationship between NPD system ambidexterity and team innovation performance.

This research did not support the hypothesized alignment between NPD system ambidexterity and leader orientation ambidexterity and team innovative performance. The lack of support for the alignment as hypothesized could be interpreted in two ways. First that alignment as defined in this research is unimportant. Rosing et al. (2011) recognized that the development process is fluid and requires continuous switching. This leaves open the consideration that this research's definition of alignment may need to be measured from a temporal viewpoint. The right alignment may not necessarily be a bulk measurement of leader opening and closing magnitudes, but it may be best defined by measuring if the leader is prompting implementation when that will best complement the NPD system process and team members' tasks, and if they are prompting exploration when that best complements their tasks. The magnitude of which counter forces or complementary forces are most helpful and when they are most helpful may be difficult to measure with a static measure like the NPD system ambidexterity.

The second interpretation is that the alignment variable used in this research lacked explanatory power due to its construction. Previous research has used the balance dimension subtraction, but this study subtracted two of these subtractions which compounds error variance. Efforts were made to use highly reliable measures to reduces these errors but this may not have been sufficient.