KNOWLEDGE CREATION IN NEW PRODUCT DEVELOPMENT TEAMS: A CONTINGENCY THEORY OF THE EFFECTIVENESS OF KNOWLEDGE INTEGRATION MECHANISMS

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ABSTRACT

For firms to be competitively viable, they must have successful—and often continual—product offerings available in the marketplace. Perpetuity of innovation in the form of new product development requires a capability of fostering creation. Creation in the form of new product development is first about information, learning, and knowledge management, and ultimately about the creation of new knowledge, as is embedded in the new products. The knowledge-based view (KBV) of the firm indicates that new knowledge is created within/for the enterprise via the (re)combination of pre-existing individuals' knowledge. Individuals' knowledge is recombined and integrated via 'knowledge integration mechanisms' (KIMs) that allow incorporation of multiple sets of knowledge.

This work is fundamentally about knowledge creation. As is precedented in the knowledge and KBV literature, this research uses new product development as a proxy for new knowledge development wherein the resultant products are considered the embodiments of newly created knowledge. This research extends existing work within the KBV by considering empirically, specifically, and exhaustively the mechanisms that allow for knowledge integration and thereby creation, as well as the characteristics of knowledge most pertinent to each of the knowledge integration mechanisms identified. Forming the basis for this work, as well as the primary research questions, are the areas that the literature has yet to explore: 1) What are all the possible KIMs? 2) What characteristics of knowledge work best with each KIM toward New Product outcomes (new product novelty, development speed, and performance)? and finally 3) How can the variables pertinent to knowledge creation in new product development teams be assembled in a theoretical model for empirical testing?

Three knowledge integration mechanisms are conceptually identified from prior literature sources (Explicit Direction, Organizational Routines and Adhocracy). KIMs are antecedents in the theoretical model developed and proposed, wherein specific characteristics of knowledge (uniqueness, tacitness, dynamism) thought to work best with their own respective KIM are considered for their interaction and moderating effects. New product development speed, new product novelty, and new product performance (in-market) are also considered, as consequences in the model.

Marketing Project Managers in Canadian manufacturing firms were surveyed, for a response rate of 29% and 157 complete responses. The measures, items, and scales used in the survey instrument all had precedence in the literature and were borrowed from previous research that had preconfirmed their validity and reliability. The number of hypotheses proposed in this work (26, as part of the model developed), as well as the number of responses possible (157 completed), supported the use of multiple regression analysis over other quantitative methods. The results generally support the model and hypotheses proposed (18 out of 26 hypotheses supported empirically) wherein KIMs do contribute to new product novelty, development speed, and product performance. As well, each of the characteristics of knowledge considered do have variable, moderating effects on the main relationships considered in the model. Generally, there was support for all three main premises proposed regarding KIMs and characteristics of knowledge: 1) that the KIM of explicit direction and knowledge uniqueness would work optimally together, 2) that the KIM of organizational routines and knowledge tacitness would work optimally together, and 3) that the KIM of adhocracy and knowledge dynamism would work optimally together. The theoretical and managerial implications of this work are ultimately considered, as are future research directions.

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PROLOGUE

Biographical Note My interest in studying the theory of knowledge creation, new product development, and cross-functional new product development teams arose in part from having worked in the practical realm of marketing and brand management within multinational consumer packaged goods companies in Canada for nine years. In this work, I survey marketing managers who are the primary drivers of, and project managers for, new product development (NPD) projects in cross-functional teams. Prior to my academic inquiry and involvement in such work, I spent years as one of the marketing project managers who were interviewed for this study. While they were successfully tested quantitatively and empirically, my in-field experience has been valuable in informing the model, constructs, and hypotheses investigated in this research. It was from personal experience in cross-functional NPD teams that I came to understand that they create more than new products: the collective of individuals, their knowledge sets, and their respective expertise has non-additive effects that foster novel ideas (that likely no single individual or other combination of individuals would have come up with), new information, and ultimately new knowledge. Concordantly, this practical experience is mirrored in the literature, because this learning is what Grant's (1996) theory of the Knowledge-Based View (KBV) of the firm stated. New product development is a great context for studying knowledge creation, as it happens fairly consistently over time as well as between and within manufacturing companies, among others, and almost always involves cross-functional teams whose members interact, integrate and recombine their respective knowledge and knowledge sets toward creating new knowledge as well as new products.

Disparity Between NPD Practice and Theory Once immersed in the theory and literature later on in life, I noticed that researchers had much better language, rhetoric and metrics around what was occurring in NPD teams, and in knowledge creation processes, than did the practitioners who were at work every day attempting (usually successfully) to accomplish such things. While the literature and theory were impressive for being able to systematically consider constructs, phenomena, and relationships associated with NPD, NPD teams, knowledge management, etc, it seemed to me that some of the particularities, specifics and processes inherent to the actual experiences were missing from the literature. On the one hand, theory had lots to say about how knowledge was accrued, transferred, stored, and converted, as well as how all this resulted in favourable in-market returns for firms, but very little to say about how knowledge was actually integrated. The KBV offered that knowledge is integrated by virtue of organizational integration mechanisms, which, speaking from practical experience, resonates as true. But what are these knowledge integration mechanisms, exactly and specifically? How many separate ones are there out there for use? What are the various possible knowledge integration mechanisms? The literature was relatively sparse on answers to these questions, and even from my perspective as a former practitioner, I couldn't verbalize much of this, though I could remember having experienced most of it. Research that not only fills some of the theoretical gaps in the literature, but that might also be able to inform practitioners in such fields, seemed worthwhile to pursue.

A Gap: What's Missing in Practice and Theory Missing from the literature—and also from the practical realm—was a comprehensive, exhaustive account of the mechanisms underlying how knowledge is integrated, as well as what types of knowledge were optimal for each of these integration mechanisms. When I was a marketing project manager on an NPD team, I didn't have the information or language for what the knowledge was that we were all using or what mechanisms were at work—I couldn't describe them fully, I didn't know exactly how they varied from one another, and they weren't organized (in my brain, manuals, textbooks or anywhere else) in any systematic way such that I could choose them, as if from an arsenal, like a toolkit. I did notice, however, that *sometimes* there was a combination of factors—such as the individuals, expertise available, and integration mechanisms at work—that worked very well toward producing neat new product creations efficiently, that ultimately commanded great market share and returns while also forming a rich basis for organizational learning (new knowledge) for everyone involved. And sometimes none of this was true.

In the literature as well, it was evident that yet to be established was an exhaustive account of what Grant (1996) called 'knowledge integration mechanisms' (KIMs) for any of these to be tested empirically, or a discussion or determination of the characteristics of knowledge that would work best with specific KIMs for optimum results in-market. Thus my motivation for this study is twofold: as a manager I would have wanted a more comprehensive description of all this so I could be more effective in practice (integrate my knowledge with others on the NPD team more effectively for greater learning and more successful new product launches) and as an academician it was of interest to discern a full theoretical description and an exhaustive account of KIMs from the existing literature—as well as the characteristics of knowledge pertinent to each of these—that would contribute to a model of knowledge creation and successful new product innovations in organizations. As is precedented in the literature (e.g. Madhavan & Grover, 1998) and as my personal experience would support, new product development was the proxy for the process of knowledge creation used in this research.

In my opinion, the results of this research are significant and positive: there is support for the model, hypotheses and theory proposed, which fill some of the gaps outlined in the current literature. It is my hope that this work will prove practically and pragmatically relevant, will spur my own and others' future research, and will be useful to both academic theorists and practitioners alike.

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CHAPTER 1: INTRODUCTION

In product-producing firms, innovation in the form of new products and new product development on an ongoing basis represents a core competency, required for sustaining a competitive advantage in the marketplace (Barney, 1991, 2001; Penrose, 1959). The market importance of new product development and innovation cannot be overstated. As an example, even in the economic downturn of late 2008 and 2009, the top 1000 global public companies *increased* innovation spending by 5.7%, an increase delta valued at almost 550 billion USD (Booz & Co, 2009). Evidently, the competitive pressure to stay current through continual new product development and innovation, as well as novelty in market offerings, is high and on the upswing in the global marketplace today.

1.1 New Product Development and Knowledge Integration

New products and new product development require the novel recombination and embodiment (physical manifestation) of previously uncombined embedded knowledge (known and stored by individual human resources) in the firm (Madhavan & Grover, 1998) and are thereby conceived to be the manifestation--and process of creation--of new knowledge. Of central interest in this research are all the possible mechanisms of knowledge combination—knowledge integration mechanisms—and the key characteristics of that knowledge, resulting in new knowledge creation that is of value to the firm in-market.

Grant (1996) conceives that the central function of a firm is to serve as an 'institution for integrating knowledge' (pp.109). As such, there must be internal processes or mechanisms that would be the catalysts by which knowledge is manifested, combined, and integrated within the organization. In his second paper in 1996, Grant describes two possible mechanisms associated with the integration of tacit knowledge specifically—

that of 'Direction' (Demsetz, 1991) and 'Organizational Routines' (March & Simon, 1958). In the present research, it is of interest to determine what—if any—other KIMs might exist, as well as to test these empirically.

Tacit knowledge has been the source of much knowledge-based research given the difficulty in explicitly identifying, communicating, and integrating it. Grant identifies that commonly the 'primary role of the organization is knowledge application rather than knowledge creation' (pp.109), which is essentially saying that, regarding knowledge, the primary role of the organization has typically been in favour of 'exploitation' of current resources (individuals' knowledge) rather than 'exploration' for new resources (new knowledge; see Atuahene-Gima, 2005; Leonard-Barton, 1992; Liu, 2006; Penrose, 1959). This research accepts that the primary purpose of an organization might be toward knowledge application, though knowledge creation is of primary interest herein, given not only how important it is in today's global economy, but also given its increasing importance for successful firm performance. This inquiry is built from theory (KBV) that states that knowledge is created via recombination and integration of individuals' knowledge within the organization via knowledge integration mechanisms (DeLuca & Atuahene-Gima, 2007; Grant, 1996).

While knowledge integration mechanisms (KIMs) in cross-functional teams have been discussed conceptually in earlier literature (e.g. Grant, 1996b; Luca & Atuahene-Gima, 2007), there have yet to be any formal empirical tests of these in the research. Further, no exhaustive account currently exists of what all the established KIMs are, or could be. Also, while the characteristics of knowledge (e.g. tacit, dynamic, explicit, unique, specific, complex, systemic) have been discussed in multiple, even disparate, streams of literature, there has yet to be any theoretical or empirical evaluation of these

regarding their interplay with KIMs—which ones work best with each type of KIM. It has yet to be established how the productivity (effectiveness or novelty, efficiency or speed) of these KIMs varies empirically as a result of characteristics of the knowledge being integrated. While some of the literature has ventured to consider either knowledge characteristics or KIMs empirically, there remains limited understanding regarding how the combinative, separate and interplaying effects of these result in the creation of new products, and further, the creation of successful new products. New product performance is considered herein as a combination of previously established measures: 1) new product (NP) novelty—a measure of novelty or innovativeness—and 2) new product development (NPD) speed—a measure of team efficiency and ability to bring ideas to fruition in the marketplace in a timely manner—all of which can result in desirable outcomes for the firm in-market (New Product Performance).

1.2 Research Purpose Still to be determined in this stream of literature then are the questions that guide this research. 1) What are all the KIMs that have been identified previously in the literature? (Is this an exhaustive account of all the possible knowledge integration mechanisms?) 2) Are the identified and developed KIMs equally effective in generating NP novelty across all pertinent knowledge characteristics? 3) Are the identified KIMs equally efficient in generating NPD speed across all pertinent knowledge characteristics? 4) How does knowledge integration result in the creation of successful new products (how does it affect NP performance) as the embodiments of new knowledge, which will create value for the firm?

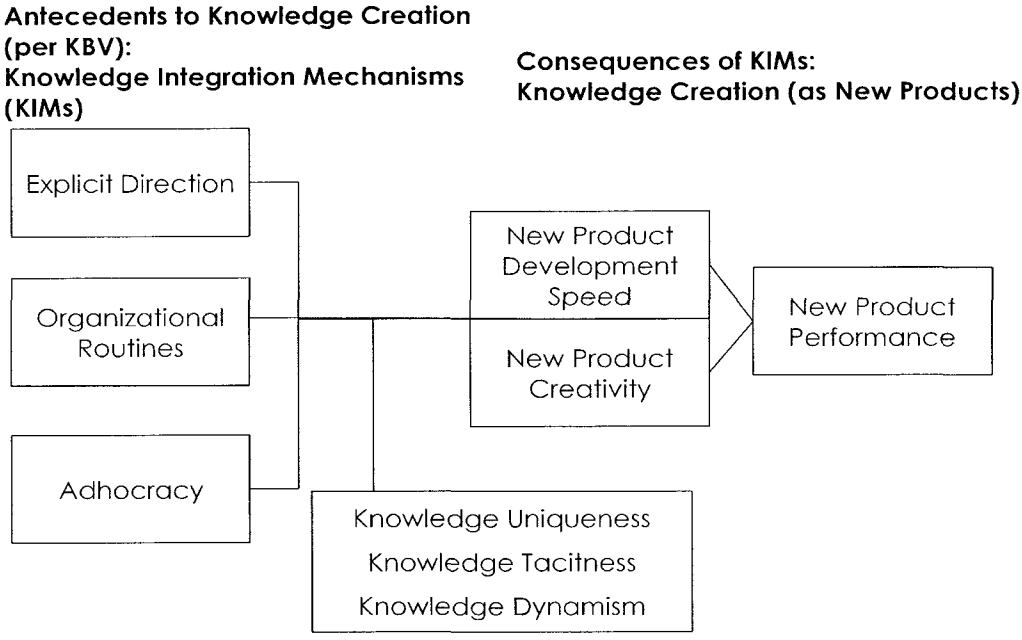
Based on these research imperatives, this research seeks to determine a few things. First, two KIMs are identified from existing literature then further developed and defined—'explicit direction,' and 'organizational/behavioural routines' (based on

Demsetz, 1991; Easterby-Smith & Lyles, 2007; Grant, 1996a, 1996b; March & Simon, 1958). Next, a third KIM was developed conceptually through literature review that included properties neither of the other two mechanisms did, allowing that the account of KIMs included in this study is conceptualized to be mutually exclusive and collectively exhaustive. This third KIM was labelled 'adhocracy' and is based on the work of Moorman (1995). Together, these three KIMs are proposed in this research as the primary drivers of new product novelty, development speed, and thereby new product performance.

1.3 Review of Intended Contributions These KIMs were examined for their main effects on two new product development outcomes (NP novelty and NPD speed) and in-market measures (ROI, market share, sales, profit margin). NP novelty and NPD speed are both considered to contribute to NP performance that is of value for the firm, and the interplay between them is of interest. Finally, a) characteristics of knowledge most pertinent to each KIM in the NPD and knowledge creation process are identified (tacitness, uniqueness, dynamism) and b) these knowledge characteristics are tested as moderators of the main effects (KIMs—NPD Speed; KIMS—NP Novelty). This paper is among the first to combine Grant's proposed KIMs (organizational routines, explicit direction) with another structural antecedent (Moorman's 'Adhocracy,' 1995) to new product novelty, development speed, and performance. The third KIM of adhocracy combines more organic aspects of coordination and ultimate knowledge integration that has received little attention in the literature to date. This work is also the first to consider KIMs empirically, as well as the interactions between KIMs and the pertinent characteristics of knowledge, as drivers of new product performance.

The remainder of this paper is organized as follows. The conceptual and theoretical backgrounds that are the predominant contributors to the framework and model under development are explored. The main constructs identified and further developed are then discussed and defined. The model itself is presented, followed by the methodological section and measures proposed for testing it. The results of this study are presented. Most hypotheses were supported, with those unsupported discussed also in the discussion section. A final concluding section summarizes the key points of this literature, research and the findings, and considers theoretical and managerial implications, as well as fruitful areas for further, future research.

FIGURE 1
Variables Considered in Model of Knowledge Creation in New Product Development



CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Knowledge-Based View of the Firm

Grant (1996) proposed a novel view of the firm, that of the knowledge-based view (KBV), by incorporating multiple streams of existing theory that considered informational capital and organizational knowledge implicitly. Grant proposed primarily that organizations came to be and served the purpose of allowing specialist individuals to integrate knowledge among themselves and apply that knowledge toward value creation for the firm. Herein, this premise is extended by considering the organization or firm as an institution in which individuals (both specialists and non-specialists) can transfer and integrate knowledge toward new knowledge creation, which in turn creates value in the form of new product offerings brought to the marketplace. Of central importance here are the intra-firm knowledge integration mechanisms (KIMs), as well as the characteristics of that knowledge that contribute to new knowledge creation.

In an important related work, Madhavan and Grover (1998) considered the relevance of cognitive intra-firm, new product development (NPD) team processes. They advanced that new product development, and thereby new products, represented a reasonable proxy for new knowledge creation within the firm by virtue of being the embodiment of that knowledge and the knowledge-creation (exchange and combination, per KBV) process.

Remaining consistent with this literature, it is also important to consider the informational, knowledge-based and cognitive characteristics of individuals engaged in new product development (knowledge creation). In order to maintain a competitive advantage in the marketplace, ensure market growth and sustain returns year over year in product-producing firms, innovation in the form of continual new product development

is critical. Because innovation in the form of NPD is established as new knowledge creation, ongoing knowledge creation within the firm is of central importance. Grant (1996a, b) also established that knowledge creation within the firm was accomplished through the transfer and integration of individuals' knowledge.

2.2 New Product Development Literature

Considerable work exists in the area of new product development. Brown and Eisenhardt (1995) identified and described three research traditions associated with new product development. The first was the 'rational plan,' in which products were produced according to an organizational (rational) plan that stressed superiority of products relative to competitive offerings. The second, performance, would logically yield market share and customer demand, resulting in favourable in-market performance, growth and value for the firm.

Implicit in this stream is a market orientation that is competitor-centric (a competitive orientation; Kohli & Jaworski, 1990), as it assumes a stable, receptive market and conceptualizes the largest threat to be competitive factors. Also implicit in this first stream is a bent toward market exploitation for business growth (as opposed to market exploration; Kyriakopoulous & Moorman, 2004), in which customers are fairly consistent and reliable, and new markets/customers are not sought as actively. Herein, performance is measured according to financial success measures such as market share, sales, and profits. 'Rational plan' would be characterized in the literature by the 'Stage-Gate'™ model of product development (see Sethi & Iqbal, 2008).

The second stream of research was labelled a 'communication web,' as it does not stress product quality or performance, particularly, but instead has a sales-based focus that would/does include pressure to communicate externally (sales) and internally

regarding the merits—or requirements—of product development and/or those products already developed. The central focus of this stream is not continual new product development or the quality thereof, but growth via favourable communication regarding firm offerings. Implicit in this stream of research is a bent toward market exploration (a market orientation; Kohli & Jaworski, 1990) in which the focal firm would not necessarily seek growth through existing customers via continual, superior product quality, but would focus energy on garnering new customers and markets through externally focused, market-oriented, sales-centred tactics. Performance is gauged by perceptual markers such as customer approval and satisfaction, and attraction of new customers/markets.

The third and final research tradition identified by Brown and Eisenhardt (1996) was that of 'disciplined problem solving,' in which the customer set was assumed to be reasonably stable (different from 'communication web'), and continual new product development toward product advantage in-market was not critical to meeting growth objectives (different from 'rational plan'), but in which product integrity was the central focus. This stream of literature implies a market orientation that is customer-centric (a customer orientation) as well as a reliance on customer growth for focal firm growth. Here, performance is measured by operational markers that involve delivering to or above customer expectations, such as speed to service, new product development or market and overall customer-centred productivity. There would likely be an interaction between the category or industry of firms under investigation and each of these three respective streams of research: the 'rational plan' strategy described is more likely to be witnessed in consumer packaged goods (CPG) manufacturing companies, whereas the 'disciplined problem-solving' strategy described is more likely in info-tech categories.

Within all the key streams of NPD literature, two key variables are predominantly and consistently discussed with respect to NP performance measures, regardless of strategies for growth (e.g. product advantage, product integrity) or variable orientations (e.g. competitor, customer or sales/market). They are 1) level of innovativeness (herein called 'novelty') and 2) speed of development and delivery to market (herein simply referred to as 'speed').

2.2.1 New Product Novelty Olsen, Walker, and Ruekert (1995) discussed the role of 'product innovativeness' on new product development, which they define similarly to what Im and Workman (2004) ultimately called 'new product novelty.' Olsen et al.'s work lends credibility and precedence to the present study of what is herein called new product novelty, as well as the fact that new product novelty would be a constituent component of the new product development process. Im and Workman (2004) discussed the importance of new product and marketing program novelty for new product success in-market. Creativity in this case is a measure of novelty, uniqueness, or newness that the products developed represent vis-à-vis competitive output and target customer requirements, in keeping with Amabile's (1983) 'output perspective' of creativity (as opposed to input). Here novelty of new products will actually be tested according to the input perspective, in which the individuals involved will be asked to relay how novel they perceive the products developed to be relative to previously developed products intra-firm. Please refer to Table 1 for a definition of this construct (and all constructs used in this work), as well as the key references.

The output perspective of novelty, or external stakeholder (customer, consumer, competitor) reaction, will be indirectly tapped into by considering the performance of new products in-market (e.g. market share measures [consumer uptake, competitive share

steal], sales figures [customer orders]). It is thought that level of novelty will have a quadratic (inverted U) relationship to new product performance, though this isn't hypothesized formally. Incremental innovation will not likely represent satisfactory product novelty for stakeholders (customers, consumers), and can contribute to inter-SKU cannibalism depleting the ultimate value to the focal firm (Chandy & Tellis, 1998). Radical innovation, on the other hand, has the inherent risk of alienating stakeholders (cross-functional colleagues, customers, consumers) who might perceive the products created as bizarre, inconsistent or unmeaningful (Im & Workman, 2004), resulting in unfavourable market returns (below target sales, profit, market share). Accordingly, it is thought that the value to the focal firm of new product success and performance will have optimal probability at a moderate-high level of novelty that represents meaningful, reasonably consistent (or expected) novelty that is embraced by cross-functional, intra-firm colleagues who have developed aptitudes and understandings for how to expedite the products created, as well as by external stakeholders who ultimately appreciate and understand the new product development (customers, consumers; Ittner & Larcker, 1997).

2.2.2 New Product Development Speed While much of the new product development literature considers the variable of speed by proxy of speed-to-market measures (e.g. Ayers, Dahlstrom, & Skinner, 1997; Henard & Szymanski, 2001; Ittner & Larcker, 1998, Moorman, 1995, etc), here, in keeping with the input perspective, the intra-firm NP development speed will be of primary interest and consideration. Individuals involved in the cross-functional new product development process will be asked to relay how efficiently the team operated in transferring, integrating and deploying embedded knowledge (that of each of the team members) into embodiment(s)

of the new knowledge created (new products) vis-à-vis prior product development episodes.

The variable role of different types of knowledge in new product development speed has a long history in the literature (e.g. Nelson, 1982), which lends further credibility to the inquiry of this research. It is thought, however (though not formally hypothesized), that speed of new product development will also have a quadratic (inverted U) relationship to new product performance. The value to the focal firm in the form of new product success and performance will likely have optimal probability at a moderate level of developmental speed and will likely interact with new product novelty. First, a rate of new product development that is too slow could tax the NPD team, its patience and resources. It will have deleterious effects on customer relationship management (creation of impatience, decreased interest and orders, a perception that the supplier is non-customer-centred, archaic, lazy, or struggling) and it will erode brand equity with consumers (no longer top-of-mind for category, perception that the manufacturer or brand is in later stages of its life cycle). All these factors will decrease the new product performance in-market.

On the other hand, new product development speed that is too rapid may also have deleterious effects, such as cannibalism of existing products in the marketplace (Chandy & Tellis, 1998). Intra-organizationally the weight and stress on supply and logistics structures and personnel for new product development that is too rapid will likely decrease productivity (efficiency, effectiveness) within the firm, resulting in negative effects for new product performance. Inter-organizationally, vertical customers who are too consistently marketed novel products will also experience logistical and supply-chain difficulties, and will come to resent the manufacturer pressure to carry too many

products (cost- and space-prohibitive), either successively or simultaneously. Ittner and Larcker (1997) discuss the characteristics of product development cycle time and notice that too rapid or too sluggish rates of innovation are deleterious for 'organizational performance.'

For consumer stakeholders, brand equity will likely erode when new product introductions are too successive or rapid, creating the impression that the products are 'fads.' Also, this will likely only attract early-adopting segments of the consumer market and market share (small slice of consumer segments). Cross-functional NPD teams with pressure to create innovative products at too rapid a pace will likely experience decreases in productivity and efficiency because of less favourable interactions likely caused in part by increased pressure. It is by virtue of this nature of the cross-functional team that high rates of new product development would interact with level of novelty of the products under development: the likelihood that products created rapidly also represent optimal levels of novelty, reliability and quality is thought to be decreased, resulting in less favourable new product performance measures in-market.

TABLE 1
Measures and Definitions

Measure	Key References	Defining Characteristics
Explicit Direction (Reliability = 0.84)	Demsetz, 1991; Grant, 1996; Olsen, Slater, &, Hult, 2005; Sethi & Iqbal, 2008	Knowledge is integrated in a formal, standardized, centralized, directed process that one (or few) individual(s) oversees and/or commands via explicit direction and communication
Organizational Routines (Reliability = 0.79)	Grant, 1996; Lawson, Petersen, Cousins, & Handfield, 2009; Olsen, Slater, &, Hult, 2005; Polanyi, 1966; Riege & O'Keefe, 2007	Knowledge is integrated in a coordinated, routinized, institutionalized fashion that does not require much role clarification or communication between members given their pre-existing understanding of the institutional roles, responsibilities and protocol; members can work in succession or simultaneously but inherently and intuitively know how to act and interact according to organizational norms
Adhocracy (Reliability = 0.92)	Moorman, 1995; Moorman & Miner, 1998	Knowledge is integrated in an uninstitutionalized, ad hoc manner in which individuals can interact intermittently, with autonomy, according to the requirement of their current tasks or projects; roles are fluid and unassigned, responsibility is dispersed; individuals are prepared to take risks and act independently/ entrepreneurially with a central concern for end results (product) over process
Knowledge Uniqueness (Reliability = 0.77)	Bou-Llusar & Segarra-Cipres, 2006; Park, Lim, & Birnbaum-More, 2009; Simonin, 1999; Zander & Kogut, 1995	Knowledge that is not common or shared by many or multiples on a team; an individual's knowledge that does not overlap with the knowledge of others on the team; individuals possessing such knowledge typically have divergent perspectives, insights, understandings, conclusions that vary from those of their counterparts
Knowledge Tacitness (Reliability = 0.83)	DeLuca & Atuahene-Gima, 2007; Grant, 1996; Heiman & Nickerson, 2002; Kogut & Zander, 1996; Ranft & Lord, 2000; Simonin, 1999a, 1999b; Subramaniam & Venkatraman, 2001	Knowledge that is classified as 'know-how'; is not easily transferred, codified, explained, communicated, or understood by those who do not possess it; requires direct experience with it in order to accrue as well as identify it; does not manifest the same way twice between individuals; is difficult to document and is specific to the

		possessor (organizations cannot document and thereby retain it independent of the personnel that possess it)
Knowledge Dynamism (Reliability = 0.85)	Achrol & Stern, 1988; Aldrich, 1979; Bou-Llusar & Segarra-Cipres, 2006; Heiman & Nickerson, 2002; Ranft & Lord, 2000; Simonin, 1999; Zander & Kogut, 1995	Knowledge that requires continual information collection and updating; evolves rapidly, intermittently, discontinuously; considered 'turbulent' knowledge
New Product Development Speed (Reliability = 0.88)	Atuahene-Gima, 1995; Atuahene-Gima & Murray, 2004; Griffin, 1997; Ittner & Larcker, 1997; Leonard-Barton, 1992; Moorman, 1995	Efficiency and duration of time spent in the process of developing a new product; measured relative to previous episodes of new product development; new product development speed is considered vis-à-vis norms for the team, industry, and firm
New Product Novelty (Reliability = 0.78)	Andrews & Smith, 1996; Atuahene-Gima, 1995; DeLuca & Atuahene-Gima, 2007; Im & Workman, 2004; Kleinschmidt & Cooper, 1991; McDermott & O'Connor, 2002; Moorman, 1995; Moorman & Miner, 1997; Olsen, Walker, & Ruekert, 1995; Sethi, Smith & Park, 2001	Level of innovativeness, novelty, or newness of new products developed; innovation that is considered 'out of the ordinary' or 'revolutionary'; new product novelty is considered vis-à-vis norms for the team, industry, and firm; can be incremental or radical for the team, industry, or firm
New Product Performance	Andrews & Smith, 1996; Atuahene-Gima, 1995; Cooper, 1998; DeLuca & Atuahene-Gima, 2007; Im & Workman, 2004; Joshi & Sharma, 2004; Leonard-Barton, 1995; Moorman, 1995; Moorman & Miner, 1997; Sethi, 2000a, 2000b; Sethi & Iqbal, 2008	How the product fares in market once it has been launched by the focal firm; herein includes composite measurement of market share metrics (relative targets, past new products developed, and norms for industry), sales metrics (relative targets, past new products, and norms for industry), profit margin metrics (relative targets, past new products, and norms for industry), and return on investment metrics (relative targets, past new products, and norms for industry)

2.3 Knowledge Integration Mechanisms

Tolstoy (2009) tested empirically the effects of knowledge combination on knowledge creation. In accordance with the fundamental assertions of the KBV (Grant, 1996), his

findings demonstrate that there is a direct, positive relationship between knowledge combination and knowledge creation. Interestingly, Tolstoy's (2009) work also impresses the importance for personnel to find ways of combining their respective knowledge, though he does not describe what these methods might be. This is fairly common to the literature—and the basis for one of the research questions guiding this work: there is much discussion of the importance of recombination and integration of knowledge between personnel, but little description of how this might actually happen, specifically. Sackmann and Friesl (2007) discuss the importance of knowledge sharing, transfer and integration on new product development teams, and Troy, Hirunyawipada, and Paswan (2008) discuss the importance of knowledge integration in cross-functional development teams for new product success, lending support to the model, hypotheses, and research design employed herein. De Luca and Atuahene-Gima (2007) discussed knowledge integration mechanisms (KIMs) as mediating the relationship between market knowledge dimensions and cross-functional collaboration and ultimate product innovation performance, though also do not describe what these integration mechanisms might be. Further, in a triple-barreled survey item, they discuss organizational learning and information, but not knowledge, to measure KIMs in their research. Sethi (2000) discusses the importance of information integration in product development teams as antecedent to new product quality. While the present study might be said to be slightly more specific in that it considers knowledge integration instead of 'information' integration, and new product novelty and development speed, instead of new product 'quality,' certainly Sethi's work lends credibility to the importance of investigating knowledge integration (independent variables) for new product outcomes (dependent variables).

Olsen, Slater, and Hult (2005) do not discuss knowledge integration mechanisms specifically, though they do consider both (marketing) organization structure and performance indicators. Interestingly, they outline two types of organization structures that are mirrored in the discussion regarding possible types of KIMs in the literature. Olsen et al.'s (2005) concept of 'formalization' of organization structure shares some similarities with the KIM of 'organizational routines' considered and tested herein, while their concept of 'centralization' also shares some characteristics with the KIM of 'explicit direction' tested herein. The predominant difference, however, is two-fold: 1) the analysis Olsen et al. (2005) are considering regarding the structural organization is at the level of the functional department (marketing department), and this work is considering knowledge integration mechanisms at the level of the cross-functional team, and 2) Olsen et al. (2005) are considering organizational structural variables (how the department is organized institutionally), and this work considers integration mechanisms (how the team organizes to interact). Olsen, Walker, and Ruekert (1995, pp.49) made the case that integration mechanisms are 'lateral linkage devices or structural coordination mechanisms' that allow cross-functional coordination and interaction for the purpose of meeting organizational goals. Grant (1996) also described mechanisms for integrating knowledge as an organizational capability within the knowledge-based view, within which he outlined two specific integration mechanisms: direction and organizational routines. Explicit Direction, pioneered by Demsetz (1991), is about explicit information being communicated at a low cost between individuals working together within the firm. Organizational routines (March & Simon, 1958) refer to an organizational mechanism that doesn't require explicit communication of information, given organized coordination that combines individuals' knowledge by virtue of their operating

simultaneously or sequentially on the same project or substrate. Please refer to Table 1 for a definition of these constructs along with other key references.

In the present study, three specific KIMs are exhaustively identified from the literature, and further defined as the independent variables. Of specific interest is the relationship of KIMs on NP novelty, and NPD speed contributing to NP performance. The characteristics of the knowledge considered in this model as moderating variables were determined as those most pertinent to the KIMs identified but unlike the KIMs considered, are not an exhaustive account of all the possible characteristics knowledge can take. In accordance also with the KBV, the knowledge is considered to be the individuals'. Please see Table 2 for a list of all the main premises of this work as well as the comparisons and contrasts between each KIM and characteristic of knowledge considered.

From the existing literature, three knowledge integration mechanisms were identified as crucial to the prediction of new product novelty, development speed, and performance: 1) knowledge integration through explicit instructions or directions being given between individuals within a firm or a team (Demsetz, 1991; Grant, 1996b; Sethi & Iqbal, 2008), 2) knowledge integration as a product of the organizational routines established in the firm and/or between team members (Grant, 1996b; Heide & John, 1992), and 3) knowledge integration that occurs as part of an ad hoc interactive, organic environment in which individuals' roles, activities and interactions are characterized by relative fluidity, lack of institutionalization, and autonomy (Moorman, 1995).

2.3.1 Explicit Direction The first knowledge integration mechanism identified in the literature involves explicit direction between individuals on the cross-functional NPD team. Demsetz (1991) described this as the most efficient method of

information/knowledge transfer between specialists and other individuals (non-specialists or cross-disciplinary specialists) Grant (1996a,1996b) goes on to argue that the more complex an activity is, the more often it needs to be performed, and the higher the performance criteria/stakes, the more likely that it will require useful, economical and risk-mitigating direction as a means of knowledge transfer and, ultimately, integration

Sethi and Iqbal (2008) described explicit direction as a means of cross-functional knowledge transfer and integration in the NPD process in terms of managerial process-control, analogous to top-down, hierarchical direction of others toward an end-goal Here, direction is considered the codifying of tacit, specialist knowledge into explicit rules and instructions for others in the NPD team to follow The items ultimately used follow those from Grant (1996) For a definition of this construct, as well as all others used in this research, please refer to Table 1

TABLE 2
Comparing and Contrasting Knowledge Integration Mechanisms (KIMs) and Knowledge Characteristics

		Knowledge Characteristic		
		Uniqueness	**Tacitness**	**Dynamism**
Knowledge Integration Mechanism	**Explicit Direction**	**Premise 1: Unique knowledge is thought to work best with a KIM of explicit direction** Knowledge that is non-common (or has less overlap) among team members will be best manifested and utilized when tasks and understandings are clearly and formally laid out by one or a few central members that can coordinate disparate individuals efforts, coordination, and interaction without these specialists (who are better used concentrating on their area of expertise relative to others) having to do so on their own (individually directed interaction is required in both other KIMs)	Given that tacit knowledge is hard to identify without personal experience possessing or using it, and is hard to codify, communicate or transfer, it is thought that the one or few individuals providing explicit direction to others with such tacit knowledge will not be making the best use of such knowledge It will be hard for such leaders to identify or acknowledge the presence and utility of such knowledge, and as such will not likely manifest or make optimum use of it on the NPD team	Dynamic knowledge can evolve, change or shift so rapidly that only the individuals who possess it can know exactly how it currently exists (how it has been modified or updated), as well as how it can best be utilized Accordingly, in a context in which the KIM in use involves direction from a party other than the possessor of such knowledge, it is unlikely that such knowledge will be put to optimum use in order to be maximally manifested, communicated, and integrated with others knowledge

	Organizational Routines	While tacit knowledge is thought to work best with a KIM of organizational routines, unique—or non-common, specialist—knowledge would likely work well enough given that in such a context individuals would not be required to explain their respective knowledge to one another, allowing for efficiencies, though a lack of true integration of respective knowledge Organizational routines, because they do not require communication—and communication is ideal for maximal manifestation, coordination, integration, recombination of unique knowledge—aren't considered supreme with unique knowledge for maximal knowledge recombination and creation	**Premise 2:** **Tacit knowledge is thought to work best with a KIM of organizational routines.** 'Know-how' that is hard to identify, accrue, understand, codify, or communicate is thought to work best in the context of a KIM that allows seamless, organized, routinized interaction that does not require discussion or communication but occurs as part of individuals' understanding of their respective organizational roles and protocol (communication is required in both other KIMs)	Organizational routines are a fairly organized, regimented, routinized, institutionalized modus of knowledge integration that—when combined with dynamic, ever-changing knowledge—might yield some inconsistencies between and among individuals on the team, in terms of what they know and contribute Dynamic knowledge works best in a context in which a high degree of communication is inherent in the knowledge integration process, as such knowledge changes intermittently and requires renegotiation of mutual understanding and input responsibilities Manifesting such knowledge—critical for integration, recombination, creation of knowledge—would suffer in the context of highly institutionalized and change-resistant organizational routines

	Adhocracy	Unique, non-common, specialist knowledge works well in a context in which communication is normative, such as in adhocracy, though it is thought to work best when a third party is able to identify and coordinate the interaction of individuals and thereby their knowledge sets Non-common knowledge is not particularly difficult to identify or codify, though the possessor is not considered as likely to identify such knowledge in others (hence why explicit direction with a directing third party is thought to work best), and therefore such knowledge would not be maximally manifested, integrated, or recombined when interaction among individuals is not directed, but is instead individually directed, albeit in a fluid, non-formalized manner such as in adhocracy A lack of formalization of roles, process or protocol—such as in adhocracy—might actually serve to create more misunderstanding or confusion among individuals who do not fully understand (even if it is possible to be explained) each other's already disparate knowledge sets	Tacit knowledge is not thought to work well in the context of a KIM of adhocracy Adhocracy, because it is characterized by informal, fluid, ever-changing roles, processes and protocols, requires of team members a relatively higher level of communication and interaction Individuals with knowledge that is difficult to communicate or explain to others who do not possess it would not likely thrive in a more turbulent context that does not regiment interaction or role function and requires communication for mutual understanding and interaction As such, tacit knowledge would not be optimally understood, manifested, integrated, and recombined toward novel knowledge creation in the context of a knowledge integration mechanism of adhocracy	**Premise 3: Dynamic knowledge is thought to work best with a KIM of adhocracy.** Knowledge that is turbulent, evolves rapidly and unpredictably, and requires continual updating is thought to work best in the context of a KIM that allows for fluid, non-formalized role structuring and interaction between individuals, is end-goal oriented, and imbues individuals with a high level of entrepreneur-like autonomy, decision-making rights, and risk-taking ability, given a lack of formalized organization inherent in the group (formalization and institutionalization of roles, process, and protocol inherent in both other KIMs)

2.3.2 Organizational Routines The second KIM identified in the literature involves knowledge transfer and integration via organizational routines in which codification is unnecessary (Grant, 1996b) In this case, knowledge integration occurs as part of an established, routinized set of activities that allow for sequential patterns of interaction that permit integration of specialized knowledge without the need to communicate the knowledge explicitly These routines are understood among individuals in the NPD team as part of the roles and structure of the team, and likely of the organization Organizational routines can be mechanistic, and usually occur similarly with each repetition (Grant, 1996, Olsen, Slater & Hult, 2005) Because organizational routines are understood to be institutionalized, they would logically be predictable, replicable, socially upheld, and resistant to change (Oliver, 1997, Scott, 1995) Given this, organizational routines can occur without explicit communication between actors, but would not be

expected to include much variation given the relative level of behavioural automation expected.

2.3.3 Adhocracy The final KIM considered was named 'adhocracy' based on Moorman's (1995) concept of a 'culture of adhocracy.' This KIM is unique and a departure from the first two in that it captures the circumstance in which roles, specialist knowledge, routines, or procedures are not institutionalized or specifically defined. The KIM of adhocracy is defined as the context in which knowledge is integrated in an uninstitutionalized, ad hoc manner in which individuals interact intermittently, with autonomy, according to the requirement of their current tasks or projects. The KIM of adhocracy allows that roles are fluid and unassigned, and responsibility is dispersed across team members. In a KIM of adhocracy, individuals are prepared to take risks and act independently/ entrepreneurially with a central concern for end results (product) over process (Moorman, 1995). Interestingly, Andrews and Smith (1996) discuss the factors that affect new product novelty, and describe many of Moorman's characteristics of adhocracy as being related to new product novelty (it is hypothesized that a KIM of adhocracy will contribute to new product novelty and thereby successful new products (H6; see section 3, Table 3). So while not always outlined as 'adhocracy' in Moorman's vein specifically, the characteristics of Moorman's construct of Adhocracy are often described and related to the NPD process and new product performance. Luo, Slotegraaf and Pan (1998) do not specifically consider new product development, though they do consider cross-functional collaboration, and describe a circumstance in which task and role fluidity (such as is observed in an adhocracy) can contribute to simultaneous cooperation and competition on the part of personnel. This type of

interactional complexity is analogous to what might be observed in a KIM of adhocracy and is considered in the development of hypotheses below.

Brown and Eisenhardt (1997) also discuss organizational structures that contribute to successful new products. In particular, they outline a version of organization that is of central interest to this discussion of adhocratic KIMs, one that has an 'organic' internal structure and that would stand in opposition to a 'mechanistic' internal structure (highly mechanized and institutionalized, such as in 'organizational routines'). This structure is described as one in which there are 'fluid job descriptions, loose organization charts, high communication levels, and few rules' (pp.7). While Brown and Eisenhardt's description is at the level of an organizational structure, and is therefore broader than simply a mechanism of (knowledge) integration, it includes characteristics of personnel interaction that are thought herein to be central to the KIM of adhocracy. Further, their conceptualization of firm organization, process, and modus operandi is aligned to Moorman's idea of a culture of adhocracy, and thereby informs the present concept, definition, and study of the third KIM.

Moorman's 1995 paper discussed the organizational cultural antecedents and market information processes that contributed to new product outcomes. An important cultural antecedent was thought to be adhocracy in which entrepreneurship, individual autonomy, novelty and adaptability are valued above rigidity in functioning and predefined procedures, roles or structures. As mentioned, adhocracies are characterized by organizational cultural alignment in terms of the valuing of informational acquisition, flexibility and their competitive position in-market above all else, and certainly above intra-organizational institutionalizations and rigidities. In an adhocracy, knowledge can be transferred and integrated between and among individual team

members in unregulated, unroutinized, unprecedented ways, on an ongoing, simultaneous or sequential basis without regard for hierarchy, process order, or specialist or expert knowledge. Noteworthy here is that adhocracy is an organizational property that characterizes the process and structure of interaction between individuals in the firm, and should not be confused with Moorman and Miner's (1996) or Miner, Moorman, and Bassoff's (1996) concept of 'improvisation,' though descriptively very similar concepts. The central focus of improvisation is that the projects themselves might be adapted for changing circumstances, not necessarily and simply the interaction between individuals. In adhocracy it is the structure and method of personnel interaction as well as knowledge integration that is considered to be adaptable to changing circumstances, not necessarily the project itself. Herein, the organizational project under consideration is always new product development.

Another interesting parallel in the literature, which lends support to the notion that the three KIMs outlined herein are indeed mutually exclusive and collectively exhaustive, is research identifying three separate, critical properties that continually innovating organizations could possess. Brown and Eisenhardt (1997) assert that these are the specific differences in organizational structures that are critical for success in multiple product innovating firms. They list three types of process properties for organizations: 1) 'semistructures,' in which order, disorder, and the balance between the two constitute a central theme for interacting personnel, 2) 'links in time,' in which personnel direct attention simultaneously or sequentially to multiple stages of the product development process, and 3) 'sequenced steps,' in which personnel follow a sequential process within or between them throughout the product development process.

Interestingly, each of these three themes mirrors some key dimensions of the three KIMs identified in this research. 1) Like 'semistructures,' explicit direction also includes a theme of control and is designed to limit disorder among personnel and throughout the new product development process. 2) Adhocracy, like 'links in time,' allows individuals—alone or in any combination—to focus simultaneously or sequentially on any stage of the new product development process and implicitly requires a significant amount of communication between personnel. 3) Like 'sequenced steps,' organizational routines includes the theme of sequential action that conforms to institutionalized behavioural templates and does not require much communication between actors.

Noteworthy is Brown and Eisenhardt's (1997) work, as well, where each of these three descriptions of organizational properties—while mutually exclusive as constructs—can be employed simultaneously within organizations. Accordingly, it is accepted herein that not only could a singular organization be utilizing one or more KIM simultaneously, but it also seems that contemporary organizational environments are trending toward use of multiple integration mechanisms and might even strive to employ multiple methods of integration and knowledge combination simultaneously, especially given the favourable results being reported in such instances (Brown & Eisenhardt, 1997).

2.4 Key Knowledge Characteristics

The literature is replete with discussions of organizational knowledge (e.g. Bou-Llusar & Segarra-Cipres, 2006; Nissen, 2005; Riege & O'Keeffe, 2007, etc.) including a myriad of titles and definitions for how various types of knowledge can be defined, dimensionalized and characterized. Problematic in the knowledge literature are separate names for very similar knowledge types. For example, and as will be discussed below, Bou-Llusar et al. (2006) refer to 'unique' knowledge, Riege et al. (2007)used a construct

of 'specific' knowledge in their research, and Simonin (1999)discusses common (with the opposite being 'non-common') knowledge, though what is meant by each of these 'types' of knowledge is very similar: there is such significant overlap in these constructs that differentiating them does not improve theory development, but rather complicates the literature unnecessarily. For the purposes of the model under investigation, three characteristics of knowledge were identified as most pertinent to the KIMs in question: uniqueness, tacitness and dynamism. 'Characteristics' of knowledge were chosen over 'types,' partly for the difficulty in the literature just described, but also because consideration of the spectrum of knowledge allowed for greater precision, meant that the knowledge considered wasn't bounded by the constraints of specific knowledge type constructs, meant that multiple characteristics of knowledge could be considered simultaneously without confounding the research, and circumvented the problem of overlapping constructs for types of knowledge described in the literature. For definitions of the characteristics of knowledge considered herein please refer to Table 1; for a concise overview of the various combinations of KIMs and characteristics of knowledge deemed most pertinent, please refer to Table 2.

2.4.1 Knowledge Uniqueness As discussed by Lubatkin (1998), as well as Lane and Lubatkin (1998), *unique knowledge is characterized as knowledge that is not* common, that is not shared among members of a group, and that is unique to the individual vis-à-vis other organizational team members. As an example, if you are an engineer, and a counterpart of yours is not, you have knowledge about engineering that is unique to you, and not common to the both of you. Further, should you like to convey something about engineering to someone, a requisite amount of engineering knowledge would be required in order for them to understand what it is that you are conveying, and

therefore uniqueness of knowledge represents a barrier to knowledge integration. Purposefully here, the term 'specialist' or 'specific' knowledge (e.g. Riege & O'Keefe, 2007) is not being used, as there is an inherent confound with this construct in the literature: sometimes these terms are used to describe non-common knowledge, and sometimes they are used to describe the knowledge that experts would possess. The intention herein was to capture the dimension of knowledge that need not necessarily be specialist or expert, but that is not a shared or common subset of knowledge among group members, and is therefore 'unique' to an individual on the cross-functional team. Both Demsetz (1991) and Grant (1996b) discussed common knowledge as a prerequisite for explicit communication of knowledge/information between any two individuals. Accordingly, non-common, unique knowledge is implicitly more difficult to codify and communicate to others, and thereby inherently includes a barrier to knowledge transfer. It is expected that knowledge that is non-common will be best integrated via a KIM of explicit direction, given that an individual with unique knowledge will have to find a way to have that which others do not know understood for the purpose of integration and recombination.

2.4.2 Knowledge Tacitness Tacit knowledge, as discussed by Simonin (1999), Grant (1999) and DeLuca et al. (1997), among many others, is knowledge that cannot easily be codified, formalized, communicated or shared. Typically, it is characterized as implicit, personal, rooted in action, and demonstrated by doing. As an example, you know how to do up your own shoelaces. You have done this so many times, you almost don't know how to describe this sequence of actions, without doing or thinking through the activity in your mind very deliberately and labouriously. In the organizational context then, the equivalent would be, as an example, for a supply chain manager, working on

the new product development team, who knows almost intuitively from years of experience how many and what types of units typically gets sold to each of the firms' customers, and therefore has a fairly good running sales and demand forecast tally at all times, cognitively. While this is true, if asked exactly how they constructed their volumetrics or sales forecasts, they would have to laboriously go and type out each type and volume of unit they know will be sold, by customer, calibrating for the information they continually receive regarding out-of-stocks, discontinuations, distribution problems, and manufacturing/supply issues, in order to be able to validate what they know to others. This supply chain manager would be said herein to have tacit knowledge—it is valuable knowledge that is very hard to communicate in any kind of simple, succinct, or timely way in the context of a new product development team, and would be most efficiently utilized if the supply chain manager was not required to explain, validate, or exchange such knowledge, but was instead solely responsible for mobilizing such knowledge toward new product development ends. Accordingly, tacit knowledge represents a barrier to knowledge integration in the context of a new product development team.

A requirement of explicating tacit knowledge verbally for transfer typically leads to such losses in information—because of having to revert to common knowledge (Demsetz, 1991; Grant, 1996b)—that its true meaning and usefulness are lost. It is expected that tacit knowledge will be particularly relevant to a KIM of organizational routines (Premise 2; Table 2), as each individual team member will be able to forgo explanation of their knowledge, and instead be able to act independently, adding value and integrating their capabilities and knowledge with those of their teammates toward the creation of novel products in the NPD (knowledge creation) process.

2.4.3. Knowledge Dynamism Dynamism was first conceptualized by Aldrich (1979) and then most succinctly established by Achrol and Stern (1988, 1991). Riege et al. (2007) describe complex knowledge as being dynamic in nature, which has similarities to the concept of dynamism of knowledge used herein. As an example, while it is not likely to be your typical job, if you were asked for a weather forecast for the rest of the day and tomorrow, you might identify this knowledge as volatile: while you have a base understanding of how weather and weather forecasts work, you would have to look this information up in order to be able to report it with any degree of accuracy. Further, because you know that forecasts can be wrong or change (and require continual updating), and that Mother Nature has been known to throw some curve balls, in order to be confident about the accuracy of the information you gave to others regarding the weather from the present moment onward, you would want to continue to collect updated information about the weather forecast yourself. Herein, while you know about weather, and you know about weather forecasts, in order to communicate weather information (which is always changing), you would have to self-educate and update your knowledge about current and future weather in order to convey this information with any accuracy to others. This is knowledge dynamism: knowledge that requires continual updating, is characterized by a relative degree of uncertainty, and requires individuals who possess it to continually update and self-educate in order to ensure its accuracy. Because continual updating, some degree of uncertainty, and information collection takes time, knowledge dynamism is thought to represent a barrier to knowledge integration. In an organizational context thus, if we return to the example of a supply chain manager working on the new product development team (it is considered possible herein for individuals to have more than one type of knowledge simultaneously, or

multiple types of barriers to knowledge integration), the information they receive—and seek out—on an ongoing basis regarding product stock discontinuations, product carrier discontinuations, plant malfunctions, distributing problems, customer category issues, customer bankruptcies etc., all represent volatilities to the accuracy of their knowledge regarding supply and demand forecasts. Accordingly, they continually have to update their knowledge sets and self-educate in order to be able to communicate such information to the NPD team with any degree of certainty or accuracy. Further, it is likely that they will continue to update the team with such information over the course of the new product development project.

Turner and Makhija (2006) describe 'incompleteness' of knowledge with the critical feature being that incomplete knowledge requires continual updating, information searching, and knowledge uncertainty—like that which is considered constituent to the concept of knowledge dynamism herein. Interestingly, they also discuss diversity of knowledge, which includes 'complexity' and 'variability' of knowledge, though neither of these constructs, as they are defined in their work (despite similar names), are related to what is conceptualized herein as dynamism of knowledge. Instead, Turner and Makhija's concept of diversity of knowledge is analogous the concept of knowledge uniqueness as it is defined and considered herein. Effectively, dynamic knowledge is that which can evolve or shift rapidly and requires frequent, ongoing updating. It is characterized by an external perception of ongoing changes, which begets a certain degree of associated uncertainty. It has been described as being most useful in circumstances of turbulence, or where there is a high degree of turnover or change in the output environment. Interestingly, because of these characteristics, it serves as a natural extension of both the former types of knowledge considered important for the model—unique and tacit

knowledge—because the individual possessing dynamic knowledge will almost certainly then possess non-common, unique knowledge, and will update the information/ knowledge according to practised, tacit cognitive schemas and aptitudes.

It is suggested that dynamic knowledge will be most beneficial in circumstances where KIMs are of an adhocratic nature (Premise 3, please see Table 2). In such a context, concern for others' action and knowledge is lessened, and focus for the end-goal of producing favourable in-market results is central. Further, it is expected that dynamic knowledge will be most valuable in entrepreneurial-type circumstances or firms that perceive more turbulence externally, as individual team members will be empowered to act with autonomy that is aligned with their unique and dynamically updated knowledge sets.

TABLE 3
Matrix of Hypotheses

Variables	Knowledge Characteristic	New Product Development Speed	New Product Novelty
Explicit Direction		H1, Positively Related	H2, Negatively Related
	Tacit	H1a, Will Attenuate	H2a, Will Attenuate
	Unique	H1b, Will Strengthen	H2b, Will Attenuate
	Dynamic	H1c, Will Attenuate	H2c, Will Strengthen
Organizational Routine		H3, Positively Related	H4, Negatively Related
	Tacit	H3a, Will Strengthen	H4a, Will Attenuate
	Unique	H3b, Will Strengthen	H4b, Will Attenuate
	Dynamic	H3c, Will Strengthen	H4c, Will Attenuate
Adhocracy		H5, Positively Related	H6, Positively Related
	Tacit	H5a, Will Attenuate	H6a, Will Attenuate
	Unique	H5b, Will Attenuate	H6b, Will Strengthen
	Dynamic	H5c, Will Strengthen	H6c, Will Strengthen
New Product Performance	N/A	H7, Positively Related	H8, Positively Related

CHAPTER 3: HYPOTHESES

Explicit Direction and New Product Development Speed

It is expected that the first identified KIM, that of explicit direction, will be positively related to NPD speed (Grant, 1996). Direction is a fairly efficient and economical manner of motivating action or behaviour from team members and, because of its hierarchical nature, direction negates the likelihood of dissention or much time spent in deliberation (Grant, 1996). The expected overall main effect of direction is toward increased organizational (and, within that, NPD) efficiency (Moorman, 1995) and thereby new product development speed. Grant (1996) effectively stated this—that explicit direction would increase the speed of organizational imperatives (certainly NPD would be included among those)—although he did not test this empirically. Griffin (1997) indicates that the more 'formal' the process of new product development is on a cross-functional team, the shorter the 'cycle time' between new product launches. Because explicit direction has formal qualities, and because product development cycle time is analogous to new product development speed, explicit direction would according be expected to be positively related to NPD speed. It is hypothesized that:

H1: A KIM of Explicit Direction will be positively related to New Product Development Speed.

While the main effect of direction on speed is projected to be positive, it is expected that if the knowledge of cross-functional personnel is also tacit, the efficiency of the process will be lost (Reed & DeFillippi, 1990). Grant (1996b) notes that specialist knowledge that is tacit must be codified according to common knowledge, the most basic of which is language, which results in considerable information loss and could also confound understandings, require repetition and create confusion. It is also expected that efficiency will be lost as part of the codification process required in direction (production of directive language on the part of the project manager, not just production of expressive language on the part of team members), when knowledge is tacit (Reed & DeFillippi, 1990; Simonin, 1999). The presence of tacit knowledge is hypothesized to

decrease the speed of new product development in the context of explicit direction as a KIM.

H1a: An increase in tacit knowledge will attenuate the relationship between explicit direction and new product development speed.

On the other hand, when knowledge is of a non-common, unique nature, but not tacit, it is expected that codification should be relatively effortless—without significant loss of time or information—and would be the most natural circumstance under which team members would be willing to comply with directives: the directing individual has knowledge that is easily understood by teammates but that they did not already know (Bou-Llusar & Segarra-Cipres, 2006). Explicit direction should be the most natural way to coordinate action and integrate knowledge when knowledge is unique in nature, because team members would understand that they do not possess the same type of information/knowledge as others, and therefore need some form of externalized, centralized direction. Unique knowledge (Bou-Llusar et al., 2006) is thought herein to work best with explicit direction (Demsetz, 1991; Grant, 1996) according to Premise 1 (Table 2). It is hypothesized that the presence of unique knowledge will increase the speed of new product development in the context of explicit direction as a KIM.

H1b: An increase in unique knowledge will strengthen the relationship between explicit direction and new product development speed.

Next, when knowledge is of a dynamic nature and is intermittently being updated or renewed, causing some amount of uncertainty associated with it (Achrol & Stern, 1991), it is thought that team members will be less willing to comply without some prerequisite qualifications and explanations from those who are directing them explicitly. Because direction is implicitly hierarchical (Demsetz, 1991; Grant, 1996) and dynamic knowledge is implicitly unique and tacit (Bou-Llusar et al., 2006), it is expected that in the team

context dynamic knowledge could increase confusion and requirement of explanation, decrease compliance, and increase deliberation such that the speed of new product development (or any project) would be lessened (Achrol and Stern, 1988, 1991; Aldrich, 1979). The presence of dynamic knowledge is hypothesized to decrease new product development speed in the context of a knowledge integration mechanism of explicit direction.

H1c: An increase in dynamic knowledge will attenuate the relationship between explicit direction and new product development speed.

Explicit Direction and New Product Novelty

Direction is expected to be negatively related to novelty. Theoretically, if a team member is (or team members are) explicitly directing others, there is less opportunity for collaboration or creative friction (although some friction is likely). Direction is inherently top-down (Demsetz, 1991; Grant, 1996), which would presumably decrease novelty of new products developed because one individual is (or a few individuals are) at the helm of making decisions regarding how new offerings should manifest and be developed. The presence of explicit direction in new product development initiatives is accepted to decrease relative novelty in new product development (Im & Workman, 2004). Olsen, Slater, and Hult (2005) state that the organization structure of centralization (not supremely different from the concept of explicit direction) tends to result in less innovative ideas being offered up, and expectedly then, less innovative products likely. Accordingly, it is hypothesized that explicit direction will be negatively related to new product novelty.

H2: A KIM of Explicit Direction will be negatively related to New Product Novelty.

It is expected that tacit knowledge will attenuate the relationship between explicit direction and new product novelty. When knowledge is tacit and direction is the knowledge integration mechanism being employed, it is expected that confusion will be increased, information will be lost in any attempted codification process, and novelty or productivity toward innovativeness and novelty will suffer (see Andrews & Smith, 1996; Grant, 1996; Im & Workman, 2004). The presence of tacit knowledge is hypothesized herein to increase new product novelty in the context of explicit direction as a KIM.

H2a: An increase in tacit knowledge will attenuate the relationship between explicit direction and new product novelty.

When knowledge is unique (non-common and thereby less easily codified; Bou-Llusar et al., 2006) and explicit direction is a knowledge integration mechanism in use (Grant, 1996), it is expected that compliance will increase and confusion between interacting personnel will be lessened overall. Unique knowledge is thought to work best with direction in general (Premise 1; Table 2) given that such knowledge is not shared by all in the cross-functional new product development team (which could increase confusion and lack of understanding between individuals; Bou-Llusar et al., 2006; Simonin, 1999), and would be best utilized in a KIM that involves centralized, direct, explicit commands (Grant, 1996). The presence of unique knowledge is hypothesized to increase new product novelty in the context of explicit direction as a KIM.

H2b: An increase in unique knowledge will attenuate the relationship between explicit direction and new product novelty.

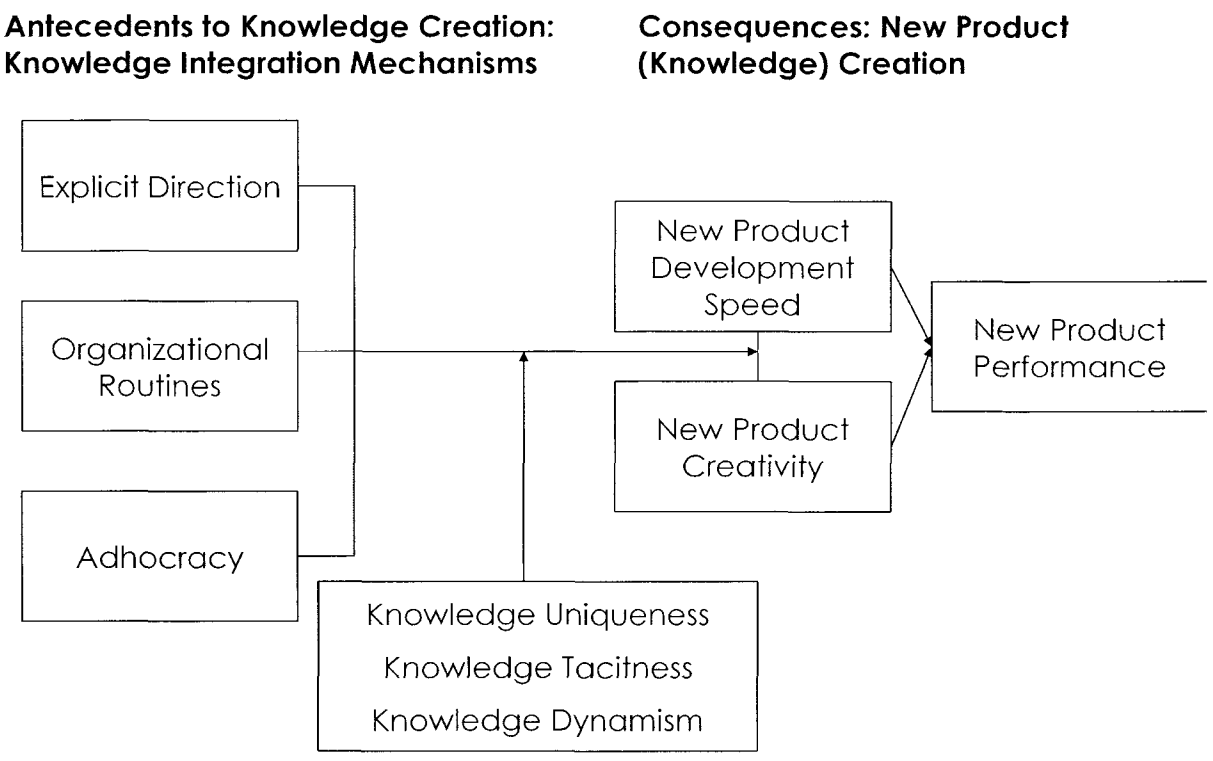
When knowledge is dynamic (requires continual updating and changes) and explicit direction (implicitly centralized and hierarchical; Grant, 1996) is the KIM being employed, it is expected that novelty will be further lessened as there will be an increase in

confusion, in explanations required, in deliberation of action on the part of team members (given that they will have to collect information and update knowledge sets intermittently; Heiman & Nickerson, 2002). Also, given that information would be expected to get lost in the codification process when cross-functional personnel interact, it might be expected that overall this would decrease the knowledge resources available to team members (Brown and Eisenhardt, 1995; Menon & Varadarajan, 1992; Nahapiet & Goshal, 1998).

Because it is expected that a KIM of explicit direction will be negatively related to new product novelty (H2), it is expected that dynamic knowledge will positively moderate the relationship between explicit direction and new product novelty. The presence of dynamic knowledge is hypothesized to decrease new product novelty in the context of explicit direction as a KIM.

H2c: An increase in dynamic knowledge will strengthen the relationship between explicit direction and new product novelty.

FIGURE 2
Effects of Knowledge Integration Mechanisms and Knowledge Characteristics on Knowledge Creation in the Form of New Product Development: A Theoretical Model


Antecedents to Knowledge Creation:
Knowledge Integration Mechanisms
Consequences: New Product
(Knowledge) Creation
Explicit Direction
Organizational
Routines
Adhocracy
New Product
Development
Speed
New Product
Creativity
New Product
Performance
Knowledge Uniqueness
Knowledge Tacitness
Knowledge Dynamism
Knowledge Characteristics Pertinent to KIMs

Organizational Routines and New Product Development Speed

When the predominant KIM being employed is that of organizational routines, it is thought that the speed of new product development will increase (Grant, 1996; Polanyi, 1966). This is expected given that within a KIM of organizational routines, roles are clearly understood by team members and there is decreased concern for others' knowledge sets or actions, so little time is wasted in deliberation, discussion, consensus or mutual understanding (Moorman, 1995; Moorman & Miner, 1997). Instead, members would be free to act according to their own roles and knowledge sets at the appropriate moment, in sequence, allowing for a relatively smooth new product development process, theoretically. It is hypothesized that organizational routines will be positively related to NPD speed.

H3: A KIM of Organizational Routines will be positively related to New Product Development Speed.

It is thought that tacit knowledge (difficult to codify; Heiman & Nickerson, 2002; Simonin, 1999) and organizational routines will be the most compatible across the knowledge types (Premise 2). This is expected theoretically given that knowledge that is difficult to identify, codify, communicate, or understand (Grant, 1996; Heiman & Nickerson, 2002; Simonin, 1999) would benefit from routinized, institutionalized patterns of action that do not require communication (Grant, 1996; Menon & Varadarajan, 1992; Moorman & Miner, 1997; Polanyi, 1966). Team members should be able to act in succession without requirement of communication or codification adding value to the new product development process reasonably seamlessly (Polanyi, 1966). In accordance with Premise 3 (Table 2), which contends that organizational routines will work most fluidly with knowledge that is tacit, it is hypothesized that the presence of tacit

knowledge will increase new product development speed in the context of organizational routines as a KIM.

H3a: An increase in tacit knowledge will strengthen the relationship between organizational routines and new product development speed.

When knowledge is unique (non-common, specialist, though relatively codifiable; Bou-Llusar et al., 2006; Simonin, 1999), it is thought that organizational routines will also work well as a KIM (Grant, 1996). Should members need to communicate, the codification of their knowledge would be relatively effortless in the context of unique knowledge (Bou-Llusar et al., 2006) and other team members would be neither confused nor deliberating, theoretically. Also, because organizational routines do not require the codification of others' knowledge given there is a shared understanding about the successive order and pattern of functioning (Polanyi, 1966) and because unique knowledge can be relatively easily codified and communicated should the necessity arise (Bou-Llusar et al., 2006; Heiman & Nickerson, 2002), this combination of KIM and knowledge should increase the speed and efficiency of team projects, including new product development. The presence of unique knowledge is hypothesized to increase speed of new product development in the context of organizational routines as a KIM.

H3b: An increase in unique knowledge will strengthen the relationship between organizational routines and new product development speed.

Organizational routines are thought to be an efficient modus operandi for the organization or team (Grant, 1996). Dynamic knowledge—because of its complexity and the requirement that it be continually updated (Bou-Llusar et al., 2006; Heiman & Nickerson, 2002)—might in some contexts be considered an inefficient form of knowledge, in terms of time spent updating it that results in lost efficiency . However,

dynamic knowledge has the efficiency advantages of being updated any time, intermittently, and independently from other teammates. Accordingly, it is expected that dynamic knowledge (Bou-Llusar et al., 2006; Achrol & Stern, 1988, 1991; Aldrich, 1979) will not decrease the efficiency of the new product development process. Further, in the presence of a KIM of organizational routines, given its inherent efficiencies (Grant, 1996; Polanyi, 1966), it is expected that this interaction will produce positive efficiencies and therefore increase the speed of new product development. Individuals update (dynamic) knowledge as the project requires, on their own time, according to their own acknowledgement of requiring it, and toward the end goal of being best informed for the current project at hand (Moorman, 1995). It is hypothesized that the presence of dynamic knowledge will increase the speed of new product development in the context of organizational routines as a KIM.

H3c: An increase in dynamic knowledge will strengthen the relationship between organizational routines and new product development speed.

Organizational Routines and New Product Novelty

In the event that organizational routines are the operative KIM, it is understood that organizational functioning will be routinized and institutionalized (Grant, 1996; Polanyi, 1966), thereby resistant to change in terms of process, order, function, or outcome (Scott, 1995) and therefore unlikely to result in drastically new ideas or novelty in the product creation process. Instead it will approximate prior episodes of new product development attempted by the new product development team. This is in accordance with the input perspective of creativity (Im & Workman, 2004), which measures the novelty of innovation—new product novelty—as a measure of how different the product of the current episode of NPD is considered to be vis-à-vis previous episodes of new

product development by the same team. (Team tenure—how long the team has worked together—is controlled for in this study.) It is hypothesized that organizational routines will be negatively related to new product novelty.

H4: A KIM of Organizational Routines will be negatively related to New Product Novelty.

When knowledge is tacit and thereby difficult to codify, it is thought that organizational routines will be the most effective method of knowledge integration (Premise 2). Accordingly, when organizational routines are in place and knowledge is tacit, it is thought that all individual team members will be able to act autonomously, in succession, adding value in the form of novel creation, without necessity of justification or of codification/communication of their actions (Grant, 1996; Polanyi, 1966). It is hypothesized that the presence of tacit knowledge will increase new product novelty in the context of organizational routines as a KIM.

H4a: An increase in tacit knowledge will attenuate the relationship between organizational routines and new product novelty.

When knowledge is unique and thereby non-common but readily codified if necessary (Bou-Llusar et al., 2006), it is thought that new product novelty will increase, by virtue of differing, non-common, new knowledge sets being present and integrated by team members, in this case via organizational routines (Grant, 1996). While organizational routines are thought herein to decrease the novelty of new product developed (H4), it is hypothesized that unique knowledge—which facilitates novelty of information and knowledge present on the team as well as likely causing some amount of creative friction between individuals—will render the process and thereby the result more 'creative' (Bou-Llusar, 2006; Im & Workman, 2004; Simonin, 1999). It is

hypothesized that the presence of unique knowledge will increase the new product novelty in the context of organizational routines as a KIM.

H4b: An increase in unique knowledge will attenuate the relationship between organizational routines and new product novelty.

When knowledge is dynamic and thereby requires continual updating to novel versions, perspectives, information sources, and understandings (Bou-Llusar et al., 2006; Ranft & Lord, 2000; Simonin, 1999; Zander & Kogut, 1995), it is thought that the result will be greater novelty of new products developed. As successive teammates are able to act independently, updating knowledge and collecting required yet novel information as they do, it is expected that each individual's (evolving, new) contribution to the team will result in an increase in the level of novelty of the new products generated through the development process—an increase in new product novelty (Im & Workman, 2004). It is hypothesized that the presence of dynamic knowledge will increase new product novelty in the context of a KIM of organizational routines.

H4c: An increase in dynamic knowledge will attenuate the relationship between organizational routines and new product novelty.

Adhocracy and New Product Development Speed

Given that a KIM of adhocracy is defined as a structural organizational context in which team members are encouraged to act autonomously, be less risk-averse in the interest of innovating creatively and first-to-market, and roles, responsibilities, protocol and guidelines are fluid in order to allow the projects and processes to be streamlined, it is expected that a KIM of adhocracy will have a positive effect on the efficiency and operating speed of the team. In the event that the KIM being employed is that of adhocracy—in which all team members value the ultimate end-goal of production and

are empowered to collect information, act autonomously, and consult or collaborate within the team in any pattern of order—it is expected that efficiency in team interactions and processes will be higher and thereby new product development speed will increase. Adhocracy is hypothesized to be positively related to speed.

H5: A KIM of Adhocracy will be positively related to New Product Development Speed.

When knowledge is tacit and members must add value to the development process by virtue of doing what they know, without an ease of communication or codification (Grant, 1996; Simonin, 1999), it is thought herein that the lack of institutionalization or routinization associated with the integration mechanism of adhocracy will further hinder their ability to act in a consistently productive, efficient way. In the case of the presence of tacit knowledge, communication by team members will be harder to codify, which likely creates more confusion and friction among members (DeLuca & Atuahene-Gima, 2007) and which can result in more time spent in establishing consensus for action on the part of the new product development team, hindering overall efficiency and operational speed. The presence of tacit knowledge is hypothesized to decrease new product development speed in the context of adhocracy as a KIM.

H5a: An increase in tacit knowledge will attenuate the relationship between adhocracy and new product development speed.

In the event that knowledge is unique and therefore novel to the team (non-common), albeit easily codified and thereby understood by others (Bou-Llusar et al., 2006), it is thought that in the context of a KIM of adhocracy, which inherently lacks institutionalization or routinized organization, speed will be decreased given an increased necessity for explanation of one's unique knowledge to others on the team.

While it helps that in an adhocracy individuals are free to consult, explain and interact according to their autonomous will (Moorman, 1995), unique knowledge is still expected to create more confusion, requirement of explanation, and overall deliberation on the team, decreasing efficiency and speed of new product development. It is hypothesized that the presence of unique knowledge will decrease new product development speed in the context of adhocracy as a KIM.

H5b: An increase in unique knowledge will attenuate the relationship between adhocracy and new product development speed.

Because dynamic knowledge requires continual updating and individualized ownership (Bou-Llusar et al., 2006; Ranft & Lord, 2000; Zander & Kogut, 1995) and given that adhocracies allow individuals to interact in a non-institutionalized, non-routinized, ad hoc basis (Moorman, 1995), dynamic knowledge is thought to work best in the context of a KIM of adhocracy (Premise 3). Should the knowledge that each individual possesses be of a dynamic nature and the KIM in place is adhocracy—in which individuals are autonomous to update information as they require it, are encouraged to produce toward the end goal of development, and are likely able to communicate easily with others on a 'need-to-know' basis (Moorman, 1995)—it is expected that overall team efficiency and thereby new product development speed will be increased. Individuals in this context will be able to utilize information or knowledge that is immediately pertinent, without the cognitive weight of extraneous information or knowledge (Heiman & Nickerson, 2002; Simonin, 1999), which is expected to allow for greater operational efficiency within the team and thereby greater new product development speed. It is hypothesized that the presence of dynamic knowledge will increase new product development speed in the context of adhocracy as a KIM.

H5c: An increase in dynamic knowledge will strengthen the relationship between adhocracy and new product development speed.

Adhocracy and New Product Novelty

It is expected that adhocracy will be positively related to new product novelty given the potential for new, evolving, leading-edge information and knowledge among new product development team members in a KIM of adhocracy. Andrew and Smith (1996) indicate that greater risk-taking behaviours and diversity in situational factors (similar to some of what is meant by 'adhocracy') resulted in more novel ideas and greater new product novelty. Olsen, Slater, and Hult (2005) describe environmental factors such as organizational formalization and centralization—which are opposite the structural characteristics of a KIM of adhocracy—as inhibiting novelty in ideas and thereby new product innovation. It is expected that within a KIM of adhocracy, novel ideas will be accepted and mutually rewarded, and that interaction between team members will be fluid enough as to allow novel transfer, combination and integration (prerequisites to knowledge creation according to the KBV; Grant, 1996) of knowledge sets contributing to innovative and creative production. Sethi, Smith, and Park (2001) also affirm that 'encouragement to take risk' (a constituent component of the KIM of 'adhocracy') contributes to new product novelty in cross-functional new product development teams, as did the very fact that the team was cross-functional ('functional diversity'). This lends support to the notion that not only would risk-taking acceptance (part of adhocracy) increase new product novelty, but that the subjects used in this investigation—new product development teams—will contribute to new product novelty. Accordingly, it is hypothesized that a KIM of adhocracy will be positively related to new product novelty.

H6: A KIM of Adhocracy will be positively related to New Product Novelty.

In the event that knowledge is tacit, however, the productivity of intra-team interactions is thought to be decreased by virtue of difficulty in codification, communication, shared mental models or understandings of information (Simonin, 1999) and might even create unfavourable friction or frustration within the new product development team. Kyriakopoulos & deRuyter (2004) established that procedural memory (similar to tacit knowledge) reduced internal information flows (or information transfer, analogous to knowledge transfer, integration) and thereby new product novelty. Also, while adhocracy allows for operational shortcuts and efficiencies (Moorman, 1995), it is expected that tacit knowledge—given the difficulty in transfer, communication, codification, and expression associated with it (Reed & DeFillippi, 1990; Simonin, 1999)—will decrease the fluidity of action and interaction within the adhocratic team. Decreasing the fluidity of interaction, efficiency of operation, and mutuality of understanding is thought to result in a decrease of meaningful contribution and interaction on the part of team members. It is hypothesized that the presence of tacit knowledge will decrease new product novelty in the context of adhocracy as a KIM.

H6a: An increase in tacit knowledge will attenuate the relationship between adhocracy and new product novelty.

When knowledge is unique and therefore novel but relatively easily codified (Bou-Llusar et al., 2006), it is expected that a KIM of adhocracy will facilitate novel ideas and recombinations of information in such a way as to increase novelty and innovativeness (Grant, 1996). In the context of adhocracy, unique knowledge is thought to increase the amount of information and novel ideas that the team works with, resulting in novelty of the new product(s) developed (Im & Workman, 2004). It is hypothesized that the

presence of unique knowledge will increase new product novelty in the context of adhocracy as a KIM.

H6b: An increase in unique knowledge will strengthen the relationship between adhocracy and new product novelty.

When knowledge is dynamic and constantly being updated, changed and reconfigured cognitively (Bou-Llusar et al., 2006; Ranft & Lord, 2000; Zander & Kogut, 1995), it is expected that novelty of ideas and collaboration will increase, resulting in greater new product novelty. Dynamic knowledge is thought to work best with a knowledge integration mechanism of adhocracy (Premise 3). Where new knowledge and information are continually being added to the system (e.g. dynamic knowledge; Bou-Llusar et al., 2006) and individuals are allowed the autonomy to incorporate them into the creative process and with other knowledge sets (e.g. recombination for knowledge creation per the KBV; Grant, 1996) on an ongoing basis (e.g. adhocracy; Moorman, 1995), it is thought herein that knowledge creation and novelty of new products will increase. It is hypothesized that the presence of dynamic knowledge will increase new product novelty in the context of adhocracy as a KIM.

H6c: An increase in dynamic knowledge will strengthen the relationship between adhocracy and new product novelty.

New Product Development Speed and New Product Performance

Finally, it is expected based on the literature that new product development speed will contribute positively to the success of new products launched by the firm (Moorman, 1995). It seems that products launched in good time, which are first- or quick-to-market, have a better chance of engaging early adopters, securing first mover advantages, commanding more market share than competitors, and thereby contributing to the revenues and ultimate profitability for the focal firm (Brown & Eisenhardt, 1994). Sethi

(2008) discusses the importance of new product quality for new product success. This research considers constituent components of new product quality (e.g. novelty, speed to market) contributing to new product performance. Sethi's work lends credibility also to the use of new product development teams as respondents for this type of investigation (effects of new product quality factors on new product performance). New product performance in market is measured by the ability of the new product to reach market share, sales, and profit margin targets, as well as provide good returns on investment (Moorman, 1995). In these cases investments could take the form of personnel allocation, research and development initiatives, market testing, focus group or other consumer reconnaissance research, quality assurance testing, competitive intelligence research, etc. Return on these investments comes in the form of sales, revenues, and margin contribution, and ultimately profitability. Based on these metrics for new product performance, it is expected that new product development speed will be positively related to new product success (Moorman, 1995). Ittner and Larcker (1997) also draw a similar parallel, and testing the positive relationship between 'product development cycle time' and 'organizational performance,' which is measured in their work as a composite of return on assets, sales growth, ROA, ROS, and perceived overall performance, find support for this relationship. Using effectively the same definitions in the present study, though calling these constructs 'NPD Speed' and 'New Product Performance' respectively, it is hypothesized that there will be a positive relationship between the two. Accordingly,

H7: New Product Development Speed will be positively related to New Product Performance.

New Product Novelty and New Product Performance

It is expected based on the literature that the novelty of the new products developed will contribute positively to the success of such products in-market (Andrews & Smith, 1996; Im & Workman, 2004). Moorman and Miner (1997) consider the impact of organizational memory on new product novelty and performance, lending support to the present consideration of a) knowledge within the organization as well as b) the notion that new product novelty would be positively related to new product performance. Henard and Szymanski (2001) studied predictors of new product performance and posited that such factors as product innovativeness (or novelty), cross-functional integration, reduced cycle time (speed-to-market; NPD speed), among others, would contribute positively to new product performance. This lends support not only to the model and research design herein, but also to H7 and H8 (below). Effectively, if a product is adequately novel for the company or the category, it will be able to 'cut through the clutter' and command higher returns within the category, given greater visibility and increased obviousness for potential customers/consumers (Andrews & Smith, 1996; DeLuca & Atuahene-Gima, 2007). Though they considered marketing programs and not specifically new products, Andrews and Smith (1996) affirm the link between 'novelty' and performance. When a new product has greater obviousness and novelty it should command more purchase intent (purchase and repurchase), loyalty, market share, sales, and accordant profit contribution for the innovating firm (Im & Workman, 2004; Moorman, 1995). Given that new product performance is measured as a combination of the new product's ability to reach market share, sales, profit margin and investment return targets (Brown & Eisenhardt, 1995; Moorman, 1995), it is expected that new product novelty will be positively related to new product success. This relationship between novelty and performance has been considered in the literature,

though not specifically regarding new product novelty and new product performance. This hypothesis is tested empirically herein.

H8: New Product Novelty will be positive related to New Product Performance.

CHAPTER 4: METHOD

4.1 Measures

4.1.1 Measure Development and Pretest The constructs, measures, and items in the proposed model were developed by using and/or slightly modifying items from existing scales in the literature from prior research (see Table 1; Appendix B). The literature review confirmed conceptual and face validity of the measures, items, and variables to be used for the model, to be proposed to respondents in a questionnaire survey instrument. A pretest of the resulting questionnaire (which included scales already tested for reliability and validity and existing in prior literature) was conducted through administration of the questionnaire as well as informal interviews with two individuals who were familiar with the present research issues as well as the context under investigation. These two field pretests and discussions aided in the provision of face, content, internal, external, criterion-related, and construct validity to the measures, hypotheses, and theoretical model proposed in this research, despite all the measures having had precedence in the literature and having been tested in prior research for reliability and validity (Churchill, 1979). These individuals also suggested modifications to the items (clarity, simplicity and omission) and made some scale inconsistencies and difficulties readily evident by virtue of their attempt to complete the questionnaire, which allowed for further modification, clarification and/or item elimination. The survey instrument ultimately used is in Appendix A.

The pertinent references, construct reliability values, and definition for each of the empirical measures used in this research are in Table 1, and an itemized review is also in Appendix B. The descriptive statistics for the individual measures are listed in Table 5. The pretesting phase (survey pretests [n=2]) was helpful in refining some of the

hypotheses and the theoretical model proposed. A pilot study was deemed unnecessary because all measures used had precedents in the literature and had already been tested – and in most cases retested – for efficacy, reliability and validity by virtue of use in consecutive studies. Please refer to Table 1 for the measures used in this research, the reliability values for constructs where applicable, the pertinent literature sources from which the measures were drawn, as well as the definition of each. The references from which the items were drawn more specifically can be seen in Appendix B.

Following are descriptions of each of the measures, justification for why they were pertinent to the theoretical model proposed, and a synopsis of how measures were synthesized and conceptualized. Please also refer to Chapter 1, Table 1, and Appendix B for further support.

4.1.1.1 Knowledge Integration Mechanisms Knowledge integration has been considered empirically in the literature by DeLuca and Atuahene-Gima (2007), Zahra, Ireland, and Hitt (2000) and Zahra and Nielsen (2002), and the characteristics of those measures are reflected in the items used for each of the specific KIMs identified in this research.

The first KIM of 'Explicit Direction' has precedence in the literature and was taken from the conceptual and empirical works of Demsetz (1991), Grant (1996b), and Sethi & Iqbal (2008) in order to measure the defining qualities of this construct: there was explicit communication between individuals, a definitive leader or leadership was evidenced in the group, clear and explicit protocol was to be followed, formal criteria for interaction among/between team members was evidenced, and instructions and directions were given to each member of the new product development team throughout the period in which they worked together. (5 items used, construct reliability of 0.84)

TABLE 4
Population and Sample Characteristics

SIC Code	% of Firms Sampled	Number of Employees	% of Firms Sampled	Average Sales Volume (000s)	% of Firms Sampled
35: Industrial Machinery and Equipment Manufacturing	39.9%	Micro (≤4)	19.8%	C$911	27.5%
36: Electronic and Other Electrical Equipment Manufacturing	36.9%	Small (5-99)	26,1%	C$1015	41.4%
37: Transportation Equipment Manufacturing	23.2%	Medium (100-499)	53.6%	C$1433	30.8%
		Large (500+)	0.6%	C$3916	0.3%
Total Responses	157		157		157

The second KIM of 'Organizational Routines' has precedence in the KBV literature wherein the measures are based on the conceptual work of Grant (1996b) and empirical work of Polanyi (1966). These items are also intended to reflect the defining characteristics of the construct: that team members would work together seamlessly without necessarily having to communicate explicitly about the process or objectives, that roles were institutionalized adequately for individuals to operate within their respective role requirements, and that personnel seem to have a behavioural script for how to interact and go about the process of new product development. (4 items used, construct reliability of 0.79)

The third KIM entitled 'Adhocracy' was borrowed from Moorman's (1995) empirical measures of a culture of adhocracy (see also Deshpande, Farley, and Webster, 1993) that capture the main qualities of this construct: that team members could be

characterized as entrepreneurial in their actions, that team members could make independent and autonomous decisions, that team members were willing to stick their necks out and take risks, that governance, job titles and responsibilities were relatively fluid and non-institutionalized, that there is a strong preference for being first-to-market, that team members were generally focused externally, toward the market (as opposed to within, internally focused). (Total of 8 items used, construct reliability of 0.92)

4.1.1.2 Characteristics of Knowledge The characteristics deemed most pertinent to the KIMs under consideration in this study were those of Uniqueness, Tacitness, and Dynamism of knowledge, and the three main premises of the contingency theory presented are interactions in which each of the KIMs would work best with each of these types of knowledge (Please see Table 2): that explicit direction (ED) would work best with unique knowledge (KU), that Organizational Routines (OR) would work best with tacit knowledge (KT), and that Adhocracy (AD) would work best with dynamic knowledge (KD).

The first characteristic of knowledge investigated is that of 'knowledge uniqueness' and is based on the empirical scale used by Bou-Llusar and Segarra-Cipres (2006), which identifies the key dimensions of uniqueness of knowledge: that team members have fundamentally different types of knowledge, that members brought unique insights or perspectives to the team throughout the new product development process, that there was a lack of overlap between what any two team members know, that team members typically evidenced dissimilar insights, perspectives, or knowledge. (5 items used, construct reliability of 0.77)

The second characteristic of knowledge considered is that of 'knowledge tacitness' and is based on the conceptual and empirical measures used in the work of DeLuca and

Atuahene-Gima (2007), Grant (1999), Reed and DeFillippi (1990) and Simonin (1999). These items (7 items used, construct reliability of 0.83) were chosen based on reflectiveness of the defining characteristics of the construct: that team members had knowledge they couldn't necessarily describe explicitly or verbally, that team members had know-how that wasn't easily communicated, explained or transferred, and that team members had knowledge that might be described as implicit, hard to document, and hard to identify without personal familiarity with it. Tacit knowledge has to be learned first-hand and comes from active experience engaging in certain contexts in which it is useful.

The third characteristic of knowledge considered was that of 'dynamism of knowledge,' which stems from the conceptual and empirical measures in the works of Achrol and Stern (1988, 1991), Aldrich (1979), Bou-Llusar and Segarra-Cipres (2006). Defining characteristics of this construct include that the environment and the knowledge required to manage the environment were continually changing and being updated, that knowledge, behaviours, and activities were acknowledged to be changing on a continual basis with information and knowledge quickly being outdated and requiring ongoing information collection and knowledge updating, and that team members observed a change in their own and others' information and knowledge throughout the time period of the new product development process. (7 items used, construct reliability of 0.85)

4.1.1.3 New Product Novelty Novelty in the new product development process is a measure of the level of novelty or newness of the resulting product developed. The items used to measure this stem from the marketing and new product development literature and are developed and used by Im and Workman (2004), among others who have used the same scale (see also Calantone and Cooper, 1981; Cooper, 1979; Kleinschmidt and

Cooper, 1991, etc.). The items used (6 items, construct reliability of 0.88) were chosen based on popularity in the literature and in order to reflect the defining characteristics of this construct: that resulting product developed through the new product development process could be considered novel to the category, industry, firm, and/or team, that the innovation was based on improvement or revolutionary changes in technology, and that products produced might be described as 'out of the ordinary.'

4.1.1.4 New Product Development Speed The new product development speed involves the efficiency with which the team works and how fast the product development is brought to market. The measures used (3 items used, construct reliability of 0.78) are precedented in the literature and are intended to test how quickly and efficiently the team is able to go from the initial conceptualizing phases of the project to launching the product on the market (Atuahene-Gima, 1995; Atuahene-Gima & Murray, 2004; Moorman, 1995). The qualities inherent in these items are that relative to the norm for the focal firm, team, or industry, the most recent new product development process took longer, and that the team was efficient in moving through the phases of new product development quickly. Also, the informants were asked to report on how long it took from beginning phases of new product development to availability on the market (in months, weeks, or days).

4.1.1.5 New Product Market Performance The market-based consequences of the new product development process are of interest in this model. Based on measures established in the literature (see DeLuca and Atuahene-Gima, 2007; Deshpande, Faley, Webster, 1993; Im and Workman, 2004; Joshi and Sharma, 2004; Matsuno, Mentzer, Ozsomer, 2002), this construct had items (4 used) that investigated the proportion of

market share, profit margin, sales targets, and return on investment reached in-market in the first year

4.1.1.6 Controls Research design--which controlled for industry type, functional role within the organization, geographic territory, political environment, currency used, type of innovation, state of the economy, rate and quality of interaction—controlled for some of the potential confounds of this research, where specific scales (which controlled for innovation type within firm, team duration, industry type, and team size) controlled for others Further discussion regarding controls included pre-, during, and post-data collection and analysis is included below

TABLE 5
Correlations and Descriptive Statistics (N = 157)

Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Explicit Direction	1 00															
2	Organizational Routines	18	1 00														
3	Adhocracy	03	- 12	1 00													
4	Knowledge Uniqueness	09	16	17	1 00												
5	Knowledge Tacitness	- 11	14	16	14	1 00											
6	Knowledge Dynamism	- 08	- 06	24	13	18	1 00										
7	NP Novelty	- 03	- 09	28	04	17	15	1 00									
8	NPD Speed	27	24	25	12	- 15	04	18	1 00								
9	Team Size	17	21	23	17	08	11	15	03	1 00							
10	Innovation Type	03	17	31	19	13	15	03	07	01	1 00						
11	Industry Type	09	03	04	13	06	08	01	04	02	09	1 00					
12	Tenure	19	29	05	24	23	01	12	18	08	07	01	1 00				
13	Market Share	08	05	08	01	01	- 03	21	28	03	03	08	05	1 00			
14	Sales	03	03	08	06	03	01	22	27	06	04	07	05	26	1 00		
15	Profit Margin	07	06	03	- 03	02	- 06	28	31	09	08	05	07	09	07	1 00	
16	ROI	05	01	09	02	01	- 01	32	23	03	01	03	07	07	03	27	1
Means		5 8	4 7	5 1	5 5	6 1	5 3	5 6	4 7	3 7	3 9	NA	3 5	2 1	2 6	3	1
Standard Deviation		1 3	2 1	9	1 3	8	7	1 3	6	1 6	1 9	NA	8	2 2	2 3	2 7	1
Number of Items		5	4	8	5	7	7	6	3	1	1	1	1	1	1	1	1
Construct Reliability		84	79	92	77	83	85	88	78	NA	NA	NA	NA	NA	NA	NA	N

Notes All correlations > 0 14 (0 19) are statistically significant at $p < 0\ 05$ (0 01)
NA = Not applicable

4.2 Research Context, Design, and Administration

4.2.1 Population, Sample, and Sampling Frame The sampling frame in this study included marketing project managers of divisions of the top manufacturing firms in terms of total sales revenue, in Canada. Specifically, the respondents were drawn from firms that fell into the Standard Industrial Classification codes of 35 (machinery and equipment manufacturing), 36 (electronic and other equipment manufacturing), and 37 (transportation equipment manufacturing).

These industries were chosen specifically because they have precedence for this kind of work in the literature (e.g. Heide, 1987; Joshi, 2009; Joshi & Sharma, 2004). Also, these industries have characteristics that are valuable for controlling for extraneous confounds, as examples, according to Industry Canada's most recent survey of such industries (Statistics Canada, 2008), 1) they have been shown to develop new products on a regular and continual basis (not as sporadically as in some industries), 2) firms in these categories are business-to-business (as opposed to business-to-consumer) operators that would follow more conservative-derived demand curves (as opposed to consumer demand curves) for their new and existing products and thereby have less variation or fluctuation in demand (and, accordantly, supply) for their new and existing product offerings (Heide, 1987)—industry turbulence and innovation-rate consistency were important to control for as part of the sampling frame, 3) the manufacturers in these categories all produce/offer tangible products exclusively in the marketplace (no commodities, services, etc.), meaning that in terms of their marketplace offerings, they were homogeneous within-firm (produce new *products* every episode of NPD, do not also have other lines of business that confound their business model) and between-firm (none of the respondents could come from a mixed-business, mixed-innovation-type

firm), which was important to control for in the sample frame, and 4) there was an adequate number of firms in each category, in Canada, for sampling purposes (response rates are never 100%), which was important for collecting a controlled, equally distributed, and large enough sample (Statistics Canada, Canadian Business Partners Database, December 2008). Because this research investigates the *type* of knowledge integration mechanism in use, and not the frequency or intensity of those variables, frequency of team member interaction, practice effects, and quality of interaction were controlled for in the sample design. First, according to Industry Canada data (2008), each of these categories has fairly consistent rates of new product development, and are all very similar, allowing that cross-functional team characteristics and interactions could be expected to be relatively homogenous across each SIC. Prescreening with participants for potential confounds, as well as explicit control variables of 'team duration' (practice effects, familiarity), 'size of team' (the number of individuals and thereby expected quality of relationship and interaction were held constant), and 'industry type' (SIC 35, 36, 37) and 'innovation type' were controlled for. Further, respondents were asked to complete the questionnaire conceptualizing only the most recent incidence of new product development—which according to the consistency within and between categories regarding new product development should eliminate several potential confounds and serve to homogenize the sample population. Lending further support to the present research design and inquiry, both Ittner and Larcker (1997) and Griffin (1997) stress the importance of researching cross-functional teams for inquiry into new product development. Please refer to Table 4 for some descriptive statistics regarding the population and sample under investigation.

4.2.2 Questionnaire Administration Procedure and Surveying A cross-sectional, survey-based research design was used to test the conceptual model and hypotheses proposed in this research. The Dun & Bradstreet database contained the name, mailing address, and telephone numbers of people in the sampling frame.

In order to improve response rates, each potential respondent was telephoned in advance to inform them of the research objectives of this project, as well as to solicit their participation. Managers who would serve as respondents had to be able to be key informants on recent new product development projects in which they were active participants and that were typical of new product development projects that occur in their respective firms. Initial telephone contact with potential respondents was also to assess whether they were in fact appropriate as informants for this research.

Of the 1000 people in the database, contact was made with 543 of them in the early spring of 2010. Of these, 412 expressed interest and agreed to participate in the study. The survey was administered over the telephone post-consent-signing, as such methodology ensures that 1) respondents are arms-length to the researcher and are therefore less susceptible to some response biases, 2) respondents are granted and sure of the confidentiality and privacy of their involvement in the study, and 3) there is minimal intrusion into the working lives of respondents such that they are not overburdened by—or lacking productivity due to—their participation in the study. The surveying was closed eight weeks after the initial contact was made, with 157 complete responses after three reminders, for a response rate of 28.9% (157 completed responses out of 543 potential).

4.2.3 Key Informant Research Justification This research follows precedent for new product development research following the methodology of Sethi, Smith and Park

(2001), who assert that marketing project managers play a driving, critical, pivotal role in new product development projects within the firm and are thereby the most critical key informants for cross-functional new product development research. Sarin and Mahajan (2001) also advocate for key informants when investigating new product development teams, given that this makes between-team comparison easier; triangulation can give rise to other confounds. Wherein Sethi et al. (2001) would argue that marketing project managers are the most critical respondents from an NPD team, Ayers, Dahlstrom, and Skinner (1997) indicate that cross-functional team members, by virtue also of being in the same organization and having self-selected into the same industry for their career, will each have similar experiences on the cross-functional new product development team. Also, Ayers et al. (1997) refer to but do not confirm the understandable logic that because cross-functional NPD teams have to come to consensus prior to taking action and launching products, NPD team members would have like experiences during the project. Accordingly, the survey respondents were marketing project managers of the cross-functional new product development team, as adequate understanding can be gleaned from surveying them, while they are understood to be most knowledgeable about team events and processes, and are often used in key informant research (see also Cini, Moreland and Levine, 1993; Cooper, 1998). Ancona & Caldwell (2007) refer to the marketing project managers and leaders of cross-functional new product development as team 'ambassadors,' understood not only to be the most knowledgeable about team activities, but also to have the most contact and interaction with each of the other members on the team. The context chosen to investigate knowledge creation through individual knowledge transfer and integration is in NPD teams working in product-producing firms.

4.2.4 Respondent Knowledgeability Bias Testing Key informant research can be susceptible to difficulties with common method, non-response, or knowledgeability biases. The surveys administered herein involved key informants who are assumed to be knowledgeable about the concepts and issues included in the survey. The validity of the data is compromised if respondents do not know enough about the concepts and issues included in the survey and lack of knowledge on the part of respondents can cause systematic error in the resulting data. Knowledgeability was determined 1) through prescreening telephone interviews in which respondents were asked about their knowledge of the subject under investigation, 2) by requiring them to report on a cross-functional new product development project they were personally involved in within their organization, and 3) by asking them to self-report how much their level of knowledgeability was associated with cross-functional new product development projects. Respondent knowledgeability was tested and found overall to be 4.6 out of a possible 5 points, which is favourable for this survey administration. These procedures together provide reasonable confidence that the respondents are adequately knowledgeable regarding the topic under investigation and thereby do not compromise the validity of the data by virtue of poor informant knowledgeability (see Kumar, Stern & Anderson, 1993).

4.2.5 Common Method Variance Testing Common method bias or common method variance (CMV)—artificial inflation of correlation or relatedness between independent and dependent variables—is another difficulty when asking the same informant to answer questions associated with all variables in a study. This was controlled for in this study via research design as well as statistical methods (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003). From a research design perspective, this bias was

controlled for by ensuring that respondents' identities were anonymous and private (arms-length telephone interviews, confidentiality and ethics documentation was signed), surveying was done in a courteous, convenient and calm manner in order that respondents were at ease while answering survey questions, and questions were rigorously pretested and copy edited to be easily understood by respondents. Furthermore, measurement of dependent and independent variables were separated temporally in order that respondents were not consciously or unconsciously likely to inflate relatedness of predictor and criterion variables (see Podsakoff et al., 2003) and so that some amount of unconscious forgetting/memory decay could occur that would further separate cognitive relatedness of constructs/concepts.

Statistically, single-factor analysis was conducted that would allow investigation as to whether any singular factor accounts for the majority of the covariance between predictor and criterion variables (Podsakoff et al., 2003). Harman's one-factor test was conducted (Podsakoff et al., 2003) via three successive exploratory factor analyses (EFAs). The first EFA measured the independent variables (KIMs of ED, OR, AD) and explained 72% of total variance, with the first factor accounting for only 27% of the variance. The second EFA measured the moderating variables (knowledge characteristics of KT, KU, KD), and explained 69% of total variance, with the first factor accounting for only 24% of the variance. The third EFA measured the dependent variables (NP novelty, NPD Speed), and explained 73% of total variance, with the first factor accounting for only 21% of the variance. Together, no singular factor accounts for much of the covariance, indicating little evidence of any common method bias/variance difficulties in this research.

This said, in accordance with standards set by Rodriguez-Escudero, Carbonell, and Munuera-Aleman (2010), among others, further investigation is required given that Harman's single-factor analysis does not have sufficient sensitivity to assess slight levels of common method variance biases. Using a market variable technique pioneered by Lindell and Whitney (2001), a marker variable (team size, in this case) that was deemed theoretically unrelated to the other variables is correlated with other variables in the model. Relatedness of any of these two would indicate the presence of common method bias.

Results indicate that the values in Table 5 (Correlation and Descriptive Statistics) did not vary significantly even after the marker variable of team size was taken into account and its significance was subtracted from the other variables in the model. The marker-variable technique, the Harman's one-factor and EFAs, as well as the research design and procedural precautions all contribute to the conclusion that common method biases—among other potential biases and confounds—did not contribute significantly to the data collected for this research.

4.2.6 Non-Response Bias Testing Finally, non-response biases can also be a problem in any survey in which individuals informing the dependent variable differ from the population they represent, possibly in some systematic way. This was assessed by comparing respondents and non-respondents (matched for sales volumes, category type, and number of employees). Please refer to Table 4 for statistical data regarding population and sample characteristics. Also tested, were early and late informants for their responses on major constructs according to precedented statistical testing methods for such biases (Armstrong & Overton, 1977). There was no statistical significance in

any of these t-test results, allowing that there is no significant evidence of non-response bias in this survey research.

CHAPTER 5: RESULTS

5.1 Further Validation of Measures and Model

The measures were validated by deleting items with low item-to-total correlations or those that demonstrated significant cross-loadings in the EFAs. The scale items were consolidated using a weighted average. After the EFAs, the data was then submitted to confirmatory factor analysis (CFA) in order to validate the measures being used in the model. Because the number of responses (N=157) means there were not five observations per item (which would have required an N of 265), it was not possible to submit the data to structural equation modelling in order to be able to perform a global CFA. Instead, separate CFA models were executed separately.

The first CFA model (Step 1) examined the validity of the antecedent constructs in the research model (Model 1.0) of Explicit Direction (ED, 5 items), Organizational Routines (OR, 4 items) and Adhocracy (AD, 8 items). The results show a statistically significant chi-square (χ_2 = 268.43, degrees of freedom [d.f.] = 116, $p < 0.001$), that Thompson (2004) indicates is of limited usefulness for testing a singular model's fit to expected data. Thompson argues that chi-squares are most useful for model-to-model comparisons only, and that other fit indices should be considered predominantly for determining the fit between expected and observed values in the data. Accordingly, the other fit indexes (average off-diagonal standardized residual [AOSR] = 0.03, normed fit index [NFI] = 0.91, non-normed fit index [NNFI] = 0.93, and a comparative fit index [CFI]

= 0.96) all provided evidence of a good fit of the model to the data, thereby confirming the validity of the measures of KIM constructs.

The second CFA model (Step 2) examined the validity of the characteristics of knowledge (KU = 5 items, KT = 7 items, KD = 7 items) used in this research. The results again show that while there was a statistically significant chi-square (χ_2 = 308.77, d.f. = 149, $p < 0.01$), the other fit indexes (AOSR = 0.04, NFI = 0.92, NNFI = 0.93, CFI = 0.94) provide evidence of a good fit of the model to the data, thereby confirming the validity of the measures of knowledge characteristics used in this research and model.

The third CFA model (Step 3) examined the validity of the outcome constructs of new product development speed (3 items) and new product novelty (6 items) in the research model. Despite a statistically significant chi-square (χ_2= 41.01, d.f. = 26, $p < 0.05$), the other fit indexes (AOSR =0.01, NFI =0.94, NNFI =0.95, CFI =0.98) provide evidence of a good fit of the model to the data, thereby confirming the validity of the measures of new product development speed and new product novelty.

Given that the construct reliability of each model construct was relatively high (refer to Table 5), coupled with the statistically significant item loadings (refer to survey instrument in Appendix A), there is evidence for good convergent validity. To test discriminant validity of the measure, the construct correlations and all the free models were each sequentially (and independently) constrained to fixed models. In each case, the chi-square of the constrained model was greater than that of the free model (the smallest chi-square difference was χ = 83.07, d.f. = 1, $p < 0.001$) indicating that the free model provides a better representation of the data than do any of the constrained models.

These results provide evidence for the discriminant validity of the measures (Gerbing and Anderson, 1988). In addition, the results from the exploratory factor analyses (EFAs) also provide evidence for the discriminant validity of the measures being examined in simultaneity. EFA 1, measuring the independent, knowledge integration factors, explained 72% of total variance, where the first factor accounted for only 27% of variance. EFA 2, measuring moderating knowledge characteristics factors, explained 69% of total variance, where the first factor accounted for only 24% of variance. EFA 3, measuring dependent, new product development outcomes (speed and novelty), explained 73% of total variance, where the first factor accounted for only 21% of variance.

Because many factors emerged from the factor analysis and the first factors never accounted for more than 27% of total variance, common methods bias does not appear to exist in the data (Menon, Bharadwaj, Adidam, & Edison, 1999). The correlation matrix and descriptive statistics for the study variables are in Table 5.

The new product performance items (measures 13-16 in Table 5) were collected in percentages. The responses were coded on a Likert scale wherein 1= less than 10%, 2=10-30%, 3=30≤x<50, 4=50≤x<75, 5=75+ and so on. Please refer to Appendix A for detailed description of these transformations beside each measure.

A similar procedure was conducted on the control variables as well (measures 9-12 in Table 5). Please refer to Appendix A for further description of all measurement codification associated with each measure and/or item, as well as the factor loadings for each item.

TABLE 6
New Product Development Speed:
Effects of Knowledge Integration Mechanisms and
Knowledge Characteristics

		Step 1	Step 2	Step 3
Independent variables	Hypothesis			
Team Size		01 (t= 27, p = n s)	01(t= 27, p=n s)	01 (t= 23, p = n s)
Innovation Type		06 (t= 83, p=n s)	03 (t= 51, p=n s)	02 (t= 43, p=n s)
Industry Type		02 (t= 44, p=n s)	01(t= 26, p=n s)	01 (t= 26, p=n s)
Team Tenure		16 (t=1 79, p< 05)	15 (t=1 73, p< 05)	12 (t=1 46, p < 10)
Explicit Direction (ED)	H1 Supported		23 (t=2 42, p< 01)	22 (t=2 30, p< 01)
Organizational Routines (OR)	H3 Supported		21 (t=2 19, p< 01)	19 (t=1 99, p< 01)
Adhocracy (AD)	H5 Supported		23 (t= 2 44, p< 01)	21 (t=2 19, p< 01)
Knowledge Tacitness (KT)			- 10 (t=-1 25, p = n s)	- 08 (t= 96, p=n s)
Knowledge Uniqueness (KU)			08 (t=1 01, p=n s)	03(t= 50, p=n s)
Knowledge Dynamism (KD)			02 (t= 45, p=n s)	01 (t= 27, p=n s)
ED X KT	H1a Supported			- 26 (t=-2 71, p< 01)
ED X KU	H1b Supported			19 (t=1 99, p< 01
ED X KD	H1c Not Supported			03 (t= 51, p=n s)
OR X KT	H3a Supported			18 (t=1 91, p< 05)
OR X KU	H3b Supported			33 (t=5 09, p< 001)
OR X KD	H3c Supported			25 (t=2 63, p< 01)
AD X KT	H5a Supported			- 18 (t=-1 91, p< 05)
AD X KU	H5b Supported			- 19 (t=-1 99, p< 01)
AD X KD	H5c Supported			22 (t=2 30, p< 01)
Change in r^2		04	10	26
Adjusted r^2		01	09	31

Note Cells include standardized beta (t-value one tailed *p*-value)

TABLE 7
New Product Novelty:
Effects of Knowledge Integration Mechanisms and Knowledge Characteristics

Independent variables	Hypothesis	Step 1	Step 2	Step 3
Team Size		14 (t=1 67, p< 05)	13 (t=1 52, p< 10)	05 (t= 70, p = n s)
Innovation Type		03 (t= 51, p=n s)	02 (t= 44, p=n s)	01 (t= 26, p = n s)
Industry Type		01 (t= 26, p=n s)	00 (t= 01, p=n s)	- 01 (t=- 31, p = n s)
Team Tenure		11 (t=1 31, p< 10)	09 (t=1 11, p=n s)	05 (t= 70, p=n s)
Explicit Direction (ED)	H2 Not Supported		- 03 (t=- 56, p=n s)	- 03 (t=- 56, p=n s)
Organizational Routines (OR)	H4 Not Supported		- 07 (t=- 96, p=n s 0	- 03 (t=- 53, p = n s)
Adhocracy (AD)	H6 Supported		26 (t=2 71, p< 01)	23 (t=2 42, p< 01)
Knowledge Tacitness (KT)			13 (t=1 52, p< 10)	09 (t=1 11, p=n s)
Knowledge Uniqueness (KU)			01 (t= 27, p = n s)	01 (t= 26, p=n s)
Knowledge Dynamism (KD)			09 (t=1 11, p=n s)	09 (t=1 11, p=n s)
ED X KT	H2a Not Supported			03 (t= 51, p=n s)
ED X KU	H2b Not Supported			07 (t= 92, p=n s)
ED X KD	H2c Supported			- 14 (t=-1 69, p < 05)
OR X KT	H4a Supported			16 (t=1 79, p< 05)
OR X KU	H4b Not Supported			- 01 (t= 25, p=n s)
OR X KD	H4c Supported			24 (t=2 54, p< 01)
AD X KD	H6a Not Supported			03 (t= 51, p=n s)
AD X KU	H6b Not Supported			- 02 (t=- 48, p=n s)
AD X KD	H6c Supported			31 (t=3 59, p< 001)
Change in r^2		02	08	17
Adjusted r^2		02	07	22

Note Cells include standardized beta (t-value, one-tailed *p*-value)

5.2 Hypothesis Testing

Multiple regression analysis was used to test the effects of all the variables in the proposed model and the interactions that knowledge characteristics have with new product development outcomes and in-market measures (see Tables 6, 7, and 8). Please refer to these results depicted in Appendix D: Charting the Interaction Effects.

The items were given a weighted average when they were consolidated and input for each construct in the regression equations. Because all relationships were tested using regression equations, there is potential for multicollinearity (Aiken & West, 1991). In order to control for this, a mean-centring approach was taken: mean-centred data were used for the predictor variables as well as their interactions. The variance inflation factors (VIF) from the resulting regression equations used were examined. These were all relatively low, with the highest being 2.6, indicating a low probability of multicollinearity (10 is the widely accepted cut-off; e.g. Aiken & West, 1991; Neter, Wasserman, & Kutner, 1990).

Out of 26 hypotheses, 18 were supported statistically. Hierarchical moderated regression was used to test this model, wherein Step 1involved considering the control variables as well as the dependent variable, Step 2 considered the independent variables as well as the dependent variable, and Step 3 involved considering the interactions. See Table 6 for DV of New Product Development Speed and Table 7 for DV of New Product Novelty.

The results of these analyses will be discussed in the following paragraphs. A synopsis of hypotheses and results with all statistical values are also available in Tables 5, 6, 7, 8, 9 and 10. An overview of all the hypotheses and results are also available in Table 11, as well as being depicted in Figure 3.

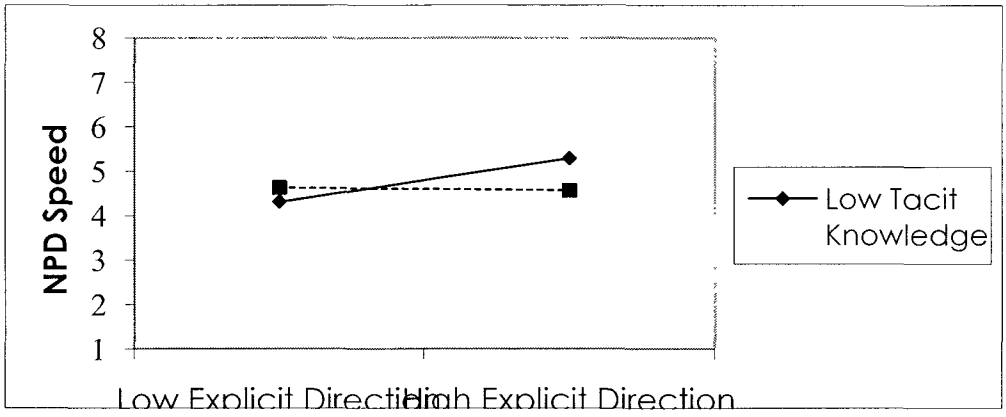
Hypotheses and Results

Variables	Knowledge Type	New Product Development Speed	New Product Novelty
Explicit Direction		H1, Positively Related, **Supported**	H2, Negatively Related, **Supported**
	Tacit	H1a, Will Attenuate, **Supported**	H2a, Will Attenuate, **Supported**
	Unique	H1b, Will Strengthen, **Supported**	H2b, Will Attenuate, **Not Supported**
	Dynamic	H1c, Will Attenuate, **Not Supported**	H2c, Will Strengthen, **Supported**
Organizational Routines		H3, Positively Related, **Supported**	H4, Negatively Related, **Not Supported**
	Tacit	H3a, Will Strengthen, **Supported**	H4a, Will Attenuate, **Supported**
	Unique	H3b, Will Strengthen, **Supported**	H4b, Will Attenuate, **Not Supported**
	Dynamic	H3c, Will Strengthen, **Supported**	H4c, Will Attenuate, **Supported**
Adhocracy		H5, Positively Related, **Supported**	H6, Positively Related, **Supported**
	Tacit	H5a, Will Attenuate, **Supported**	H6a, Will Attenuate, **Not Supported**
	Unique	H5b, Will Attenuate, **Supported**	H6b, Will Strengthen, **Not Supported**
	Dynamic	H5c, Will Strengthen, **Supported**	H6c, Will Strengthen, **Supported**
New Product Performance	N/A	H7, Positively Related, **Supported**	H8, Positively Related, **Supported**

Explicit Direction and NPD Speed

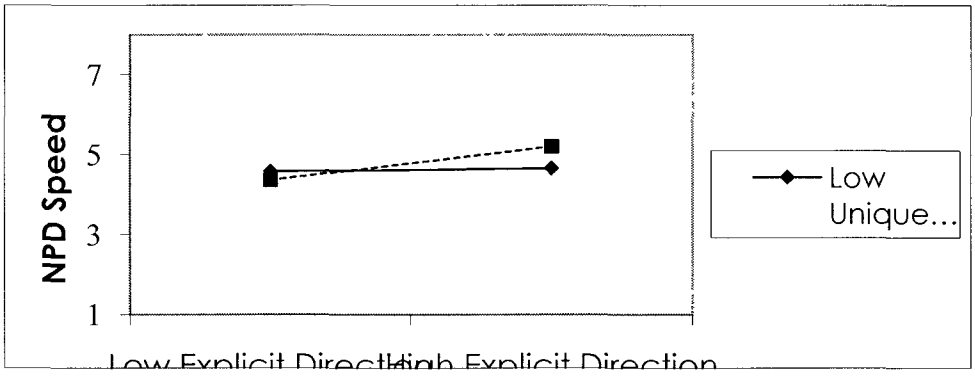
The first hypothesis was that explicit direction would be positively related to NPD speed, which was supported ($b=0.22$, $t=2.30$, $p< 0.01$). It was then conceived that tacit knowledge, which is difficult to communicate by definition, would attenuate the positive relationship between the KIM of explicit direction and new product development speed. H1a was supported ($b=-0.26$, $t=-2.71$, $p <0.01$).

GRAPH 1:
Effect of Knowledge Tacitness on ED→NPD Speed (H1a; Supported)



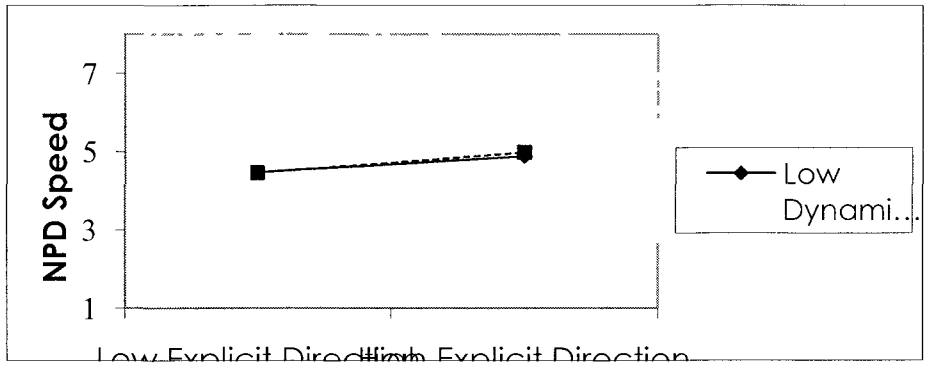
Unique knowledge was thought to increase the positive relationship between explicit direction and new product development speed, given that unique knowledge was thought to work best with explicit direction (Premise 1). H1b was supported (b=0.19, t=1.99, p <0.01).

GRAPH 2:
Effect of Knowledge Uniqueness on ED→ NPD Speed (H1b; Supported)



Dynamic knowledge was thought to attenuate the positive relationship between explicit direction and new product development speed because dynamic knowledge is thought to take longer to update, consolidate, and communicate etc. H1c was not supported (b=0.03, t=0.51, p=n.s.).

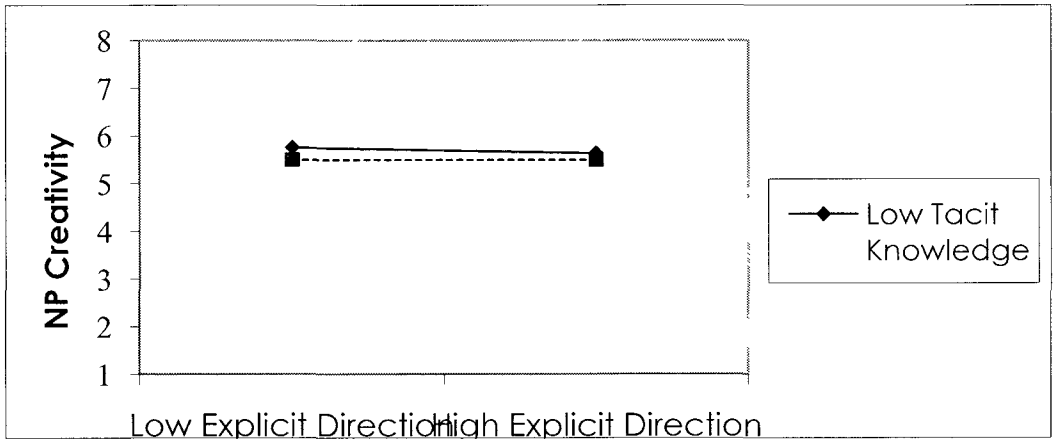
GRAPH 3:
Effect of Knowledge Dynamism on ED→NPD Speed (H1c; Not Supported)



Explicit Direction and NP Novelty

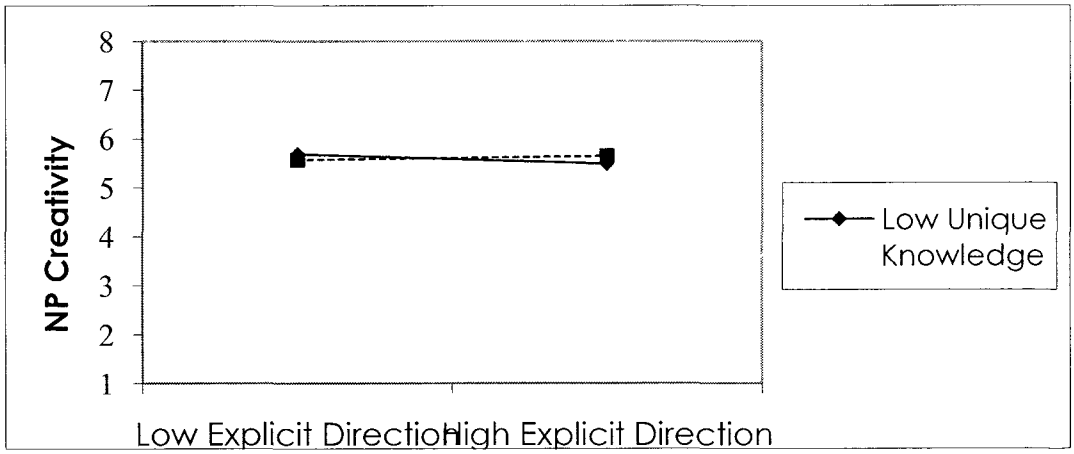
The second hypothesis was that the KIM of explicit direction would be negatively related to new product novelty given that a centralized method of instruction was thought to inhibit novel thinking on the aggregate. Though negative, H2 was not supported statistically (b=-0.03, t=-0.56, p=n.s.). Tacit knowledge was thought to attenuate the relationship between a KIM of explicit direction and new product novelty, given that tacit knowledge, by virtue of its lack of communicability, might increase novelty of thought or action, or just decrease the amount that explicitness in direction put downward pressure on novelty. Though the relationship did move from negative to positive, H2a was not statistically significant (b=0.03, t=0.51,p=n.s.).

GRAPH 4:
Effect of Knowledge Tacitness on ED→NP Novelty (H2a; Not Supported)



Unique knowledge was also expected to attenuate the downward pressure a KIM of explicit direction was thought to put on new product novelty, as each individual in the team with unique knowledge would bring a novel perspective regardless of how the team was organized or directed. H2b was positive, though not statistically significant (b=0.07, t=0.92, p=n.s.).

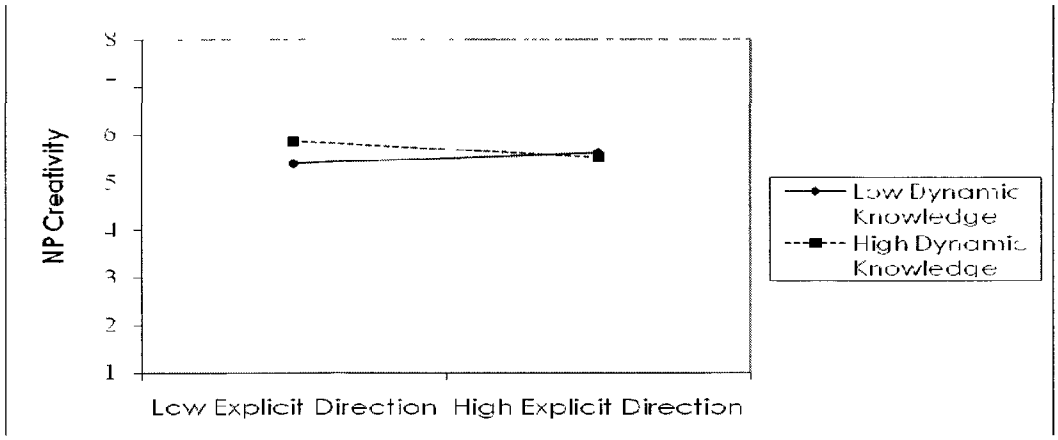
GRAPH 5:
Effect of Knowledge Uniqueness on ED→NP Novelty (H2b; Not Supported)



Dynamic knowledge was thought to strengthen the negative relationship between a KIM of explicit direction and new product novelty given that dynamic knowledge is not

expected to work particularly well with explicit direction, takes longer to update and integrate, and was thought likely to create disruption or frustration in teams using a KIM of ED, ultimately decreasing novelty. H2c was supported ($b=-0.14$, $t=-1.69$, $p<0.05$).

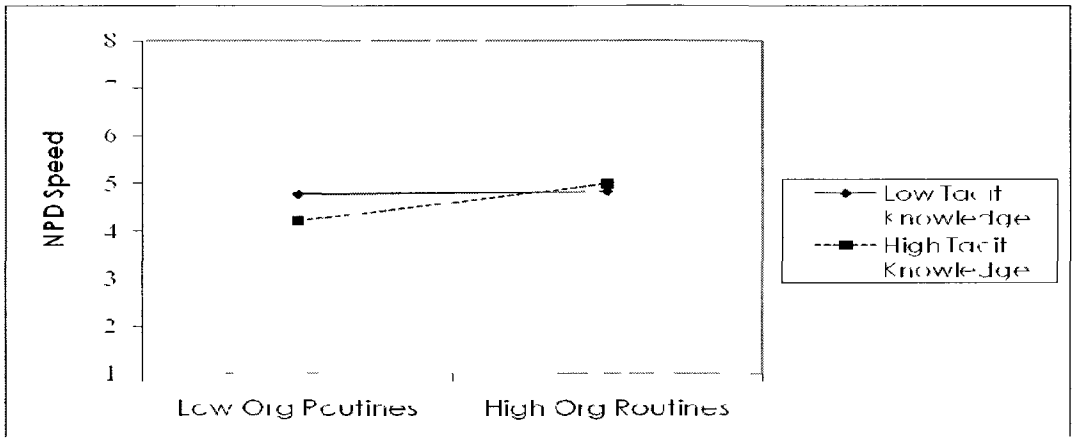
GRAPH 6:
Effect of Knowledge Dynamism on ED→NP Novelty (H2c; Supported)



Organizational Routines and NPD Speed

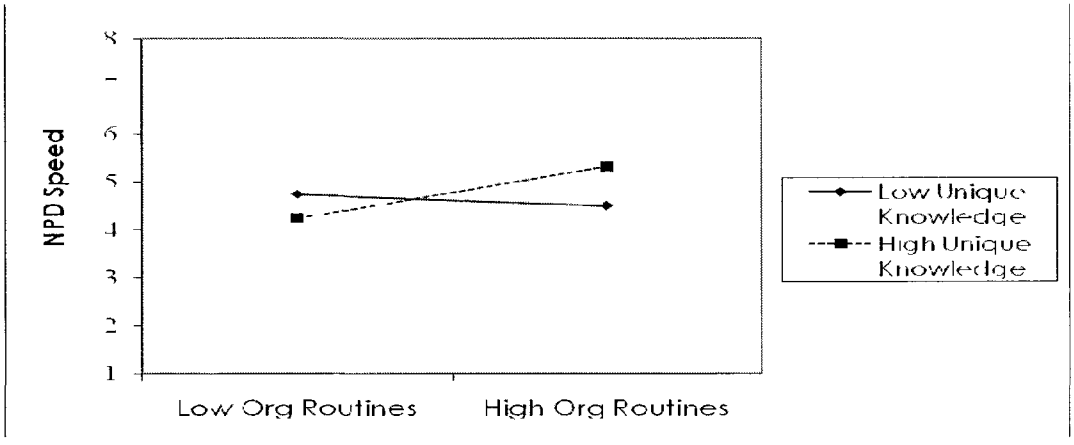
The third hypothesis was that a KIM of organizational routines would be positively related to NPD speed. It is thought that organized, routinized, institutionalized behaviours would require less time on the part of the respective team members determining roles and responsibilities. Also, given that the KIM of OR would allow members to operate in a predictable, fluid way without having to spend time communicating with others, there would theoretically be greater ease of operation, efficiency, and thereby less time would be spent in new product development phases. H3 was supported ($b=0.19$, $t=1.99$, $p<0.01$). Tacit knowledge was thought to strengthen this relationship, mostly because tacit knowledge was thought to work best with organizational routines, or in other words when organizational routines are the KIM in use, tacit knowledge is thought to be the most functional characteristic of knowledge to have present. H3a was supported ($b=0.18$, $t=1.91$, $p<0.05$).

GRAPH 7:
Effect of Knowledge Tacitness on OR→NPD Speed (H3a; Supported)



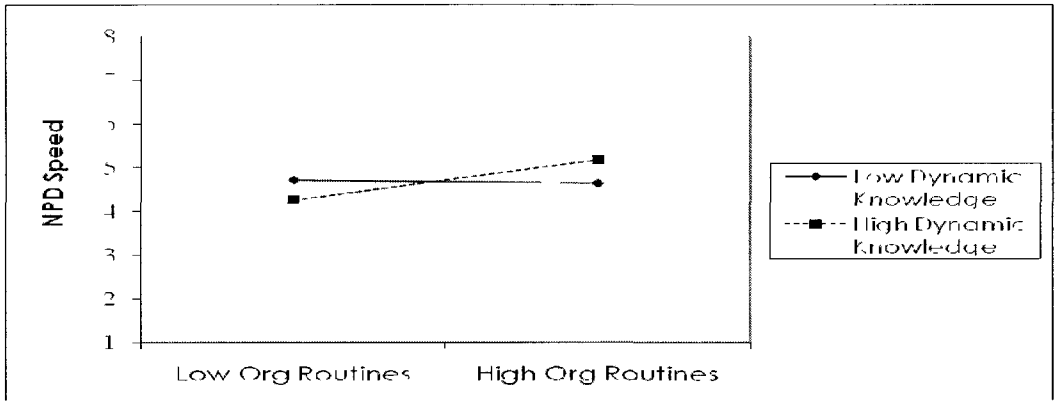
Unique knowledge was thought to strengthen the relationship between organizational routines and NPD speed, given that individuals with unique knowledge do not necessarily take time to communicate their knowledge to one another, as they know others do not know what they do. As such, little time is spent in the process of trying to transfer information or knowledge, and this type of operational predisposition is thought to work best with organizational routines as a KIM. H3b was supported (b=0.33, t=5.09, $p<0.01$).

GRAPH 8:
Effect of Knowledge Uniqueness on OR→NPD Speed (H3b; Supported)



Dynamic knowledge was thought to strengthen the relationship between organizational routines and new product development speed given that dynamism of knowledge would likely work well in a context where individuals do not have to waste much time parsing out roles or responsibilities (OR) but can promote efficiency by using pieces of an evolving knowledge set for the challenges at hand. H3c was supported (b=0.25, t=2.63, p<0.01).

GRAPH 9:
Effect of Knowledge Dynamism on OR→NPD Speed (H3c; Supported)

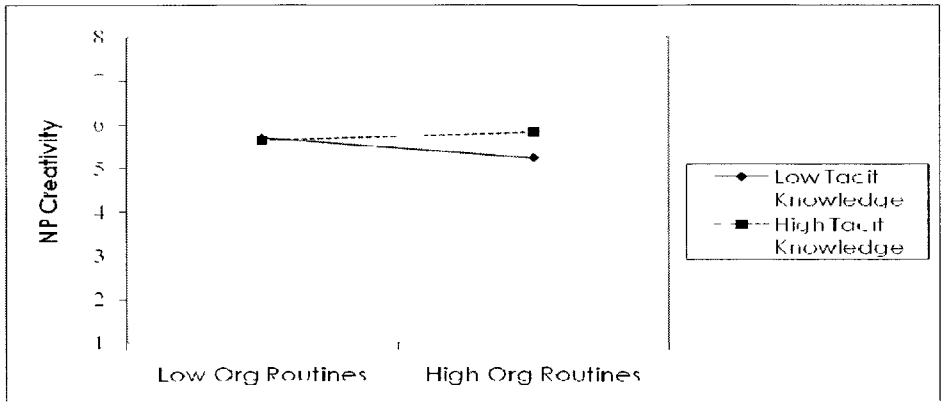


Organizational Routines and NP Novelty

A KIM of organizational routines was thought to be negatively related to novelty of new products given that organizational routines are fairly impervious to change (because of their institutionalization; Scott, 1995), which would decrease the level of novelty expected in the resulting products. This relationship was negative, though H4 was not supported statistically (b=-0.03, t=-0.53, p=n.s.). Tacit knowledge was thought to attenuate the proposed negative relationship between organizational routines and new product novelty, as it was expected that tacit knowledge would work best with organizational routines (Premise 2). Given that tacit knowledge is hard for individuals to communicate, as well as being particular to each individual, this might contribute to an

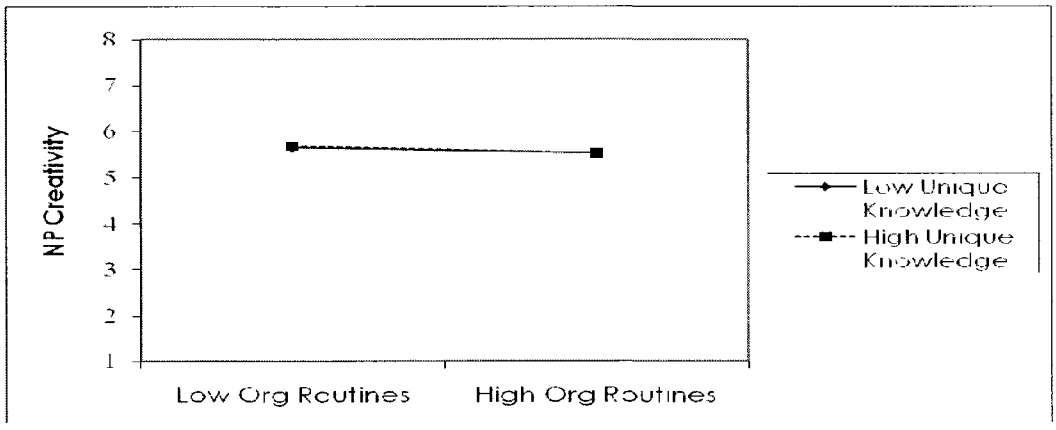
increase in novelty of the resultant new products. H4a was supported (b=0.16, t=1.79, p<0.05).

GRAPH 10:
Effect of Knowledge Tacitness on OR→NP Novelty (H4a; Supported)



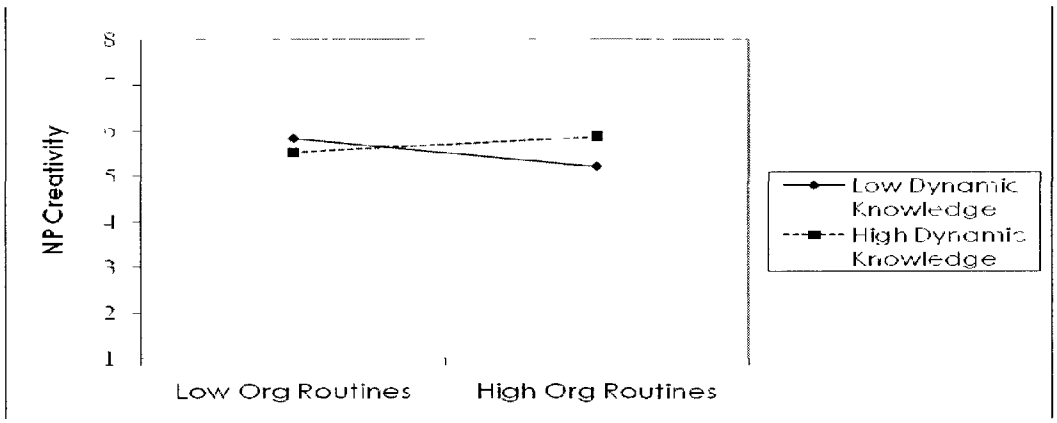
Unique knowledge was thought to attenuate the negative relationship between a KIM of organizational routines and new product novelty because unique knowledge was thought to contribute to constructive friction between individuals in the team who also do not share knowledge or information among or between them, which should logically increase the level novelty or newness of the resulting products. Unique knowledge did change the direction of the relationship between organizational routines and novelty—unique knowledge decreases the novelty under the KIM of organizational routines, rendering them negatively related—though H4b is not supported statistically (b=-0.01, t=0.25, p=n.s.).

GRAPH 11:
Effect of Knowledge Uniqueness on OR→NP Novelty (H4b; Not Supported)



Dynamic knowledge was thought to attenuate the expected negative relationship between organizational routines and new product novelty given that dynamic knowledge requires continual updating, which accommodates an influx of new information that would logically contribute to the level of novelty of the resulting products. Dynamic knowledge did increase the novelty of new products created under a KIM of organizational routines. H4c was supported (b=0.24, t=2.54, p<0.01).

GRAPH 12:
Effect of Knowledge Dynamism on OR→NP Novelty (H4c; Supported)

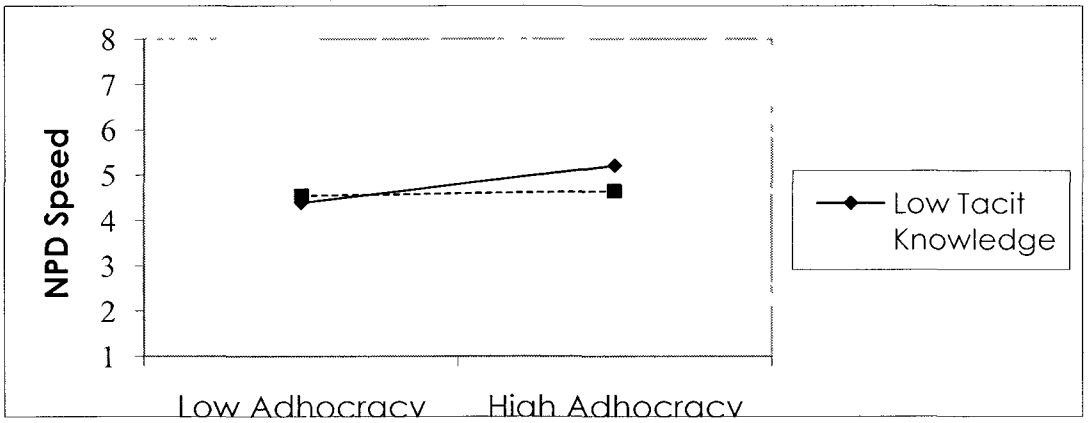


Adhocracy and NPD Speed

The fifth hypothesis was that adhocracy would allow for greater end goal orientation, autonomy, and decision-making ability on the part of group members, allowing them to come to a finished product in an efficient amount of time. H5 was supported (b=0.21, t=2.19, p<0.01).

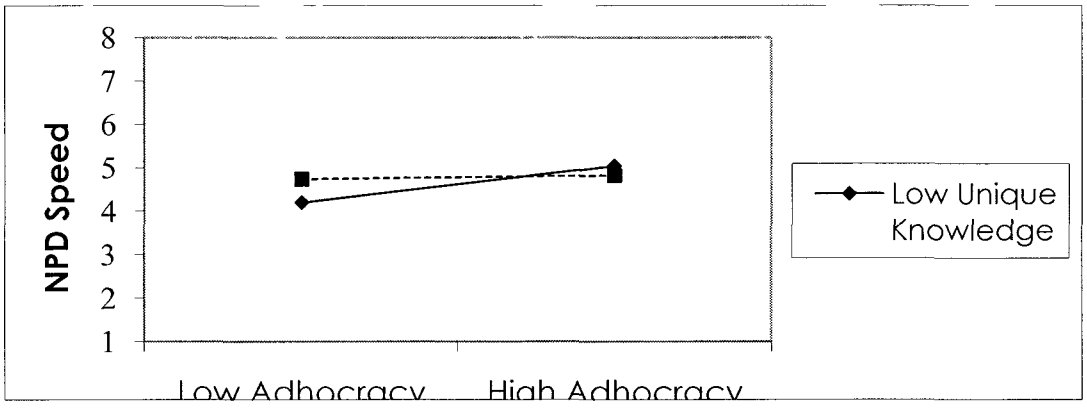
Tacit knowledge was thought to attenuate the expected positive relationship between a KIM of adhocracy and new product development speed, given that tacit knowledge might take a while to deploy in a context with a relative lack of established process, protocol, or institutionalization of role functions. H5a was supported (b=-0.18, t=-1.91, p<0.05).

GRAPH 13:
Effects of Knowledge Tacitness on AD→NPD Speed (H5a; Supported)



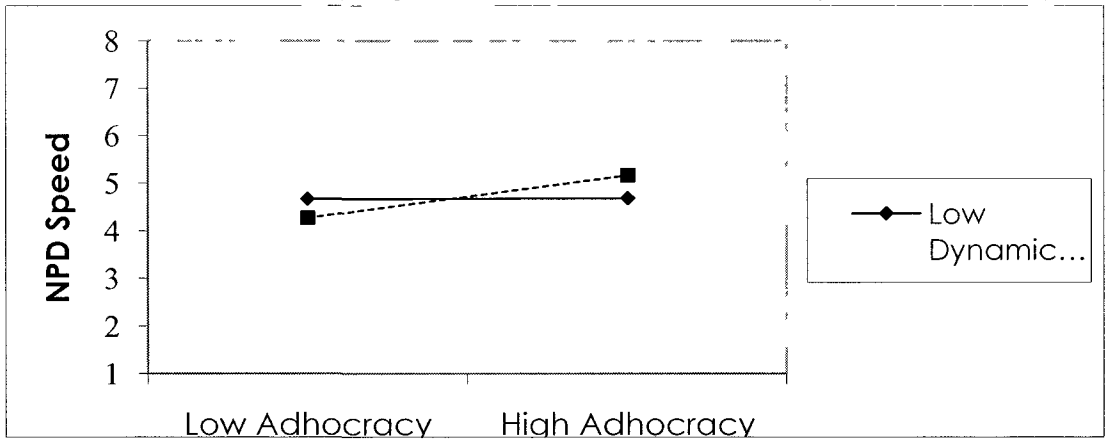
Unique knowledge was thought to attenuate the expected positive relationship between adhocracy and new product development speed given that a lack of overlap in knowledge sets is also hard to deploy in a context where individuals have little structure or organization to be able to coordinate activities toward a mutual end state (new product). Unique knowledge did decrease the speed at which team members developed a new product when adhocracy was the KIM. H5b was supported (b=-0.19, t=-1.99, $p<0.01$).

GRAPH 14:
Effects of Knowledge Uniqueness on AD→NPD Speed (H5b; Supported)



Dynamic knowledge was thought to strengthen the positive relationship between a KIM of adhocracy and new product development given that adhocracy is thought to work best with dynamic knowledge (Premise 3). Dynamic knowledge is a form of knowledge turbulence that would work best when roles, responsibilities, processes, and protocol are fairly fluid and individuals are able to make decisions as they progress in a project at their own discretion. Dynamic knowledge did increase the strength of the positive relationship between a KIM of adhocracy and NPD speed. H5c was supported (b=0.22, t=2.30, p<0.01).

GRAPH 15
Effects of Knowledge Dynamism on AD→NPD Speed (H5c; Supported)

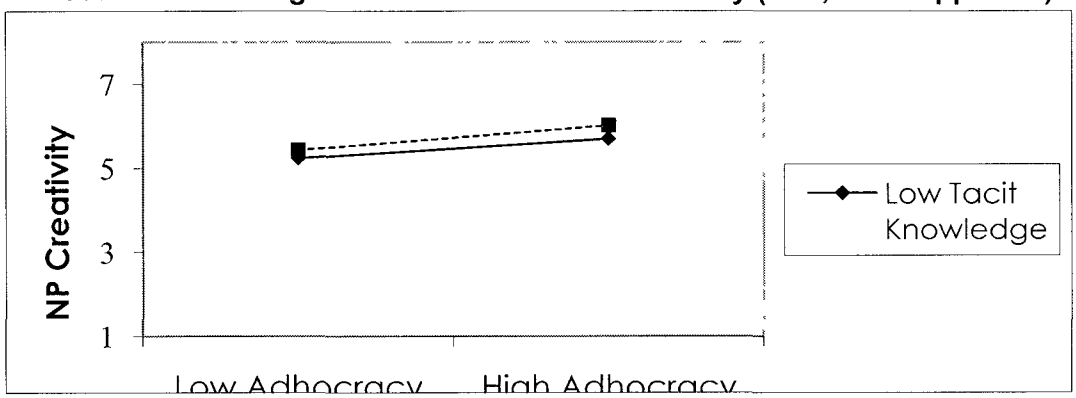


Adhocracy and NP Novelty

The sixth hypothesis was that a KIM of adhocracy would be positively related to new product novelty. This was expected given that adhocracies allow individuals to interact in unroutinized ways; such a context affords individuals the freedom to have variable influences or experiences throughout the new product development process; and adhocracies allow group members to stick their necks out, think 'outside the box,' suggest unprecedented ideas, etc. A KIM of adhocracy did promote novelty of new products developed. H6 was supported (b=0.23, t=2.42, p<0.01).

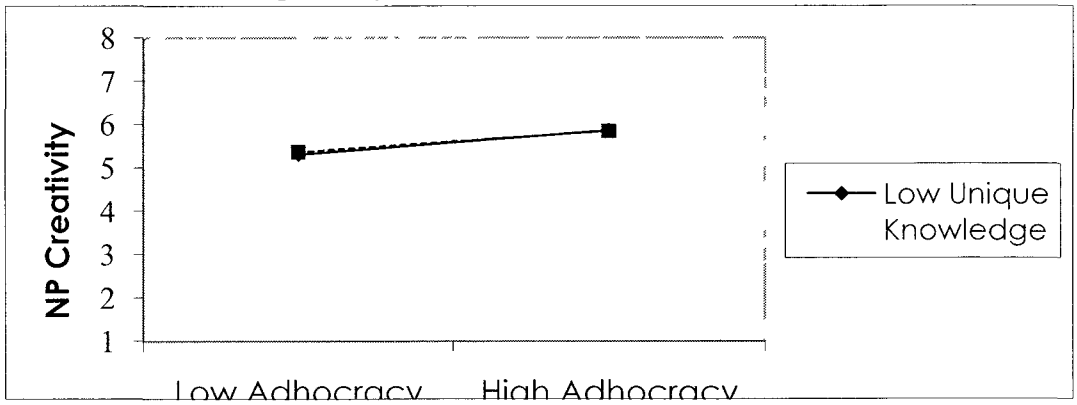
Tacit knowledge was thought to attenuate the expected positive relationship between novelty of new products and a KIM of adhocracy, given that tacit knowledge is hard to communicate, coordinate or deploy generally, and certainly in an adhocratic environment that lacks formalization, institutionalization or organization. While tacit knowledge does decrease the strength of the AD→NP Novelty relationship, it was not statistically significant in this study. H6a was not supported (b=0.03, t=0.51, p=n.s.).

GRAPH 16:
Effects of Knowledge Tacitness on AD→NP Novelty (H6a; Not Supported)



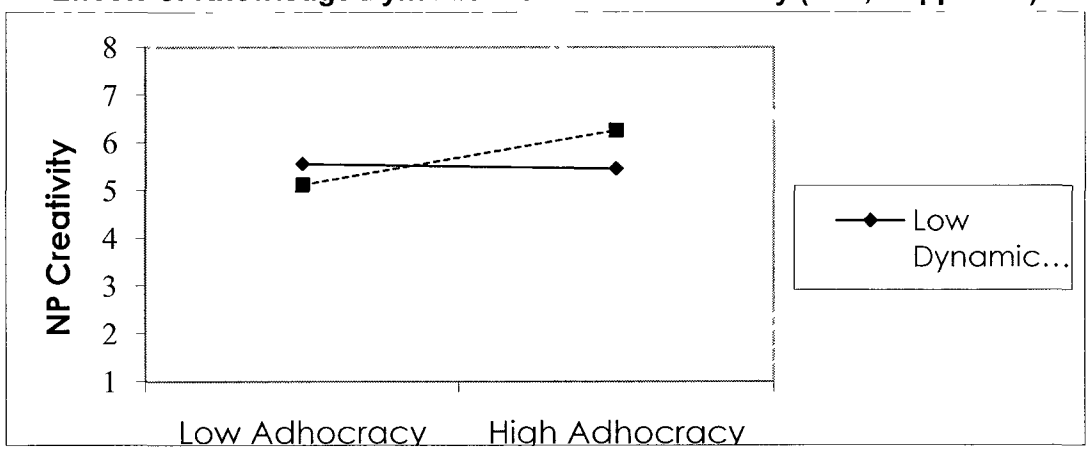
Unique knowledge was thought to increase the level of novelty of new product development given that a lack of overlap in knowledge sets of individuals on the team could increase 'creative' or 'constructive' friction, especially where individuals are free to interact fluidly such as with a KIM of adhocracy, and this would then contribute to the novelty of new product development. H6b was not supported (b=-0.02, t=-0.48, p=n.s.).

GRAPH 17:
Effects of Knowledge Uniqueness on AD→ NP Novelty (H6b; Not Supported)



Finally, dynamic knowledge was thought to increase the expected positive relationship between a KIM of adhocracy and new product novelty given that dynamic knowledge is thought to work best with adhocracy and requires continual updating allowing novel information and contributions. H6c was supported (b=0.31, t= 3.59, $p<0.001$).

GRAPH 18:
Effects of Knowledge Dynamism on AD→NP Novelty (H6c; Supported)



5.3 Evaluating the Direct Effects of NPD Process Variables on New Product Performance

The proposed model also indicates that new product development speed (3 items, construct reliability of 0.78) and new product novelty (6 items, construct reliability of 0.88) would both be positively related to new product performance (H7, H8). New product performance was a composite of four measures: market share relative to objectives, sales figures relative to objectives, profit margin contribution relative to objectives, and return on investment relative to objectives. Respondents were asked to indicate how the products had performed once they had been in-market for one year. It is conceived that new product development that is more efficient and less costly in terms of time will have better returns in terms of investment and will be more likely to be first to market in a competitive category (first mover advantages), which could help with sales and market share figures.

New product development was positively and significantly related to NP Performance in-market ($b=0.26$, $t=2.71$, $p<0.01$, refer to Table 8). Accordingly, NP Novelty is thought to have a hyperbolic, inverted U relationship to new product performance. Lack of novelty is likely to hinder new product performance, whereas extreme novelty is also expected to hinder new product performance since it might be unrecognizable, too disruptive or too radical for the consuming segments in order that it the returns to the focal firm would be less than maximal. Pragmatically, however, the result of new product development is rarely so novel or radical that the latter is likely, allowing that novelty or novelty should still contribute meaningfully to new product performance in-market, in the industries investigated in this study. New Product Novelty

was positively and significantly related to NP performance in-market (b=0.22, t=2.30, p<0.01).

TABLE 8
New Product Performance:
Effects of New Product Novelty and
New Product Development Speed

		Step 1	Step 2
Independent variables	Hypothesis		
Team Size		.04 (t=.62, p=n.s.)	.01 (t=.26, p=n.s.)
Innovation Type		.05 (t=.71, p=n.s.)	.03 (t=.50, p=n.s.)
Industry Type		.04 (t..63, p=n.s.)	.01 (t=.27, p=n.s.)
Team Tenure		.15(t=1.73, p<.05)	.15 (t=1.74, p<.05)
NPD Speed	H7: Supported		.26 (t=2.71, p<.01)
NP Novelty	H8: Supported		.22 (t=2.30, p<.01)
Change in r^2		.03	.12
Adjusted r^2		.01	.10

Note: Cells include standardized beta (t-value, one-tailed *p*-value)

5.4 Evaluating the Mediating and Indirect Effects of New Product Novelty and Development Speed

No formal hypotheses were extended a priori regarding the possibility that New Product Performance and New Product Novelty might mediate the relationship between the KIMs and New Product Performance in this research, as testing for mediation in these variables violates the first test condition according to Baron and Kenny (1986), and such mediation was not part of the intended theoretical contribution of this work. That said, it was ultimately deemed worthwhile to test, given especially that more recent work in regression analysis and mediation research has refuted the necessity for adherence to Baron and Kenny's test conditions (e.g. Preacher & Hayes, 2004; Shrout & Bolger, 2002; Zhao, Lynch & Chen, forthcoming). Specifically, given validity would be

uncompromised to test mediation of NP Novelty and Development Speed, as well as the fact that Preacher and Hayes (2004) assert that omission of post hoc mediation testing on intermediate variables can give rise to other errors in analysis.

Also, given that it is expected that NPD speed and NP novelty would contribute to NP performance (and shown to be statistically significant in Table 8 above), it is worthwhile investigating whether or not NPD speed and NP novelty in fact mediate the relationship between the KIMs (ED, OR, AD) and NP performance. While there is no reason to expect these antecedent variables to affect NP performance directly, given the linkages (e.g. KIMs→ NP Novelty, Development Speed → NP Performance), mediation is worthwhile investigating post-hoc. Said another way, as an example, there is no reason why one would expect that any of the independent variables (IVs) in this case (KIMs of ED, OR and AD) would have a direct effect on market share, profitability, sales targets, or return on investment—all of which comprise the resultant variable of NP performance. As has already been discussed at length, there is significant reason to expect 1) that the KIMs—the mechanisms by which the team interacts, coordinates, and recombines knowledge—would have an effect on both the speed of new product development, as well as the level of novelty of those products (IV→DV), and 2) that speed of new product development (speed-to-market) and level of novelty of new products would affect market share, sales, return on investment and profit margin (sales of product – costs incurred producing it; DVs→NP Performance). The following tables (Tables 9 and 10) provide the results of the regression analyses wherein no mediation was found to be significant, except NPD speed having a slight mediating effect on organizational routines ($b=0.14$, $t=1.67$, $p<0.05$).

TABLE 9
Mediating Effect of NPD Speed on the Relationship between Knowledge Integration Mechanisms and New Product Performance

	Step 1 Dependent Variable = NPD Speed	Step 2 Dependent Variable = NP Performance	Step 3 Dependent Variable = NP Performance
Independent Variables			
Team Size	01(t= 27, p=n s)	02 (t= 44, p=n s)	02 (t= 43, p=n s)
Innovation Type	03 (t= 51, p=n s)	06 (t= 83, p=n s)	05 (t= 70, p=n s)
Industry Type	01(t= 26, p=n s)	01 (t= 27, p=n s)	02 (t= 44, p=n s)
Team Tenure	15 (t=1 73, p< 05)	03 (t= 51, p=n s)	01(t= 26, p=n s)
Explicit Direction (ED)	23 (t=2 42, p< 01)	09 (t=1 11, p=n s)	03 (t= 52, p=n s)
Organizational Routines (OR)	21 (t=2 19, p< 01)	14 (t=1 67, p< 05)	07 (t= 92, p=n s)
Adhocracy (AD)	23 (t= 2 44, p< 01)	08 (t=1 01, p=n s)	02(t= 45, p=n s)
NPD Speed			26(t=2 71, p< 01)
Adjusted r^2	07	01	10

Note Cells contain standardized beta (t-values, and one-tailed *p*-value)

TABLE 10
Mediating Effect of NP Novelty on the Relationship between Knowledge Integration Mechanisms and New Product Performance

	Step 1 Dependent Variable = NPD Speed	Step 2 Dependent Variable = NP Performance	Step 3 Dependent Variable = NP Performance
Independent Variables			
Team Size	13 (t=1 52, p< 10)	04 (t= 62, p=n s)	04 (t= 60, p=n s)
Innovation Type	02 (t= 44, p=n s)	03 (t= 51, p=n s)	03 (t= 52, p=n s)
Industry Type	00 (t= 01, p=n s)	06 (t= 83, p=n s)	06 (t= 81, p=n s)
Tenure	09 (t=1 11, p=n s)	07 (t= 92, p=n s)	07 (t= 94, p=n s)
Explicit Direction (ED)	- 03 (t=- 56, p=n s)	05 (t= 07, p=n s)	05 (t= 03, p=n s)
Organizational Routines (OR)	- 07 (t=- 96, p=n s)	01 (t= 26, p=n s)	01 (t= 27, p=n s)
Adhocracy (AD)	26 (t=2 71, p< 01)	03 (t= 52, p=n s)	03 (t= 51, p=n s)
NP Novelty			22 (t=2 30, p< 01)
Adjusted r^2	07	03	07

Note Cells contain standardized beta (t-values, and one-tailed *p*-value)

Classical mediation—in which the independent variable has a direct effect on the dependent variable (Baron & Kenny, 1986)—was not expected theoretically, and was not supported statistically overall. That said, more recent work has argued for the significance of indirect effects through intermediate variables even when no direct effects (classical mediation) are found (e.g. Zhao, Lynch & Chen, forthcoming).

Preacher and Hayes (2004) indicate that even if there is no significant direct effect between the independent and dependent variables (KIMs and New Product Performance in this case), there could be significant indirect effects, allowing that such indirect effects should also be tested. Sobel's (1982) test was conducted and indicated significant indirect effects through New Product Development Speed for Explicit Direction ($b=0.15$, $t=1.73$, $p<0.05$), Organizational Routines ($b=.12$, $t=1.63$, $p<0.01$), as well as Adhocracy ($b=0.15$, $t=1.74$, $p<0.05$) on New Product Performance.

Interestingly, Sobel's test did not indicate significant indirect effects through New Product Novelty for Explicit Direction ($b=-0.04$, $t=-0.57$, p=n.s.) or Organizational Routines ($b=-0.06$, $t=-0.91$, p=n.s.), though Adhocracy was statistically significant ($b=0.15$, $t=1.68$, $p<0.05$). While no direct effects for mediation were found, all the KIMs have indirect effects on New Product Performance via NPD Speed, and the KIM of Adhocracy has indirect influence through both NP Novelty and Development Speed. Overall then, NPD Speed transfers more of the influence of all the KIMs to NP Performance than does NP Novelty, with the exception of the KIM of Adhocracy, for which both NP Novelty and Development Speed effectively transfer its influence to NP Performance. (See also Soper, 2010.)

CHAPTER 6: DISCUSSION

6.1 Overall Significance, Contribution, and Importance of New Product Development in Knowledge Creation

While the theoretical implications of this work are discussed by premise, hypothesis, and interaction effect in further detail in sections 6.2, 6.3, and 6.4 (regarding the theoretical contributions this work makes to extant literature and theory in the three main areas of the KBV, NPD, and Organizational Theory), it is important to consider here how this work would be situated—at a less granular level—vis-à-vis the current literature. Firstly, the current literature on innovation and new product development does not concertedly recognize the dimensions or variation that knowledge can take on, even with the new product development team. To date, research that considers the new product development team and members' knowledge , has been silent on the differing types of knowledge characteristics these members could have—it assumed that all individuals brought effectively the same type of knowledge to the table (e.g. DeLuca & Atuhene-Gima, 2007). The present research does a concerted effort at attempting to identify, conceptualize, dimensionalize, and operationalize the differing types of knowledge characteristics that new product development team members might possess, by looking to the organizational learning, knowledge, and memory literature.

Secondly, the empirical research that does consider variation in possible characteristics of knowledge, does not necessarily consider such variation as Grant's (1996b) conceptual paper does: as sources of knowledge integration barriers. This works not only acknowledge variation in knowledge characteristics to be predominant sources of integration obstacles, but identifies (from the literature), which types of knowledge represent particular barriers to integration, according to existing theory

regarding how each manifests within the organization: knowledge uniqueness, knowledge dynamism, and knowledge tacitness were all identified accordingly.

Thirdly, while KIMs (as an undimensionalized construct) had been tested previously (e.g. DeLuca & Atuahene-Gima, 2007) in the literature, they had yet to be properly dimensionalized and operationalizd. This work does not only that—by identifying three KIMs from the extant literature and finding already existing measures, items and scales for each (e.g. Grant, 1996b; Moorman, 1995; see Table 1 and Appendix A)—but conceptualizes each as a solution to overcoming particular obstacles to integration: explicit direction is thought to help overcome the barrier to integration of knowledge uniqueness; organizational routines is thought to help overcome the barrier to integration of knowledge tacitness; and adhocracy is thought to help overcome the integration barrier of knowledge dynamism. This is effectively a contingency theory, the granularity of which, had yet to be done in the literature.

Finally, the extant literature had yet to consider all of these variables in concert, in a singular model, to be tested empirically. As an example, though Grant's works (1996a, 1996b) form a strong undergirding theoretical background to this research, neither of his predominantly considered pieces were empirical. Accordingly, this work contributes newly to the literature a theoretical, conceptual model that was tested empirically with practicing marketing project managers on new product development teams in the Canadian marketplace, found to have good fit indicators (see CFA, EFA results in section 5.1 as well as Appendix A), and including the consequence variables of NP Novelty, NPD Speed, and NP Performance in-market. This works finds itself at the forefront of important organizational research: exactly—at a detailed and granular level, considering, together, all variation that the individuals, their knowledge, their

organization, their interaction, and the integration of knowledge (KIMs) can take—how is knowledge created within, and for, the organization? This is the first paper in the author's larger research agenda toward answering this question (see also Section 6.5 'Future Research Directions').

Continual new product development is critical for the growth and competitive advantage of firms. Sustaining a competitive advantage in goods-producing firms requires that new product development be timely (reasonable time to completion of new product development) and meaningful to the market and consuming populations (not too radical or incremental; Brown & Eisenhardt, 1995; Chandy & Tellis, 1998; Im & Workman, 2004). Madhaven and Grover (1998) established that personnel have information, data, and knowledge embedded (in them) in the organization, which manifests physically—or is 'embodied'—in the new products that firms develop, effectively establishing that new product development is fundamentally about creation of knowledge. The knowledge-based view of the firm (Grant 1996) establishes that all organizational activities—in fact, the firm as an institution—serves the fundamental purpose of movement, collection, maintenance and integration of knowledge. Knowledge creation and integration were of primary interest in this research. The proxy for knowledge creation in this research follows the precedent outlined by Brown and Eisenhardt (1995), Madhaven and Grover (1998) and Im and Workman (2004) of new product development.

The KBV asserts that knowledge is created through the novel integration or recombination of multiple sets of knowledge, and that there are mechanisms by which this happens among/between individuals in an organization (Grant, 1996). Grant (1996b) indicates that two main knowledge integration mechanisms (KIM) exist: 'direction'

(herein referred to as 'explicit direction') and 'organizational routines,' though these weren't measured empirically in this work, as much as discussed conceptually.

6.2 What are all the KIMs in the literature?

The first KIM of explicit direction involves directive, expressed communication between individuals, and entails that individuals are directed, typically by a leader, in a formalized, organized manner. The second KIM of organizational routines does not include explicit communication between individuals necessarily but entails routinized, institutionalized behaviours of operation that are organized and collectively understood and anticipated by individuals in the organizational system.

A third KIM was adapted from Moorman's (1995) concept of cultural adhocracy in which individuals interact—and share, integrate and recombine knowledge—in an *improvisational, non-institutionalized, fluid and flexible manner* (see also Brown and Eisenhardt, 1997). These three KIMs are considered herein to be mutually exclusive and collectively exhaustive of the types of KIMs possible. Part of the research imperative herein was first to identify these and then to test them empirically in terms of their effect on the new product development process and performance in-market. Scales, measures, and items for the variables considered were developed from existing works and administered on new product development project (marketing) managers in Canadian goods-producing firms.

6.3 A Theoretical Model of Knowledge Creation in NPD Teams, Tested

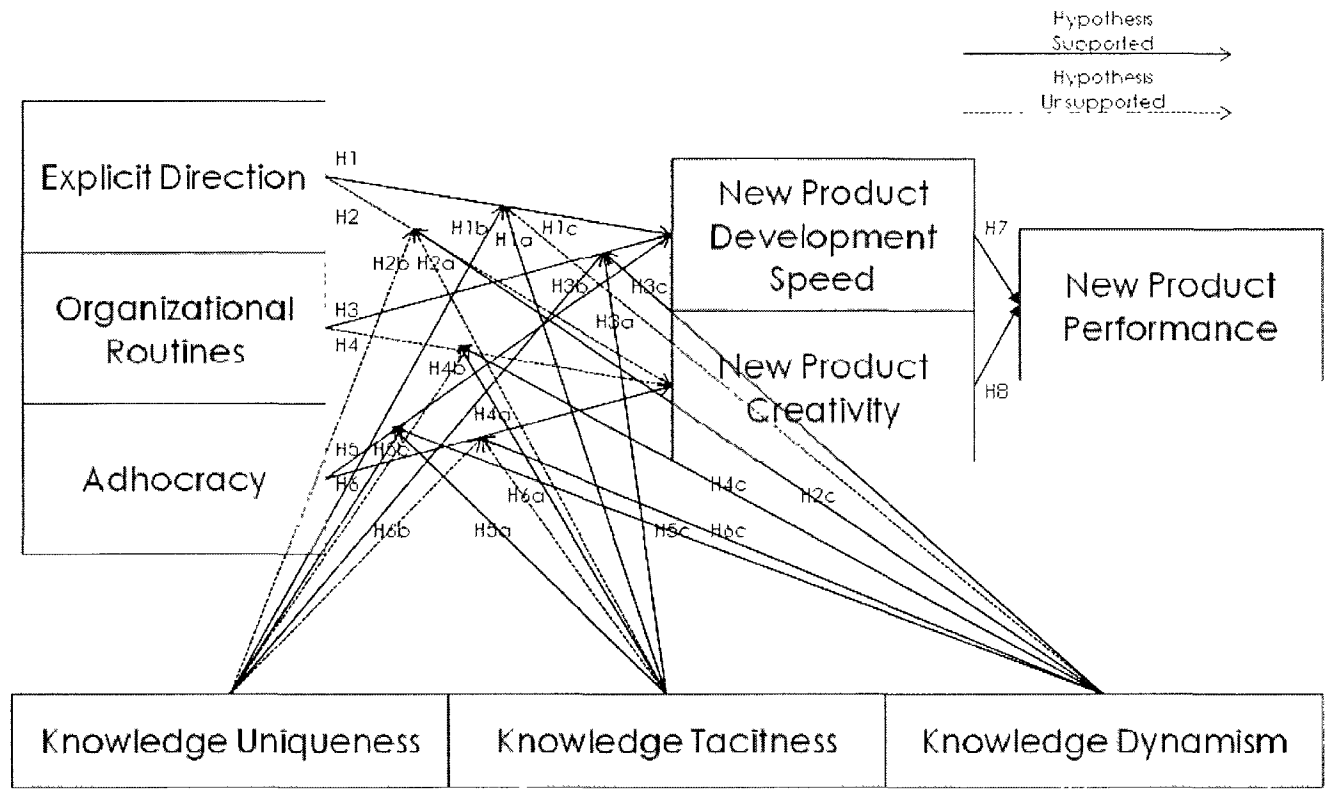
A theoretical model was developed (refer to Model 1.0) that engendered three main premises and 26 hypotheses. Independent variables were the three KIMs considered. New product development speed and new product novelty (level of product innovation,

Im & Workman, 2004) were considered as dependent variables contributing dually to new product performance in-market. Three characteristics of knowledge—unique knowledge (lack of overlap between knowledge sets of individuals), tacit knowledge ('know-how' that is difficult to communicate or document and is learned by doing), and dynamic knowledge (knowledge that requires continual updating and information gathering such that it changes on an ongoing basis)—were thought to be most pertinent to each of the KIMs and were considered as moderating variables in the model and this research.

It should be noted that it is possible for one or more types of knowledge to exist on the same team and at the same time, and that multiple KIMs might well be in use simultaneously as well. While the hypotheses tested isolated for the possibility of this multiplicity (1+ knowledge characteristics present on team; 1+ KIMs in use on team—KIMs were tested independent of one another, as were characteristics of knowledge), it should be acknowledged that not only are multiple characteristics of knowledge on the same team possible, but they are often desirable, as are multiple KIMs. Brown and Eisenhardt (1997), as an example, indicate that organizations (and thereby their constituent teams, certainly), are trending toward attempting to use multiple forms of knowledge, organizational structures, personnel interaction mechanisms, and knowledge integration. In fact, multidimensionality of such factors (e.g. KIMs, knowledge) can have positive returns for both the efficiency with which the NPD process progresses, as well as the innovativeness of the process and novelty of the resultant products (DeLuca & Atuahene-Gima, 2007; Im & Workman, 2004). Please refer to the concluding section of this paper for suggestions regarding future research using this data and model that would include testing for the interactive and combinative effects of the existence of

multiple KIMs and/or characteristics of knowledge simultaneously on the same NPD team.

FIGURE 3
Model of Knowledge Creation in New Product Development Teams: Research Results Depicted



6.4 Theoretical Contribution of Findings

Results indicate that 18 of the 26 hypotheses were supported. Interestingly, the three main premises—that explicit direction would work best with unique knowledge, that organizational routines would work best with tacit knowledge, and that adhocracy would work best with dynamic knowledge—were all found to have theoretical and empirical merit given the results of this research. The results also answer to the research questions of whether all the KIMs are equally efficient at generating NPD speed—and equally effective at generating NP novelty—across all pertinent knowledge characteristics.

Explicit Direction and NPD Speed

The results show that explicit direction did indeed improve the speed and efficiency of the new product development process (H1 supported). This was hypothesized based on the literature and logic indicating that directed, organized, explicit communication regarding what to do, in the context of a new product development team, would decrease ambiguity or time spent determining roles, responsibilities or requirements for the project at hand, allowing greater efficiency and less time required (Demsetz, 1991; Grant, 1996). Pleasingly, the hypothesis (H1a supported) that tacit knowledge would attenuate the relationship between explicit direction and speed was upheld. This was expected based on the notion that tacit knowledge—knowledge that is hard to communicate, document, or understand without personal experience using it (De Luca et al., 1997; Grant, 1999; Simonin 1999)—would take longer to identify, activate and integrate in a meaningful way toward an end-goal of new product development, even in a context with explicit, directive communication.

Unique knowledge was hypothesized to strengthen the relationship between explicit direction and NPD speed, given that unique knowledge was thought to work best in a context of a KIM of explicit direction (Premise 1). Individuals possessing unique knowledge in the context of a new product development team would not share as much of their knowledge sets with others on the team—at least some of the knowledge that they have is unique to them. Hypothesis (H1b) was supported. This was expected given that explicit direction should work best when individuals have knowledge that is fairly static (not dynamic) and therefore well known and communicable (not incommunicable), yet varies from that of others in a meaningful way that contributes to the efficiency of the team given a lack of knowledge (and thereby effort) redundancy.

Dynamic knowledge—because it requires continual information collected, knowledge-set updating, and can change so rapidly (Achrol and Stern 1988, 1991; Aldrich, 1979)—was expected to attenuate the relationship between explicit direction and speed given that it was expected to decrease the efficiency with which team members could operate, therefore extending the new product development timeframe. This hypothesis (H1c) was not supported as statistically significant, though the relationship was weakened when considering knowledge dynamism. In fact, the relationship between explicit direction and speed falls almost to 0 ($b=0.03$, $p=$n.s.; ED—Speed was $b=0.27$, $p<0.01$), indicating that the presence of dynamic knowledge erodes the strength of the relationship between ED and speed almost entirely. ED does not help efficiency or speed when dynamic knowledge is present.

Considered another way, while there is an erosion of NPD speed, it could be that in a context where individuals are having to update their knowledge sets and collect new information/knowledge continually—something that would prove fairly chaotic and

taxing—it could be very helpful to have direction being given explicitly in a NPD group. ED could help streamline processes, set expectations, and organize individuals who are otherwise doing a significant amount of self-managing or self-educating. Demsetz (1991) and Grant (1996) also describe 'direction' as useful in the context that information need be communicated between 'specialists and the large number of other persons who either are non-specialists or who are specialists in other fields' (pp.172; 379), which, on a cross-functional new product development team, would likely be the case. Further, it is possible—while not the definition—that knowledge dynamism is something that specialists would possess, and therefore would work well with ED, not significantly attenuating the strong positive relationship between ED and speed. As such, both unique and dynamic knowledge seem to allow efficiencies in the context of ED as a KIM.

Explicit Direction and NP Novelty

It was conceived that explicit direction—by virtue of its centralized and directive nature—would not contribute to novelty of new product development particularly. The hypothesis (H2) that ED would be negatively related to novelty was not supported. This could be because when individuals are able, encouraged, and expected to communicate explicitly to one another in the context of a new product development team, they would contribute to novelty of the new product being developed by a) recombining their information sets (definition of a KIM) during conversations/interactions throughout the NPD project, b) having to clarify or rectify (i.e. change) their expectations or ideas they put forward because they are being directed, or c) contributing to the amount of constructive or creative friction individuals experience in interaction with one another throughout the NPD project. It is also possible that individuals who are told explicitly what to do might seek opportunity to dissent or enact control or agency in ways that

might not disrupt the social order of the group, but could change the nature of the work accomplished in unforeseen or unpredictable ways, thereby contributing positively to the level of novelty of the products.

Tacit knowledge was hypothesized to attenuate the expected negative relationship between ED and novelty (H2a), though this wasn't supported. Said differently, tacit knowledge was expected to increase novelty even in the context of ED, given that knowledge tacitness allows individuals to bring knowledge or information to the new product development process that cannot be explicitly known, communicated, manipulated, or controlled, and given that it isn't knowledge that is under conscious control, contributing then to some variation in what individuals bring to the table, as well as some (creative) friction associated with trying to communicate to one another throughout the NPD process, theoretically.

If tacit knowledge does not contribute to NP novelty, albeit in the context of ED, this could be because it is harder to integrate multiple individuals' tacit knowledge (and thereby creating new knowledge), being as it is hard to communicate, extend, access consciously, recombine or even identify in others without having personal experience with it. If this is the case—that the very nature of this type of knowledge precludes its being (re)combined easily or effectively—then this lends further credibility to the theory that knowledge needs to be recombined and/or integrated in order for new knowledge to be created (Grant, 1996). Also, tacit knowledge, because it is not under conscious control, is learned by doing, is not easily overridden or manipulated, is likely fairly resistant to change, and is not readily adopted, allowing that the outcome of an individual or individuals using such knowledge could be expected to be similar or the same over successive episodes of new product development projects. Also, to explain

the unsupported hypothesis, if tacit knowledge is resistant to change and therefore manifests mechanistically every time it is activated, then it wouldn't be expected to contribute to novelty of new products in the NPD process and therefore wouldn't attenuate (or make more creative) an expected negative relationship between ED and novelty. Kyriakopoulos and deRuyter (2004) found empirically that procedural memory (analogous tacit knowledge), decreased the value of internal information flows (analogous knowledge integration), for product novelty, allowing that tacit knowledge did not contribute to new product novelty. This work would postulate therefore that knowledge tacitness might have been expected to strengthen the(expected negative) relationship between explicit direction and NP novelty, as opposed to attenuate it.

TABLE 11

Matrix of Hypotheses and Results

Variables	Knowledge Type	New Product Development Speed	New Product Novelty
Explicit Direction		H1, Positively Related, **Supported**	H2, Negatively Related, **Supported**
	Tacit	H1a, Will Attenuate, **Supported**	H2a, Will Attenuate, **Supported**
	Unique	H1b, Will Strengthen, **Supported**	H2b, Will Attenuate, **Not Supported**
	Dynamic	H1c, Will Attenuate, **Not Supported**	H2c, Will Strengthen, **Supported**
Organizational Routine		H3, Positively Related, **Supported**	H4, Negatively Related, **Not Supported**
	Tacit	H3a, Will Strengthen, **Supported**	H4a, Will Attenuate, **Supported**
	Unique	H3b, Will Strengthen, **Supported**	H4b, Will Attenuate, **Not Supported**
	Dynamic	H3c, Will Strengthen, **Supported**	H4c, Will Attenuate, **Supported**
Adhocracy		H5, Positively Related,	H6, Positively Related,

		Supported	**Supported**
	Tacit	H5a, Will Attenuate, **Supported**	H6a, Will Attenuate, **Not Supported**
	Unique	H5b, Will Attenuate, **Supported**	H6b, Will Strengthen, **Not Supported**
	Dynamic	H5c, Will Strengthen, **Supported**	H6c, Will Strengthen, **Supported**
New Product Performance	N/A	H7, Positively Related, **Supported**	H8, Positively Related, **Supported**

Unique knowledge—which is expected to work best with ED—was expected also to attenuate the hypothesized negative relationship between ED and novelty. In other words, it was expected that unique knowledge, similarly to tacit knowledge, would make the relationship between ED and novelty stronger, or the process more creative. This was not supported. This could be 1) because as above in the discussion about tacit knowledge, ED does not actually hinder novelty of NP and therefore other factors would not necessarily decrease the lack of novelty of NP developed with a KIM of ED, or 2) because unique knowledge has properties that do not allow for an increase in level of innovativeness for products developed.

Unique knowledge—knowledge that does not have much redundancy or overlap among members of the NPD group—might not be easily recombined or integrated toward creative, new or novel ends given that other members in the group might not be able to identify, understand, integrate or build on it. If this type of knowledge to some extent precludes recombination, then, as above, this lends further proof to the KBV understanding that knowledge, in order to be created newly, needs to recombined and integrated from one or more disparate individuals/sources (Grant, 1996). Unique knowledge either does not recombine easily and therefore does not contribute meaningfully to novelty in NPD, or does not affect the relationship between ED and novelty, which while expected to be negative, did not prove to be such—therefore in the

context of ED novelty does not appear to be (statistically) significantly hindered and therefore cannot be increased contingent on knowledge characteristics in use in the NPD group.

Dynamic knowledge was hypothesized to strengthen the negative relationship between ED and novelty (H2c) and was supported. It appears then that knowledge dynamism does affect the ED-novelty relationship, rendering it more negative (less creative). What is interesting here also is that dynamic knowledge did not slow the speed of the NPD process under ED (H1c), but does decrease the novelty of the process under ED. It appears that dynamic knowledge then does not disrupt the NPD process at all: it does not slow it (although it was expected to) and it does not produce novel results. Accordingly, as originally posited, there is evidence herein that dynamic knowledge—which is time-consuming and confusing to continually update, assess, and re-assimilate cognitively—is not functional in helping the process be more innovative, creative, or novel. It would appear that new ideas do not come from dynamic knowledge under the context of ED. Instead, the presence of dynamic knowledge seems to foster new products that lack novelty. This could be because project managers faced with the task of having to explicitly direct individuals with dynamic knowledge sets are more rigid, stringent, directive, or commanding, which decreases the amount of creative friction possible in the group, and thereby renders the process less creative or novel overall. Another possibility lies in the fact that confusion, disorganization or chaos associated with knowledge dynamism are relatively dysfunctional and do not facilitate the production of novel new products.

Organizational Routines and NPD Speed

Organizational routines were supported to be positively related to NPD speed (H3). This was expected largely because the hallmarks of organizational routines are that individuals are able to work seamlessly, without undue interaction or communication, in ways that are routinized, mechanistic, institutionalized, understood, predictable, and well known to them. As such, OR is conceptualized to be the most efficient KIM, streamlining the interaction and productivity process and allowing for economy of timelines in the NPD process.

Tacit knowledge (which is thought to work best with OR; Premise 2) was hypothesized to strengthen the relationship between OR and speed. H3a was supported, likely because with tacit knowledge—knowledge that is hard to communicate, identify, transfer, or justify—OR is the easiest KIM to operate within, contributing positively to the pace at which NPD tasks get accomplished.

In the context of OR, individuals are able to add value to the new product development process without having to communicate or codify their thinking, actions, or behaviour, allowing that tacit knowledge would be the most functional knowledge characteristic to employ in this circumstance. Also, individuals with tacit knowledge in an OR context don't have to waste time in continual communication with others toward the end goal of creating new products or in the new product development process. Instead they can contribute meaningfully and productively without having to verbalize explicitly tacit information and/or knowledge that is hard for them to codify.

Unique knowledge was hypothesized to strengthen the relationship between routines and speed, similarly to tacit knowledge, and this was supported (H3b; $b=0.33, t=5.09, p<0.001$). The existence of non-common, unique knowledge means that individuals would likely prefer not to have to codify or explain what they know, should

there be a mechanism that would allow it. The KIM of OR allows this lack of explicit communication. That said, unique knowledge should otherwise be relatively easy to codify vis-à-vis tacit knowledge, allowing that it would not necessarily slow any process to have to explain, given that it is not likely to be particularly difficult to justify what one knows compared with someone who does not share that knowledge. As such, it is posited that unique knowledge would work very well in the context of OR—contributing to the speed of the NPD process—and would not be particularly slowed even by a requirement of explicit communication, meaning that unique knowledge should (and did) contribute positively to speed when the KIM of OR is present.

It was thought that even in the context of a KIM or OR, dynamic knowledge would attenuate the relationship between OR and NPD speed given that this type of knowledge requires such continual information collection, knowledge-set updating, and reorientation on the part of personnel who possess it. It was thought that such continual, individual, turbulent work would slow down productivity and thereby NPD speed. H3c was supported ($b=0.25, y=2.63$, $p<0.01$), indicating that in fact dynamic knowledge increased NPD speed in the context of a KIM of OR. While dynamic knowledge is generally thought to decrease the speed at which individuals work together by virtue of the amount of maintenance it generally requires, where the efficiencies that adhocracies allow were expected to work best with this type of knowledge toward NPD speed (Premise 3), it turns out that the context of OR also provides such efficiencies. OR might increase the speed of NPD when there is dynamic knowledge present given that individuals who are busy information-finding and updating their knowledge sets would not also have to spend time codifying and laboriously communicating information. Instead they would be allowed to act autonomously within their own area of knowledge and responsibility,

contributing it to the team in a synchronized, predictable way that does not also require elaborate interaction and communication among team members.

Organizational Routines and NP Novelty

It was expected that a KIM of OR would be negatively related to novelty because anything that is routinized or mechanized is typically fairly institutionalized, wherein institutionalization can indicate a resistance to change or to the influx of new processes, methods, or ideas. Where this is true, level of newness or novelty in the new product development process—and thereby the resulting products—was expected to be relatively lower. H4 was not supported statistically (b=-0.03, t=-0.53, p=n.s.), although the relationship was negative. Accordingly, it must be possible for individuals—albeit acting within their own organizational roles that might well be mechanized or routinized—to still have enough agency, autonomy, or variability, etc. to alter the (NPD) process episode over episode toward novel results.

Tacit knowledge was expected to attenuate the expected negative relationship between OR and novelty given that tacit knowledge was expected to work best with OR (Premise 2), increasing the relative novelty of the process given the efficiency of using it in the context of OR. This hypothesis (H4a) was supported (b=0.16, t=1.79, p<0.05). It appears that tacit knowledge does increase the novelty of the new products created. This might be due to the fact that tacit knowledge—because it goes uncommunicated and is inherently an individualized type of knowledge—never manifests in two individuals exactly the same way twice, and given that it is difficult knowledge to codify, does not suffer from the homogenization resulting from a requirement of group understanding or consensus. As such, individuals with tacit knowledge could contribute meaningfully to the NPD process, adding novelty without having to justify, codify or communicate how they are doing so to the group—which saves time as well as allowing individuals to help increase the level of innovativeness of the NPD process and the resulting new products.

Unique knowledge was expected to attenuate the expected negative relationship between OR and NP novelty. Similar to the hypothesis for tacit knowledge in this relationship, it was conceived that unique knowledge—knowledge that is not shared or common between members of the team—would positively increase the level of novelty of new products developed. This seemed logical given that non-common knowledge would allow for greater discrepancy, less homogenization, and more 'creative' or 'constructive' friction between team members, which would increase how novel the products developed manifested. This hypothesis, H4b, was not supported (b=-0.01, t=0.25, p=n.s.). An alternative explanation might be that the friction created by individuals on the same team who do not share information, knowledge, or perspectives is actually destructive given that discrepant viewpoints require some amount of compromise, resulting in homogenization or thought polarization, and this results in less novel products developed. It is further possible that while information or knowledge might not be shared by individuals, the variation in information is not necessarily applicable or useful to the NPD process, and thereby would not contribute to the novelty (or speed) of new products developed.

Dynamic knowledge was also hypothesized to attenuate the expected negative relationship between OR and NP novelty given that the dynamism of the information/knowledge, the requirement of constant information/knowledge set updating, and the implied turbulence of dynamic knowledge would increase the newness of information or knowledge held by individuals on the aggregate, and certainly on an individual basis, allowing them to contribute such to the NPD process and the resulting new products. H4c was supported (b=0.24, t= 2.54, p<0.01). Dynamic knowledge increases the level of novelty of new products developed, even in the context of a KIM of

OR. This is likely also because the novelty of new products is being measured vis-à-vis previous episodes of developing new products, and given that dynamic knowledge is continually changing, such turbulence and evolution could contribute to the novelty of new products developed in iterative NPD episodes.

Adhocracy and NPD Speed

Given that a KIM of adhocracy (the way it is defined herein) allows team members to act autonomously, interact according to necessity and without precedent, and favour the end goal of products launched over the process of producing it, it was expected that adhocracy would be positively related to NPD speed. H5 was supported ($b=0.21$, $t=2.19$, $p<0.01$). While adhocracies can have a certain amount of chaos or turbulence associated with them organizationally (Moorman, 1995), they allow members to act according to their own discretion and subjective opinion regarding means to ends and productivity, which is likely to increase the efficiency with which organizational actors behave and interact, and thereby collaboratively develop new products.

Tacit knowledge was hypothesized to attenuate the expected positive relationship between adhocracy and speed, effectively decreasing the speed of the new product development process. H5a was supported ($b=-0.18$, $t=-1.91$, $p<0.05$). Tacit knowledge does appear to decrease the efficiency with which team members are able to produce new products. It is thought that because tacit knowledge is difficult to identify, justify, communicate or codify, the requirement—even on an ad hoc basis—of having to would slow down the process of NPD. Where individuals are required to communicate and interact, albeit in a non-routinized, non-institutionalized, or non-mechanized way (which allows some efficiencies) and knowledge is also tacit—which means it is hard to communicate or explain—NPD speed is decreased overall.

Unique knowledge was also hypothesized to attenuate the expected positive relationship between adhocracy and NPD speed. This hypothesis, H5b, was supported ($b=-0.19, t=-1.99, p<0.01$). It appears that when individuals do not share knowledge, their knowledge is unique or non-common and they are in an adhocratic KIM context, their efforts are slowed and efficiency and speed are decreased. In this case, knowledge that is not common to others will likely require more explanation and justification to other team members. Where this is true, more time and productivity must be spent explaining one's perspective to other members of the team, even if on an ad hoc or unregimented basis (KIM of adhocracy). Unique knowledge is expected to create relative confusion, the need for explanation and increased deliberation, as compared to other types of knowledge, and as such decreases efficiency and speed of new product development.

Dynamic knowledge was hypothesized to strengthen the expected positive relationship between adhocracy and NPD speed given that dynamic knowledge is expected to work best within a KIM of adhocracy (Premise 3). H5c was supported ($b=0.22, t=2.30, p<0.01$). A KIM of adhocracy, as it is defined herein, allows individuals to interact on ongoing basis as they deem necessary in an unroutinized, unmechanized, uninstitutionalized way that allows for organizational or process efficiencies, theoretically. Also, because dynamic knowledge requires continual updating on an ongoing basis, it is expected that it would work best in the context of an adhocracy, increasing the efficiency with which the team operates and new products are developed. In this case individuals are not expected to have to manage the cognitive weight of extraneous information, interaction, or institutionalization of process, effectively creating operational efficiencies and increasing NPD speed.

Adhocracy and NP Novelty

It was expected that adhocracy—which is inherently entrepreneurial, uninstitutionalized and goal oriented—would be positively related to NP novelty. Hypothesis 6 was supported ($b=0.23, t=2.42, p<0.01$). Adhocracy seems to allow for novel ideas, as individuals in the NPD team are encouraged to interact fluidly toward an end goal of creating something innovative. Such interactional fluidity would also allow for novel transfer, combination, and integration of knowledge sets, contributing to new product development and creative production, theoretically and herein empirically.

Tacit knowledge was hypothesized to attenuate the expected positive relationship between adhocracy and novelty. H6a was not supported ($b=0.03$, $t=0.51$, p=n.s.). It was conceived that tacit knowledge, in the context of a KIM of adhocracy, might create enough confusion or friction as to decrease the novelty of the products developed. This does not appear to be the case. Alternatively, it could be considered that tacit knowledge, by virtue of its individualized and non-codifiable qualities, actually increases the novelty of the contributions that individuals can make within the NPD team. Tacit knowledge never manifests the same way in two people, and is therefore difficult to communicate in the context of an adhocracy. It could be relatively easy to engage with others on a 'needs' basis, as adhocracies allow for uninstitutionalized, unroutinized interaction between individuals on an NPD team that would never occur the exact same way twice, contributing overall to the novelty of new products developed in separate NPD episodes.

Unique knowledge was hypothesized to strengthen the expected positive relationship between a KIM of adhocracy and NP novelty. H6b was not supported ($b=-0.02$, $t=-0.48$, p=n.s.). It was conceived that unique, non-common knowledge would logically increase the amount of information and knowledge that the team possessed

that was new or novel, and thereby products developed would manifest that. This does not appear to be the case. It could be that unique knowledge actually confounds the interaction among individuals as the presence of such knowledge increases the requirement to discuss, justify, and communicate team members' ideas, which results in greater homogenization of the group, more polarized thought and less constructive contributions on the part of team members during the NPD process, resulting in less novel products. Unique knowledge in the context of a KIM of adhocracy might actually serve to create friction that is not 'creative' or 'constructive' but rather destructive, which would increase the likelihood that individuals would then revert to processes, ideas, or methods of product development that they had seen previously, rendering new products developed relatively non-novel vis-à-vis other NPD episodes.

Dynamic knowledge (thought to work best within a KIM of adhocracy) was hypothesized to strengthen the expected positive relationship between adhocracy and novelty. H6c was supported ($b=0.31$, $t=3.59$, $p<0.01$). It appears that dynamic knowledge—which is thought to be the best characteristic of knowledge to possess in the context of a KIM of adhocracy—increases the novelty of the new products developed by virtue of its being a fairly turbulent and evolving type of knowledge to begin with. When dynamic knowledge is present and team members are continually required to collect new information, update their knowledge sets, and reorient their perspectives, their ideas are likely more novel relative to other NPD episodes, and thereby the products developed are more creative. Also, the KIM of adhocracy and dynamism of knowledge allow for continual, ad hoc, transformational recombination of information, knowledge sets, and interaction among team members, which contributes positively to the novelty of the NPD process, and thereby the new product developed ultimately.

New Product Development Speed and New Product Performance

It was expected that NPD speed would contribute positively to the performance of the product developed in-market. This was supported (b=0.26,t=2.71, p<0.01) and makes sense in light of much of the research (e.g. DeLuca & Atuahene-Gima, 2007; Joshi & Sharma, 2004; Madhaven & Grover, 1998). New product performance measures considered were return on investment, profit margin, and sales and market share within the first year vis-à-vis their original targets. Logically, when the process of creating a new product is efficient, there will be better returns on the investment a firm is making toward producing the product given that the product reaches the marketplace faster, has a greater likelihood of being first to market (first-mover advantages), which would thereby allow greater command of market share, resulting in better sales, and likely profitability and profit-margin (profit contribution), should expenses be maintained (Cooper, 1998). Also, it was of interest to ask about the results of these measures as percentages of expected or stated targets, as this was expected to increase the response rates of project managers who would otherwise intend to keep this type of information private and proprietary.

New Product Novelty and New Product Performance

It was expected that NP novelty would contribute positively to the in-market performance of the new products developed. This was supported (b=0.22, t=2.30, p<0.01). Im and Workman (2004) helped define new product novelty as part of their work, and posit that there would be a direct relationship between NP novelty and NP success in the marketplace given that innovative and novel products would be relevant to customer and consumer populations because of their ever-changing needs. It was considered herein that the relationship between NP novelty and NP performance might

well take on the shape of an inverted U (hyperbolic) given that 1) radically novel new product development could alienate customers or consumers (e.g. McDermott & O'Connor, 2002) by virtue of its departure from what such stakeholders consider normalized for the category, as an example, and 2) that incremental new product development could be disappointing to these main stakeholders, while also not creating adequate attention in-market upon launch to command dramatic market share increases or resultant sales, return on investment or profit contribution.

However, given the assumption that radical new product development would be fairly rare and that companies would not invest significant resources or teams to product development initiatives if the intention was not for satisfactory levels of new product novelty, it was assumed that NP novelty witnessed in the sample would result in positive in-market performance measures for new products developed (Kleinschmidt & Cooper, 1991). Novel new products might also have the advantage of creating a halo effect of sorts for the innovating company overall in that customers/consumers would reflect favourably upon the focal company (and any of its other offerings) if new products are creative and meaningful enough (Im & Workman, 2004).

6.5 Future Research Directions

Future research in this line of study could investigate the interactive effects of other types of knowledge (extending beyond tacit, dynamic, and unique knowledge) on the KIMs proposed. Although it was not under consideration herein, it would be interesting to consider empirically the complexity of organizational contexts where multiple types of knowledge exist within and between individuals on teams: future research might look more specifically at combinative effects of the use of multiple KIMs and/or knowledge types. The interactive effects of multiples of all these being present simultaneously on

new product outcomes would be of theoretical and empirical interest, given that it is outstanding in the literature to date. Because this research surveyed marketing project managers from technology manufacturing, transportation equipment manufacturing and machinery manufacturing in Canada, it might also be of interest to produce further work on each of the industries independently, investigating in depth the differences in product development between each of the respective industries. Further, it would be of interest to understand how the model behaves when other industries are considered: service-based, experiential-based, or consumer-centric industries would also be interesting contexts for this model and research.

6.6 Limitations

Quantitative, survey research comes with its own difficulties, as does a cross-sectional design. It would be valuable to consider some of these concepts qualitatively, by interviewing marketing project managers in order to understand some of the themes and experiences associated with use of differing knowledge integration mechanisms, especially within the context of a new product development team. Survey research usually yields the perspective of a singular team member at a specific point in time. It would be of value to consider multiple team members, and study them in more than one instance of data collection. The nature of cross-sectional research is such that there is potential for other, more macro, confounds in the research, such as political, economic or circumstantial realities that skew responses and thereby the data. Longitudinal research designs aid here; it could be valuable to understand how this model, the measures, and any of these hypotheses behave over time within manufacturing organizations and in-market. Survey research also has the difficulty of asking key respondents about their perceptions—which are subjective—and may or may not reflect

the reality. Objective data (such as in-situ observation, triangulation through multiple respondents, or experimental designs) would help mitigate perceptual biases inherent to respondents, which is a potential source of error. Many of these limitations are addressed in the procedural research design, controls in the data, and post-collection analyses, though they merit consideration in any discussion of intentions for future research as well.

6.7 Managerial Implications

It is part of the intention of this research, that the findings be relevant to a practitioner audience. By providing an exhaustive list of the KIMs established in the literature to date, as well as defining each, it is possible for practitioners and managers to identify that which they are already doing in practice, choose one they would like to actualize in their NPD teams, and be able to name the processes they currently employ. Also, this research highlights the characteristics of knowledge that are most useful to each of the KIMs, so that it might be possible for managers to a) call on specific preexisting knowledge characteristics depending on the KIM they identify as predominantly in use in their teams, or b) tailor the operations and team mechanisms for interaction based on the knowledge they identify as predominantly in use on their teams. Based on the findings it is possible for practitioners to select the type of KIM and knowledge they use for increased NPD Speed, and/or greater NP Novelty, both of which contribute to the New Product Performance in-market, post-launch.

While managers might find relevance in the model proposed and tested (causal relationships between how their team works and the types of knowledge they might employ towards greater market returns), there might also be value for managers in considering , pragmatically, operations from the three separate (theoretical) vantages

that informed this work: the knowledge-based view of the firm (Grant, 1996), the new product development literature (Brown & Eisenhardt, 1995, as well as organizational theory (learning, memory, information literature, e.g. Moorman, 1995; Moorman & Miner, 1997; Oliver, 1997; Scott, 1995). As an example, there is practical benefit in re-conceptualizing the firm, per Grant's albeit theoretical assertions: if the primary role of the firm is to bring together individuals with separate, specialist types of knowledge in order that they be able to interface, interact, and recombine their knowledge toward new knowledge creation, then the primary role of the new product development team is no longer simply new product development in the practical sense, either. Here, managers could reframe their undergirding assumptions regarding NPD team functions, and mobilize themselves and their counterparts for their ability to contribute knowledge and information to the team. Member success in this case, as an example, might then be measured based on how much each was able to contribute in terms of ideas, either singly or in combination with others, and not necessarily based solely on observable tangible tasks completed. Further, new product development managers who acknowledge that the predominant role of organizational interaction is to allow knowledge sets to interact and recombine toward novel creation of knowledge, will not only assess member contribution based on this, but will select potential members according to their abilities to aide this process, and will be more likely to foster a team atmosphere that is conducive to this, allowing for greater returns in-market ultimately (as this study finds).

The next subset of literature, that of new product development, might help managers formulate better organizational and intra-team metrics as well. While, based on my own experience, there is certainly a tacit acknowledgement in new product

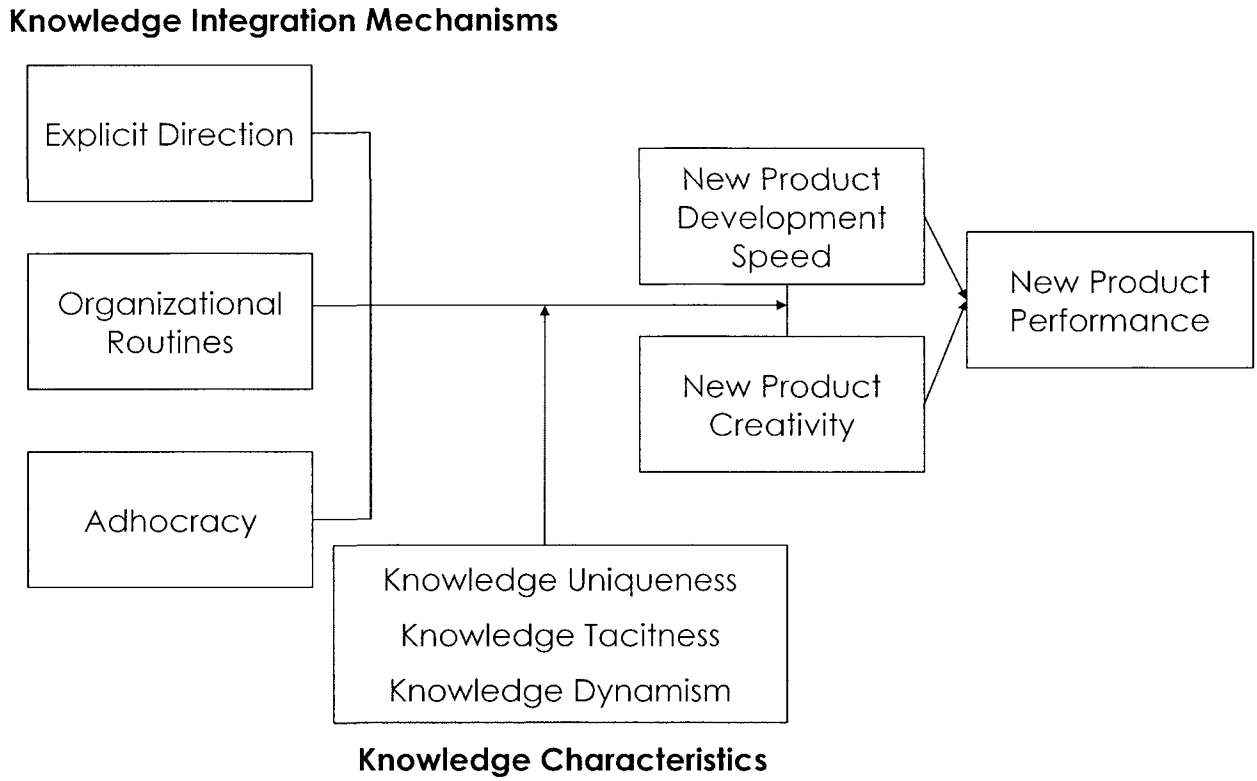
development teams (at least in Canadian consumer packaged goods companies) that products developed need be novel and get to market rapidly, there is little pragmatic consideration or understanding of exactly how novel a product should be (When is a product too radically novel? Do we know if what we've created the market will think is merely incremental?) nor how fast a new product should get to the marketplace (Do we base this on competitive activity? What about our more recent product launch, has it had enough time in distribution to merit a new launch of something? etc). The NPD literature, if brought to managers in pragmatic form—such as this study attempts to do—could certainly inform all of this. Not only does this literature accord each of these questions a metric (NP Novelty, NPD Speed, as is measured and reported herein), but could help managers overcome some of the organizational constraints that often preclude solid consideration of such questions. As an example, typically, novelty of new products is considered vis-à-vis what the team has produced before, as well as the most recent competitive launch. Based on the NPD literature, as well as this study, it might be informative for new product development managers to consider the actual metrics of NP Novelty (e.g. Im & Workman, 2004), which considers novelty to be based on innovation vis-à-vis former launches, competitive launches, category launches, and indicates that NP novelty might have an inverted U relationship to market success (e.g. innovation that is too incremental or too radical won't likely yield optimal returns). Further, in my experience, speed-to-market is usually governed by organizational and budgetary constraints: as soon as new product development managers are internally mobilized to launch another product, they will. This subset of literature however, also informs ideal timing and speed to market (Brown & Eisenhardt, 1995). Managers might take solace in the notion that while it is organizationally beneficial to get products to market once new

product development has been initiated (less time wasted, organizationally efficient, greater 'speed-to-market'), there is often merit in separating the timing of launches according to competitive activity and focal firm activity. As an example, some of the NPD literature, indicates that successive launches in a category, whether by the focal or competitive firms, actually serves to deflate the category given cannibalism and consumer confusion, allowing for negative returns (see Brown & Eisenhart, 1995; Chandy & Tellis, 1998; DeLuca & Atuahene-Gima, 2007 etc). Accordingly, the diligence and granularity of this research would certainly be beneficial information for practicing new product development managers, although few have access to it via academic distribution forums.

As a final component of the predominant managerial implications from this work, the organizational memory, knowledge, and information theory, literature, and research components are also likely to be helpful to practicing new product development managers. Herein such theory is used to explain how information and knowledge manifests, is stored, is transferred, can be recombined, and is ultimately created, as well as how organizations set up and organize new product development initiatives (typically in teams). Such consideration has value in a practical realm as well, given that while managers know they are housing information, have their own knowledge sets, often have difficulty communicating what they know or recombining what they know with others' knowledge sets, there isn't much explicit discussion of such constructs or mechanisms, in practice. Managers who are enabled to think more concretely about 1) the types of knowledge they and others possess, 2) communication mechanisms that allow them to effectively be understood and to understand others on the new product development team, and 3) methods that allow them to recombine their knowledge with

that of others, will likely be better able to work productively on a team. Further, much of the frustration inherent to working with others of conflicting perspectives or knowledge types could be lessened if managers were privy to the granular research and information, such as in this work, which highlights the various dimensions knowledge, integration, communication, and team organization can take. A better understanding of what these various constructs are termed, as well as how they work together (see Figure 3, Table 11), could only serve to ease interaction, understanding, and productivity among managers working together on a new product development team.

FIGURE 4
Theoretical Model of Knowledge Creation in New Product Development Teams



CHAPTER 7: CONCLUSION

New product development is critical for ongoing business growth of firms (Brown & Eisenhardt, 1995). Conceptually speaking, such innovation can take on either an internal or external orientation, such as in an 'input' or 'output' perspective on product novelty (Im & Workman, 2004). Olsen, Slater, and Hult (2005) discuss marketing organization behaviour variables and consider 'innovation orientation' as well as 'internal/cost orientation,' which is analogous to what is meant by 'externally oriented' and 'internally oriented' innovation, respectively, in the literature (e.g. Fagerberg, Mowery, & Nelson, 2005). Internally oriented innovation refers to innovation that is enacted on the organization internally in order to render firm processes and personnel more efficient, productive or creative, thereby creating pre-sales and efficiency- or value-based returns for the focal organization. Internally oriented innovation might take the form of technological implementation that streamlines workflows or allows an aggregated combination of knowledge sets; new task forces or teams that are better able to expedite work; new behavioural templates or best practices for how to complete particular acts or projects; development or training that makes personnel better able to communicate and work together, etc.

Externally oriented innovation refers to innovation that is intended for the external marketplace—such as new product development—and creates sales-based value for the focal firm by virtue of market successes (outside the organization). Externally oriented innovations are marketplace offerings that might take the form of products, services, or experiences (Holt, 2004) that have better speed-to-market, are more novel

than previous market offerings, or radically change—or create—a category (incremental vs. radical novelty, Atuahene-Gima & Murray, 2004; Chandy & Tellis, 1998), etc.

In this work, internal characteristics considered (e.g. characteristics of personnel knowledge, integration of human resources' knowledge sets, knowledge integration mechanisms) are considered as antecedents to externally oriented innovation (new product development, speed-to-market of newly developed products, level of novelty of new product development) that results in value to the focal (product producing) firms (such as in-market share, return on investment, increased sales, or better financial margins).

This work sits at the intersection of the three streams of new product development literature that Brown and Eisenhardt outline (refer to Table 1, pp 347, Brown & Eisenhardt, 1995). The model and results reported herein can lend insight into the following variables that Brown and Eisenhardt (1995) discuss: superiority of products developed (rational plan); the organization as a rational entity (rational plan); success via internal communication (communication web); success via problem-solving with discipline (disciplined problem-solving); the importance of information and knowledge (resource) dependence (communication web); product advantages of cost, quality, uniqueness (rational plan); senior management as supportive (rational plan) as well as subtly controlling (disciplined problem-solving); cross-functional interaction and communication (rational plan, communication web, disciplined problem-solving); the planning and effectiveness of work organization (rational plan); overlap of development phases, testing, iterations and planning (disciplined problem-solving); project managers as small group leaders (rational plan), some with significant control (disciplined problem-solving); performance as measured by financial successes (profits, sales, market share;

rational plan); and performance success as operational speed and productivity (internal innovation orientation as above; disciplined problem-solving).

This research spans multiple theoretical domains. Fundamentally about knowledge creation, this work sits squarely within the paradigm of the knowledge-based view of the firm (Grant 1996), which stemmed from the resource-based view of the firm, and includes some institutional theory considerations (Oliver, 1997). This paper used new product development theory (Brown and Eisenhardt, 1996) as a proxy for manifested knowledge (Madhaven & Grover, 1998). Including some organizational learning and memory (e.g. Miner, Bassoff, & Moorman, 2001; Moorman & Miner, 1997, etc.), as well as information and knowledge transfer theory (e.g. Bou-Llusar & Segarra-Cipres, 2006), the directions that future research with this work could take are multiple.

It was the intention to answer the research questions 1) What are the knowledge integration mechanisms that can be identified from the literature? 2) Are the identified KIMs equally effective in generating NP novelty across all pertinent knowledge characteristics? 3) Are the identified KIMs equally efficient in generating NPD speed across all pertinent knowledge characteristics? and 4) How does knowledge integration result in the creation of successful new products (which are the embodiments of knowledge)? A model and hypotheses based on these questions were determined, tested, and answered.

Ultimately, all types of KIMs tested were positively related to new product development speed. This is interesting given that while knowledge might take time to integrate, its very integration increases the efficiency and speed of the new product development—or knowledge creation—process. The KBV asserts that knowledge was created via the recombination of individuals' knowledge. These findings confirm that

axiom, as well as demonstrating that the development of a proxy for knowledge (new products) happens faster when there are mechanisms in place for the integration of individuals' knowledge. It was not demonstrated (despite hypotheses to this effect) that any of the KIMs would decrease the novelty of the new products (new knowledge) developed. This is interesting, and it is arguably because KIMs contribute to interaction and creative friction between personnel, increasing the overall level of innovativeness of the new knowledge created.

The multidisciplinary approach to work is in keeping with the ever-changing, contemporaneous realities of theoretical research. Academicians should strive to bridge multiple research traditions, streams of research, and theoretical disciplines, in order to inform theory anew, and ensure the non-redundancy of educational efforts, research expenditures, and knowledge creation in already over-specified fields. Given the global trend toward knowledge-based vocations, industries, and economies, as well as the increasing importance of data and information (the collection, maintenance, transformation, transfer, sharing, etc.) in popular culture and society in general, the very etiology of knowledge—how knowledge is created—should be of primary theoretical interest for all types of researchers moving forward.

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APPENDIX A: SURVEY INSTRUMENT

Instructions
Please rate the extent to which the most recent new product development process you were involved in demonstrated the following characteristics.
Please assign each question a number along this continuum: 1 = strongly disagree...7 = strongly agree.

Independent Variables (CFA Model 1: $\chi_2 = 268.43$, d.f. = 116, $p < 0.001$; AOSR = 0.03; NFI = 0.91; NNFI = 0.93; CFI = 0.96)

Question A: Explicit Direction (Construct Reliability = 0.84)
- In this NPD project, the activities were clearly laid out for each member #:___ (Factor Loading = 0.81)
- In this NPD project, formal criteria were used to regulate interaction among team members #: ___ (Factor Loading = 0.86)
- In this NPD project, direction was given to each member of the NPD team #: ___ (Factor Loading = 0.83)
- In this NPD project, standard operating rules guided each team member's activities #: ___ (Factor Loading = 0.89)
- In this NPD project, there was a clear protocol about task assignment for NPD team members #: ___ (Factor Loading = 0.80)

Question B: Organizational Routines (Construct Reliability = 0.79)
- Most team members worked in a coordinated fashion without requiring significant amounts of discussion to clarify task allocation #: ___ (Factor Loading = 0.83)
- Most team members worked together in such a way that they could contribute their respective expertise without having to make their thoughts explicit to one another #: ___ (Factor Loading =0.77)
- Most team members seemed to have an intuitive understanding of the processes that need to be followed in bringing new products to market #: ___ (Factor Loading =0.76)
- Most team members seemed to have an internal understanding for how the organization works to bring new products to market #: ___ (Factor Loading = 0.79)

Question C: Adhocracy (Construct Reliability = 0.92)
- Most team members could be characterized as entrepreneurial #: ___ (Factor Loading = 0.93)
- Most team members were able to make independent or autonomous decisions #: ___ (Factor Loading = 0.91)
- Most team members were willing to stick their necks out and take risks #: ___ (Factor Loading = 0.92)
- Most team members had a focus of delivering innovation first-to-market #: ___ (Factor Loading = 0.89)

- Most team members seemed more concerned with the end result than the process #: ___ (Factor Loading = 0.95)
- Most team members were generally focused externally, toward the market environment, rather than concentrating predominantly on the internal organizational circumstances #: ___ (Factor Loading = 0.91)
- The organization, roles, and activities of the team members were relatively fluid #: ___ (Factor Loading = 0.90)
- The way team members were managed could be described as informal #: ___ (Factor Loading =0.94)

Moderating Variables (CFA Model 2: χ_2 = 308.77, d.f. = 149, $p < 0.01$; AOSR = 0.04; NFI = 0.92; NNFI = 0.93; CFI = 0.94)

Question D: Knowledge Uniqueness (Construct Reliability = 0.77)
- Team members brought different types of insights to the table #: ___ (Factor Loading = 0.77)
- Team members had a unique understanding of things that other team members did not share #: ___ (Factor Loading = 0.48; omitted in subsequent analyses)
- Team members had a critical understanding of things that other team member did not share #:___ (Factor Loading = 0.82)
- Most team members commonly reached conclusions that were fundamentally different from those reached by other team members #: ___ (Factor Loading = 0.81)
- Most team members shared the same types of knowledge as others #: ___ (Factor Loading = 0.73)
- Team members generally had similar knowledge sets #: ___ (0.76)

Question E: Knowledge Tacitness (Construct Reliability = 0.83)
- Team members had know-how that was not easily transferred to others #: ___ (Factor Loading = 0.82)
- Team members had know-how that was not easily communicated to others #:___ (Factor Loading = 0.84)
- Team members had know-how that seemed more implicit than explicit #: ___ (Factor Loading = 0.83)
- Team members had knowledge that would be difficult to document in manuals or reports #: ___ (Factor Loading = 0.77)
- Team members had knowledge that would be difficult to identify without personal experience in having used it #: ___ (Factor Loading = 0.86)
- Team members seemed to have knowledge that they acquired through active, not passive, learning #: ___ (Factor Loading = 0.81)
- Team members had knowledge that they learned from having performed their activities before #: ___ (Factor Loading = 0.83)

Question F: Knowledge Dynamism (Construct Reliability = 0.85)
- Team members' knowledge about the innovation product and process was continually changing #: ___ (Factor Loading = 0.85)
- Information and knowledge about the competitive landscape evolved continually throughout the project #: ___ (Factor Loading = 0.86)

- Team members had a general perception that what worked yesterday would not necessarily work in the future #: ___ (Factor Loading = 0.87)
- Team members seemed to share the outlook that information can change suddenly #: ___ (Factor Loading = 0.81)
- Team members seemed to share the outlook that knowledge can change rapidly #:___ (Factor Loading = 0.89)
- Team members received new information for updating their knowledge sets relatively frequently #: ___ (Factor Loading = 0.79)
- Team members possessed knowledge that evolved or changed noticeably over time #: ___ (Factor Loading = 0.83)

Dependent Variables (CFA Model 3: χ_2 = 41.01, d.f. = 26, $p < 0.05$; AOSR =0.01; NFI =0.94; NNFI =0.95; CFI =0.98)

Question G: New Product Novelty (Construct Reliability = 0.88)
- The product(s) developed were new to the industry #: ___ (Factor Loading = 0.88)
- The product(s) developed were new to the firm #:___(Factor Loading = 0.86)
- The product(s) developed were based on revolutionary advances in technology #:___ (Factor Loading = 0.89)
- The product(s) developed could be considered radically different from anything produced by this team before #:___ (Factor Loading = 0.86)
- The product(s) developed could be considered 'out of the ordinary' for the industry #:___ (Factor Loading = 0.82)
- The product(s) developed could be considered 'revolutionary' for the industry #:___ (Factor Loading = 0.85)

Question H: New Product Development Speed (Construct Reliability = 0.78)
- Relative to what is normal for this team, this product took longer to develop #: ___ N/A D/K (Factor Loading = 0.76)
- Relative to what is normal for this industry, this product took longer to develop #:____ N/A D/K (Factor Loading = 0.78)
- Relative to what is normal for this firm, this product took longer to develop #: ____ N/A D/K (Factor Loading = 0.79)
- How long did it take from innovation conceptualization to availability on the market? # months:___ (Respondents were unwilling to answer: Item was deleted from scale)
- From conceptualization to market availability, what is the norm for innovation speed for a product of this kind? # months:____ D/K (Respondents were unwilling to answer: Item was deleted from scale)

Control Variables

Question I: Number of Team Members
How many individuals were in the NPD team? _____
Coding: 1 = less than 5; 2 = between 5 and 10; 3 = 11 to 15; 4 = 16 to 20; 5 = greater than 20

Question J: Type of Innovation

What were you creating in this team?

_____

Question K: Industry
What industry is your firm in?
Coding: 1 = sic 35; 2 = sic 36; 3 = sic 37

Question L: Team Duration
How long had that team worked together, in months? __
Coding: 1 = less than 3; 2 = 3 and 6; 3 = more than 6 and less than 9; 4 = 9 to 12; 5 = more than 12

Question M: Market Performance (Indicate percentage or dollar value; if N/A circle; if DK circle)

- Is this product in market currently? Y N
- **Market Share:** Regarding **market share targets, what percentage was/will be reached in the first year?** (i.e. 50% means half of the target, 200% means target was doubled) ____% N/A D/K
  Coding: 1 = less than 10%; 2 = 10 to 30; 3 = >30 and < 50; 4 = 50 but < 75; 5 = 75+
- What was the approximate market share of the product developed, in the first year?____% N/A D/K
  Coding: 1 = less than 10%; 2 = 10 to 30; 3 = >30 and < 50; 4 = 50 but < 75; 5 = 75+
- **Sales:** Regarding **sales targets, what percentage was/will be reached in the first year?** ____% N/A D/K
- What were the approximate sales of the product developed, in the first year? $____ N/A D/K
  Coding: 1 = less than 100,000; 2 = ; 5 = greater than 5 million
- **Profit Margin**: Regarding **profit margin targets**, what percentage was/will be reached in the first year? ____% N/A D/K
- What was the approximate profit margin of the product developed, in the first year?____% N/A D/K
  Coding: 1 = less than 5%; 2 = 5 to 10? 3 = 11 to 15%; 4 = 16 to 20%; 5 = greater than 20%
- **ROI:** Regarding **return on investment (ROI) targets, what percentage was/will be reached in the first year?** ____% N/A D/K
- What was the approximate ROI on the product developed, in the first year?___% N/A D/K
  Coding: 1 = less than 5%; 2 = 5 to 10? 3 = 11 to 15%; 4 = 16 to 20%; 5 = greater than 20%

APPENDIX B: DEVELOPMENT OF MEASURES AND ITEMS

The following are abbreviated definitions of the measures used The references cited are those whose items were used in the survey instrument above Please see also refer to Table 1 for an expanded definition of each as well as other references that contributed to the definition and consideration of the constructs in the model and hypotheses proposed

Explicit Direction (Demsetz, 1991, Grant, 1996b, Sethi & Iqbal, 2008)
Definition Knowledge is integrated within a formal, objective, consistent and directed team process
Organizational Routines (Grant, 1996)
Definition Organizational behavioural script that provides a mechanism for coordination that is not dependent on the need for communication of knowledge in explicit form, informal procedures in the form of commonly understood roles and interactions among/between team members
Adhocracy (Moorman, 1995)
Definition The organization of the roles and activities in the team is fluid, knowledge is integrated ad hoc, with considerable flexibility, individuals have the flexibility to make entrepreneurial, independent decisions, the end-result is supreme to the process Adhocracies value flexibility and competitive position in external environment They tend to emphasize entrepreneurship, novelty and adaptability Information acquisition, resource procurement and boundary spanning activities are strong in adhocracies
Unique Knowledge (Bou-Llusar & Segarra-Cipres, 2006)
Definition Unique knowledge is knowledge that is significantly different from what others know, knowledge that is not shared among others in the group, non-common knowledge, represents a fundamental departure from knowledge others have
Tacit Knowledge (DeLuca & Atuahene-Gima, 2007, Grant, 1999, Reed & DeFillippi, 1990, Simonin, 1999)
Definition Tacit knowledge cannot be easily codified, formalized, communicated or shared, it is implicit, personal, rooted in action, learned/demonstrated by doing
Dynamic Knowledge (Achrol & Stern, 1988, 1991, Aldrich, 1979, Bou-Llusar & Segarra-Cipres, 2006)
Definition Knowledge that is dynamic, evolves or shifts rapidly, knowledge that is perceived to change or be updated with relatively greater frequency, the character of which has a higher degree of uncertainty
New Product Novelty (Andrews & Smith, 1996, Atuahene-Gima, 2004, DeLuca & Atuahene-Gima, 2007, Im & Workman, 2004, Moorman, 1995)
Definition Degree of newness of new products developed (radical vs incremental), level of novelty or innovativeness that the new products demonstrated
New Product Development Speed (Moorman, 1995)
Definition Length of time it took from initial conception of a new product to be developed to the point when it was actually present and available in the marketplace (measured in weeks)
NP Performance (Im & Workman, 2004, Moorman, 1995)
Definition How the NP performed post-development, in-market

APPENDIX C: SAMPLE INFORMED CONSENT DOCUMENTATION USED

A. Sample Informed Consent Form for Telephone Survey to be Used

My name is Brynn Winegard. I am a student at York University in the Schulich School of Business. My contact information and that of the professor who is supervising this work is provided below. If you have any questions about the ethics review process or substance of this research, please feel free to contact me or my supervisor, Dr. Ashwin Joshi, phone 416 736 2100, for clarification. You can reach me any time at bwinegard@schulich.yorku.ca.

This research pertains to the process of knowledge creation that occurs intra-firm during the process of creating new products in product development teams. We intend to telephone survey yourself and other marketing project managers of these product development episodes with a short survey of questions regarding your possible experience having utilized the knowledge and/or integration mechanisms of knowledge. The questions are non-invasive, non-personal, and post-experiential and do not in any way pose a threat to any of the respondent's career, proprietary knowledge sets, prospective innovations or employing companies.

I am therefore asking if you would agree to participate in my research by answering a series of questions that will be recorded by me and that are completely private. Your identity will never be revealed at any point after the collection of your answers.

Please understand that you do not have to participate in this research and that you can terminate your participation at any time during the course of the research. Also feel free to skip any particular question and move on the next one at any time during the research. Once the research is finished, you have the right to ask me to not include the information you provided in my research.

This research is confidential and no individuals or organizations will be identified. Any information that could reveal your identity or that of your organization will be excluded from any future papers or research reports that are written based on this research. I will destroy any surveys or notes at the end of this project.

This research has been approved by York University's Human Participants Review Sub-Committee and the Schulich School of Business Human Participants Review Committee.

Participant:
I am fully aware of the nature and extent of my participation in this project as stated above. I hereby agree to participate in this project and proceed with the telephone survey questions to be administered.

_____ _____

Consent of Participant Date

_____ _____

Printed name of participant Signatures of researcher(s)