Your new product development (NPD) is only as good as your process: an exploratory analysis of new NPD process design and implementation

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Given industry competitiveness, how do firms' new product development (NPD) process designs differ when responding to an innovation mandate? How do NPD design elements differ across firms when implementing NPD processes? These design elements are strategic business unit (SBU) senior management involvement, business case content, customer interactions, and cross-functional integration. What are the consequences of different combinations of NPD process design elements for innovation productivity? We explore these questions via a collective case study of newly implemented NPD process designs at three different SBUs of a major US-based international conglomerate, 1 year after receiving the mandate to grow through innovation. Our analysis suggests that industry competitiveness and firm characteristics influence the NPD process design as SBUs employ distinct combinations of NPD design elements. The differential emphasis on design elements leads to variation in process design and divergence in innovation productivity.

1. Introduction

Organic growth is both a desire and a challenge to most firms (Hamel and Getz, 2004). The only way to achieve profitable growth in dynamic industries is through increasing innovation productivity, i.e. creating value-generating innovations while ensuring speed to market and controlling development costs (Kim and Mau-borgne, 2004b; Cooper and Edgett, 2005). Innovation productivity at the strategic business unit (SBU) level signifies maximum new product innovativeness for given time and resource commitments (Cooper and Edgett, 2005), or 'more bang for every innovation buck' (Hamel and Getz, 2004; p. 27). This is not to say that incrementally new products do not have performance implications, but rather 'it is radical ideas that yield the

biggest innovation payoffs and drive above-average growth' (Hamel and Getz, 2004; p. 35). New product development (NPD) involves competing goals of minimizing risk by acquiring sufficient market information while reducing costs and time to market, thus escalating the importance of NPD process design and implementation. Despite scholarly interest in NPD structures (Cooper and Kleinschmidt, 1994; Kessler and Chakrabarti, 1999; Liker et al., 1999; Sethi et al., 2001; Bonner et al., 2002; Filippini et al., 2004; Troy et al., 2006), the question of how firms should implement an effective new NPD process design for decreased cycle time and increased innovation productivity remains largely unanswered. It appears that there is no 'one-size-fits-all' solution.

NPD processes involve a series of stages aimed at delivering a functional commercial benefit to customers (Calantone et al., 1995). Proficiency in executing NPD processes is important because it determines the degree to which businesses can meet and/or exceed demand, and thus succeed (Kleinschmidt and Cooper, 1991). Organizational design is a critical problem for NPD processes because the design needs to enable effective coordination and conflict resolution and facilitate cross-functional sharing of resources (Olson et al., 1995). Influential organizational design elements include formally planned stages, senior level involvement, business case preparation, customer input, and cross-functional integration (Barczak, 1995; Kahn, 1996; Bonner et al., 2002; Frishammar and Horte, 2005). However, empirical results are conflicting regarding outcomes.

To manage product development effectively, managers are recommended to use stepwise approaches such as stage-gate processes (Cooper and Kleinschmidt, 1991), where required tasks, their sequences, and taskforces are specified explicitly (Griffin, 1997). These approaches seek to manage risk and increase efficiency through adherence to a structured NPD process (Calantone and Di Benedetto, 1988). More generally, such NPD process models facilitate action across functions and projects by providing a common language and framework to enhance communication (Engwall et al., 2005). Recent research suggests, however, that stage-gate processes often result in lower-risk, immediate-reward, and incremental projects (McDermott and O'Connor, 2002).

Centralization and senior-level involvement may positively impact NPD by providing supervision for project uncertainties (Meyers et al., 1999). At the same time, centralized decision making tends to repress the creativity, brain-storming, and experimentation acknowledged to promote innovation (Miller et al., 1988; Covin and Slevin, 1989; Damanpour, 1991). Meanwhile, rapid technological change and global competition lead firms to focus on customer relationship building and embrace coordination mechanisms that make possible empowered and responsive cross-functional teams (Gupta and Wilemon, 1986; Johne and Snelson, 1988). Flexible and informal mechanisms provide teams with greater autonomy and encourage idea exchange (Mintzberg, 1979; Dewar and Dutton, 1986). Interfunctional collaboration and continuous customer interactions may engender responsiveness and effectiveness, while also sacrificing efficiency.

Given these prevailing debates in the NPD literature, the question still remains: how do/should firms implement effective new NPD process designs for the timely launch of desirable new products to ensure growth? To explore this research question and to gain more in-depth knowledge, we conducted a collective case study at three US-based SBUs of a major international manufacturing conglomerate. We performed multilevel field interviews at each SBU approximately 1 year after they received a top–down mandate from the conglomerate to grow via innovation. Our aim is to explore how these SBUs tailored formal stage-gate processes, business case content, cross-functional integration, and customer input into their processes in response to this mandate, contingent upon their industry competitiveness. Managers may benefit from an analysis of contingency relationships, as our case analysis findings indicate which structural elements may compensate each other and which combination(s) may engender higher innovation productivity.

As the SBUs in our sample operate in the building materials industry, our research focuses on low-technology markets. The implementation of NPD processes in low-technology firms is important and requires in-depth analysis for several reasons: (1) low-tech industries are large in terms of employment, sales, and revenue, as well as products generated, (2) innovation is acknowledged as the key differentiation mechanism for all firms (not only high-tech firms), (3) low-tech firms are required to innovate for their survival and growth, (4) NPD may be relatively more difficult for low-tech firms as innovations have recently been a key success driver in this industry, and (5) industry boundaries are gradually becoming blurred as low-tech innovations appear to be direct substitutes or competing products to high-tech innovations (Kim and Mauborgne, 1999;

2004a; Mohr et al., 2005). Consequently, our results may provide managers of companies in low-tech industries with guidelines as to how to improve innovation productivity.

The paper is organized as follows: first, we describe the research method. Next, we identify similarities and differences between the units to develop insights related to NPD process implementation. We conclude with our conceptual framework and associated propositions with which we have organized our managerial implications.

2. Methods

We employ a collective case study method based primarily on in-depth interviews (Eisenhardt, 1989; Miles and Huberman, 1994; Stake, 1994; Cresswell, 1997). In-depth interviews capture an individual's or group's perceptions of behaviors after they occur, allowing important issues to be discovered. Compared with other research methods (i.e. surveys, secondary data analysis), the multiple case comparison method has the highest potential to provide deep contextual understanding of factors underlying the NPD process design (Eisenhardt, 1989). Hence, we conducted three case studies, comparing how SBUs in the same large conglomerate implement NPD processes to comply with the corporate mandate to grow through new products, given the particulars of their NPD environments. We aim to probe the phenomenon of NPD process design in its natural setting and contribute to theoretical knowledge through our conceptual framework (Bonoma, 1985). The SBUs we examine provide a unique advantage in that they are all charged with the innovation mandate; and hence, we are able to observe the implementation of brand new NPD processes.

The top management team at the conglomerate provided us with access to three SBUs operating in various building materials industries. Firms generally face pressures to attain performance goals set by corporate headquarters, usually in the form of short-term profits and operating ratios, which frequently result in a focus on immediate returns, low operating costs, and incremental improvements (Cooper and Edgett, 2005). This indeed was the case for the SBUs in our sample: they had been focusing on developing low-risk new products that would generate immediate rewards. Despite initial competitive advantages in their major markets, they had not been proficient in growing their businesses and were experiencing performance difficulties resulting from new entrants and intensifying competition. In response, the conglomerate undertook a major change in corporate strategy and issued a mandate calling for value-generating innovations that would foster a long-term focus and engender organic growth. This innovation mandate required each SBU to scrutinize and improve its NPD process proficiency and NPD productivity. Consequently, although our sample of SBUs all operated in various low-technology industries, they had been facing difficult challenges akin to those in high-tech industries.

A prominent assumption in the past has been that high-tech firms operate in turbulent environments while the environments of low-tech industries tend to be stable (Bourgeois and Eisenhardt, 1988). Hence, we ask whether this difference still exists? Extant research argues that a distinction between high- and low-technology industries based on common perceptions may be misleading as industry boundaries have become blurred because increased of global competition and economic risks (Kim and Mauborgne, 1999; 2004a; Mohr et al., 2005). More specifically, because high-technology applications have broadened in scope to include 'traditional' low-tech companies, the technical uncertainty in the ultimate outcome of the development process (i.e. 'Will the NPD process engender a commercializable product with a compelling value proposition?') that holds for high-tech industries is valid also for low-tech companies.

We conducted the fieldwork 1 year after mandate institution. Data were collected through in-depth, face-to-face interviews with 13 informants (Table 1): six engineers/designers and seven senior-level executives (i.e. vice president (VP) or senior director of marketing, manufacturing, or program/product management). Although one informant is female, we shall refer to all informants in the masculine to ensure anonymity. The engineers provided insights into the team members' personal experiences with the NPD process implementation, while the managers discussed information flows between management and team members and how managers ensure NPD implementation aligns with SBU strategy. Our sample is especially appropriate to explore the research questions because the SBUs operate in distinct industries, which allows us to obtain a variety of perspectives on NPD process implementation in diverse settings resulting from the same innovation mandate (Cresswell, 1997; Eisenhardt and Graebner, 2007).

Nukhet Harmancioglu, Regina C. McNally, Roger J. Calantone and Serdar S. Durmusoglu

Table 1. Titles of the informants

	SBU1	SBU2	SBU3
Engineer/Designer Informants	Senior Product Engineer	Senior Product Designer	Marketing Product Manager
	Senior Product Engineer	Corporate Product Engineer	Product Engineer
Senior Manager Informants	Vice President of Marketing and Product Development	Director of Manufacturing Services/ Product Management	Senior Vice President, Marketing
	Senior Director of Product Development and Engineering	Program Manager	Senior Vice President, Technology and Purchasing
		Senior Marketing Product Manager	

SBU, strategic business unit.

We used standard interview protocols to ensure completeness and consensus (Tables 2a and 2b). Interviews were conducted in an unstructured fashion in that we did not follow the protocol strictly, encouraging informants to talk freely (Fontana and Frey, 1994). At least two investigators were present in every interview to obtain convergence and enhance precision in findings (Eisenhardt, 1989). Interviews were audio recorded and transcribed. The only exception is for the SBU3 marketing senior VP, who requested the interview not be recorded. The data for this informant consist of the field notes of the three researchers who conducted the interview. Together, the researchers produced combined case notes for each SBU and mapped each SBU's NPD process using IBM WBI Workbench version 4.2.3 software. For triangulation purposes, the data consist of transcriptions, field notes, combined case notes, and other archival data gathered on site (Miles and Huberman, 1994; Stake, 1994; Eisenhardt and Graebner, 2007). To ensure accuracy and to validate our analysis, the final combined case notes and process maps were reviewed by our informants and were modified based on their comments. The next section reviews the analysis and results.

3. Analysis and results

To analyze our data, we used the procedure suggested by Miles and Huberman (1994). In light of our research questions, we first displayed our data in figures and matrix-like tables, compared and contrasted the results, and followed by reducing our interpretations into a conceptual framework (Miles and Huberman, 1994). In our comparative analysis, we sought similarities, particularities, and relationships regarding innovation productivity (i.e. the primary outcome). Tables 3 and 4 aid in comparing the characteristics of the SBUs on the constructs represented in our conceptual framework. Figures 1–3 depict the flow of stages and the different design elements employed at each stage, and highlight process improvements implemented after the corporate mandate.

Table 3 encompasses both the internal and external climate surrounding the NPD processes at each SBU and includes firm size, the intensity of market competition, and performance before and after the process improvements. We obtained approximate estimates for the annual sales and number of employees from all SBUs except for one.[1] We categorize the intensity of competition in the industries of the SBUs as high, moderate, or low, depending on the concentration and intensity of rivalry within the SBU's target market (Cooper, 1979; Bourgeois and Eisenhardt, 1988; Mullins and Sutherland, 1998). Finally, SBU performance before and after the mandate indicates the overall perceived performance in terms of marketing and financial objectives (Griffin and Page, 1996).

Table 4 presents the NPD characteristics in terms of innovation productivity, the extent of senior management involvement, use of formal stage-gate processes, business case content (i.e. items included in the plan), and the extent of customer input and cross-functional integration. Innovation productivity signifies the degree of new product innovativeness given the amount of time spent on NPD. We view product innovativeness as the degree of market newness of the products commercialized by the SBUs, ranging from 'new to the world' and radical innovations to incremental products such as line extensions

Table 2. Interview protocol

(a) (Engineer level)
1. Please tell us about your NPD process. What are the items/steps/routines/sequences in developing NPs?
2. In general, does top management at the division or group level provide clear/well-defined goals for an NPD project?
3. How was the last new product development project carried out? Also, how were project goals communicated?
4. In your opinion, what are the strengths of your NPD process? What are the areas that need improvement?
(b) (Senior Manager level)
1. Do you set a strategic agenda for NPD programs? If so, how is it set?
2. Do you guide the cross-functional teams in their NPD activities based on a strategic agenda? Are these goals also set for individual development projects?
3. How do you communicate these goals to the development teams?
4. How do you make sure that the goals are communicated effectively and that the development processes are proceeding in the right direction?
5. Can you give an example where you guided the cross-functional teams in their NPD activities based on a strategic agenda for an individual project?
6. In general, what are the strengths/weaknesses of your firm in strategic agenda setting?
7. In general, what are the strengths/weaknesses of your firm's NPD process?

NPD, new product development.

Table 3. Firm characteristics, industry competitiveness, and firm performance

	SBU 1	SBU 2	SBU 3
Annual sales	> $300 million	> $650 million	Not disclosed due to confidentiality requirements
Number of employees	1,400	4,000	Not disclosed due to confidentiality requirements
Industry competitive intensity	Moderate: competition on price, quality, and distribution with new entrants	High: price competition	Low: a niche strategy follower
Past performance (before mandate)	Dominant market share in majority of served markets	Non-dominant market share in served markets; had been the market leader	Dominant in their niche markets
Recent performance (since mandate)	Dominant market share in majority of served markets	Gaining on competition by introducing new products (nearly 25% of products sold introduced in last 3 years)	Dominant in their niche market (compounded annual growth about 10 times industry average in last 2 years)

SBU, strategic business unit.

and product upgrades (Garcia and Calantone, 2002). Cycle time is the time elapsed between initial stages (i.e. idea generation) to ultimate commercialization (Ali et al., 1995; Kessler and Chakrabarti, 1999). Senior management involvement in this research signifies the degree to which top management intervenes in team decisions throughout the NPD process (Bonner et al., 2002). We define the use of formal stage-gate processes with reference to the extent to which the formal design of roles and mechanisms is used to control and integrate work activities and resource flows (Cooper and Kleinschmidt, 1987, 1995; Olson et al., 1995; Griffin, 1997). A business case delineates project goals, market projections, and possible product specifications. We compare our sample of SBUs with regard to the degree of detail incorporated into their business case document and the extent to which they use it to control their processes (Crawford, 1984; Tatikonda, 1999). We describe the extent of customer input allowed into NPD to indicate if the SBUs listen to the 'voice of the customer' or to the 'voice of the salespeople' (Cooper and Edgett, 2005, p. 7). Finally, the extent of cross-functional integration signifies the nature of the collaboration among the members having an active role in the project: whether all functions commit and contribute to each NPD stage or whether certain functions are the forerunners throughout the process (Kahn,

Nukhet Harmancioglu, Regina C. McNally, Roger J. Calantone and Serdar S. Durmusoglu

Table 4. NPD characteristics

	SBU 1	SBU 2	SBU 3
Innovation productivity			
Product innovativeness	Incrementally new products	Incrementally new products	Incrementally new products Radical merchandising innovations
Approximate cycle time	12–15 months (plus 90 days for launch)	Not available. Business plan preparation: 3–6 weeks for line extensions, 6 months for new designs	60 days to 2 years
Senior management involvement			
Extent (and top management roles)	High: idea-generator; planner; orchestrator; gate-keeper	High: idea-generator; planner; orchestrator; gate-keeper	Low: gate-keeper
Stages	Idea generation Idea screening Project proposal and clarification Concept creation Post-launch review	Idea screening Project proposal and clarification Post-launch review	Idea screening Project proposal and clarification Launch
Use of formal stage-gate process	Evolving	Improving	None
Business case			
Detail	Moderate	Exhaustive	Comprehensive
Content	Product specifications Volume forecasts Timeline	Target channels Production cost figures Preliminary designs Technical feasibility Risk analysis Financial plan Timeline	Product specifications Capital requirements target cost/price Financial plan Volume forecasts Timeline
Customer input and feedback			
Source	Directly through customer interactions and indirectly through marketing and sales functions	Directly through customer interactions and indirectly through marketing and sales functions	Directly though customer interactions
Stages	Idea generation Feedback: concept creation, prototype testing and product development	Idea generation: focus groups Feedback: idea screening, project proposal, and product development	Feedback: idea screening, Project proposal, concept creation, prototype testing, and product development
Cross-functional integration			
Extent	Some; specific departments lead in different NPD stages	Extensive	Extensive
Stages	Project clarification	Idea screening Project proposal Prototype development and testing Launch	Idea generation and screening Project proposal Product development (field testing) Launch

SBU, strategic business unit; NPD, new product development.

1996; Olson et al., 2001). This table also lists the stages at which customer input, senior management involvement, and cross-functional collaboration occur.

The corporate mandate requiring a focus on growth via new products led the SBUs to change their NPD processes. They did not implement entirely different processes for different projects, but acted to achieve timely responses to environmental challenges. SBU1 incorporated front-end activities, allowing marketing insights and customer input into their processes. SBU2 advanced
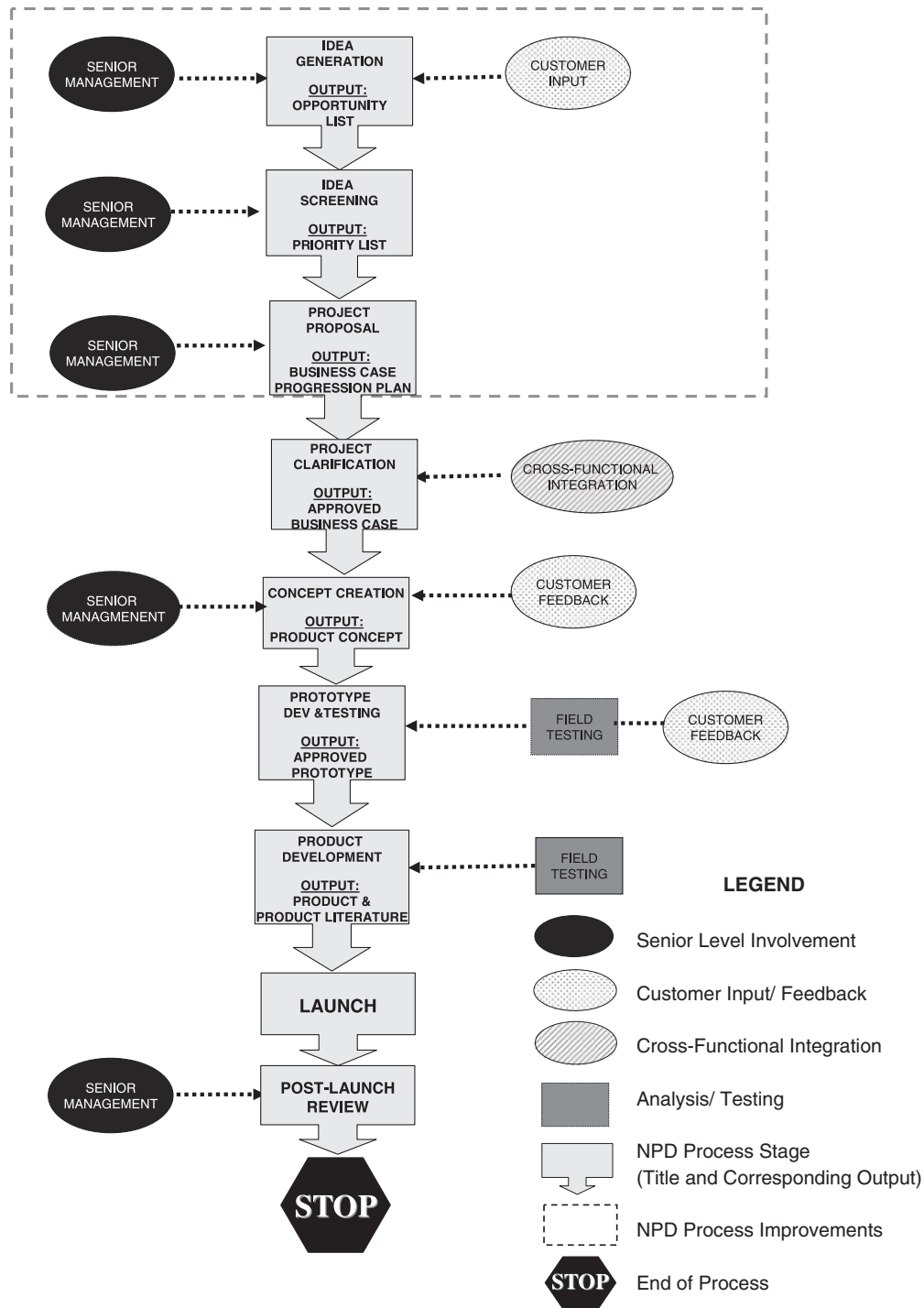
Figure 1. Strategic business unit 1 new product development (NPD) process.

with a formal process execution, increasing business case prominence and marketing input. SBU3 retained the most flexible structure, where controls and interactions resided in their 'hallways,' resulting in a rather simple process. They did improve cross-functional input in business case development.

3.1. SBU1: becoming a designer for the market

SBU1 operates in a moderately competitive industry and has a majority market share for their core products in the US market. The competitive pressures our informants recently experienced

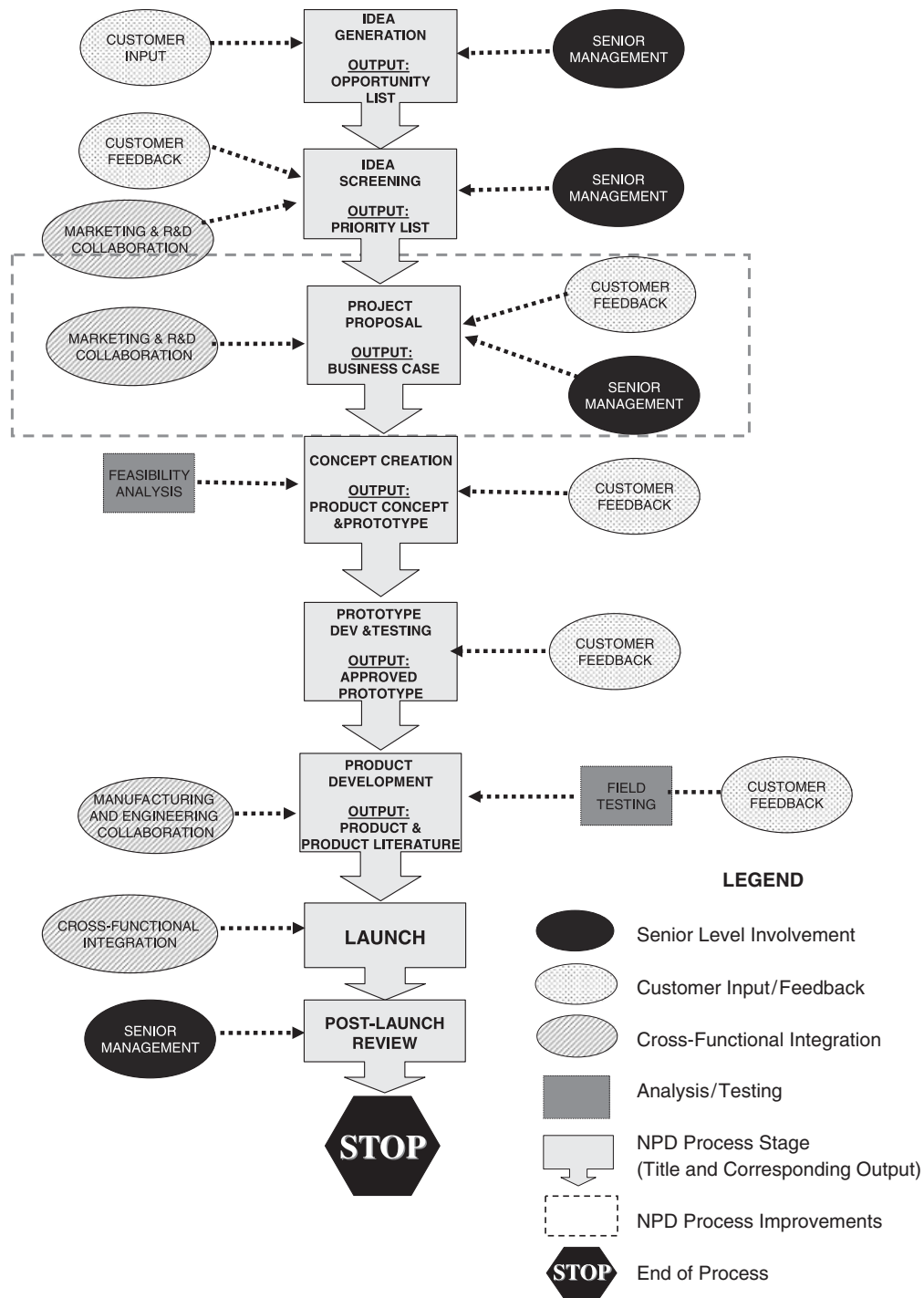*Nukhet Harmancioglu, Regina C. McNally, Roger J. Calantone and Serdar S. Durmusoglu*

Figure 2. Strategic business unit 2 new product development (NPD) process.

include domestic competition for distribution and price rivalry with Asian firms. Most importantly, despite their positional advantages in the US market, they experience pressure to deliver high-quality products that best meets customer needs, both externally due to industry standards and internally due to the corporate mandate for higher innovation. The Senior Director of Product Development and Engineering describes their performance and industry:

> We are recognized, we are the brand leaders, we have a 70–80 % market share. We are facing a fragmented, changing market where
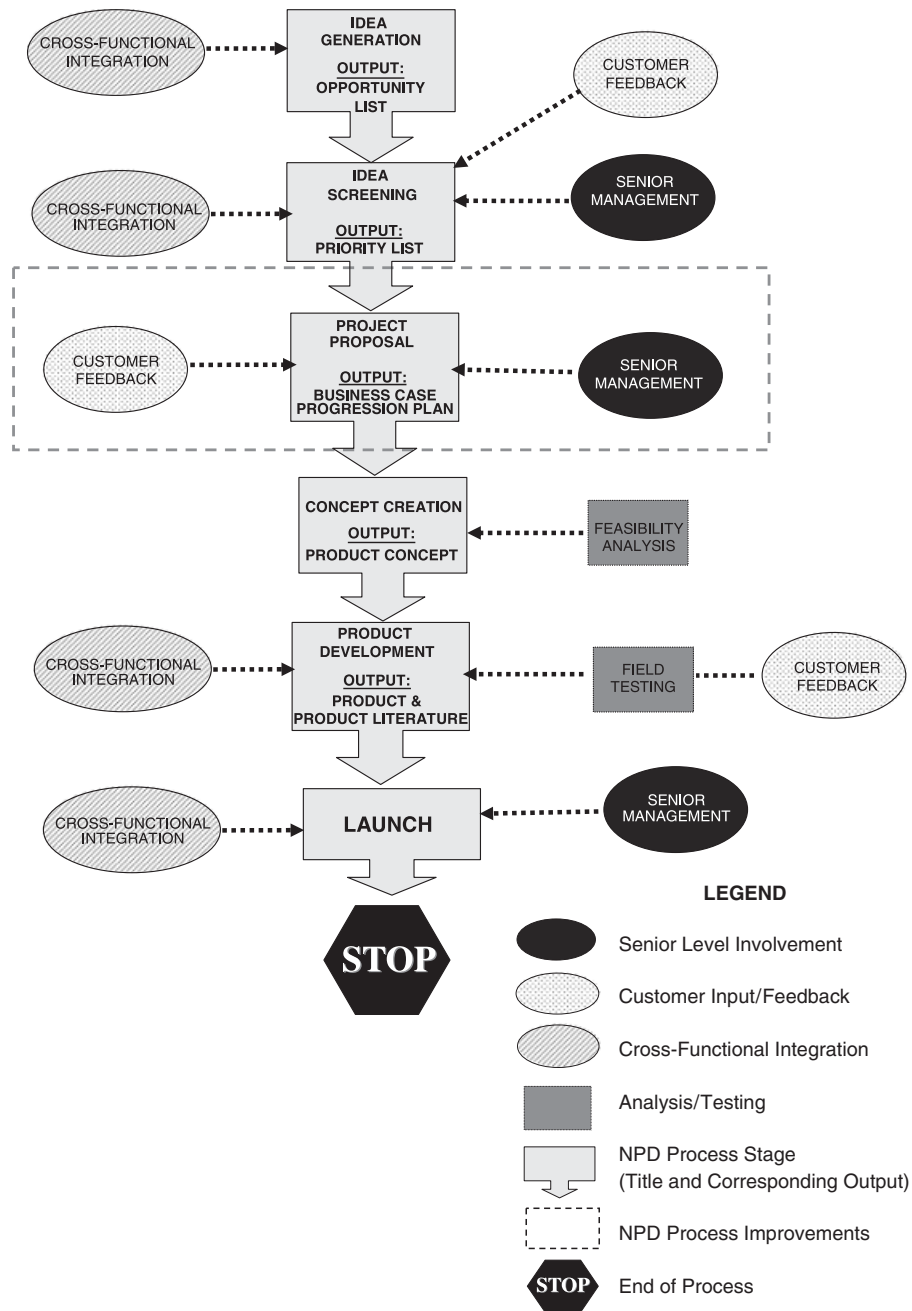
Figure 3. Strategic business unit 3 new product development (NPD) process.

we've got to sustain our quality. It's accepted, it's given, we don't get credit for it. But if we fail, we will lose what is our biggest asset.

However, before the mandate, SBU1 lacked a clear NPD program strategy and fell short in closely monitoring market dynamics, which resulted in lost market opportunities:

Product Development didn't have any Marketing input. It wasn't driven by what was going on in the market place; I don't know where the ideas came from. But, what would happen if Engineering would start the process; so they would start the concept development and that could go on for years ... they < the teams > were missing too many opportunities. The opportunity would be

there in the beginning, by the time the product came out, the opportunity need had changed.

In response to the mandate, they endeavour to 'reinvent' themselves, by establishing a well-defined NPD strategy and by restructuring their NPD processes. First, they focus on commercializing products that meet customer expectations and pre-empt competitor actions in their target markets. Second, they are undertaking a broad initiative to restructure their development process', hiring the VP of Marketing and Product Development to guide the new process implementation and forming a new functional group devoted to NPD. They defined their prior process as 'a traditional functional system without a standardized process.' NPD had a 'fragmented' structure (as indicated by the Senior Director) characterized by different processes depending on the extent of the change. In the earlier structure, there was a gap between product development and customer needs. The major process change they made is adding the three stages of idea generation, idea screening, and project proposal to allow customer input (Figure 1). In addition, the voice of the customer is now incorporated in concept creation and prototype development. The VP of Marketing indicates the degree to which they are customer-driven in their product development:

> We want the customer in every part of the development phase . . . so right from the beginning up to the identification, we try to understand the customers' needs and then go to concepts and development phase. We want to show 3D concepts to customers . . . and then when we get the physical prototypes we want to show those to the customers. We want to make sure we are going down the right path at all times. So we want to involve them all the times.

SBU1's culture is based on communication and consensus building to ensure everyone understands the need for change and the new process. The VP of Marketing and Product Development states the objective of their new process design to emphasize this culture: 'it really feeds a lot of other functions and departments to make everything work better.' The downside is that it often inhibits flexibility and timeliness. The VP describes their challenges:

The company has a culture that emphasizes building of consensus. This company is very considerate of their people and their attitudes. But, change occurs very slowly.

Cross-functional collaboration occurs in one stage, i.e. project clarification, during which Marketing, R&D, and Engineering members develop the business case with equal involvement and commitment. Senior management plays a dominant role in project screening, business plan development, and launching performance assessment. This senior committee also holds monthly project review meetings. A Product Engineer expressed his contentment with the degree of supervision the teams received:

> In the monthly meetings, projects are discussed with < the senior manager committee > . The teams are able to confirm that they are on the right track and that they have understood what is expected from them.

Although teams are interdisciplinary, the NPD process is not entirely carried through cross-functional collaboration. The VP of Marketing suggests that the leading functions and the extent of management supervision on the development teams differ in each NPD stage:

> There is that involvement and with every phase of the product development process there is a different emphasis. The first phase, opportunity identification, is largely Marketing for every phase to understand what the market place needs, and that involves me because I'm the VP of Marketing. Then in phase 2 when we are doing the project proposal, again that is more Marketing than Sales. So that would include various VP's of Sales and myself. The next phase, project proposal and project clarification, would involve all the effective VPs, again myself, VP of Sales, VP of Manufacturing is involved (since they are manufacturing the part). Then when we get to concept development, that again is driven by my group because I have Engineering as well. Then we go into prototyping, where we are starting to make that transition from Engineering to Manufacturing. The next phase is development and launch, which is mostly driven by Manufacturing. So there would be a Manufacturing rep, Quality rep, Packaging rep, things that the VP of Manufacturing will have to sign off on. Then after launch we go to a post review audit to monitor the project.

Despite a few projects that require new development capabilities for the unit, SBU1 focuses on developing line extensions rather than products radically innovative to the market. One of the senior Product Engineers states that is what their customers want, ' ... we make the same <product>that we made 50 years ago.' Their customer focus does not involve overreliance on customer product expectations but on understanding their needs and performance expectations.

Another major source for new product ideas is the cross-functional NPD teams, who identify opportunities through brainstorming and research activities. Referring to a specific project he was involved in, the senior Product Engineer explains the idea generation process:

> We were away not meeting for 2 weeks and working on some concepts. Then we would regroup, everyone would share their concept, and brainstorm awhile just verbally on what could we do and what do we want. So the brainstorming started a long laundry list of maybe 30–40 items. Working and looking at those you can boil it down to some things that really apply. Brainstorming is broad and some of the ideas of brainstorming didn't really apply to the project or they were pie in the sky.

To commercialize more innovative products in a timely and less-costly fashion, they further plan to divide engineering into various groups: an Advanced Engineering group for process innovations and improvements, an NPD group for product innovations, and a Product Maintenance group for sustaining work. The VP asserts:

> The structure I'm trying to put in place here is trying to divide Engineering into functions; one of them is Advanced Engineering for R&D type of engineering where innovations really begin to take form.

SBU1 has a fairly standardized process in their vision, as all our informants have provided comparable descriptions of their new process structure. Each team is responsible for developing specific product types and reports to their functional managers. New product ideas are screened by a special committee of senior managers, which reviews project proposals and prioritizes opportunities. For priority projects, a business case that includes product specifications, volume forecasts, and a timeline is developed. One of the senior

Product Engineers refers to the business case as 'kind of a living document and it will be updated and tweaked.' The teams also develop a product progression plan with a 3–5-year horizon, which the committee also reviews.

At project clarification, which now entails cross-functional involvement and collaboration, customer needs, deliverables, and timeframes are clarified. In this stage, Manufacturing and Engineering contribute for the first time by reviewing suggested product features. In concept creation, the team creates preliminary product concept drawings for review by the senior management committee. They also create a matrix document for project comparison that aids the Manufacturing VP in selecting the most feasible concepts. A senior Product Engineer describes

> The functional matrix is a master list of wants: by functionality, possible expansion, and product line future development. Everybody can understand where the opportunities are.

Subsequently, engineers begin concept testing and prototyping and conducting field tests with lead customers, followed by production ramp-up and market launch. Although field tests allow the NPD team to collect feedback from their customers, they also create certain challenges:

> Field testing reduces launch risk, but extends the launch timeframe. Part of the delay comes from confusion about the purpose of field testing, which is not to test the design but to identify any other problems that cannot be identified in the lab. Its purpose is to identify if there is anything about the environment that would impact product performance. This causes internal struggle because it takes too long.

Finally, SBU1 conducts a formal postlaunch review where profitability, sales, and production volume are evaluated. Under senior executive supervision, this audit comprises an in-depth accounting analysis.

Overall, SBU1 is in the midst of a major NPD restructuring for two primary reasons, first, to remain competitive in their key target markets; and second, to bring about more unique products with compelling value propositions to their customers. Other distinct characteristics of SBU1 include the following: (1) senior management plays a dominant role in idea generation and decision making during the NPD process,

Nukhet Harmancioglu, Regina C. McNally, Roger J. Calantone and Serdar S. Durmusoglu
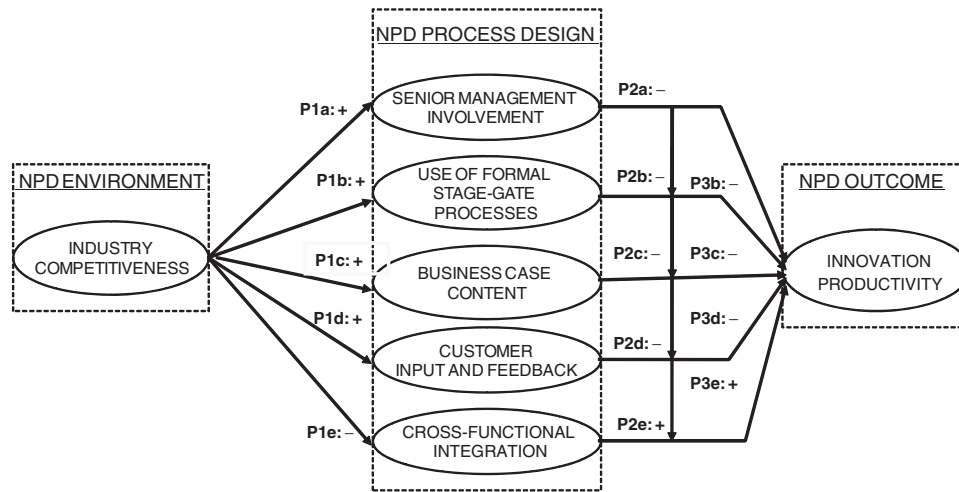
Figure 4. Conceptual framework.

(2) NPD strategy is reflected in the business case, which gets reviewed and updated during project execution, (3) each NPD stage is led by one or two functions, and (4) customer input and feedback is (planned to be) allowed throughout the process.

3.2. SBU2: focal person supervision

SBU2, the largest manufacturer in its US industry, operates in a dozen manufacturing plants and has three distinct product lines. As their operations are spread all over the nation, they increasingly face competition from both regional and national firms. Their customers, across different supply chain levels, are very sensitive to price. Until recently, the unit did not innovate, lagging behind competitors, and lacked a formal NPD process. The Manufacturing and Product Management Director explains the industry and their competitiveness:

> Up until 3 years ago we introduced very little new product here, we were known as a tired company that was not innovative. Our competition caught up and passed us. We began introducing products our competition had already introduced, so we just caught up. < New products > were going to be home runs. The philosophy we have developed is not to be the leading edge company. If you look at the product life cycle curve we want to be in the upper 1/3. We now have to slide down that curve slightly and become a little more innovative. We have to balance now that we have maximized capacity of our company, we have fantastic numbers but we have a capacity

constraint. It is a difficult business, price is major, and service is where we are able to challenge the price ... And it is our service that is our most valuable asset to customers.

Consequently, to respond to their competitors' pre-emptive actions and their customers' diminishing preference for their products, they adopted a fast-follower strategy and initiated a formal NPD process implementation (Figure 2). They started to launch line extensions and innovate on how they bundle their products. These initiatives have improved their market performance significantly. The Senior Marketing Product Manager contends that:

> < New product line > will provide a collection of things that no other competitor has. We have identified a gap in the market place. We have been a fast follower, but now we are innovating by seeing and filling this gap.

Referring to a recent project, this manager discusses the company's focus on innovations in the presence of corporate and environmental pressures:

> It really makes it very difficult when people are putting pressure on you to innovate but your whole strategy is to be a fast follower. Finally we can be a fast follower with those types of items < previous projects >, but we can innovate in how we put it together and how we present it.

However, they still lack an effective creative stage. They view documenting the front end of the

process and extending the time and effort spent in identifying opportunities as necessary and urgent actions to be taken. Despite such awareness, certain bottlenecks they encounter result in time inefficiencies and force the unit to focus on products guaranteed to sell and refrain from radical initiatives. Until recently, they have been incurring high inventory costs and falling short of part numbers for new products (due to system constraints) and storage locations for their components. The Director of Manufacturing and Product Management contends:

> We have to have 99% probability, we may lose sales up front but that's okay because we want to make sure it is proven to sell. We are not the low cost; we are one of the higher costs ... We deliver very rapidly. This means we have to have stock components ... this does not give room for mistakes in new products, like massive amounts of inventory that doesn't sell ... We have to learn to balance how we react to, 'If it doesn't sell, what do we do with the inventory?' Fuzzy front end, it is getting the details on paper before we see a product, it is the hardest area we have. Making sure all SKUs are on there, so we don't have to go back before moving ahead. We are working with our Product Manager so they see the trends, impacts, and ideas. 20% of products we sell are introduced in the last 36 months. We know we have to and we are hitting that. < The conglomerate > has set the 20%.

Senior management plays an important role in 'gates' to select projects, approve the business case, and ensure certain prescribed criteria are met. The weekly meetings involve top–down control of the teams' adherence to project goals. Almost every process stage allows customer input and generally involves collaboration between two major departments. SBU2 has a fairly explicit formal process, where each stage is dominated by different functions:

> In the beginning, we need a lot of direction from Marketing because we are capable of making most anything they want. But, we need to know what you want, and what exactly you want it to look like. We need the details which require the design sketches and request them. And we will go back and forth on the Engineering side, we'll look at that design and say, 'Review it with Manufacturing; is that manufacturable, or not?' And if it is not quite

the way that they would like, we'll make modifications, and make a drawing and then present it back to Marketing and say, 'This is what you asked for, and this is what we can do.' ... because we have to balance it out, and because we are capable of certain things and certain plans. And we work with Marketing and they are good about that ... We have excellent communication with the plants, as far as when it comes time to get down to making it happen, once we have the information that we need, we can implement and I think that a company of our size, we deal with eight plants, and when it comes down to our corporate office, we do a good job.

SBU2 focuses on building customer relationships and generates product ideas by interacting with their customers. Teams of Product Managers conduct nationwide focus groups where they present prototypes to customers and request suggestions for product improvements. Through these Marketing Product Managers, the Development teams learn about the expectations of their target customers. The Product Managers request recommendations regarding product improvements and provide customers with the firm's new product ideas. The Senior Product Designer states:

> In the very upfront, we, as a company, try to get information from our customer base on what is the product that you are looking for. What are their expectations of what we as a company need to manufacture, and what we in turn have available to sell or purchase and the correct product, that meets their expectations ... Now once they talk with the customer, okay, what is our competition doing, the price point that we need to hit and what it is that the customer demands, that pretty much answers those questions.

Documentation and championship are key elements of the NPD culture and process at SBU2. Program champions coordinate the new product teams throughout the development process, particularly in prioritizing new product ideas and preparing business cases. The Program Manager and the Senior Product Manager serve as champions, continuously interacting with top managers at initial phases and research and development (R&D) and plant representatives in later stages. The Program Manager, whom the Director of Manufacturing refers to as 'the master

of the plan,' describes their responsibilities as program champions:

> <The Senior Product Manager>'s responsibility is the front end product definition. Because of my expertise and responsibility for the whole process, I am involved, but don't really have any input into what we do, just more like how to do it, or how are we going to do it. And the people look to me to do that. So, this process was a way to help standardize the process . . . In my office on my wall I have a large flow chart that shows all of these together, but for the sake of the documentation we broke it out and attached decision point bubbles with milestones that are defined.

The Senior Product Manager records the customers' new product ideas and compiles a priority list of upcoming releases, prioritizing projects based on corporate objective fit and feasibility. Based on this list, idea screening is completed through interactions among the Marketing VP, the Manufacturing VP, the President, and the Senior Product Manager. This senior team selects the projects for which the business case will be developed. As soon as a Marketing member introduces a new product idea to the senior team for their approval, the R&D and Engineering staff begin to contribute to the process. Hence, this stage involves input from across functional departments. The Program Manager collects the documents and assembles the business case, which consists of target channels and dates, production costs, preliminary designs, promotion and operating plans, feasibility, and project risk analysis. The Program Manager explains this front-end process:

> . . . An idea comes to our Product Managers from our customer . . . the voice of the customer. We don't/shouldn't put a lot of judgment into if it is the right thing to do but we try to concentrate on how to get it done. Sometimes the President here just says we have to have it and that is how things get done. Once we have everyone<the executive team>saying, 'Yes that is a project we can do,' and understand the cost and time involved, we document everything we know in a business plan. There is a point of view section, summary of competitive product, a summary of what the product means to us, a forecast. We try to use what we know based on an average cost of our highest running SKUs.

SBU2 does not have an explicit project clarification stage: when the business case is assembled, it is signed off by the senior committee. The Program Manager describes the business plan and indicates its importance:

> <The business case>becomes a baseline of what the project is supposed to be . . . prepared fairly early in the process before we even involve the plants too heavily, so that we distribute this to Plant Managers and the people critical to implementing it at the plants . . . so that it is a baseline of reference documentation that everybody has agreed to – that this is what we are trying to do . . . There is so much detail in the plan that it is difficult for something not to be covered. It is costly if something is not initially covered.

After approval, the business plan is regularly updated as tasks are completed and is utilized to document development progress. A group meeting is held to communicate the business case and each function's activity timeline. From that point on, the program manager is in charge of ensuring adherence to the timeline, and updating senior management of the team's progress. All communications are documented. A senior Product Designer asserts satisfaction with their approach:

> We try and document everything we possibly can, so if there are discussions in meetings that can be misconstrued and misinterpreted, that we do have it in writing that everyone can refer back to . . . It's basically staying on top of everything daily, using the timeline to make sure all the links, tasks have been taken care of on time – so that someone that needs information or needs something else to be done first isn't held up because that prior task isn't taken care of.<The Program Manager>does a pretty good documentation of the different processes and responsibilities of those who are involved in the process.

SBU2 categorizes their new product projects by design newness and project size. They implement slightly different processes for different project types. Prototypes for really new products are generally built before business plan approval. A corporate Product Engineer signifies the divergence in the processes of different projects by contending that 'The decision processes for large projects are not well-defined.' Once built, prototypes are presented to Marketing, Engineering,

Manufacturing, and customers. In most cases, Marketing decides on whether the prototypes match the product requirements.

During product development, two separate weekly meetings are held under the supervision of the Senior Product Manager: manufacturing and marketing. Representatives from each plant, Project Engineers, the Program Manager, the Inventory Control Manager, the Manufacturing Engineering Manager, and the Product Manager attend the weekly meetings. Plants are monitored for adherence to the timeline and project requirements. In these meetings, problems are addressed, and the pre-launch requirements, promotional decisions, and specifications are determined. Moreover, as the Marketing Manager points out, these weekly meeting also 'help the communication of changes.'

For field testing, product samples are sent to customers 2 months before the proposed launch date and are requested to be rated by them within the focus groups held (see Figure 2). A month before launch, information packages and promotional materials are also mailed to customers. As the orders are received, production is ramped up. SBU2 also implements a 60-day post-launch review to rate their proficiency in executing launch activities and decide on possible improvements or corrective measures, if needed. The executives closely monitor ratings, playing a significant role in final decisions. The Program Manager describes:

> We have a post launch review ... this is what the business plan said, but this is what really happened kind of thing. We are graded on that, and that's what factors into our merit increases at the end of the year ...

NPD in SBU2 is characterized by high levels of senior management involvement and documentation in order to manage their limited capacity and to decrease the teams' uncertainties due to the intense rivalry in their industry. Senior management is not only involved in decision making at NPD gates and business case preparation, but also in idea generation. Customer input is allowed in both earlier and later NPD stages, but the teams listen to the voice-of-Marketing and the voice-of-Salespeople rather than to the actual customers. Although a cross-functional team structure is in place, the NPD stages are led by specific functions or people.

3.3. SBU3: a 'Hallway' company

Since inception, SBU3 has been an industry leader with a reputation for the highest quality products. They follow a niche strategy of offering only premium products and do not face much competition in their industry. They do not pursue lower price opportunities because of the potential damage to their premium brand and entrepreneurial firm reputations. The Marketing Product Manager identifies the source of their success:

> This company has grown at a wonderful rate, and behaves in many ways like a smaller company.

The Senior Vice President of Technology and Purchasing describes this expansion as organic growth and attributes this success to their innovativeness:

> Our president ... has merited a policy for the company that we would in fact push our growth more from organic growth than acquisitions. This is truly an entrepreneurial company, we are kind of big now, but we are not big. I mean, when people look at companies, and they look at, high-tech, for example ... <their primary industry> companies aren't considered high-tech at all. But in terms of what we actually do here, is actually pretty high-tech.

Their entrepreneurial orientation is reflected in their focus on innovation. In line with the corporate mandate, SBU3 pursues growth by introducing new products and 'merchandising innovations' that generate significant returns and by enhancing consumers' product understanding and increasing purchase intentions. These innovations serve to solve specific customer problems and provide higher value as compared to competing products. The Senior VP explains their market positional advantages:

> ... one of the strengths of this company, which is execution ... other companies in our industry ... what they are always trying to do, is make their product cheaper. Versus, we are always looking to make the product better.

One year after the corporate mandate, this SBU still does not have a formal process. Although they have developed an overarching framework for their NPD processes (as we depict in Figure 3), their NPD implementation is carried out in a

flexible and adaptable fashion as opposed to in a linear sequence. They employ an approach similar to what Cooper and Edgett (2005) refers to as 'spiral development' (pp. 59–67), that is, they take precautions against changing market demand and expectations by developing versions of their product and collecting customer feedback at several NPD stages. In the past, the informality has led to difficulty and confusion among the development team members due to frequent product design alterations. However, they have taken actions to somewhat alleviate this problem through cross-functional meetings and some documentation. The Marketing Product Manager describes the challenges:

> There is a lot of personal responsibility for getting your portion of a project done ... The challenge is that there isn't a real process in place for anyone to step in at any moment and follow along this process.

A Product Engineer explains the key to their success in implementation:

> There is direct communication and if there is important information on a project, then we'll just call a meeting and sit down with the Marketing group to review it if we think we need to get everybody together. We also have regularly scheduled meetings between Marketing and R&D. They are pretty regular and we don't like to break away from these meetings, but sometimes it might get moved a day or two. But they are pretty regular. Those meetings are designed to bring both groups together on the overview of projects ... The < firm > tradition is: when the job needs to get done, we pull all the departments together and make it happen.

Their 'unstructured' NPD process encompasses lower degrees of senior management supervision, but higher levels of informal discussions and inter-functional collaboration compared with the other SBUs (Figure 3). The Senior VP of Technology explains how this is instrumental in their firm's successful NPD efforts:

> By being an entrepreneurial company, we aren't as structured as one might expect. We are getting more structured, and we are trying to do that, and we have absolutely no apology for not being too structured. Because, what we have got is amazingly good. We are very informal about all this. If I want to talk to anybody in this company, I don't normally

wait for the meeting; I go down and talk to them. I'm not trying to be funny about it, but that's the nature of the entrepreneurial culture we have. We don't want to change that.

The most important distinguishing characteristic of SBU3 is that it sells the great majority of its products to a single retail customer. Hence, their NPD strategy is tied strictly to this customer's demands. As the VP of Technology indicates: 'Our primary customer ... they are the giant. And when we brought up a product, if they didn't have interest in it, then we just don't do anything with it.' Hence, the unit often faces significant opportunity costs, as they frequently kill projects that the retailer is unlikely to accept. Consequently, the main source of product ideas is the insights they obtain in interactions with this customer. The development team also attempts to commercialize technological breakthroughs that adopt substantially new and different technologies. SBU3 holds weekly R&D meetings where new opportunities are identified occasionally. Our conversation about a specific new product project with a Product Engineer illustrates the unit's innovation strategy and capabilities:

> ... that's one key area that has fuelled further projects that we've had. Where now, if you look at our mix of our new product development projects today, many of them are geared towards high performance. Can we take something of our current product and one up it and hit something that really delivers recognizable, measurable, and demonstrable performance to our customer at our next price point. So the desire was to have a product that < end users > could < use and it would work as intended >. Marketing identified what they thought were the key competitive products that this product would be going up against. It's important that we introduce new products and put new life into the system to revitalize the program. It brings visibility; it draws people to the other products in that whole program.

The Marketing Product Manager also considers this project as a radical new product in the true sense. When we asked what triggered this definition, his reply was:

> New technology, new chemistry. It provides new benefits. Provides a longer life of the product ... In this type of product, it was the first time the technology was included in a product.

Ideas stemming from R&D-driven technological breakthroughs are first communicated by Marketing to the retailer before clarification and production proceeds. Hence, SBU3 is driven more by technological innovations than the other two, but commercializes technologically advanced products only if its major retailer agrees. The Marketing Product Manager explains:

> The product, the final product go/no-go decision is, in a lot of cases, based on < the retailer > and senior management . . . There is also a level where senior management and < the retailer > are negotiating a new product, trying to get a new product into the store. That is kind of where the go/no-go decision is at their level and it's handed down to us.

Despite this close relationship with their major customer, the new product ideas 'unlike other industries, don't come from the customer. But, from Sales and Marketing and the Technical group typically,' as the Senior VP of Technology describes. The Marketing Product Manager also emphasizes the extent of cooperation in the idea generation phase:

> I think that it is very much a cooperative effort in the early stages. As Product Managers, we identify potential new products. Knowing our competitors, and also knowing the landscape. And then we look to the lab, so it is kind of a partnership.

When ideas are generated, they are discussed in monthly R&D and Marketing meetings. The project go/no-go decisions are made by the senior-level executives in 'milestone' meetings. For accepted ideas, the business case is prepared by the development team and the project is listed on the 'opportunity board,' which consists of 10 priority projects categorized by sales potential, volume forecasts, and proposed schedule. R&D works only on projects listed on the opportunity board. The VP of Technology explains:

> Once we decide to work on that project, that becomes one of our high priority products. We work with that typically on our top 10 projects. We have a list of 10 projects that we consider our top 10. That is something we collect in the Sales and Marketing and Technical departments, and management decides to do it. Normally the President doesn't come and get involved in that. He can have his input but

basically Sales and Marketing and my department make that decision. From the technical stand point, we don't really have a lot of opinion about whether it's going to work or not, but we have agreed that this is something that can be done. So once you make a decision, it's our responsibility to make sure the product is right. So it's kind of a joint decision for Technical, Sales, and Marketing. Those are the key departments. And Manufacturing, if there is new equipment required, they need to be in the works. All of the other departments are kind of like support systems.

The business case and opportunity board are used to manage the NPD program and monitor initiated projects, with the additional benefit of preventing product definition changes. These documents also alleviate frequent stops in their progress and prevent numerous changes in product definitions. A Product Engineer also explains the benefits of the opportunity board:

> We try to only have 10 on the opportunity board at one time. Now that we have a more manageable number of projects going at once, we don't have the start and stop. Because we only allow 10 projects on the opportunity board at one time, there is a much greater likelihood that all these projects are going to be taken to completion. There is an agreement between all parties that this is what you want the R&D lab to work on . . . These weren't so visible in the past and there were 20 projects going on at once. Each week the priority would shift from this one, to that one, to the other one, and you would have projects that were started and maybe worked on for a certain amount of time and then someone would say, 'Don't put anymore time in it.' And it would become incomplete. This < opportunity board > really forces the company to focus on what are the important projects so R&D isn't working on so many things at once. I think with this controlled system it helps us not only start the project but it also keeps the progress of the project very visible.

The business case also serves to distribute tasks across departments and specify activities requiring inter-functional integration. The Manufacturing function identifies the raw material and packaging restrictions. The Marketing department analyzes the competitive products and prices, develops the forecasts, and specifies the product features together with the R&D depart-

ment. The document includes the following: (i) key parameters of each product in the form of minimum requirements, (ii) target cost and price, and (iii) capital requirements identified by the Manufacturing department. As an R&D engineer describes, the business case:

> . . . really focused the direction of the project and since everything was down on paper and agreed to, it helped eliminate one of the big problems that we had in the past. There would be some major change or needs of the product and maybe it would be something we didn't learn and our customer later said that we need to have this property that we initially didn't anticipate. Those things would fall on R&D's lap at the last minute and we would have to turn the whole project around. Now if something like that happens, it gets documented on the form.

As soon as the business case is completed, the Senior Vice President of Marketing and of Technology and Purchasing produce the cost estimates for manufacturing and identify the development timeline. Even though SBU3 does not have an explicit project clarification stage, the business case is discussed and finalized by a team of senior executives.

Once the ideas receive initial approval, the subsequent decision is regarding the need for a feasibility study. Projects familiar to the business unit do not require a feasibility analysis; the business case is prepared at once. The senior Vice President of Marketing describes their project screening and selection:

> To choose among opportunities, we look at the financial return, that is, how big the opportunity is in terms of revenue. And, the chemists evaluate the technical feasibility of the opportunity. We choose pragmatically.

For product ideas that necessitate a feasibility study, their assessment lasts about 3–5 months. If the result is that the project is not feasible, then it is dropped. For projects that are determined to be feasible, a target launch date is set, which is also influenced by their retail customer. Similar to SBU2, their processes vary by project type:

> For something new waiting, we may go ahead and make a batch at the plant. This is what we call scale up. One batch, two batches, whatever number of batches to make until we are comfortable with it. I want you to understand the risk.

Both product development and launch entails cross-functional integration. While Marketing develops product packaging, R&D conducts development activities. The next step is conducting the field testing with lead users, which is under the responsibility of the Applications and Benchmarking department, and the Marketing and Sales functions. The data are collected and analyzed by the R&D group while the Manufacturing function focuses on possible improvements. The Technology Senior VP assigns engineers to projects who work independently on different parts of the design. Senior management works closely with the retailer in approving the launch decision. SBU3 lacks the final stage of a formal post-launch review, which may not be necessary because SBU3 employs the business case and opportunity board to monitor performance.

As indicated by the Product Manager, SBU3 has a flexible NPD structure characterized by high cross-functional collaboration and low senior management intervention. They allow input to their innovation processes from both the Marketing and the Technical functions. Although less frequently compared with the other SBUs, teams at SBU3 work closely with their customer, directly acquiring information regarding their preferences and expectations. Despite its challenges, they view their 'informal' culture as a major strength and the underlying reason for their success in innovation and implementation.

> Well, I think that the strengths are that there is personal accountability for the process, there is a lot of face-to-face interaction. There is a person in Marketing and there is a person on the lab side who is accountable for every stage of the process and who is involved in every stage of the process. The disadvantages are that a lot of it is kind of intuitive. A new person couldn't come into the Product Manager role or the lab Product Steward role, and understand all of the nuances of the product development process. Because there is really not a system in place where at week two, this is what happens. Because week two could be very different from one product or project to the next.

4. Findings and proposed model

Although our informants stated their aspirations as developing highly successful products, the development efforts at SBU1 and SBU2 primarily

focused on incremental innovations and product extensions. Most mentioned resource constraints (e.g. limitations due to inventory holding capacity and costs) and pressure to accelerate schedules, thus focusing on products that are 'doable' or 'guaranteed to sell.' Their documentation-based and customer-led processes often favoured incremental marketing innovations over technological breakthroughs. For instance, SBU2 emphasizes their need for more radical innovations to surpass competition, but implements a stage-gate process with frequent gates and senior management control. They work (perhaps too) closely with their customers and have no mechanism to encourage team members to brainstorm and generate new product ideas. Meanwhile, SBU3 has adopted a more fluid, organic, and learning-oriented approach. In fact, SBU3 is the only unit holding separate R&D meetings, which engender internally generated technologies and breakthrough product ideas.

The challenge we observed was in balancing innovation and speed to market given industry competitiveness and available resources. Hence, we explored the different approaches each SBU has adopted to meet the requirements of the mandate issued by the conglomerate and dramatically increase their innovation productivity given their internal climate and external environment. We define innovation productivity as the degree of new product returns per time and resources invested. We argue that to generate higher growth, companies must commercialize unique products with superior value for the customers. Based on our observations, we present a conceptual framework and a set of formal propositions on how to design and implement a brand new NPD process for increased innovation productivity given their NPD environment (Figure 4).

From an organizational design perspective, contingency frameworks examine how firms construct strategies and design organizational systems to fit external conditions (Burns and Stalker, 1961; Covin and Slevin, 1989). The key to superior outcomes lies not only in matching the internal organization to the external environment but also in developing and maintaining differing abilities to deal with competitive forces (Day, 1994). Industry competitive intensity indicates the degree to which market forces are unpredictable and uncontrollable and the extent to which monitoring competitor actions and customer preferences is difficult (Bourgeois and Eisenhardt, 1988). In our sample, SBU2 faces the highest level of industry competitiveness from both regional and national firms. SBU1 is witnessing the entrance of Asian firms to their market. SBU3 encounters minimal competition as it serves niche markets with premium products.

The organizational literature suggests that competitive environments necessitate organic mechanisms (i.e. decentralized decision-making, informal and flexible task execution), whereas stable industries require mechanistic approaches (i.e. hierarchical and centralized, formalized rules; Aiken et al., 1980; Miller, 1987). Based on our informant records and observations, we view SBU3 and SBU2 on the opposite sides of the organicity versus mechanisticity continuum, with SBU2 locating in between.

4.1. NPD environment impact on NPD process design

4.1.1. Senior management involvement

We refer to the CEOs and their direct subordinates responsible for SBU strategies as the senior management. Senior management sets the broad strategic goals for the NPD program and projects as well as provides teams with autonomy and empowerment to meet these goals (Sethi, 2000; Bonner et al., 2002; Nakata et al., 2006). Tushman and Nadler (1978) and Johne and Snelson (1988) describe their role as one of envisioning, energizing and enabling the innovation program. Through close monitoring, they make strategic decisions at NPD process gates during process implementation, keep the teams on track and on schedule, and coordinate cross-functional cooperation (Gupta and Wilemon, 1986; Song and Parry, 1997; Sethi et al., 2001; Cooper et al., 2002).

In SBU1 and SBU2, senior-level executives set the vision for essential NPD activities. Leaders direct staff and resources to implement activities. Senior executives operate as gatekeepers: they make the go versus kill decisions and evaluate the performance of the NPD teams using visible metrics at the end of each stage. They supervise idea generation, project selection, and post-launch. Compared with SBU3, the senior executives play a more prominent role in these two SBUs. As mentioned, contingency research suggests that firms adopt a less centralized, more organic structure in dynamic and uncertain environments (Miller and Friesen, 1982; Covin and Slevin, 1989). Our findings indicate the contrary, that centralized approaches (such as in SBU2) generate more uniform responses to environmental changes. Consensus-building efforts take time and may add

to conflicts, proving inefficient and dysfunctional for reacting to market dynamics (Bourgeois and Eisenhardt, 1988). Hence, we propose that greater environmental uncertainty necessitates increased senior management involvement in NPD:

> P1(a): Industry competitive intensity is positively related to senior management involvement.

Use of Formal Stage-gate Processes. Stage-gate processes represent formal management procedures in which the required NPD tasks, their sequence and the employees responsible for their completion are laid out before execution (Johne and Snelson, 1988; Griffin, 1997). SBU3's process is simple and flexible, characterized by frequent interdepartmental collaboration and informal interactions. Teams own the projects and the different functions that comprise the development teams contribute almost equally to each NPD phase. Although they use a process flowchart to guide these cross-functional teams, the NPD process is flexibly executed without extensive documentation or senior management intervention. SBU1 and SBU2, operating in competitive industries, have a standardized flow of NPD phases that they implement sequentially and conform to in almost all projects. Moreover, senior management prepares the business case and adopts 'gate-keeper' roles.

The contingency framework posits that in environments demanding fast reactions, firms choose fluid and flexible organizational designs for free information flow across different functions and for learning (Burns and Stalker, 1961). Our sample suggests the contrary. In response to market turbulence (e.g. SBU2), SBUs employ formal processes to ensure harmonious operations. Thus, we posit that industry competitiveness fosters the use of stage-gate processes:

> P1(b): Industry competitive intensity is positively related to the use of formal stage gate processes.

4.1.2. Business case content
A business case (or product charter) defines the strategic scope of a new product program and the goals of a specific project, along with the requirements of the potential market and possible product specifications. Moreover, these business cases also reflect the strategic directions mandated in the corporate plan (Crawford, 1984). Firms generally create and employ business cases to ensure agreement among the team members, to

monitor their progress, and to reduce uncertainties (Bart, 1991; Tatikonda, 1999).

All three SBUs generate project progression plans that include project goals, potential market information, and product specifications. Similar to formal process use, they employ business cases to build consensus among team members and coordinate operations. The documents also reflect the mandated strategic direction. SBU2 creates an exhaustive business case, that is, a document incorporating thorough product definitions, forecasts, and timelines, and exercises more rigid controls based on this document. However, at SBU3, senior executives do not impose strict constraints and guidelines and seldom evaluate project execution. Hence, we find empirical support for the proposition that, in the context of intense rivalry, formalized procedures and documentation provide supervision to reduce uncertainty, regulate task performance, and assign role responsibilities (Meyers et al., 1999). Therefore:

> P1(c): Industry competitive intensity is positively related to the use of a solid business case.

4.1.3. Customer input and feedback
Customer input and feedback signifies the degree to which the voice-of-the-customer (i.e. not the voice of the Marketing and Sales functions) is integrated into NPD throughout process execution (Sethi, 2000; Cooper and Edgett, 2005). Information related to the customers' new product knowledge and perceptions of ease of use enables the NPD team to refine product features and to provide innovations with unique and visible benefits (Narver et al., 2004). In turbulent environments, managers face the larger challenge of allocating marketing resources and activities efficiently. Among our sample of SBUs, SBU2, which operates in the highest competitive intensity, allows customer input and feedback throughout project execution, suggesting that industry competition increases the need for customer knowledge. SBU2 interacts less frequently with customers than SBU1, while SBU3 interacts even less frequently compared with SBU1 and SBU2. Accordingly, we argue that the environmental uncertainty resulting from competitive intensity increases the need for customer input and feedback:

> P1(d): Industry competitive intensity is positively related to customer input and feedback.

4.1.4. Cross-functional integration
The study and use of cross-functional teams for product development, which includes members

from several functional areas such as Marketing, Engineering, Manufacturing, and Purchasing, has seen increasing frequency among researchers and businesses (Olson et al., 1995; Griffin and Hauser, 1996; Sethi et al., 2001). The underlying reason for its popularity is the general belief that the integration and concurrent processing of NPD activities lead to successful process implementation and product commercialization. Cross-functional team structures are acknowledged to provide richer information from diverse viewpoints, and hence, more creative solutions (Song and Parry, 1997; Kahn, 2001; Bonner et al., 2002). Teams have their disadvantages, however. Researchers suggest that cross-functional collaboration creates the potential for stress and confusion, as teams may frequently engage in endless conversations to make NPD decisions and wander away from the NPD goals (Swink, 2000). Hence, team structures do not always reduce NPD uncertainties, and thus require monitoring in order to ensure adherence to project goals, schedules, and/or budgets (Griffin and Hauser, 1996; Calantone et al., 1997; Olson et al., 2001; Carbonell and Rodriguez, 2006).

In SBU1, Marketing is more prominent in idea generation and boundary spanning activities, while technical departments first contribute during project clarification. Project clarification is the only phase involving inter-functional input. In SBU2, the Product Manager continuously interacts with senior executives in initial phases and R&D and plant representatives in later stages. This manager's efforts serve as a bridge between internally developed, potentially breakthrough concepts, and customer preference knowledge. In reacting to market dynamics, SBU1 and SBU2 adopt centralized and top management-dominated decision making to facilitate implementation by reducing conflict and ambiguity in competitive environments. Alternatively, SBU3's process involves collaboration and shared dependence among all departments. Marketing acquires customer preference knowledge through continuous interactions. R&D and Product Engineering determine the technical resources needed for concept development and develop the on-hand technologies into desired product designs. Marketing, R&D, and Engineering departments also integrate their inputs in later stages. Although research supports increasing cross-functional integration with perceived environmental uncertainty (Gupta and Wilemon, 1986), our data suggest that interdepartmental collaboration may not be well suited to competitive environments that demand fast reactions and require control. Thus:

P1(e): Industry competitive intensity is negatively related to cross-functional integration.

4.2. NPD process design element effects on innovation productivity

Formal processes, clear project goals, and senior management supervision may provide efficiencies and reduce conflicts. Flexible processes and informal interactions facilitate sharing and creativity, but over-reliance on brainstorming and informality may add to operational costs, cycle time, and organizational frictions. Hence, innovators face the challenge of balancing formality and flexibility. To achieve balance, SBUs implement different combinations of NPD process design elements. What we observe is that SBUs compensate for senior-level involvement by employing other design elements.

4.2.1. Senior management involvement
Particularly in more dynamic and competitive environments, consensus building may take too much time, resulting in a continual crisis orientation (Bourgeois and Eisenhardt, 1988). Top management supervision may reduce the time and cost involved in and the uncertainties associated with NPD decision making and implementation (Olson et al., 2001). In our sample, however, the relationship between top management involvement and NPD outcomes appears to be inverse: senior manager supervision suppresses rather than encouraging innovation productivity. At SBU1 and SBU2, senior management committee held monthly project review meetings to make certain that team members do not wander off the NPD strategies, do not engage in continual debate on product specifications, and adhere to NPD objectives, schedule, and budget. Furthermore, at SBU2, top management identifies market needs and determines the concept ideas for the teams to work on, which may be hindering their capacity to innovate. On the other hand, SBU3 managers only play gate-keeper roles, while the cross-functional teams are responsible for idea generation and business planning. Given the innovation productivity differences across SBUs, we propose:

P2(a): Senior level involvement is negatively related to innovation productivity.

4.2.2. Use of formal stage-gate processes
NPD stages and gates are implemented to manage risk and increase efficiency (McDermott and O'Connor, 2002). Adhering to a structured development process with pre-determined milestones and time-

based objectives can accelerate and lower the costs of NPD as time-consuming rework and modifications may be avoided (Kessler and Chakrabarti, 1999; Olson et al., 2005). SBU1 is appending idea generation and business planning to their prior manufacturing-driven process, while SBU2 is formalizing their front-end activities. SBU2 is concerned about their front end being so 'fuzzy' that it is difficult to map. To implement these changes, both SBUs incorporate extensive top-level supervision and devote significant time to project planning.

However, neither SBU1 nor SBU2 focuses on commercializing really new products. This suggests that the use of formal processes may enhance process implementation by avoiding delays and cost overruns; however, at the same time, the routinized nature of NPD activities may hinder the team members' autonomy and creativity (Cooper and Kleinschmidt, 1994; Kessler and Chakrabarti, 1996; Song and Parry, 1997). Hence, the capabilities of the product and the overall innovation productivity of the team may decline. As we have observed in SBU1 and SBU2, devoting time and resources to strategic planning may provide operational efficiencies and engender line extensions or upgrades, but not breakthroughs. SBU2's top management-driven idea generation, coupled with their lack of vision for breakthrough products, indicate that a documented and centralized procedural framework may reduce team autonomy and motivation, and thus discourage new product idea development. Hence, we posit that formal stage-gate processes along with extensive senior management involvement push efforts toward more low-risk, immediate-reward projects.

> P2(b): The use of formal stage gate processes is negatively related to innovation productivity.

> P3(b): Senior level involvement combined with the use of formal stage gate processes is negatively related to innovation productivity.

4.2.3. Business case content
A stable business case that includes a solid product definition may be expected to reduce costs and increase speed, as breaks in the process flow and changes in the product concept or benefits may be avoided (Gupta and Wilemon, 1986; Cooper and Kleinschmidt, 1994). A stable (i.e. not necessarily complete) business case is an indication of a solid understanding of customer expectations, in-depth knowledge of a product's

technology as well as other market factors (e.g. competition, suppliers, and distributors; Larson and Gobeli, 1989; Cooper and Kleinschmidt, 1994), which may all increase innovation productivity. In SBU3, although not complete, teams establish a stable business plan with sufficient information to manage the later stages of the process. Alternatively, SBU2 devotes considerable time and effort to develop an exhaustive business case in the early NPD stages, which appears to hinder the timely launch of highly innovative product offerings.

Senior management sets and communicates new product program and/or project goals and guides the teams in fulfilling these goals (Gupta and Wilemon, 1986; Swink, 2000; Sethi et al., 2001). As the Engineers and Designers, particularly in SBU1, suggest, even the technical development process requires guidance and mentoring via clear statements of corporate and project goals. The business cases at SBU1 lack detailed product definitions and financial plans, which may lead to Engineers' demand for senior management supervision. Meanwhile, setting forth the project goals and timeline earlier during the process leads to less demand for top management support, as in SBU2 and SBU3. However, a complete product definition and project goals, determined early on and employed further to control processes (as in SBU2), may hinder radical innovation development. More specifically, while top management may improve the time and cost advantages accrued to the innovating firm through formulating a complete product definition (Bonner et al., 2002), we argue that their close monitoring and high intervention in the implementation of the business case may impede team creativity and radical innovation development. Hence:

> P2(c): The use of an exhaustive business case is negatively related to innovation productivity.

> P3(c): Senior level involvement combined with the use of an exhaustive business case is negatively related to innovation productivity.

4.2.4. Customer input and feedback
Customer integration in the NPD process may decrease the development costs and time-to-market by reducing the need for product redesign and development activities re-execution. However, some researchers argue that customers are only

able to define their product preferences by referring to their experiences with existing products (Sethi, 2000; Narver et al., 2004). Hence, overreliance on 'the voice of the customer' may hinder teams' abilities to identify unmet customer needs and to generate new product ideas. In our sample (as in SBU3), innovations provide value and new uses resulting from allocating additional effort to technical activities and less to customer interactions and market information gathering.

We observe that senior management supervision is lower in highly productive businesses that interact frequently with customers. Particularly in SBU2 and SBU3, customer intelligence shapes project goals and reduces the need for supervision. However, SBU2's idea generation and opportunity identification is strictly controlled by the top managers, which may be the underlying reason for their loss of market dominance in terms of innovation productivity. As in SBU3, sharing of customer intelligence across functional areas is encouraged through less senior management intervention. The empowerment of the NPD team members along with such idiosyncratic knowledge may engender innovation generation capabilities. Thus:

> P2(d): Customer input and/or feedback is negatively related to innovation productivity.

> P3(d): Senior level involvement combined with customer input and/or feedback is negatively related to innovation productivity.

4.2.5. Cross-functional integration
Through joint effort and sharing of NPD responsibilities, cross-functional integration may facilitate timely launch of value generating new product innovations (Griffin, 1997; Kessler and Chakrabarti, 1999; Sherman et al., 2000). As stated before, teams have their disadvantages: they may drift away from the strategic focus of the NPD project and/or may take substantial time to arrive at decisions or solutions (Swink, 2000). Hence, NPD teams need to be coordinated to ensure harmony (Calantone et al., 1995; Griffin and Hauser, 1996; Olson et al., 2001; Carbonell and Rodriguez, 2006), and may require increased intervention from upper-level managers (Carbonell and Rodriguez, 2006; Nakata et al., 2006).

A unique characteristic of SBU3's NPD process is that cross-functional collaborations occur more often than senior level involvement. Both

early and later stage interactions among Marketing, R&D, and Operations may be the keys to their vision in developing innovative products. They balance formality and flexibility by adopting a more formal and centralized approach to reduce uncertainty and make strategic decisions, while also encouraging frequent cross-functional interactions and collaborations to minimize divergence and establish shared values. For instance, at SBU3, senior managers oversee teams more closely as uncertainty increases (in project screening and project proposal) to make priorities and goals explicit, but empower teams and encourage inter-functional collaboration during idea generation and product development. Such approaches may allow building of common understanding and increase innovation productivity. Hence:

> P2(e): Cross-functional integration is positively related to innovation productivity.

> P3(e): Senior level involvement combined with cross-functional integration is positively related to innovation productivity.

5. Conclusion

NPD is a system encompassing the dynamic interaction between internal and external factors. In an environment with sudden and dramatic changes, delay in action for a firm possessing distinctive competencies may inhibit success. As contemporary competitive pressure increases, many companies face the challenges of increasing efficiency, creating breakthroughs, and pre-empting competitors (Calantone et al., 1995; Meyer and Utterback, 1995; Kessler and Bierly, 2002). Thus, rapid and efficient commercialization of new products quickly has become a top priority in many organizations. As a result, design and implementation of NPD processes is a dominant concern (Bonner et al., 2002; Filippini et al., 2004).

Our case study analysis of three SBUs of a major international conglomerate operating in industries with different levels of competitive intensity suggests that SBUs tailor their NPD approaches based on environmental dynamics. Interestingly, contrary to the literature (e.g. Burns and Stalker, 1961), they adopt more centralized structures and formalized processes in dynamic

and uncertain environments. Both the academic research and popular press emphasize the demand for fast reactions in contemporary environments. The sample SBUs' NPD processes are implemented distinctively to reduce uncertainty and achieve timely market response. Thus, their processes do not resemble each other, nor do they perfectly conform to the 'stage-gate' model, but are tailored to the immediate requirements of their environments.

The primary contribution of this research is to develop a theoretical framework (Figure 4) on the innovation consequences of NPD design and implementation given NPD environment. NPD researchers have generally investigated a few structural elements (e.g. cross-functional teams, formal stage-gate processes, and top management support) or have focused on a single success factor in one study (e.g. Kahn, 1996; Griffin, 1997). The synergistic combinations of these different NPD design elements and their consequences for increased innovation productivity are yet to be explored. We try to address the question of 'how should firms design and implement new NPD processes to create breakthroughs as well as ensure timeliness and efficiency?' This study may benefit practitioners by offering insights in coordinating NPD programs and securing competitive advantages.

These SBUs do not operate in high-tech industries, which may limit generalizability. The study of NPD design in such industries requires further research. However, we argue that since the major differences between high- and low-tech industries are the rate of technological change and the intensity of customer and competitor uncertainty (Mohr et al., 2005), our theoretical framework may also apply to high-tech industries, while an empirical analysis of our model may generate more substantial effects. Referring to Cooper and Edgett's (2005) work and our conceptual model, we argue that the escalated unpredictability of customer requirements and competitor strategies in high-tech industries would require (1) use of step-wise NPD processes, (2) establishment of a stable though not exhaustive business case, (3) full integration of customers, and (4) higher specialization (as opposed to cross-functional collaboration).

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Note

1. The respective information on SBU3 is not disclosed in Table 3 due to confidentiality requirements.