THE EFFECT OF NEW PRODUCT DEVELOPMENT

PROJECT PORTFOLIO MIX ON NEW PRODUCT

DEVELOPMENT PROGRAM PERFORMANCE

By

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DEDICATION

This dissertation is gratefully dedicated to my late mother Mrs. Shail Srivastava for all her love, sacrifice, support, and encouragement. She always inspired me to strive against the odds. It is because of her who I am today.

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CHAPTER I

INTRODUCTION

Over the years, new product development (NPD) has been acknowledged by

marketing researchers as an important area of investigation. In today's global market

place, new product development has become a very complex process. According to

Datamonitor's Productscan online database (www.productscan.com), some 33,185 new

food, beverage, health and beauty, household, and pet products were launched in the

USA and Canada in 2004. Importance of creativity, innovation, and new product

development has been reverberated in popular press (Business Week 2005). Though new

products provide increased sales, profits, and competitive advantage for organizations

(Cooper 1985; Griffin and Page 1993, 1996; Devinney 1992), nearly half of the new

products introduced in the market each year fail, causing considerable financial loss to

companies (Zirger and Maidique 1990, Griffin 1997). Because of this, companies are

trying to find new ways to increase the success of their new product development efforts.

This dissertation is a step in that direction and presents and empirically tests a framework

of organizing new product development by integrating literatures from new product

development and strategic alliances.

To minimize the risk associated with the financial loss of failed new products and to share the rising costs of R&D, many firms are opting to conduct new product activities through alliances (Rindfleisch and Moorman 2001, Varadarajan and Cunningham 1995). Also, many firms are forming new product development alliances because of the increased global competition, and a need for standardization, In addition, to overcome budgetary constraints, organizations enter alliances to quicken the pace of innovation, share risks, and gain access to resources (e.g., technological, financial) not otherwise available to them (Bleek and Ernst 1993; Vardarajan and Cunningham 1995).

New Product Development Project Portfolio Mix: Challenges and Solutions

Innovations and new product development are the lifeblood of any firm. To remain successful over long periods, organizations must be able to implement incremental, radical, as well as other types of product changes. The management of radical or discontinuous innovation poses a unique set of challenges for managers. It is a long and investment intensive process, marked by set-backs and unpleasant surprises, and with no guarantee of success (Lynn et. al., 1996).

Success in the competitive environment involves exploitation of firm's existing capabilities, whereas survival in a dynamic environment involves exploration for new capabilities (March 1991, Levinthal and March 1993). Exploration is the search for new knowledge (things), whereas exploitation is the use and development of things already known. The question is, whether the company should use a new technology (exploration – uncertain profits) and cannibalize their profitable old technology (exploitation) and how to manage (balance) both? "The risk in excessive exploitation is obsolescence in a

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changing environment and the risk in excessive exploration is failure to harvest the value of any single discovery" (Knott 2002, pg. 341). Managers (firms) need to be able to do both at the same time. They need to be "ambidextrous" (Tushman and O'Reilly 1996).

Incremental innovations allow firms to address the needs of current customers and keep positive cash flows but it must be supplemented by periodic infusions of radical innovations (Leifer et. al. 2000). A study of US firms that have succeeded in head-to-head competition against Japanese firms in electronics-related markets found that the US successes were built on a combination of radical innovations, incremental improvements, new market, and new technology innovations. "These businesses built and renewed, and continue to build and renew their competitive advantage through radical and incremental innovations. They sustained that advantage over time through incremental product line improvements and extensions – but it is on the basis of the riskier, failure-laden, expensive, and time consuming efforts to pioneer new-to-the-world (radical) technologies that their competitive advantage was and still is established" (Morone 1993 pg. 217, Lynn et. al., 1996). Companies that have succeeded over the long haul, such as Corning, GE, Motorola, and 3M, interpose ongoing innovations with radical innovations (Leifer et. al. 2000, Morone 1993).

Research Focus

After extensive search of the literature, it was found that no one has examined the question of what proportion of a firm's NPD (R&D) should focus on radical innovation versus other types of innovations. Also, no study has examined the question of what proportion of a firm's NPD projects should be conducted with alliance partners.

Research Questions

The purpose of this dissertation is to examine the following research question: How will the NPD project portfolio mix affect the firm's NPD program performance? Also, how will the mix of NPD partnerships affect the relationship between the NPD project portfolio mix and the NPD program performance and how will environmental turbulence affect the relationship between NPD project portfolio mix and NPD program performance?

More specifically:

1. How will the mix among NPD projects affect the firm's NPD program performance?

2. How will the NPD partnership mix (own vs. alliance) affect the relationship between NPD project portfolio mix and NPD program performance?

3. How will environmental turbulence affect the relationship between NPD project portfolio mix and NPD program performance?

These research questions are presented graphically in Figure 1 below.
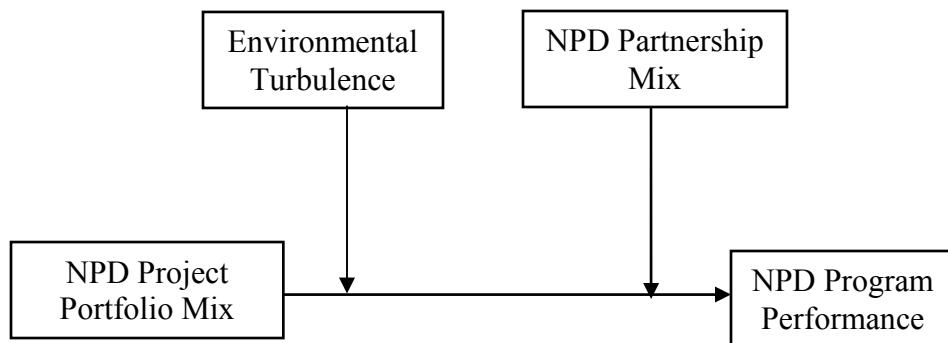
Figure 1: The Basic Conceptual Model

Significance of the Dissertation

This dissertation integrates research from both new product development and strategic alliance research streams. So, the results of this study have implications for both of these streams of research. To my knowledge, no study has talked about and empirically tested achieving a right proportion of radical projects in a firms NPD project portfolio mix. Also, no study has talked about and empirically tested achieving a mix of NPD partnership. Hence, this dissertation extends the new product development theories and well as tests the strategic alliance theories. Also, findings of this study will have several implications for managers. Although, incremental change is absolutely necessary for short-term success but it is not sufficient for long term success. Long-term success requires a multi-pronged approach. The results of this study will help managers to find the right proportion of radical NPD projects in their NPD project portfolio to optimize the NPD program performance.

Outline of the Dissertation

The dissertation is organized into five different chapters. Chapter I, the current chapter, introduces the dissertation, purpose and significance of the study, and the research questions. The second chapter explains the concept of new product development, new product portfolio mix, NPD partnership mix, new product program performance, and environmental turbulence. The second chapter also provides the theoretical rationale for the study by reviewing the relevant literature and proposes the research hypotheses. Chapter III describes the research objectives for empirical investigation. This chapter delineates the research design and methodology that used in

conducting the study. The chapter also describes the measures used. Sample profiles and

the actions taken to ensure the validity and reliability of the study are also discussed.

Results of hypotheses testing are presented, discussed, and reviewed in Chapter IV.

Finally, in Chapter V, discussion of the results and the theoretical and managerial

implications are presented and discussed. Chapter V also presents the limitations of the

study and future research directions.

CHAPTER II

LITERATURE REVIEW AND RESEARCH HYPOTHESES

This chapter reviews the extant literature related to the study and presents the concepts and hypotheses. First, new product success measures are discussed and then the reason for measuring new product development program performance is presented. Second, literature on new product development and innovation is discussed. Then, new product development project portfolio mix is presented and discussed. These discussions lead to the first hypothesis for the relationship between new product development project portfolio mix and new product program performance. Next, literature on strategic alliances, new product development alliance, and NPD partnership mix is discussed. The resource based theory is integrated with the above discussion and this leads to the second hypothesis. Finally, literature on environmental turbulence and contingency theory is discussed followed by the third hypothesis. After that, control variables are discussed that may affect the hypothesized relationships. At the end, a detailed model is presented and hypotheses are summarized.

New products provide increased sales, profits, and competitive advantage for most organizations. Successful new products contribute to financial and market performance and open up previously undetected opportunities for business (Swink 2000).

However, nearly half of the new products introduced in the market each year fail causing considerable financial loss to companies. New Product Development (NPD) has become an increasingly complex and costly task (Kleinschmidt and Cooper 1991).

NPD Program Performance

"Success is not just elusive; it is also multifaceted and difficult to measure." (Griffin and Page 1996, pg. 478). Measuring NPD performance is a difficult task because there are so many ways to measure success. NPD success may be measured at the individual project level as well as at the overall NPD program level. But most new product studies have concentrated on the product itself as the unit of analysis, rather than on the firm's total new product program (Cooper 1983). "Concentrating only on the new product rather than the totality of the firm's new product program could result in a 'win the battle, but loose the war' outcome" (Cooper 1983, pg. 244).

An analysis of about 1,500 new product announcement by 250 + companies between 1975 and 1988 has concluded that product innovations have increased the market value of these firms by more than \$10 billion (Devinney 1992). Previous research has determined that NPD project success consists of three independent dimensions: consumer-based, financial, and technical or process-based success (Griffin and Page 1993, 1996). Firms frequently sacrifice some level of success on one dimension to achieve success on another.

In this dissertation performance is measured at the program level, i.e., the performance of all the NPD projects in a firm's NPD portfolio. The reason is that the proposed model investigates the effect of a firm's entire NPD portfolio constituting many

different NPD projects (incremental, radical, as well as others). It is measured as ROI (new product development program), percent of sales form new products, and percent of profits from new products. Perceptual measures such as "relative to your firm's objective, how successful has the NPD program been in the last 3 years in terms of *profits*?" is also used to determine the congruency between objective and subjective measures.

New Product Development (Innovation)

Innovations and new product development are the lifeblood of any firm. Innovations have been classified by whether they address the needs of existing customers or are designed for new or evolving markets (Christensen and Bower 1996). Innovation has been studied at the industry, the firm, and the individual level. This dissertation focuses on innovation at the strategic business unit (SBU) level where SBU is defined as a profit center with distinct products and markets. Cooper (1979) identified that the single most important dimension leading to new product success is product uniqueness and superiority. Unique, superior products are typically highly innovative and new to the market. Cooper (1985a) has done a comprehensive study on product innovation strategy and its impact on success. His analysis produced 20 separate dimensions, measured by a total of 66 variables. Technological innovativeness, newness to the market, and the proactiveness of the program were the strongest strategic drivers across success dimensions. Level of new product innovativeness is likely to influence perceived success or failure factors to a far greater degree than does level of experience in the industry and new product development or level of past success (Link 1987). "Although technical and

market changes can never be fully understood or controlled, proactive new product development can influence the competitive success, adaptation, and renewal of organizations" (Brown & Eisenhardt 1995, pg 344). New product development is important because it is a critical means by which members of organizations diversify, adapt, and even reinvent their firms to match evolving market and technical conditions. Thus, new product development is among the essential processes for success, survival, and renewal of organizations (Brown & Eisenhardt 1995).

New product's advantage, superiority and/or differentiation over competitive offerings, and new product's innovativeness, perceived newness, originality, uniqueness, and radicalness, have been identified as important predictors of new product performance repeatedly (Henard and Szymanski 2001). However, "a basic idea underlying the model of product innovation is that products will be developed over time in a predictable manner with initial emphasis on product variety and later emphasis on product standardization and cost" (Utterbeck and Abernathy 1975, pg. 642). This results in a variety of innovation types, typically called 'radical innovation' at the early stages of diffusion and adoption of the products and incremental innovations at the advanced stages of the product lifecycle.

NPD researchers have identified various innovation types:

1) Radical

2) Discontinuous

3) New-to-the-world

4) Really New Product

5) Incremental

6) Continuous

7) Dynamically Continuous

8) New-to-the-industry

9) New-to-the-firm

Radical Product Innovation

"Radical new products (innovations) often do not address a recognized demand but instead create a demand previously unrecognized by consumers. This new demand cultivates new industries with new competitors, firms, distribution channels, and new marketing activities" (Garcia & Calantone 2002, pg 121). Chandy and Tellis (1998, pg. 475) defined radical product innovation as "the propensity of a firm to introduce new products that (1) incorporate substantially different technology from existing products and (2) can fulfill key customer needs better than existing products."

Discontinuous Product Innovation. Previously unknown products that establish new consumption patterns and behavior changes (PDMA Handbook 2005). Examples include microwave ovens and the cellular phones. This is similar to radical innovation.

New-to-the-world Product Innovation. A good or service that has never before been available to either consumers or producers (PDMA Handbook 2005). The automobiles and microwave ovens were new-to-the-world when they were first introduced. This can be classified under radical innovation.

Really New Product Innovation. An entirely new product category and/or production and delivery system. A really new product relies on technology never used in the industry, has an impact on or causes significant changes in the whole industry, and is

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the first of its kind and totally new to the market (Song and Montoya-Weiss 1998). This description is similar to the description of radical new products mentioned above and can be classified under it.

Radical product innovations can be the source of competitive advantage to the innovators (Wind and Mahajan 1997, Chandy and Tellis 1998). Radical innovation is very important to marketing as it is "linked intrinsically with a firm's product-market strategy and can set the tone for the rest of the marketing program" (Chandy and Tellis 1998, pg. 474).

I combine key elements of these definitions for a comprehensive definition of radical innovation. Thus, radical innovation often do not address a recognized demand but instead create a demand previously unrecognized, incorporate substantially different technology from existing products, previously unknown that establishes new consumption patterns and behavior changes, never before been available to either customers or producers, and creates an entirely new product category and/or delivery system.

Incremental Product Innovation

Incremental new products are defined as products that provide new features, benefits, or improvements to the *existing* technology in the *existing* market. An incremental new product involves the adaptation, refinement, and enhancement of existing products and/or production and delivery systems (Garcia & Calantone 2002, Song and Montoya-Weiss 1998). "Incremental innovations involve relatively minor

changes in technology and provide relatively low incremental customer benefits per dollar" (Chandy and Tellis 1998, pg. 476).

Continuous Product Innovation. A product alteration that allows improved performance and benefits without changing either consumption patterns or behavior. The product's general appearance and basic performance do not functionally change. Examples include fluoride toothpaste and higher computer speeds (PDMA Handbook 2005). This is similar to incremental innovation.

Based on the above definitions, I define incremental innovation as innovations that provide new features, benefits, or improvements to the existing technology and provide improved performance without changing consumption patterns or behavior.

New Technology Products

New technology products are products that involve major changes in technology and changes in consumption behavior but not necessarily consumption pattern. Examples include Palm Pilots, electric toothbrushes, and electric hair curlers. These are also called dynamically continuous product innovations.

New Market Products

Some new products can be classified as new market products that create an entirely new market for the company and involve relatively minor changes to existing products (e.g., adult diapers).

Henard and Szymanski (2001) have done an extensive review of the literature and identified various predictors of new product performance. These are listed in Table 1.

They divided these predictors into four categories such as product characteristics, firm strategy characteristics, firm process characteristics, and market place characteristics. Henard and Szymanski's (2001) categories refer to a single product while my model refers to the NPD project portfolio and NPD program. Their four sources of new product success are adopted in my model as follows: product characteristics are represented in the NPD project portfolio mix, firm strategy and process characteristics are represented in the NPD partnership mix, and market place characteristics are represented by environmental turbulence.

TABLE 1

PREDICTORS OF NEW PPRODUCT PERFORMANCE
(Henard & Szymanski 2001, pg 64)

PREDICTORS	DEFINITIONS
Product Characteristics	
Advantage	Superiority and/or differentiation over competitive offerings
Meets customer needs	Extent to which product is perceived as satisfying desires/need of the customer
Price	Perceived price-performance congruency (i.e., value)
Technological sophistication	Perceived technological sophistication (i.e., high-tech, low-tech) of the product
Innovativeness	Perceived newness/originality/uniqueness, radicalness of the product
Firm Strategy Characteristics	
Marketing synergy	Congruency between the existing marketing skills of the firm and the marketing skills needed to execute a new product initiative successfully
Technological synergy	Congruency between the existing technological skills of the firm and the technological skills needed to execute a new product initiative successfully
Order of entry	Timing of marketplace entry with a product/service
Dedicated human resources	Focused commitment of personal resources to a new product initiative
Dedicated R&D resources	Focused commitment of R&D resources to a new product initiative
Firm Process Characteristics	
Structured approach	Employment of formalized product development procedures
Predevelopment task proficiency	Proficiency with which a firm executes the pre-launch activities (e.g., idea generation etc.)
Marketing task proficiency	Proficiency with which a firm conducts its marketing activities
Technological proficiency	Proficiency of a firm's use of technology in a new product initiative
Launch proficiency	Proficiency with which a firm launches the product/service
Reduced cycle time	Reduction in the concept-to-introduction time line (i.e., time to market)
Market orientation	Degree of firm orientation to its internal, competitor, and customer environments
Customer input	Incorporation of customer specification into a new product initiative
Cross-functional integration	Degree of multiple-department participation in a new product initiative
Cross-functional communication	Level of communication among departments in a new product initiative
Senior management support	Degree of senior management support for a new product initiative
Marketplace Characteristics	
Likelihood of competitive response	Degree/likelihood of competitive response to a new product introduction
Competitive response intensity	Degree, intensity, or level of competitive response to a new product introduction (market turbulence)
Market potential	Anticipated growth in customers/customer demand in the marketplace

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New Product Development Project Portfolio Mix

New product development project portfolio mix can be defined as a mix of incremental NPD projects, radical NPD projects, new technology NPD projects, and new market NPD projects in a firms NPD program. Tushman and O'Reilly (1996) suggest that organizations must be ambidextrous in new product development to be successful over the long-term. Incremental change is absolutely necessary for short-term success but not sufficient for long term success. Long-term success requires a multi-pronged approach.

Managing NPD project portfolio mix requires making choices about how various projects fit together in light of an organization's capabilities and strategy (PDMA Handbook 2005). By having a clear direction regarding the appropriate mix of radical and other NPD projects, a firm can reduce conflicts about goals and tactics and also promote employee commitment to innovative new product development. Portfolio as defined by PDMA is "a set of projects or products that a company is investing in and making strategic trade-offs against" (PDMA Handbook 2005, pg 599).

Product development portfolio is the collection of new product concepts and projects that are within the firm's ability to develop, most attractive to firm's customers', and deliver short-term as well as long-term corporate objectives, spreading risk and diversifying investments (PDMA Handbook 2005, pg 601). *Project Portfolio* is the set of projects in development at any point in time. These will vary in the extent of newness or innovativeness (PDMA Handbook 2005, pg 604).

Kleinschmidt and Cooper (1991) described two possible views of the relationship between innovativeness and success. First, more innovative products create more

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opportunities for differentiation and competitive advantage, therefore higher product innovativeness may increase performance. Second, and an opposing view, is that less innovative products are more familiar to the firms and customers and less uncertain to develop, hence lower innovativeness may increase performance (Song and Montoya-Weiss 1998). This apparent contradiction might indicate a curvilinear relationship between NPD program performance and the proportion of radical innovation projects in the NPD project portfolio mix. To maximize the NPD program performance, firms need to find a right mix of incremental, radical, new technology, and new market NPD projects. However, the focus of this dissertation is on the proportion of radical NPD projects in a firm's NPD project portfolio mix. Hence, the following hypothesis is presented:

H 1: The proportion of radical new product development projects in a firm's NPD project portfolio mix is positively related to its NPD program performance.

Three important resources sought for new product development involve capital, technology, and market access. Not every organization has all three available to them. Organizations form strategic alliances to overcome these constraints. Strategic alliances are an economical and flexible way to gain access to resources, cope with market uncertainties, and gain competitive advantage (Day 1995). Many organizations form alliances to develop new products. A review of strategic alliance literature is presented next. After that, strategic alliance literature is linked with new product development alliance literature and NPD partnership mix.

Strategic Alliances

Alliances are a manifestation of inter-organizational relationships. In recent years, there has been a substantial increase in the number of alliances (Varadarajan and Cunningham 1995). This might be a result of an opening up of the world economy and increased globalization, changes in the market structure and environment, and/or changes in customer preferences. Though there is a substantial increase in the number of alliance formations, as per some estimates, over 50% of alliances fail (Bleek and Ernst 1993, Harrigan 1998).

Strategic alliances help firms achieve competitive advantage either by reducing cost to customers compared to the benefits offered or by increasing benefits compared to customers' costs by differentiation (Gulati 1995). The extant alliance research can be organized into five distinct research streams (Gulati 1998): (i) rationale for forming alliances, (ii) governance structure of alliances, (iii) dynamic evolution of alliances, (iv) performance of alliances, (v) performance consequences of firms in alliances. This dissertation falls under the research stream of rationale for strategic alliance formation.

A strategic alliance involves the pooling of specific resources and skills by the cooperating organizations in order to achieve common goals as well as goals specific to each individual partner (Sheth and Parvatiyar 1992, Varadarajan and Cunningham 1995). Parkhe (1991, pg 581) defines strategic alliances as "relatively enduring interfirm cooperative strategy involving flows and linkages that utilizes resources and/or governance structure from autonomous organizations, for the joint accomplishment of individual goals linked to the corporate mission of each sponsoring firm."

Origins of inter-organizational partnerships can be traced back to Adler's (1966) description of "symbiotic marketing" where he describes the firms developing relationships with other parties who are not linked by the traditional marketer-marketing concept. Also Arndt (1979) describes "domesticated markets" where firms started forming exchange relationships instead of engaging in discrete exchanges. There are many different theories that have been applied in the study of alliances such as "domesticated market" (Arndt 1979); theory of market power and effectiveness (Kogut 1988); social exchange theory (Thibaut and Kelly 1959, Blau 1964, Homans 1974, Lambe, Wittman, and Spekman 2001); resource dependence theory (Pfeffer and Salancik 1978); transaction cost economics (Coase 1937, Williamson 1975, 1985, 1991, Rindfleisch and Heide 1997); resource based view (Barney 1991, Wernerfelt 1984, Das and Teng 2000); and institutional economics (Day and Klein 1987). I will be using the resource based view (Barney 1991) discussed later as this explains better the rationale for strategic alliance formation.

Alliances have been referred to using many different terms such as strategic alliances (Varadarajan and Cunningham 1995, Gulati 1995), corporate alliances (Dyer et. al.), cooperative strategies (Contractor and Lorange 1988, Parkhe 1993), cooperative ventures (Rindfleisch and Moorman 2001), collective strategies (Astley & Fombrun 1983, Dollinger and Golden 1992), joint ventures (Varadarajan and Cunningham 1995), competitive alliances (Peak 1991), inter-organizational partnerships (Gulati and Higgins 2003), multi-firm alliances (Hwang and Burgers 1997), and networks (Achrol and Kotler 1999). This dissertation deals with new product development alliances which are similar to cooperative research ventures described by Rindfleisch and Moorman (2001).

Alliances can be formed between two parties or more. When alliances are formed among three or more firms, it is called a multi-firm alliance or a network. Achrol and Kotler (1999) have described four different kinds of network organizations (Miles and Snow 1992, Miles, Snow, and Coleman 1992, Achrol 1997, Snow 1997, Walker 1997) such as: (1) Internal network, (2) Vertical network, (3) Inter-market network, and (4) Opportunity network. Two different kinds of opportunity networks are described as: (a) Business opportunity network (Type I) and (b) Customer opportunity network (Type II).

Alliances can be categorized as an equity alliance or a non-equity alliance. An equity alliance is, when each party holds an ownership position in a separate but jointly owned entity (e.g., joint ventures). Non-equity alliances are created by separate entities that form partnerships but do not hold an equity position in their partner or the joint entity.

Alliances can be described as *vertical* or *horizontal* alliances. When an alliance is formed between parties whose economic activity are at adjacent level of the value chain (e.g., between manufacturer and supplier), they are called vertical alliances. When an alliance is formed between firms at the same level of the value chain activity (e.g., between competitors), it is called a horizontal alliance.

Not all alliances can be called strategic alliance because the whole idea of strategy is to create competitive advantage. Some of the vertical alliances can be considered only as operational alliances because they are used for streamlining the operations. For example, P&G forming alliance with Wal-Mart as well as with Wal-Mart's competitors Kmart and Target for reducing the cost of similar kinds of operations (Vardarajan and Cunningham 1995).

Based on a thorough literature review Vardarajan and Cunningham (1995)

identified several reasons for alliance formation which are listed in Table 2.

TABLE 2

REASONS/MOTIVES FOR ALLIANCE FORMATION

Reasons for Alliance formation
Gaining access to new market (e.g., international alliances)
Protecting the home market
Accelerating the pace of entry into a new market
Raising entry barriers
Overcoming entry barriers
Reducing threat of future competition
Reducing marketing costs or manufacturing costs
Increasing resource use efficiency
Learning new skills
Reducing/sharing new product development costs
Acquiring resource

Table 2 presents the various reasons for alliance formation identified by

Vardarajan and Cunningham (1995). NPD alliances are generally formed for acquiring

resources, reducing and/or sharing development costs, and learning new skills. Day

(1995) has asserted that alliances are an economical and flexible way to cope with market

uncertainties and gain competitive advantage. But forming alliances are not free of cost.

Some of these costs of alliances identified by Varadarajan and Cunningham (1995) are

listed in Table 3.

TABLE 3

COST OF ALLIANCE FORMATION

Costs of Alliance formation
Cost of time spent by managers in negotiating, implementing, and monitoring alliances
Loss of flexibility and freedom in the area of joint interest
Leakage of proprietary knowledge to alliance partner
Atrophying of firm capabilities which have been given up to alliance partners

Some scholars might question the relationship of the study of alliances with the field of marketing but, Webster (1992) notes that virtually all alliances are related to the field of marketing as they involve relationships with existing or potential customers or with suppliers and other firms for the development of new products/services or new processes.

There are many reasons for alliance formation and many theories have been used to explain these alliances. Next, I present some of these studies. Rindfleisch and Moorman (2003) studied the effect of alliances on customer orientation (Narver and Slater 1990, Slater and Narver 1994, 1995). In their longitudinal study, they found a significant decrease in customer orientation of firms in a competitor centered alliances (horizontal alliances). Where as, no significant change was found in customer orientation for vertical alliances. Lambe, Spekman, and Hunt (2002) studied the effect of "alliance competence" of firms on alliance formation and performance. Using a resource based view, they found that alliance competence is an antecedent to the resources necessary for alliance success and it also has a direct impact on alliance success. Bucklin and Sengupta (1993) explained co-marketing alliances and performance consequences of co-marketing alliances. Based on their study of 98 alliances, they found that gain in alliance

effectiveness can be achieved by reducing power and managerial imbalances. Parkhe (1993) used game theory to explain formation and governance of alliances. Based on an empirical study of 111 inter-firm alliances, he suggested that there is a need for greater focus on game theoretic structural dimensions and institutional responses to perceived opportunism in the study of alliances. Heide (2003) talked about "plural governance" (make and buy) in his manuscript in an alliance context. Drawing on agency theory and information economics, he showed that firms do not necessarily make mutually exclusive choices of market contracting or internal organization, but often they combine both into a common structure, which he called plural governance. Wathne and Heide (2004) studied the effect of "alliance governance ability" on upstream and downstream partners. The authors showed that the ability to show flexibility toward a (downstream) customer under uncertain market conditions depends on the governance mechanisms that have been deployed in an (upstream) supplier relationship. Das and Teng (2000) used a resource based view (Barney 1991, Wernerfelt 1984) in studying the alliance formation and performance. They discussed the structural preferences of alliances based on the resource profile. They have also proposed a typology of inter-partner resource alignment. Ireland, Hitt, and Vaidyanath (2002) used a resource based view (RBV) in alliance management and explained the importance of alliance management for alliance performance and success. They proposed alliance management as a resource and source of competitive advantage.

The above literature review on strategic alliances explains that there are many different theories used for different kinds of alliances. Each one of these has a different

objective and rationale for alliance formation. In this dissertation, my main focus is on new product development alliance and the resource based view.

New Product Development Alliances

Many firms have formed alliances for new product development (NPD) (Sivadas and Dwyer 2000, Rindfleisch and Moorman 2001). The rationale for these kinds of alliances might be to share the risks/costs of developing a new product/process or to access resources for NPD. Sivadas and Dwyer (2000) explained the new product success in an alliance based context using a construct called "cooperative competency." As the name suggests, it is the competency of alliance partners to cooperate among themselves efficiently and effectively. It is composed of three different components – trust, communication, and coordination. Cooperative competency is a property of the relationship among the organizational entities participating in NPD. Based on their study, the success of NPD hinges on the cooperative competency of the firms involved (Sivadas and Dwyer 2000). Cross-functional cooperation is perceived as critical to the success of NPD. Conflicts can arise from differences in culture and differing responsibilities. Also, vested interests can prevent effective progress on a good project (Urban and Hauser 1980). Trust is a critical ingredient for inter-functional cooperation, which in turn affects the success of NPD. Without trust, there can be little sharing of information. In the absence of proper coordination, efficiency suffers and goal attainment is delayed or thwarted. The need for cooperative competency in a relationship arises from reciprocal dependence in NPD and the constraints imposed by the need for mutual adjustment (Sivadas and Dwyer 2000). Cooperative competency manifests itself

through effective exchange of information (communication) and negotiation and design of activities and roles (coordination). Sivadas and Dwyer (2000) found a positive relationship between cooperative competency and new product success.

Rindfleisch and Moorman (2001) used a strength-of-ties perspective (Granovetter 1973) in explaining the NPD alliances. Specifically, they talk about strength of weak ties between the firms in a horizontal alliance. First, they explained the difference between individual relationship and organizational partnerships using the concepts of "relational embeddedness" and "knowledge redundancy" which is opposite in these two cases. Then, they explained the relationship of these constructs with *new product creativity* and *new product success*. They found that horizontal new product alliances appear to enjoy benefits of new product development effectiveness in the form of higher levels of new product creativity and faster speed of development due to the synergy created by the redundancy of their product development-related knowledge, skills, and capabilities.

The above review of alliances explains a variety of alliance types, reasons for alliances, and cost associated with forming these alliances. NPD alliances are formed to share the financial cost as well as risk associated with product development and to have access to resources which are not readily available. These alliances help firms gain sustainable competitive advantage in the market place. The resource based view (RBV) helps to explain how firms use alliances to gain sustainable competitive advantage, which is discussed next.

<u>Resource Based View (RBV)</u>

The resource based view (RBV) (Barney 1991, Wernerfelt 1984) helps in explaining the rationale for formation of alliances. As per RBV, in a market structure, firm resources are heterogeneous and inimitable. This heterogeneity and inimitability of firm resources leads to four attributes of resources, which leads to sustainable competitive advantage of the firm. These attributes are called VRIN (Value, rareness, imperfect imitability, and non-substitutability) attributes presented in figure 2.

```
┌──────────────────┐        ┌────────────────────────┐        ┌──────────────┐
│ Firm Resource    │        │ Value                  │        │ Sustained    │
│ Heterogeneity    │        │ Rareness               │        │ Competitive  │
│                  │ ─────► │ Imperfect Imitability  │ ─────► │ Advantage    │
│ Firm Resource    │        │  • History Dependent   │        │              │
│ Immobility       │        │  • Causal Ambiguity    │        │              │
│                  │        │  • Social Complexity   │        │              │
│                  │        │ Substitutability       │        │              │
└──────────────────┘        └────────────────────────┘        └──────────────┘
```
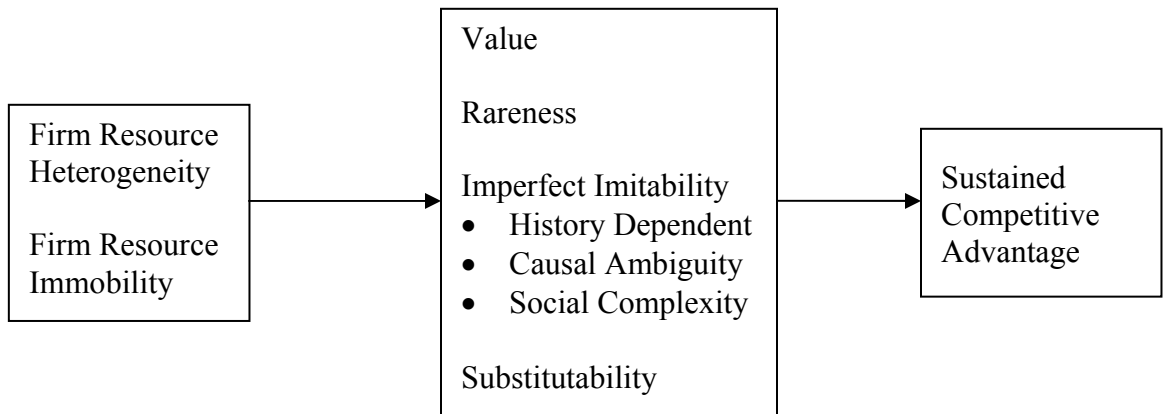
Figure 2: Resource Based View *(Barney 1991, pg. 112)*

To achieve sustainable competitive advantage, a resource should be valuable, it should be rare among firms, and it should only be imperfectly imitable by other firms. The imperfect imitability might result because of one or a combination of three reasons:

    i. History dependence of the resource

    ii. Causal ambiguity of the resource

    iii. Social complexity of the resource (Deirixk and Cool 1989)

The fourth attribute of nonsubstitutability says that, there should not be any substitute resource available which can be used by competing firms to implement the same or similar kind of strategy.

Since RBV is a theory of the firm, not a relationship, I will be using the "Relational View" (Dyer and Singh 1998), which is an extension of RBV and incorporates the effect of relationships among firms. According to the relational view, firms can generate relational rents by leveraging the complementary resource endowments of an alliance partner. Complementary resource endowments have been defined as "distinctive resources of alliance partners that collectively generate greater rents than the sum of those obtained from the individual endowments of each partner" (Dyer and Singh 1998, pg. 666). Here, relational rent is defined as "supernormal profits jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (Dyer and Singh 1998, pg. 662).

NPD Partnership Mix

NPD partnership mix is defined as the ratio of NPD projects with alliance partners to total NPD projects in a firm's NPD project portfolio mix. The above review of literature explains that radical innovation needs more resources and skills than other innovation types. Also, radical innovation is perceived to be more risky than incremental and other innovations. Based on the above, I propose the following hypothesis:

H 2: NPD partnership mix moderates the relationship between NPD project portfolio mix and NPD program performance such that when firms engage in more *radical* new product development projects and in *more* alliances, it results in greater NPD program performance.

Environmental Turbulence

The task environment, i.e., conditions external to the firm, affects the organization's internal behavior and functioning. Major organizational subsystems are related to the task environments components, like consumers and competitors (Pierce and Delbecq 1977). The extent to which the environment is turbulent influences organizational innovations. It forces organizations to face environmental changes and makes them more sensitive to external cues (Aiken and Alford 1970).

The role of competitive environment in innovation has received considerable attention in recent times. Empirical studies (e.g., Baldwin and Scott 1987, Kamien and Schwartz 1982, Robertson and Gatignon 1986) generally support the hypothesis that innovation by firms is positively related to intense technological activities in the industry. Market characteristics also influence innovation (Gatignon and Xeureb 1997). Turbulence in the form of frequent changes in technology and/or market preferences requires organizations to adjust to these changes, and to be more aware of external innovations and informations, and to adopt more radical innovations (e.g., Ettlie 1983, Gatignon and Robertson 1989, Pierce and Delbecq 1977). Also, the extent to which the environment is turbulent influences innovation because the organization braces up to tackle environmental changes (Aiken and Alford 1970).

Environments are neither certain nor uncertain in themselves, but are simply perceived differently by key managers of organizations (Pfeffer and Salancik 1978). Hence, Environmental turbulence, as defined by Milliken (1987) is the perceived inability of an organization's key managers to accurately assess the external environment of the organization or the future changes that might occur in that environment. Turbulence results from scarcity and environmental fluctuations. According to resource dependence theory (Pfeffer and Salancik, 1978), inter-organizational exchange arises from uncertainty regarding the availability of productive inputs and markets for finished goods (demand). The scarcity of resources increases unpredictability about the availability of both the supply of inputs and demand for outputs. In other words, unpredictability exists when and organization is unable to assign a subjective probability to the outcome of its actions (Keister 1999). Environmental turbulence has two prominent dimensions, market turbulence and technological turbulence.

Market turbulence specifies the changes in the composition of customers and their preferences (Kohli and Jaworski 1990). *Technological turbulence* is the rate of technological change in a given market (Kohli and Jaworski 1990). Technological turbulence specifies the amount and unpredictability of change in product, process, or service technologies.

Many strategy scholars (Rumelt 1974, Cooper and Schendel 1976, Miller and Friesen 1983, etc.) contend that firms must find a match between the environment and strategy for their long-term success. Also, the environment poses challenges which must be dealt with structurally (Burns and Stalker 1961).

Both strategic management and organizational theory literatures point to the potential increase in performance that can occur when businesses match themselves to their environment (Bourgeois 1985, Burns and Stalker 1961, Henard and Szymanski 2001). An aligning of the product, strategies, and processes to the environmental context can be important for augmenting new product performance in the sale of goods and services. It is important to match the level of new product change to the turbulence level in the environment. Contingency theory, discussed below, explains the performance effect of environment-strategy match.

Contingency Theory

As mentioned by Calantone et. al. (2003), two assumptions of contingency theory are:

(i)   There is no best strategy or structure (Glazer and Weiss 1993).

(ii)   A given strategy or structure will not be equally effective under different environmental or firm-specific conditions (Galbraith 1973).

Contingency theory explains firm performance contingent on other variables (Hunt and Morgan 1995, Balachandran and Friar 1997). I adopt the environment-strategy-structure-performance paradigm. The paradigm states that firms will maximize performance when strategy and structure fit the environment (Miles and Snow 1978, Miller and Friesen 1982, Mintzberg 1983). Strategic contingency theorists maintain that an appropriate fit between strategy and environment results in superior performance.

Miller (1988, 1991) suggested that strategies that differentiate offerings via innovation would succeed in a turbulent environment. He found that the match between

strategy and environment was positively related to performance. This study explores the relationship between NPD project portfolio mix and NPD program performance contingent upon environmental turbulence. Based on the above discussion, following hypothesis is proposed:

H 3: Environmental turbulence moderates the relationship between NPD project portfolio mix and NPD program performance such that when environmental turbulence is *high*, more radical new product development results in greater NPD program performance.

Control Variables

This study also controls for the effects of the following variables: type of industry, firm size, age of the firm, R&D expenditure, alliance experience, and repeated ties as these might offer an alternative explanation for hypothesized relationships.

Type of Industry

Organizations of all types develop new products in response to changes in their external and internal environments. However, organizational factors may unequally influence new product development in different types of organizations. The extra-organizational context and the industry or sector in which an organization is located influences new product development activities (Damanpour 1991).

<u>Firm Size</u>

Large organizations have more financial slack, marketing skills, research capabilities, and product development experience (Schumpeter 1942, Kimberly and Evanisko 1981). Large organizations are thus better equipped to tolerate potential losses caused by unsuccessful innovations/new product developments. Alliances formed between firms of approximately equal size, especially when both are large, are more likely to succeed. When firms are asymmetric, a large firm can take a greater risk than a smaller firm can afford. But large size has also been thought to inhibit innovation/new product development because large organizations are typically more standardized, have more inertia, and the managerial commitment to innovation is lower. Whereas small organizations are thought to be more innovative because they are more flexible, have greater ability to adapt and improve, and demonstrate less difficulty accepting and implementing change (Damanpour 1996, Ettlie and Rubenstein 1987). There are more than 100 articles which have studied the effects of size on innovation (Acs and Audretsch 1991). However, results of these studies have been mixed (Chandy and Tellis 1998). Because of these reasons, I have controlled the affect of firm size on the proposed relationships.

<u>R&D Expenditure</u>

Many researchers have found a strong association in R&D expenditure (per dollar of sales) and subsequent growth in sales (Morbey 1988, 1989). Generally, if a company is spending more money in an activity, it would expect a greater return for that. I have

controlled for the R&D expenditure because of the positive effect of higher R&D expenditure on NPD program performance.

Age of the Firm

According to extant literature, firm's age has a mixed effect on firm's performance (Henderson 1999). A liability of newness suggest that selection processes favor older, more reliable organizations, so failure rates are expected to decrease with age (Freeman, Carroll, and Hannan 1983, Hannan and Freeman 1984). The liability of adolescence argument suggests that failure rates have an inverted U-shaped relationship with age (Fichman and Levinthal 1991). The liability of obsolescence argument is that firms are highly inertial and tend to become increasingly misaligned with their environments. Hence, failure rates are expected to increase with age (Baum 1989, Henderson 1999). Because of this influence of firm's age on performance, I have controlled for it.

Alliance Experience

Alliance experience provides information about new alliance opportunities, potential partners, and their quality. Firms learn to manage alliances from alliance experience (Dutton and Thomas 1984, Lambe et. al. 2002). A firm's knowledge of managing alliances may be embodied in manuals, databases, and simulations that codify the key insights gained through reflection on past alliance experiences. Such tools may aid the firm in assessing current alliance performance and guide it in selecting

appropriate future alliance partners (Hoang and Rothaermel, 2005). Thus, firms have greater success with more alliance experience.

Repeated Ties

Repeated ties allows for the emergence of relationship-specific heuristics (Uzzi 1997). Past experience with the same partner helps overcome the initial difficulties associated with exchanges and transfers and it helps the partners to reach stability in relationship quickly. Hence, past experience with a partner smoothens the inter-firm interactions and exchange processes and enhances the effectiveness of the alliance (Gulati 1995). Through recurrent allying over time, dyadic alliance partners may be induced to invest in interfirm relation-specific assets that reduce transaction costs and thus increase value created (Dyer and Singh 1998). The refinement of partner-specific interfaces and the development of partner-specific decision making as well as conflict resolution routines enhance subsequent alliance performance (Hoang and Rothaermel, 2005). Because of these reasons, alliance experience and repeated ties were controlled.

Model of NPD Project Portfolio Mix

The proposed model of NPD project portfolio mix including constructs used in the study is presented in Figure 3. The unit of analysis for this study is strategic business unit (SBU), where SBU is defined as a profit center with distinct products and markets. The study investigates the direct effect of NPD project portfolio mix on NPD program performance. Moderating effects of environmental turbulence and NPD partnership mix

on this relationship are also investigated. The hypotheses deriving from the model are summarized below.

```
                    ┌─────────────────────────┐        ┌─────────────────────────┐
                    │  NPD PARTNERSHIP MIX    │        │    ENVIRONMENTAL        │
                    │   (Own vs. Alliance)    │        │     TURBULENCE          │
                    └─────────────────────────┘        └─────────────────────────┘
                                │                                   │
                              H₂                                  H₃
                                │                                   │
                                ▼                                   ▼
  ┌─────────────────────┐                                              ┌─────────────────────┐
  │   NPD PROJECT       │────────────────────────────────────────────▶│   NPD PROGRAM       │
  │   PORTFOLIO MIX     │                 H₁                           │   PERFORMANCE       │
  └─────────────────────┘                                              └─────────────────────┘
                                                              ▲
                            ┌─────────────────────┐          │
                            │    CONTROL          │──────────┘
                            │    VARIABLES        │
                            └─────────────────────┘
```
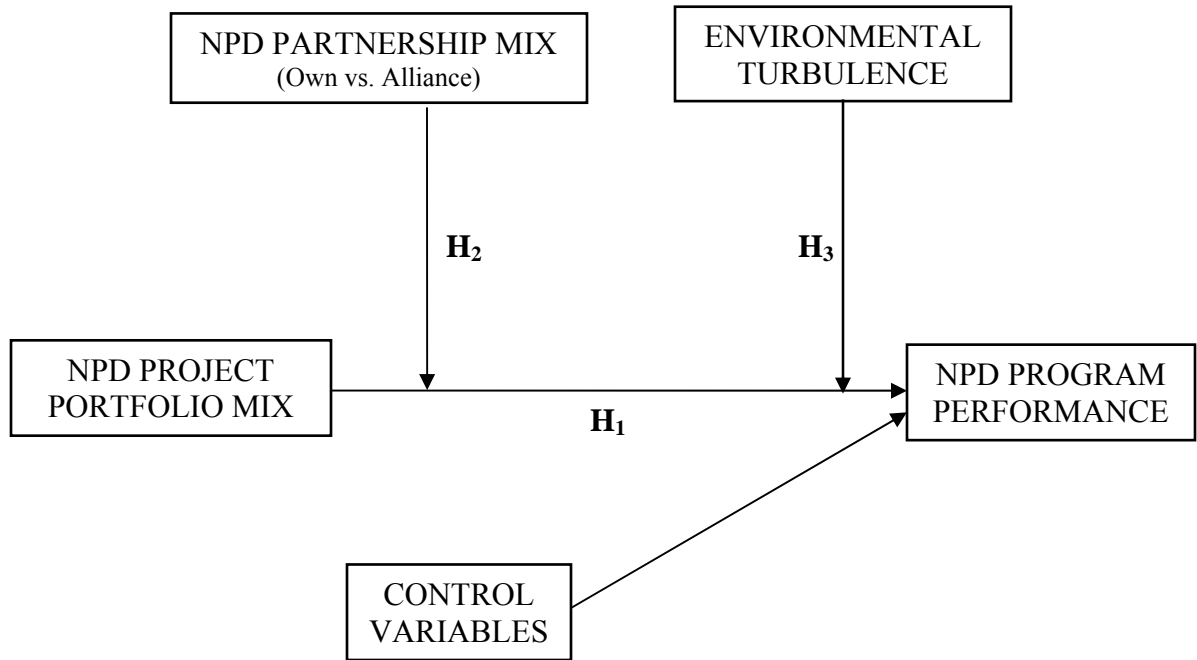
Figure 3: Model of NPD Project Portfolio Mix

Hypotheses

H 1: The proportion of radical new product development projects in a firm's NPD project portfolio is positively related to its NPD program performance.

H 2: NPD partnership mix moderates the relationship between NPD project portfolio mix and NPD program performance such that when firms engage in more *radical* new product development projects and in *more* alliances, it results in greater NPD program performance.

H 3: Environmental turbulence moderates the relationship between NPD project portfolio mix and NPD program performance such that when environmental turbulence is *high*, more *radical* new product development results in greater NPD program performance.

Chapter Summary

The chapter started with a review of new product development program research. Then, literature on new product development and innovation is summarized. After that, new product development project portfolio mix is presented and discussed. Next, literature on strategic alliances, new product development alliance, and NPD partnership mix is discussed and integrated with resource based theory. Finally, literature on environmental turbulence and contingency theory is discussed. Based on these discussions, three hypotheses are presented. After that, control variables are discussed that may affect the hypothesized relationships. At the end, a detailed model is presented and hypotheses are summarized.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

This chapter delineates the research approach for the study. First, choice of field study, survey approach, sample selection, and key informants are discussed. Next, the measurement aspects are discussed including operationalization of the constructs, measurement instruments, and specific scales to measure the constructs. Then, control variables are discussed, and finally a brief discussion of the data analysis techniques and procedures, including measurement quality assessment and hypotheses testing, are presented.

Research Design

Field Study and Survey Approach

To test the hypotheses, a field survey of key informants was conducted to obtain information about the NPD program performance and other constructs. A field study was chosen because of the large sample requirement (Gatignon and Xuereb 1997, Iyer 2001). A survey of key informants was conducted to obtain information about elements of their NPD project portfolio mix, NPD partnership mix, environmental turbulence, and perceived performance (NPD program performance). This is a common approach and has been successfully applied for many studies in marketing and new product development (Weiss and Heide 1993, Gatignon and Xuereb 1997, Iyer 2001).

It enabled me to reach a geographically dispersed population in a relatively short period of time and at a low cost. The key informants (Vice president of R&D, CEO, etc.) were asked to a complete self administered questionnaire. This approach enabled me to obtain information about an organization by collecting data from the selected person (key informant) within that organization who is highly knowledgeable about the phenomena under study (Campbell 1955). These respondents were at a level in the firm where they are likely to be well informed about issues related to their new product development program. The key informant approach has been successfully employed in many organizational studies (Anderson et. al. 1987, Gaski 1986, John and Reve 1982, Weiss and Heide 1993, Morgan and Hunt 1994). These studies followed the guidelines developed by Campbell (1955) in identifying key informants. Though, there is a statistical preference for soliciting responses from multiple informants (Phillips 1981), a single informant was selected due to time and other resource constraints. This approach maximized the number of organizations that could be surveyed (Conant, Mokwa, and Varadarajan 1990).

The survey approach operationalized the constructs using multiple items for measuring them, where applicable (John and Martin 1984). This approach is regularly used to obtain managers' perception of major theoretical concepts. The method taps the organization's characteristics and behaviors from the viewpoint of the respondent manager. As a validity check, respondents were asked the number of years they have worked for their firm and their familiarity and involvement with the NPD program in question. A detailed description of the respondents is provided in Chapter IV.

Unit of Analysis

The unit of analysis is the strategic business unit (SBU) as represented by the perception of the key respondents of the respective SBUs. SBU is defined as a profit center with distinct products and markets.

Sampling Frame

The ideal sampling frame includes the total population of SBUs in U.S. developing new products since the study involved new product development efforts of SBUs. However, no comprehensive sampling frame existed meeting this criterion and developing a new sampling frame was neither practical nor feasible. Therefore, I decided to use an existing sampling frame that was a good representative of the target population containing a reasonable diversity of SBUs in all geographic areas and many different industries. The specific sampling frame for this research is the "CorpTech" directory. This directory includes over 95,000 U.S. based technology companies. Out of these, a random listing of 6,000 firms, who had a listed R&D executive in the database, was acquired. These 6,000 names were randomly arranged and initially 3,000 executives were contacted by telephone. This represents a reasonable approximation to the overall population and selection error should be minimal. The executives from these firms listed in the database were chosen as the key respondents. A detailed sample profile is presented in Chapter IV.

<u>Sample Selection and Data Collection</u>

Testing the proposed hypotheses required a large representative sample. A cross-sectional field survey method was employed to meet the sample size requirement to provide an adequate level of statistical power (Gatignon and Xuereb 1997, Iyer 2001).

The development and administration of surveys was done following Dillman's (1991, 2000) Tailored Design Method (TDM). The questionnaires were emailed, faxed, or mailed as desired by the respondent. If questionnaires were mailed, they were mailed along with a cover letter on Oklahoma State University letter head and a postage-paid return envelope. Alternatively, cover letters and questionnaires were faxed with a return fax number listed. The fax cover letters were also written on Oklahoma State University letter head. The cover letters were specifically addressed by name of an executive (CEO, VP of R&D or Marketing, etc.) explaining the purpose of the survey. It also included a nondisclosure agreement indicating that the responses would be treated confidentially and data would be used in an aggregate form only. Appeals were used to highlight the importance of each response and the research. As an incentive to participate in the study, to increase the response rate, I offered to share the results in summary form, if the informant so desired. Reminders were sent out to those respondents who did not respond within 14 days. A second reminder was also sent out to those who did not respond after four weeks.

Data collection involved a sequence of contacts that consisted of phone calls, faxes, and/or emails from mid March to early July. Phone calls were made to each of the 3,000 potential subjects in order to:

(i)   Verify the position of the key informant

(ii)   Solicit participation and pre-notify the key informant about the survey

(iii) Ask the preferred method for survey delivery and to get email address/fax number or to verify the mailing address of the respondent

A phone call was made to each potential subject. If I was not able to reach the subject directly, I left a message on the voice mail or with the secretary. The phone conversation consisted of a brief introduction, a short description of the research, the incentive, and solicited the participation. The subjects were also informed that it would take approximately 20 minutes to complete the survey. If the subjects agreed to participate, their preferred survey delivery method (email, fax, or surface mail) was asked. The phone message also included a brief introduction, a short description of the research, the incentive, and the call back phone number.

These phone calls resulted in a commitment from 871 subjects who agreed to participate in the study. Surveys were delivered to these subjects by their preferred method either by e-mail, fax, or surface mail. E-mail was the most preferred method by these subjects. Out of these, 197 (22.6% of 871) subjects declined to complete the survey after receiving it, citing either company policy for non disclosure of confidential information or non-applicability of the survey to their business. 389 respondents declined to participate when the first phone call was made because of one of the following reasons: no time, no interest, don't do R&D, no longer works for the company, or incorrect number. Remaining subjects were unreachable even after a second call back and message.

<u>Response Rate</u>

It is very rare in survey research that all surveys will be completed and returned back. A total of 206 responses were received from the remaining 674 (871-197) participants who agreed to complete and return the questionnaire for an overall response rate of 30.6%. These represented 206 distinct Strategic Business Units (SBU). 139 questionnaires were returned without any reminder, 41 were returned after *one* reminder, and 26 were returned after *two* reminders. All the questionnaires were examined to assess their usability (Table 4). After careful examination, 23 questionnaires were found to be unusable because of a large amount of missing data on study variables, hence they were excluded from the study. The remaining 183 usable questionnaires resulted in an effective response rate of 27.15%.

TABLE 4

RESPONSE RATE

Description	N	Comments
Total Phone calls	3000	
Said No Immediately	389	No Time/Interest, Don't do R&D, Incorrect number
Agreed To Participate	871	
Said No Later	197	Don't do R&D, Confidential info.
Total Responses	206	
Not Usable	23	Incomplete, missing large data
Final Sample	183	Final usable responses
No Reminder	139	Responded without a reminder
One Reminder	41	Responded after one reminder
Two Reminder	26	Responded after two reminders

<u>Non-Response Bias Estimation</u>

The response rate analysis above indicates that non-response may be a potential source of bias in this research. It occurs when a systematic difference between respondents and non-respondents is observed. To assess if non-response bias exist in this research, a series of analyses were completed. Armstrong and Overton (1977) suggested a method of checking non-response bias by comparing early versus late responders. The responses were divided into early and late response groups on the basis of their arrival dates. A similar approach has been used in other research as well (Iyer 2001). Responses received after initial emailing and without any reminders were classified as early responders and those who responded only after a reminder, were classified as late responders. This method is based on the premise that those who respond only after an added stimulus can be treated similar to non-responders. This is called an extrapolation approach (Armstrong and Overton 1977, pg. 397).

A set of t-tests for independent samples were performed to identify any significant differences between early and late respondents (responded after 1st reminder). There was no significant difference observed for both number of employees (t = 0.843, df = 168, p = 0.400) and annual sales (t = -1.151, df = 158, p = 0.251). Similar results were observed between early responders and responders who responded after 2nd reminder (number of employees: t = 0.397, df = 152, p = 0.692; and annual sales: t = 0.348, df = 141, p = 0.728). Also, there were no significant difference between people who responded after one reminder and people who responded after two reminders (number of employees: t = -0.223, df = 56, p = 0.824; and annual sales: t = 1.201, df = 53, p = 0.253). Similar analyses were performed for determining the difference between early and late

responders on various other demographic variables. No significant differences were found for any of the variables such as respondents' level of education (t = -1.411, df = 171, p = 0.160), years in current position (t = 0.566, df = 170, p = 0.572), years employed with SBU (t = -0.102, df = 170, p = 0.919), years employed in the industry (t = 0.678, df = 169, p = 0.499), average annual R&D expenditure (t = 0.819, df = 122, p = 0.414), and SBU's age (t = 0.238, df = 167, p = 0.778). In addition, means of the dependent variable were compared and no significant difference was found (t = -0.906, df = 170, p = 0.366).

Additionally, I checked non-response bias by comparing the respondent firms with the non-respondent firms from the entire database of 3,000 firms as we had secondary data available on sales and number of employees for most of the firms. T-tests comparing responding firms with non-responding firms are presented in table 5 below. These also resulted in a conclusion that non-response bias is not a concern for this research.

TABLE 5

NONRESPONSE BIAS ASSESSMENT

Factor	t-statistics	df	Significance*
Employees (entire database)	-0.023	2998	.981
Sales (entire database)	1.466	2500	.143
Performance	-0.906	170	.366
Years in Current Position	0.566	170	.572
Years Employed with SBU	-0.102	170	.919
Education	-1.411	171	.160
R&D Expenditure	0.819	122	.414
SBU's Age	0.283	167	.778

*p< 0.05

<u>Measurement</u>

A measure is not the same as a construct and it is only an instrument to tap into the construct. Established measures in extant literature were used to measure the variables after modifying them to fit the study context. This study is based on the perceptions of key informants of the participating firms. Self administered questionnaires were used to measure the constructs and other demographic variables (SBU's size, SBU's age, key informant's experience and involvement with NPD program, etc.). The following sections describe how each variable in the study was measured.

<u>New Product Development Program Performance (Dependent Variable)</u>

In this dissertation performance was measured at the program level, i.e., the performance of all the NPD projects in an SBU's NPD project portfolio. The reason for this is that the proposed model investigated the effect of an SBU's entire NPD portfolio constituting many different NPD projects (incremental, radical as well as others). It was measured as Return on Investment (ROI new product development program), percentage of sales from new products, percentage of profits from new products, and percentage of NPD projects the business unit considers as success. These measures were based on absolute percentages. Behavioral measures were also used to determine the congruency between objective and subjective measures. Subjective performance measures are commonly used in these kinds of research. Also, research indicates a strong correlation between subjective and objective measures (Dess and Robinson 1984). These items were based on an excellent review of the product development success measures by Griffin and Page (1996). They contend that innovative firms need to assess the NPD program's

contribution to company growth. The last six items are based on Calantone et. al.'s

(2003) measure of NPD program performance scale which are Likert scale items with

end points of "a great failure" to "a great success" on a 1 to 7 scale and are presented in

Table 6.

TABLE 6

NEW PRODUCT DEVELOPMENT PROGRAM PERFORMANCE MEASURE

For NPD projects your **business unit** worked on during the **past three years**, what is the:									
Approximate Return on Investment (**ROI** - for the new product development program)_____									
Approximate percentage of business unit's *profits* from new products_____									
Approximate percentage of business unit's *sales* from new products_____									
Approximate percentage of NPD projects the business unit considers as success_____									
Degree to which the NPD projects lead to future opportunities.		Not at all						Very much	
		1	2	3	4	5	6	7	
Overall success of the NPD program, in management's opinion.		Very Unsuccessful						Very Successful	
		1	2	3	4	5	6	7	
Please respond to following questions for NPD projects your **business unit** worked on during the **past three years**:		A Great Failure						A Great Success	
Relative to your business unit's **objectives**, how successful has the NPD program been in terms of:	Profits	1	2	3	4	5	6	7	
	Sales	1	2	3	4	5	6	7	
	Market Share	1	2	3	4	5	6	7	
Relative to your **major competitors,** how successful has the NPD program been in terms of*:	Profits	1	2	3	4	5	6	7	
	Sales	1	2	3	4	5	6	7	
	Market Share	1	2	3	4	5	6	7	

New Product Development Project Portfolio Mix (Independent Variable)

The measure for NPD project portfolio mix was developed by modifying the

product innovativeness measure developed by Gatignon and Xeureb (1997), which is also

referred to as *innovation radicalness* scale. Respondents were provided the definition of

four types of NPD projects and instructed to answer the questions in the context of the

NPD project portfolio of their business units by completing the four quadrants. The measure is presented in Table 7. The definitions which were provided to respondent are listed below:

New Market Products: create an entirely new market for the company and involve relatively minor changes to existing products (e.g., adult diapers).

Incremental New Products: are products that provide new features, benefits, or improvements to the existing technology in the existing market. These involve minor changes in technology (e.g., new model of hand drill).

New Technology Products: involve major changes in technology and changes consumption behavior but not necessarily consumption patterns (e.g., electric tooth brush).

Radical New Products: these products often do not address a recognized demand but instead create a demand previously unrecognized. They incorporate substantially different technology from existing products; establish new consumption patterns and behavior changes that have not previously been available to either customers or producers. They create an entirely new product category and/or delivery system (e.g., digital camera).

TABLE 7

NEW PRODUCT DEVELOPMENT PROJECT PORTFOLIO MIX MEASURE

Please write in each quadrant the percent of NPD **projects** your business unit has in process or has developed during the last 3 years (Four quadrants should total to 100%):

Market	New	New Market _____% of all NPD **projects**	Radical _____% of all NPD **projects**
	Current	_____% of all NPD **projects** Incremental	_____% of all NPD **projects** New Technology
		Minor Change	Major Change
		Technology	

Environmental Turbulence (Moderator Variable)

Environmental turbulence is assessed as two dimensional measures: (a) technological turbulence, and (b) market turbulence. The five-item measure of technological turbulence and four item measure of market turbulence have been derived from Jaworski and Kohli (1993), Miles and Snow (1978), Miller and Droge (1986), and Milliken (1987). The dimensions of turbulence are determined by creating a summated scale score by calculating the mean of the scores across nine items. High environmental turbulence scores indicate that the organizations operate within relatively dynamic uncertain markets and technologies. These responses were based on seven-point Likert scales anchored by "strongly disagree/strongly agree" (see Table 8 for items).

TABLE 8

ENVIRONMENTAL TURBULENCE MEASURES

Environmental Turbulence Items
Technological Turbulence   i. The technology in our industry is easy to predict. (R)   ii. A large number of new product ideas have been made possible through technological breakthroughs in our industry.   iii. In our industry, the modes of production and service change often.   iv. In our industry, virtually no R&D is done. (R)   v. In our industry, the modes of production and service change in major ways as opposed to slowly evolving.
Market Turbulence   vi. In our industry, customer *demands* are fairly easy to forecast. (R)   vii. In our industry, customer *needs* are fairly easy to predict. (R)   viii. We cater to many of the same customers as in the past. (R)   ix. In general, in this business unit, market share is stable among the same competitors. (R)

<u>NPD Partnership Mix (Moderator Variable)</u>

NPD partnership mix is the ratio of NPD projects with alliance partners to total

NPD projects in a firm's NPD project portfolio mix. These were measured by asking the

respondents percentage of their radical NPD projects that involve alliances, percentage of

new technology NPD projects that involve alliance, percentage of new market NPD

projects that involve alliance, and percentage of incremental NPD projects that involve

alliance. Respondents were asked to complete both, percentage of different types NPD

projects with alliance partners and percentage of different types of NPD projects on their

own, for these four categories. The measure is provided in Table 9.

TABLE 9

NPD PARTNERSHIP MIX MEASURE

Please tell us the percent of NPD **projects**, in each quadrant, your business has in process or completed with **alliance partners** (suppliers, competitors, or customers), during the last 3 years (each should total to 100%):

Market	New	New Market		Radical	
		_____ % with **alliance partners**		_____ % with **alliance partners**	
		_____ % on **your own**		_____ % on **your own**	
	Current	_____ % with **alliance partners**		_____ % with **alliance partners**	
		_____ % on **your own**		_____ % on **your own**	
		Incremental		New Technology	
		Minor Change		Major Change	
		Technology			

Control Variables

I have controlled for the firm size, firm age, R&D expenditure, and the industry type. I also controlled for some alliance specific variables such as alliance experience and repeated ties. These variables are designed to control individual differences and features of firms that might serve as potential confounds or alternative explanations for hypotheses about the relationship between NPD project portfolio mix, NPD partnership mix, environmental turbulence, and NPD program performance (see Table 10).

Annual R&D expenditure was measured by asking the respondents the average R&D expenditure for the last three years. Age of the SBU was measured by asking "how many years the business unit has been in existence?" Organizational size is typically measured as annual sales or the number of employees. Sales volume strongly correlates with the number of employees (Smith, Guthrie, and Chen 1989). This study measured both sales volume of the strategic business unit and number of employees as firm size. Respondents were asked to provide the annual sales volume and number of employees of

the strategic business unit. Firm size was measured at both SBU and corporate level.

This study uses number of employees as the SBU size. Industry type was measured by

asking the business unit's principal industry as identified by the SIC or NAICS code. It

was controlled by using dummy variables.

TABLE 10

FIRM LEVEL CONTROL MEASURES

Firm Level Control Items
i. What is your business unit's principal industry as identified by SIC_____ or NAICS_____ code?
ii. Approximately how much was your **average annual** R&D expenditure for the last three years? $_____/Year
iii. Approximately how long has your business unit been in existence? _____ years
iv. What is the approximate number of employees in your **business unit** (Please check one)?
☐ Less than 25   ☐ 101-200   ☐ 501-800   ☐ 1001-5000
☐ 25-100   ☐ 201-500   ☐ 801-1000   ☐ More than 5000
v. If applicable, what is the approximate number of employees in your **parent organization** (Please check one)?
☐ Less than 25   ☐ 101-200   ☐ 501-800   ☐ 1001-5000
☐ 25-100   ☐ 201-500   ☐ 801-1000   ☐ More than 5000
vi. What is the approximate annual sales of your **business unit** (Please check one)?
☐ Less than $250,000   ☐ $10 m - Less than $20 m
☐ $250,000 - $499,999   ☐ $20 m - Less than $50 m
☐ $500,000 - $999,999   ☐ $50 m - Less than $100 m
☐ $1m - Less than $5 m   ☐ $100 m - Less than $500 m
☐ $5 m - Less than $10m   ☐ More than $500 million
vii. If applicable, what is the approximate annual sales of your **parent organization** (Please check one)?
☐ Less than $500,000   ☐ $100 m - Less than $500 m
☐ $500,000 - $999,999   ☐ $500 m - Less than $1 b
☐ $1 m - Less than $10 m   ☐ $1 b - Less than $10 b
☐ $10 m - Less than $50 m   ☐ $10 b - Less than $50 b
☐ $50 m - Less than $100 m   ☐ More than $50 billion

Alliance level control measure, alliance experience provides information about

new alliance opportunities, potential partners, and their quality. Firms learn to manage

alliances from alliance experience (Dutton and Thomas 1984, Lambe et. al. 2002). Thus, firms tend to have greater success with more alliance experience. Alliance experience was measured using the Lambe et. al (2002) scale for alliance experience.

Repeated ties allow for the emergence of relationship-specific heuristics (Uzzi 1997). Past experience with the same partner helps overcome the initial difficulties associated with exchanges and transfers and it helps the partners to reach stability in relationship quickly. Hence, past experience with a partner smoothens the inter-firm interactions and exchange processes and enhances the effectiveness of the alliance (Gulati 1995). These items were measured on a seven-point Likert scale anchored by "strongly disagree/strongly agree". The items are presented in Table 11.

TABLE 11

ALLIANCE LEVEL CONTROL MEASURES

Alliance Level Control Items

Alliance Experience
  i. Our business unit has a deep base of partnership experience with customers, competitors, or suppliers.
  ii. Our business unit has participated in many alliances.
  iii. Our business unit has been a partner in a substantial number of alliances.*

Repeated Ties
  i. Our business unit has partnered many times with the same firm.
  ii. Forming alliances with new firms is important to our business unit. (R)

Survey Development

Dillman's (1978, 2000) tailored design methods (TDM) were adopted to improve the survey response rate in designing the data collection instrument. The questionnaire appeared professional and its length was also controlled. An initial survey instrument was developed after it went through many iterations between me and the committee

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members. This helped in accomplishing face and content validity as well as better organization of the survey instrument. After that, the survey instrument was pre-tested with three industry experts. They evaluated and completed the survey instrument and provided some feedback. In addition to that, they were asked to rate the survey instrument on the following questions: 1) the questionnaire is well organized; 2) instructions are easy to follow; 3) questions are clear; 4) questionnaire is easy to read; and 5) it is of appropriate length (i.e., not too long). They were also provided space for any additional comments. Overall, they had a positive opinion about clarity, organization, and length of the questionnaire. Based on these experts' feedback, some questions were reworded and reorganized. After that, the survey instrument was finalized for data collection and submitted to IRB for approval. A copy of the questionnaire can be found in Appendix B, and IRB approval in appendix C.

Data Analyses Plan

The data analyses plan is based on many steps. First, after receiving the responses, data were coded, entered, and checked for errors. Data collected in the study were factor analyzed to examine the support for the a priori scales. A confirmatory factor analysis was run to extend further support to the measurement instrument. Reliabilities were estimated by computing the coefficient alphas and item-to-total correlations. The results of the analyses for each construct are discussed in the next chapter.

The proposed hypotheses are investigated using moderated regression analysis and multivariate analysis of variance where appropriate. This helped me to assess the hypothesized relationship between NPD project portfolio mix, NPD program

performance, NPD partnership mix, and environmental turbulence. As mentioned earlier, data for this research were collected via a field study.

Chapter Summary

Chapter 3 delineated the research design and the method used for data collection. The measurement scales and their operationalization were discussed in detail. Also, development of the survey instrument was discussed. Finally, data analysis procedures were discussed which will be used for assessing the measurement quality and testing the hypotheses.

CHAPTER IV

TESTS OF HYPOTHESES AND RESEARCH RESULTS

This chapter presents the results of empirical examination of the conceptualized relationships for the model presented in Chapter II. The current chapter is divided into three sections. The first section describes the sample characteristics including the SBUs' profile as well as respondents' profile. The second section presents the quality aspect of measurement instruments used for this study. Descriptive statistics, reliabilities, and validities of the scales are discussed. Finally, in the third section, results of hypotheses testing are presented. This includes an examination of the direct relationship between predictor variable and outcome variable as well as moderating effect of environmental turbulence and NPD partnership mix on this direct relationship. These relationships were examined using multiple regression and analysis of covariance.

Before analyzing the data, it was checked for any data entry errors. Descriptive statistics were run to check for minimum, maximum, and range of the scale items. All of them were found satisfactory except one, which was corrected later by referring to the respective questionnaire.

Sample Characteristics

On the survey instrument, respondents were asked to provide information about themselves and the SBUs they represent. As described earlier, out of total 3000 contacts

which resulted in 871 commitments, 206 responses were received. 23 responses were not usable because of a large amount of missing data and resulted in a final sample size of 183. Sample characteristics are discussed next and divided into two parts. First, characteristics of the SBUs are discussed and then survey respondents' characteristics are discussed.

Strategic Business Units' (SBU) Characteristics

The final sample represented 12 different industry codes (two digit SICs). Most SBUs (more than 86%) are in the manufacturing sector. Table 12 presents the industry profile of these SBUs.

TABLE 12

INDUSTRY PROFILE

SIC Code	Description	n	%
28	Chemical & Allied Products	28	15.3
30	Rubber & Miscellaneous Plastics Products	2	1.1
32	Stone, Clay, Glass, & Concrete Products	8	4.4
33	Primary Metal Industry	1	0.5
34	Fabricated Metal Products	11	6.0
35	Industrial & Commercial Machinery & Computer Equipment	39	21.3
36	Electronic & Other Electrical Equipment & Components (Except Computer Equipment)	27	14.8
38	Measuring, Analyzing, & Controlling Instruments	43	23.5
39	Miscellaneous Manufacturing Industries	1	0.5
49	Electric, Gas, & Sanitary Services	1	0.5
73	Business Services	2	1.1
87	Engineering, Accounting, Research, Management, & Related Services	17	9.3
--	Missing	3	1.6
	Total	183	100

More than 93% of the SBUs had less than 500 employees. 65 (35.5%) SBUs had less than 25 employees, 66 (36.1%) had between 25 to 100 employees, 22 (12%) had between 101 and 200 employees, and 17 (9.3) percent had between 201 and 500 employees. Only 7 (3.8%) SBUs had between 501 and 800 employees, 2 (1.1%) had between 801 and 1000 employees. Only 2 (1.1%) SBUs had between 1001 and 5000 employees and only 1 (0.5%) had more than 5000 employees. Based on this analysis of number of employees, only 12 (7%) SBUs can be considered as large and the remaining 93% are small to medium organizations.

Based on the analysis of annual sales volume, most SBUs (more than 86%) had an annual sale of more than a million dollar. Only 1 SBU (0.5%) had an annual sale of less than $250,000, 3 (1.6%) had an annual sale between $250,000 and $499,999, 10 (5.5%) had annual sales between $500,000 and $999,999. Of the SBUs that had annual sales of more than a million dollar, 51 (27.9%) had annual sales between $1 million and $5 million, 27 (14.8%) between $5 million and $10 million, 25 (13.7%) between $10 million and $20 million, 21 (11.5%) between $20 million and $50 million, 16 (8.7%) between $50 million and $100 million, 16 (8.7%) between $100 million and $500 million. Only 3 (1.6%) SBUs had annual sales volume of more than $500 million. About 10 (5.5%) the SBUs did not report their annual sales.

The above analysis indicates that the study sample represents the target population well. The average SBU age is 33.07 years which ranged from 3 years to 120 years. Also, the average annual R&D expenditure is $2,377,148 and ranged from $10,000 to $90 million. Table 13 presents the demographic profile of the SBUs.

TABLE 13

STRATEGIC BUSINESS UNITS' PROFILE

Characteristics	Frequency (n)	Percentage
Number of Employees		
Less than 25	65	35.5
25 – 100	66	36.1
101 – 200	22	12.0
201 – 500	17	9.3
501 – 800	7	3.8
801 – 1000	2	1.1
1001 – 5000	2	1.1
More than 5000	1	0.5
Missing	1	0.5
Total	183	100
Annual Sales		
Less than 250,000	1	0.5
250,000 – 499,999	3	1.6
500,000 – 999,999	10	5.5
1m – Less than 5m	51	27.9
5m – Less than 10m	27	14.8
10m – Less than 20m	25	13.7
20m – Less than 50m	21	11.5
50m – Less than 100m	16	8.7
100m – Less than 500m	16	8.7
More than 500m	3	1.6
Missing	10	5.5
Total	183	100
	Mean	Range
Age of SBU in years (N=177)	33.07	3 to 120
Annual R&D Expenditure (N=136)	2,377,148	10,000 to 90m

Respondents' Characteristics

As mentioned earlier, the data were collected by asking key informants to complete a self administered questionnaire. These informants are senior level executives and are at a level in the firm where they are likely to be well informed about issues related to their new product development program.

The key informants were asked to provide information about their job title, functional area, gender, highest education achieved, experience in the industry, experience with the SBU, and experience in their current position. They were also asked about their level of involvement with the NPD program, and knowledge about the new products being developed by the SBU. Respondent characteristics are presented in Table 14.

TABLE 14

RESPONDENTS' PROFILE

Characteristics	Frequency (n)	Percentage
Job Title		
President, CEO, Owner	41	22.4
Chief Technology Officer (CTO)	6	3.3
Chief Operating Officer (COO)	4	2.2
Chief Scientific Officer (CSO)	3	1.6
Vice President	49	26.8
General Manager & Manager	41	22.4
Director	32	17.5
Other	7	3.8
Total	183	100
Functional Area		
Research & Development	36	19.7
New Product Development	11	6.0
Business Development	1	0.5
Engineering	32	17.5
Operations	7	3.8
Technology	24	13.1
Sales and Marketing	7	3.8
Other	65	35.5
Total	183	100
Gender		
Male	176	96.2
Female	6	3.3
Missing	1	.5
Total	183	100
Education		
High School	4	2.2
College Degree	73	39.9
Master's Degree	61	33.3
Ph.D.	41	22.4
Missing	4	2.2
Total	183	100
	Mean	Range
Experience (years)		
In the Industry	22.7	1 to 60
With the SBU	14.8	1 to 47
In Current Position	10.9	1 to 45
Involvement with the NPD program	6.47	1 to 7
Knowledge about the new products by SBU	6.54	1 to 7

The above table 14 shows that almost all the respondents are senior level executives. 22.4 % (41) of respondents are either president, CEO, or owner of the firm. 7.1% (13) respondents are either chief technology officer, chief operating officer, or chief scientific officer. 26.8% (49) respondents are vice presidents, 22.4% (41) are general manager and manager, and 17.5% (32) are directors of the SBUs. The remaining 7 (3.8%) respondents did not report their job title. Most of the respondents are either in research & development, new product development, engineering, operations, or technology field.

Overall these respondents have 4,040 years of total experience in the industry with an average of 22.7 years. The average respondent has 14.8 years of experience with the SBU and 10.9 years of experience in their current position.

Over 96% (176) respondents are males and only 3.3% (6) respondents are females. Based on their reported education level, 41 (22.4%) have a Ph.D. degree, 61 (33.3%) have a master's degree, and 73 (39.9%) have a college degree. 4 (2.2%) respondent have only high school degree and 4 (2.2%) respondent did not report their education level.

Respondents reported a very high level of *involvement* with the NPD program. The average score is 6.47 on a scale of 1 to 7. They also reported a very high level of *knowledge* about the new products being developed by the SBUs. The average score is 6.54 on a scale of 1 to 7.

The above analyses explain that the respondents are senior level executives with considerable education and experience. They possess adequate involvement and

knowledge about the NPD program and provided valid information. This gives me a

high level of confidence in my data collection procedure and the data.

Measurement Quality Assessment

Measurement issues related to reliability and construct validity are discussed in

this section. The final survey contained measures of the dependent variable, independent

variable, moderator variables, control variables, and a set of additional variables. These

additional variables were included in order to help analyze and interpret the survey

results and to provide data for future research efforts. These additional variables will not

be discussed here further. The key constructs are independent variable NPD project

portfolio mix (NPDPPM), dependent variable NPD program performance (NPDPERF),

and moderator variables NPD partnership mix (NPDPART) and environmental

turbulence (ENVTURB). In addition, control variables such as SBUs' size, age, industry,

and R&D expenditure were assessed. Additionally, alliance level controls such as

alliance experience and repeated ties were also assessed.

The study employed existing scales from extant literature with sound

psychometric properties for measuring the variables. All study measures are reflective in

nature. The constructs of NPD project portfolio mix and NPD partnership mix are

measured on a single item ratio scale. Environmental turbulence, NPD program

performance, and alliance level control variables are measured on multi-item interval

scales. Control variables SBU age and annual R&D expenditure are measured on a ratio

scale, size is measured on an ordinal scale, and industry is measured as a categorical

variable.

The multi-item measures are evaluated for dimentionality, reliability, and validity. I conducted internal consistency reliability via item-to-total correlation and Cronbach's alpha. I also conducted exploratory factor analysis and confirmatory factor analysis. I used SPSS to conduct reliability and exploratory factor analysis and used LISREL 8.72 (Joreskog and Sorbom, 1997) for convergent & discriminant validity, and confirmatory factor analyses. Scales were modified and items were dropped from the scales based on these analyses.

Reliability and Exploratory Factor Analysis

I used all previously established measures, which seem to be content valid. As reliability is necessary for validity, I checked the reliability of scales for my data sample first. An internal consistency reliability check was used to calculate Cronbach's coefficient alphas. I checked the inter-item correlations for all the multi-item scales to check if any item's correlation is low compared to other items. Based on reliability and Exploratory Factor Analysis, some items were dropped from the measure from further analyses. The NPD project portfolio mix and the NPD partnership mix were measured on a single item ratio scale hence reliability and exploratory factor analyses were not conducted for these two measures. Below, the analyses for environmental turbulence and NPD program performance are presented.

Environment Turbulence (ENVTURB):

As mentioned in previous chapters, environmental turbulence was measured as a two dimensional construct including market turbulence and technological turbulence. As

in previous research (Ward and Lewandowska 2005, Kuivalainen et. al. 2004), a summated scale score is then created by combining these two dimensions. These two dimensions are discussed separately and then the combined scale is presented.

Market Turbulence (MTurb). The initial market turbulence measure consisted of four items. Based on reliability (item-to-total correlation) and exploratory factor analysis, the last two items were dropped from the final scale. Hence, the final scale consisted of two items. The results of reliability (Cronbach's alpha 0.90) and exploratory factor analysis (EFA) analysis are presented in Table 15.

Technological Turbulence (TTurb). This measure consisted of five items. Table 15 shows that a one factor solution was obtained for this measure when it was analyzed separately. Based on EFA results and reliability analysis, all five items were retained.

Finally, the reliability and EFA analyses were conducted by putting these two dimensions together. EFA analysis resulted in two factor solution as expected. The two factors combined were able to explain about 63% of the variance. The analyses results are presented in Table 15.

TABLE 15

RELIABILITY AND EXPLORATORY FACTOR ANALYSIS FOR
ENVIRONMENTAL TURBULENCE

Scale	Factor Loading	Item-to-total Correlation
Market Turbulence (MTurb)		
MTurb 1	0.953	0.818
MTurb 2	0.953	0.818
Eigen Value	1.82	
Percent of Variance	90.9	
Cronbach's Alpha	0.900	
Technological Turbulence		
TTurb 1	0.612	0.430
TTurb 2	0.758	0.584
TTurb 3	0.769	0.546
TTurb 4	0.585	0.406
TTurb 5	0.777	0.560
Eigen Value	2.49	
Percent of Variance	49.8	
Cronbach's Alpha	0.738	
Environmental Turbulence		
MTurb 1	0.948	
MTurb 2	0.953	
TTurb 1		0.425
TTurb 2		0.778
TTurb 3		0.778
TTurb 4		0.602
TTurb 5		0.789
Eigen Value	2.82 and 1.61	
Percent of Variance	63.3	
Correlation (MTurb and TTurb)		0.252

NPD Program Performance (NPDPERF).

A five item scale was used for measuring NPD program performance. As Table 16 shows, exploratory factor analysis resulted in a one-factor solution for this construct with an eigen value of 3.17 and 63.4% of the variance extracted. All item loadings were high. Also, reliability analysis indicated that the reliability for this construct was high with a Cronbach alpha of 0.854 and satisfactory level of item-to-total correlations.

TABLE 16

RELIABILITY AND EXPLORATORY FACTOR ANALYSIS FOR
NPD PROGRAM PERFORMANCE

Scale	Factor Loading	Item-to-total Correlation
NPD Program Performance		
NPDPerf 1 (Future Opportunities)	0.713	0.568
NPDPerf 2 (Overall Success)	0.796	0.672
NPDPerf 3 (SBU Objective-Profits)	0.813	0.686
NPDPerf 4 (SBU Objective-Sales)	0.852	0.744
NPDPerf 5 (SBU Objective-Market Share)	0.800	0.672
Eigen Value	3.17	
Percent of Variance	63.4	
Cronbach's Alpha	0.854	

Similar analyses were performed for multi-item control variables alliance experience and repeated ties and were found to be satisfactory. Based on the pretest, one item was dropped from the final measure of alliance experience as it was repetitive of the previous item. The alliance control measures are used only in analysis where the affect of NPD partnership mix is analyzed. All SBU level control variables are single item measures therefore measurement quality assessments were not performed for these measures.

Confirmatory Factor, Convergent, and Discriminant Analyses

After reliability and exploratory factor analysis, a confirmatory factor analysis (CFA) was conducted to check the performance of the measurement scales using LISREL 8.72 (Joreskog and Sorbom 1997). Also, convergent and discriminant validity were checked as recommended by Fornell and Larcker (1981) and Gerbing and Anderson (1988). Convergent validity refers to the agreement among scale items of the same construct. Discriminant validity refers to the distinctiveness of the constructs by different set of items.

The CFA analysis was run by putting all three multi-item measures in a single model. NPD program performance has 5 items, market turbulence has 2 items (after EFA and reliability analysis), and technological turbulence has 5 items. The initial model was not satisfactory based on this analysis. Chi-square ($\chi2 = 178.89$, df = 51, p = 0.00) was significant with unsatisfactory fit indices (GFI = 0.85, CFI = 0.89, NFI = 0.85). After further investigation it was found that the average variance extracted by technological turbulence measures (AVE = 0.374, CR = 0.727) was well below the recommended level of 0.5 (Fornell and Larcker 1981). Further investigation also revealed that the factor loading for Ttech 1 and Ttech 4 were very low (0.39 and 0.34 respectively). These two items were dropped and the analysis was conducted again. This resulted in a satisfactory model although the chi-square was significant but factor loadings and fit indices were good ($\chi2 = 96.78$, df = 32, p = 0.00, GFI = 0.90, CFI = 0.93, NFI = 0.89). This also resulted in better composite reliability (CR = 0.77) and average variance extracted (AVE = 0.543) for technological turbulence. The results of the final three factor model are present in Table 17 below.

TABLE 17

CONFIRMATORY FACTOR ANALYSIS

Construct	Standardized Loading	t-value	Composite Reliability (CR)	Average Variance Extracted (AVE)
NPD Program Performance			0.854	0.544
NPDPerf 1	0.56	--		
NPDPerf 2	0.66	6.59		
NPDPerf 3	0.79	7.30		
NPDPerf 4	0.87	7.53		
NPDPerf 5	0.76	7.18		
Market Turbulence			0.903	0.824
MTurb 1	0.84	--		
MTurb 2	0.97	5.23		
Technological Turbulence			0.770	0.543
TTurb 2	0.48	--		
TTurb 3	0.82	5.85		
TTurb 5	0.85	5.77		

The discriminant validity of the final model was assessed as per Fornell and

Larcker's (1981) suggestions. They suggested that satisfactory measure should explain at

least 50% of the variance (i.e., error variance less than 50% and AVE 0.5 or higher). The

current model meets those criteria as presented in Table 17. The discriminant validity is

also estimated by comparing the correlation between factors with the AVE of the

constructs. The AVE estimate of each factor should be greater than squared correlations

between the factors to establish discriminate validity (Fornell and Larcker 1981). These

analyses also confirm discriminant validity as AVEs exceeded squared correlations

between constructs ($phi_{12}^2 = 0.0196$, $phi_{23}^2 = 0.0529$, $phi_{13}^2 = 0.0576$). Also, each item

demonstrated a significant loading on its respective construct establishing convergent validity (Fornell and Larcker 1981).

Hypotheses Testing

The hypotheses proposed in chapter II are:

H 1: The proportion of radical new product development projects in a firm's NPD project portfolio is positively related to its NPD program performance.

H 2: NPD partnership mix moderates the relationship between NPD project portfolio mix and NPD program performance such that when firms engage in more *radical* new product development projects and in *more* alliances, it results in greater NPD program performance.

H 3: Environmental turbulence moderates the relationship between NPD project portfolio mix and NPD program performance such that when environmental turbulence is *high*, more *radical* new product development results in greater NPD program performance.

To test the hypotheses, a series of multiple regression (OLS) and analysis of covariance (ANCOVA) analyses were conducted. NPD program performance (NPDPERF) was the dependent variable and NPD project portfolio mix (NPDPPM) was the independent variable in the first analysis. I also had two moderator variables namely NPD partnership mix (NPDPART) and environmental turbulence (ENVTURB). Some control variables were also used in analyses as covariates to control for the effect of these variables on hypothesized relationships. Also, care was taken to assess and minimize multicollinearity and to identify outliers/influential observations.

An initial analysis of the data set revealed that the correlations among NPD

program performance and its antecedents and moderators are not strong. Table 18

presents the correlation matrix and descriptive statistics of important study variables.

TABLE 18

CORRELATIONS, MEANS, AND STANDARD DEVIATIONS

Construct	NPDPERF	NPDPPM	NPDPART	ENVTURB
NPD Program Performance	1.00			
NPD Project Portfolio Mix	0.16[*]	1.00		
NPD Partnership Mix	0.06	0.01	1.00	
Environmental Turbulence	0.19[*]	0.23[*]	0.05	1.00
Mean	4.75	23.50	38.08	4.04
Standard Deviation	1.11	20.90	40.43	0.99

*Correlation is significant at the 0.05 level

Hypothesis 1:

To test Hypothesis 1 which proposed that the proportion of radical NPD projects

in a firm's NPD project portfolio mix is positively related to its NPD program

performance, ordinary least square (OLS) regression analysis was conducted. The use of

OLS was preferred as it provides the best linear unbiased estimates and has been utilized

in previous studies in a similar context (Gatignon and Xuereb 1997).

Control variables R&D expenditure, SBU age, and SBU size (number of

employees) were used in all analyses as covariates because they showed a significant

correlation with either dependent variable, independent variable, or moderator variable.

Industry type was not significantly correlated with any study variables hence was not

included in further analyses. The initial regression analysis was performed without these

control variables as well but analysis including control variables resulted in much better model performance.

The first regression equation was run with the NPD program performance as dependent variable and the NPD project portfolio mix as independent variable. The control variables average annual R&D expenditure, SBU's age, and number of employees were entered in the model before the independent variable. This model was found to be significant with an R^2 of 0.122 (F = 4.447, p = 0.002) meaning that it was able to explain about 12.2% of variance. The results indicate that NPD project portfolio mix is significantly and positively related to NPD program performance (β = 0.190, p = 0.025). The results of this analysis lend support for Hypothesis 1. Also, control variable SBU age was found significantly related to NPD program performance which will be discussed later. Table 19 presents the results of this analysis.

TABLE 19

REGRESSION ANALYSIS RESULTS FOR HYPOTHESIS 1

Variable	β	T	p
R&D Expenditure	-0.163	-1.733	0.086
Age	-0.260	-2.907	0.004
Number of Employees	0.011	0.116	0.908
NPD Project Portfolio Mix	*0.190*	*2.264*	*0.025*
Constant	5.562	24.535	0.000
R^2 = 0.122			
Adj. R^2 = 0.095			
Model F = 4.447			
df = [4, 128]			
p-value = 0.002			
N = 133			

Dependent Variable: NPD Program Performance

The above analysis included those SBUs also which had no radical NPD projects in their NPD project portfolio mix (i.e., radical = 0%). A similar analysis was run by excluding these SBUs which did not have any radical NPD projects in their portfolio that resulted in same conclusion and lending support for H 1. This is a more stringent test and was conducted to check if the results hold. However, in this analysis, sample size (N = 72) reduces considerably. The results of this analysis are presented in Table 20.

TABLE 20

REGRESSION ANALYSIS RESULTS
FOR H 1 (EXCLUDING RADICAL = 0%)

Variable	β	t	p
R&D Expenditure	-0.196	-1.593	0.116
Age	-0.397	-3.578	0.001
Number of Employees	-0.055	-0.426	0.671
NPD Project Portfolio Mix	*0.220*	*2.069*	*0.042*
Constant	5.796	19.571	0.000
$R^2 = 0.274$			
Adj. $R^2 = 0.230$			
Model F = 6.308			
df = [4, 67]			
p-value = 0.000			
N = 72			

Dependent Variable: NPD Program Performance

Another regression analysis was run to check the curvilinear relationship between NPD project portfolio mix and NPD program performance, though it was not proposed but suspected. First, a square term of NPD project portfolio mix variable was created. After that, NPD project portfolio mix and its square term were mean centered to minimize the effect of multicollinearity. In the regression model, all the control variables were entered first, then mean centered NPD project portfolio mix, and mean centered

square term were entered as independent variables. NPD program performance was the dependent variable. The overall model was significant but the variables were not significant. Only control variable SBU age was found to be significant in this model as well.

To test hypotheses 2 and 3, analysis of covariance (ANCOVA) method was used as creating cross product terms with independent and moderator variables and using them in moderated regression equation were resulting in a very high multicollinearity. Even mean centering of the variables did not solve the problem of multicollinearity (VIF in the range of 20 to 26). Also, the objective was to explain the interaction effects so ANCOVA was considered suitable for these analyses. All interaction effects were analyzed one at a time in separate models for easier understanding.

Hypothesis 2:

Hypothesis 2 proposed that when firms engage in more radical new product development and when they do this more with alliance partners, it results in greater NPD program performance. To test this hypothesis, first of all, the NPD project portfolio mix (NPDPPM) variable was divided into two groups of low radical projects and high radical projects by median split (median = 15%). In this analysis, those SBUs who do not have radical projects in their portfolio mix (i.e., radical = 0) were not included. The reason being, those SBUs who do not develop radical NPD projects, obviously, will not have partnership for radical NPD projects. The NPD partnership mix (NPDPART) variable was divide into two groups of low alliance and high alliance by median split (median = 27.5%). After that 2X2 ANCOVA analysis was run including all the control variables as

covariates. Though the overall model was significant (F = 3.629, p = 0.006), this analysis did not result in a significant interaction effect between NPD project portfolio mix and NPD partnership mix (F = 0.024, p = 0.878). Therefore H 2 is not supported. The results of this analysis are presented in Table 21 and 22 below.

TABLE 21

ESTIMATED MARGINAL MEANS AND SAMPLE SIZE (H 2:1)

NPD Project Portfolio Mix		NPD Partnership Mix	
		Low	High
Low	Mean	5.05	5.31
	N	17	15
High	Mean	5.36	5.54
	N	19	19

TABLE 22

ANCOVA RESULTS FOR H 2 (NPDPPM 2 GROUPS)

Effect	SS	df	F-Stat	p-value
NPDPPM (2 Groups)	1.176	1	1.113	0.296
NPDPART (2 Groups)	0.606	1	0.573	0.452
NPDPPM*NPDPART	0.025	1	0.024	*0.878*
R&D Expenditure	2.180	1	2.063	0.156
Age	10.193	1	9.643	0.003
Number of Employees	0.695	1	0.658	0.420
Alliance Control	0.621	1	0.588	0.446
Corrected Model	23.485	7	3.629	0.006
Error	65.533	62		
$R^2 = 0.264$				
N = 70				

Dependent Variable: NPD Program Performance
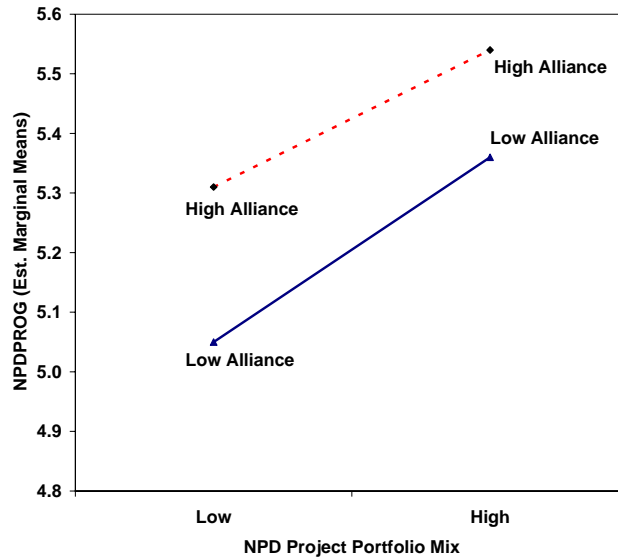
Figure 4: Interaction of NPD Project Portfolio Mix and NPD Partnership Mix

On a post hoc basis, the NPD project portfolio mix (NPDPPM) variable was split into three groups (lowest < 10%, medium 10-25%, and highest >25%) and similar analysis was performed as a 3X2 ANCOVA including all control variables as covariates. This analysis resulted in an overall significant model (F = 3.330, p = 0.002) as well as an interaction term at p = 0.058 and F = 2.996. The results are presented in Table 23 and 24. This analysis lends only partial support for H 2 and further analysis was not conducted.

TABLE 23

ESTIMATED MARGINAL MEANS AND SAMPLE SIZE (H 2:2)

NPD Project Portfolio Mix		NPD Partnership Mix	
		Low	High
Lowest	Mean	5.06	5.37
	N	17	11
Medium	Mean	4.70	5.68
	N	8	13
Highest	Mean	5.79	5.23
	N	11	10

TABLE 24

ANCOVA RESULTS FOR H 2 (NPDPPM 3 GROUPS)

Effect	SS	df	F-Stat	p-value
NPDPPM (3 Groups)	1.307	2	0.661	0.520
NPDPART (2 Groups)	0.072	1	0.710	0.403
NPDPPM*NPDPART	5.929	2	2.996	*0.058*
R&D Expenditure	1.838	1	1.857	0.178
Age	8.801	1	8.895	0.004
Number of Employees	1.569	1	1.586	0.213
Alliance Control	0.693	1	0.701	0.406
Corrected Model	29.651	9	3.330	0.002
Error	59.367	60		
$R^2 = 0.333$				
N = 70				

Dependent Variable: NPD Program Performance
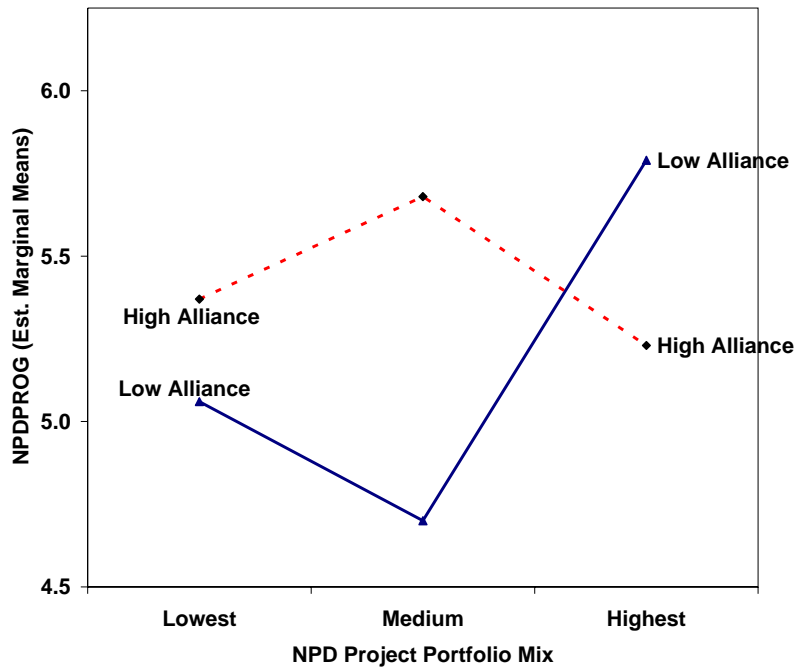
Figure 5: Interaction of NPD Project Portfolio
Mix (3 Groups) and NPD Partnership Mix

Hypothesis 3 proposed that when firms are operating in high turbulent environment, if they develop more radical products, they will have greater NPD program performance. To test this hypothesis, first of all, the NPD project portfolio mix (NPDPPM) variable was divided into two groups. The first group had SBUs which did not have any radical projects (no radical), and other group had SBUs which have some radical projects (some radical) in their NPD project portfolio mix. A question arises here if these two groups represent different industries. But an industry group analysis indicated that these two groups were represented almost equally in different industry types. Also, the environment turbulence (ENVTURB) variable was divided into two groups of low turbulence and high turbulence by median split (median = 3.80). After that 2X2 ANCOVA analysis was run including all the firm level control variables as covariates. This analysis resulted in a significant overall model (F = 4.453, p < 0.000) as well as a significant interaction term (F = 11.210, p = 0.001) between NPD project portfolio mix and environmental turbulence. Therefore H 3 is supported. The interaction term was disordinal in nature. The results of this analysis are presented in Table 25, 26, and Figure 6 below.

TABLE 25

ESTIMATED MARGINAL MEANS AND SAMPLE SIZE

NPD Project Portfolio Mix		NPD Partnership Mix	
		Low	High
No Radical	Mean	5.32	4.76
	N	38	22
Some Radical	Mean	4.87	5.67
	N	29	43

TABLE 26

ANCOVA RESULTS FOR H 3 (NPDPPM 2 GROUPS x ENVTURB)

Effect	SS	df	F-Stat	p-value
NPDPPM (2 Groups)	1.614	1	1.312	0.254
ENVTURB (Low-High)	0.441	1	0.359	0.550
NPDPPM*ENVTURB	13.793	1	11.210	*0.001*
R&D Expenditure	2.009	1	1.632	0.204
Age	6.104	1	4.961	0.028
Number of Employees	0.210	1	0.171	0.680
Corrected Model	32.876	6	4.453	0.000
Error	153.807	125		
$R^2 = 0.176$				
N = 132				

Dependent Variable: NPD Program Performance
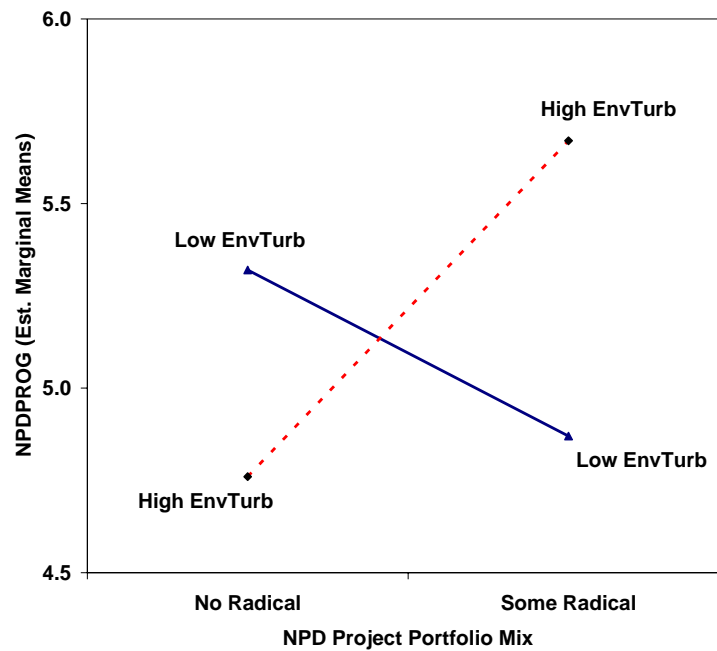
Figure 6: Interaction of NPD Project Portfolio Mix
and Environmental Turbulence

The above figure 6 indicates that when environmental turbulence is high and

firms are developing radical products, their performance is higher, but when

environmental turbulence is low, these firms have significantly lower performance. Therefore, it can be concluded that firms are better off with developing more radical products in highly turbulent environments but they are worse off when environmental turbulence is low. In other words, they are wasting resources in low environmental turbulence condition by developing radical products.

A further analysis was conducted by dividing NPD project portfolio mix variable in three groups. The first group contained those SBU who were not developing radical products (no radical). The group with SBUs developing radical products (some radical), was further divided into two groups by median split (median = 15.0) into low radical and high radical groups. Therefore, in no radical group, SBUs have 0% radical projects in their portfolio mix, in low radical group, SBUs have more than 0% but less than or equal to 15% radical projects in their portfolio mix, and in high radical group, SBUs have more than 15% radical projects in their portfolio mix. The environment turbulence (ENVTURB) variable was divided into two groups of low turbulence and high turbulence by median split (median = 3.80). Similar results were obtained and are provided in Table 27 and 28 and presented pictorially in Figure 7.

TABLE 27

ESTIMATED MARGINAL MEANS AND SAMPLE SIZE (H 3:2)

NPD Project Portfolio Mix		NPD Partnership Mix	
		Low	High
No Radical	Mean	5.32	4.77
	N	38	22
Low Radical	Mean	4.66	5.41
	N	12	20
High Radical	Mean	5.02	5.91
	N	17	23

TABLE 28

ANCOVA RESULTS FOR H 3 (NPDPPM 3 GROUPS x ENVTURB)

Effect	SS	df	F-Stat	p-value
NPDPPM (3 Groups)	4.767	2	1.952	0.146
ENVTURB (Low-High)	3.702	1	3.031	0.084
NPDPPM*ENVTURB	14.415	2	5.901	*0.004*
R&D Expenditure	1.808	1	1.481	0.226
Age	5.696	1	4.664	0.033
Number of Employees	0.078	1	0.063	0.801
Corrected Model	36.452	8	3.731	0.001
Error	150.231	123		
$R^2 = 0.195$				
N = 132				

Dependent Variable: NPD Program Performance
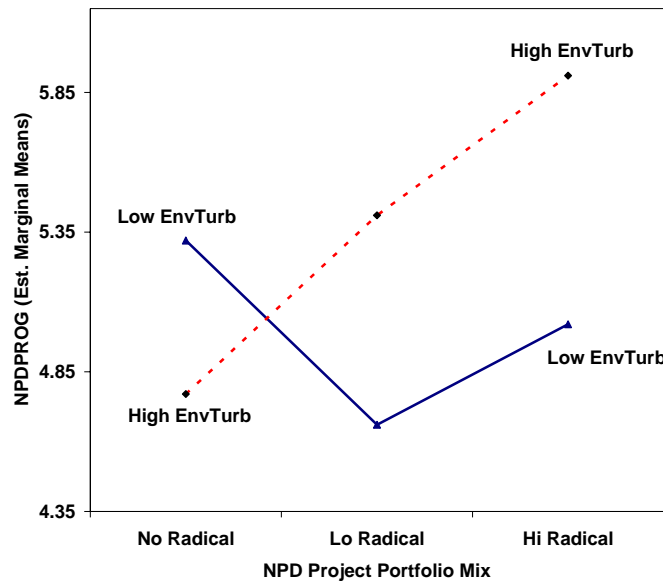
Figure 7: Interaction of NPD Project Portfolio Mix
(3 Groups) and Environmental Turbulence

The above figure 7 indicates that firms are much better off developing radical

products in high environmental turbulence but they should not develop radical products

in low environmental turbulence conditions as this results in a lower overall NPD program performance.

In summary, hypothesis 1 and hypothesis 3 are supported but hypothesis 2 is not supported. A higher proportion of radical NPD projects in a firm's NPD project portfolio mix results in greater NPD program performance but this is contingent upon the level of environmental turbulence in which the firm is operating. The level of alliance partnership mix has no effect on the relationship between NPD project portfolio mix and NPD program performance.

Further analyses were conducted to check for violation of assumptions. These analyses did not indicate any serious violation of regression and ANCOVA assumptions.

Chapter Summary

This chapter presented the results of analyses for this dissertation. The sample characteristics including firm and respondent characteristics were presented. After that, the quality of the measurement instruments was judged, including descriptive statistics, reliability, and validity. Finally, hypotheses test results were presented. The next chapter presents the discussion of results, their implications for researchers and managers, the limitations of the study, and future research directions.

CHAPTER V

DISCUSSION AND IMPLICATIONS

This chapter starts with a discussion of research findings. Implications of the

study for researchers and managers are presented next. After that, limitations of the

research are presented. The chapter concludes with future research directions.

The objective of this dissertation study was to examine the effect of the

proportion of radical new product development projects on a firm's new product

development program performance. This study argued to balance the proportion of

radical NPD projects based on the level of environment turbulence as well as balance the

NPD partnership mix based on the proportion of radical NPD projects.

The study results indicated a significant and positive relationship between new

product development project portfolio mix and new product development program

performance. This finding supports previous literature that firms developing more unique

and radical products are more successful in the market (Henard and Szymanski 2001).

The results of this study also extend this finding by empirically testing and suggesting

that this relationship is contingent upon the nature of the environment in which the firm is

operating. More specifically, if firms are operating in highly turbulent environment,

higher proportion of radical NPD projects in a firms portfolio will lead to much higher

performance but in low environmental turbulence higher proportion of NPD projects will

lead to lower performance. This suggests that firms will be wasting scarce resources in low turbulent environment by developing radical products, when it is not needed.

The empirical findings failed to support the proposition that if firms are developing more radical projects jointly with alliance partners, they will perform better. Although a post hoc analysis provides some support for this relationship.

Another interesting finding was the relationship of age with NPD program performance. Though it was entered as a control variable in the models, it had a negative relationship with the performance. As previous research indicated, firm's age had a mixed effect on NPD performance. This finding might support the liability of adolescence argument which suggests that failure rates have an inverted U-shaped relationship with age (Fichman and Levinthal 1991). The liability of obsolescence argument might also be supported with this finding which suggests that firms become highly inertial and tend to become increasingly misaligned with their environments as they become old. Hence, failure rates are expected to increase with age (Baum 1989, Henderson 1999). Overall, this finding might suggest that older and more established firms are less inclined to make riskier investments by developing more radical products.

Implications

The propositions for this research were developed by integrating research from both new product development and strategic alliance research streams. So, the results of this study have implications for both of these streams of research.

<u>Theoretical</u>

Theoretical implications focus on the relevance of the study results for organizational researchers as they relate these results to further studies in the field. No study has talked about or empirically tested achieving a right proportion of radical projects in a firms NPD project portfolio mix. Also, no study has talked about or empirically tested achieving a mix of NPD partnership. Hence, this dissertation extends the new product development theories and well as unsuccessfully tests the strategic alliance theories. It has implications for researchers in both fields.

<u>Managerial</u>

Findings of this study have several implications for managers. Although, incremental change is absolutely necessary for short-term success, it is not sufficient for long term success. Long-term success requires a multi-pronged approach. The results of this study will help managers to find the right proportion of radical NPD projects in their NPD project portfolio to optimize the NPD program performance. This study also suggests that it is important to develop radical new product in a high turbulent environment but it will be a waste of scarce resources to develop radical products in a low turbulent environment. Although this study did not find a significant relationship among proportion of radical new product, alliance partnership, and program performance, a further (post hoc) analysis provides some support for this relationship. This will help managers find a mix of radical NPD projects in alliances to improve their NPD program performance for long-term survival of the firm.

Research Limitations

This study had several limitations of which some of the possible limitations are discussed in this section. First of all, the current study utilized a cross-sectional approach. Although several studies have been conducted using this approach in new product development and other marketing related research, caution must be exercised when drawing causation based on these results. Since strategy making is a process, its impact can best be studied over time by using methods of longitudinal analysis (Miller and Friesen 1982). Unfortunately, due to the nature of data (cross-sectional), I cannot establish causal directions since the changes in strategy making and environment are measured for the same interval. Therefore, to establish causation, studies utilizing longitudinal design would benefit research in this area.

The use of a descriptive research design for this study poses a threat to internal validity. Unlike experimental research designs that allow control for extraneous variables, descriptive research designs are not intended to control extraneous variables. This also makes it difficult to establish causal relationships. However, in order to account for their effects, several steps were taken by including control variables in the model that were identified by previous research to have an influence on the variables under investigation.

Another limitation of this study is the use of single key informant. Time and resource constraints did not allow collecting data from multiple respondents as study involved measuring variables at NPD program level which involves several projects. Though respondents reported high familiarity and knowledge with the NPD projects but they might not have familiarity with all the projects in a firm's NPD portfolio. Also,

because of the use of a single key informant for data collection, the current study might suffer from the common method variance. The use of self-administered questionnaire also presents a threat of response bias. Although the respondents possessed high degrees of relevant knowledge, all the measures are self reported and therefore subject to hindsight and other biases. Estimates of performance are rough and depend on the memory of respondents.

Also, the generalizability of the study results is constrained by the non-response bias. Though the study has tried to minimize the effect of non-response bias and has found no significant differences between respondents and non-respondents, there is always a possibility that non-respondent firms differ systematically with respondent firms. Hence, study results should be interpreted with caution.

Another limitation to the generalizability of this study is that the study drew mostly from firms in manufacturing sector. More than 87% of the firms represented manufacturing industry therefore the results of this study should be generalized with caution to other contexts.

The current study has also limitations in measurements. Perceptual measures of NPD program performance and environmental turbulence were used to test the proposed hypotheses. More objective measures would have offered a greater confidence in study results.

Future Research Directions

The findings of the current study provide a base for several future research directions. The current model could be enhanced by including other relevant variables such as organizational learning level, absorptive capacity, market orientation (proactive and reactive), top management risk taking, organizational memory, etc.

The current study can be extended by investigating the effect of NPD project portfolio mix on organizational learning level. It can be suggested that proportion of radical (exploration) projects will affect the organizational learning level of an organization. The level of absorptive capacity of a firm may also have an affect on this relationship which can be investigated by future research.

The proportion of radical projects in a firm's NPD project portfolio mix might depend on the level of market orientation of the firm. This proportion might differ based on whether the firm is proactive market oriented or reactive market oriented.

The proportion of radical projects in a firm's NPD project portfolio mix might also depend on whether the top management is risk taker or risk averse as radical NPD projects are deemed to be more risky.

NPD project portfolio mix of the firms might vary based on their business strategy typology proposed by Miles and Snow (1978). Different firms operating in the similar environment might have different mix depending on whether they are prospector, analyzer, or defender.

Future research may also address another issue. This study investigated the relationships among NPD project portfolio mix, NPD partnership mix, environmental turbulence, and NPD program performance from a cross-sectional perspective. However,

adopting a longitudinal research perspective could provide more insight into these

relationships and might lend support for unsupported proposition.

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APPENDIXES

APPENDIX A

Cover Letter

Dissertation Study

February 3, 2006

Dear   ,

    Thank you for helping with my dissertation. Your participation is an important contribution for this research. The information provided by you and other participants is vital to improve decision making with respect to new product development. In appreciation for your participation, I have provided a space in the questionnaire for you to indicate whether you would like to receive an executive summary of the results. I will be happy to send you the summary via email or surface mail.

    Your business unit's new product development program is the subject of this questionnaire. Please give me your opinions with respect to various aspects of new product development by completing the enclosed questionnaire. There are no right or wrong answers. So please provide your best estimate to answer all questions. It should take you approximately 20 minutes to complete. Be assured that your answers will remain *completely confidential.* Information from the questionnaire will be kept in *aggregate form,* and the questionnaire will be destroyed.

    Please return the questionnaire in the enclosed postage paid envelope or by fax to (405) 744-5180. If you have any questions regarding your rights as a participant in this research, please contact Dr. Sue Jacobs, IRB Chair, 415 Whitehurst Hall, 405-744-1676. If you have questions about this research, please contact me, Prashant Srivastava at (405-744-5947 or prashant.srivastava@okstate.edu) or my adviser, Dr. Gary L. Frankwick at (405-744-5192 or mktgglf@okstate.edu). We truly appreciate your completion of this questionnaire.

Sincerely,

Prashant Srivastava
Ph.D. Candidate in Marketing

Enclosure:

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APPENDIX B

Measurement Instrument

OKLAHOMA STATE UNIVERSITY
NEW PRODUCT DEVELOPMENT SURVEY

The purpose of this study is to explore new product development issues. Your responses will remain **strictly confidential**. All of the reports generated from this research will take the form of aggregate statistics. We will not release individual company data to anyone. Participation in this study is voluntary. If you do not want to answer a particular question, just skip it. You can also quit at any time. However, complete surveys will add to the study significantly. This survey should take about 20 minutes to complete.

For NPD projects your **business unit** worked on during the **past three years**, what is the:

Approximate Return on Investment (**ROI** - for the new product development program)_____

Approximate percentage of business unit's *profits* from new products_____

Approximate percentage of business unit's *sales* from new products_____

Approximate percentage of NPD projects the business unit considers as success_____

	Not at all						Very much
Degree to which the NPD projects lead to future opportunities.	1	2	3	4	5	6	7

	Very Unsuccessful						Very Successful
Overall success of the NPD program, in management's opinion.	1	2	3	4	5	6	7

Please respond to following questions for NPD projects your **business unit** worked on during the **past three years**:		A Great Failure						A Great Success
Relative to your business unit's **objectives**, how successful has the NPD program been in terms of:	Profits	1	2	3	4	5	6	7
	Sales	1	2	3	4	5	6	7
	Market Share	1	2	3	4	5	6	7
Relative to your **major competitors**, how successful has the NPD program been in terms of:	Profits	1	2	3	4	5	6	7
	Sales	1	2	3	4	5	6	7
	Market Share	1	2	3	4	5	6	7

Please mark the number that best reflects your level of agreement with each of the following statements about your business unit.	Strongly Disagree						Strongly Agree
Top managers in this business unit consistently accept higher financial risks in order to obtain higher rewards.	1	2	3	4	5	6	7
Top managers in this business unit accept occasional new product failures as being normal.	1	2	3	4	5	6	7
Top managers in this business unit encourage the development of innovative marketing strategies, knowing some will fail.	1	2	3	4	5	6	7
In this business unit, bold wide ranging acts are common place.	1	2	3	4	5	6	7
In our industry, customer demands are fairly easy to forecast.	1	2	3	4	5	6	7
In our industry, customer needs are fairly easy to predict.	1	2	3	4	5	6	7
We cater to many of the same customers as in the past.	1	2	3	4	5	6	7
In general, for this business unit, market share is stable among the same competitors.	1	2	3	4	5	6	7
The technology in our industry is easy to predict.	1	2	3	4	5	6	7
A large number of new product ideas have been made possible through technological breakthroughs in our industry.	1	2	3	4	5	6	7
In our industry, the modes of production and service change often.	1	2	3	4	5	6	7
In our industry, virtually no R&D is done.	1	2	3	4	5	6	7
In our industry, the modes of production and service change in major ways.	1	2	3	4	5	6	7
Our business unit has a deep base of partnership experience with customers, competitors, or suppliers.	1	2	3	4	5	6	7
Our business unit has participated in many alliances.	1	2	3	4	5	6	7
Our business unit has partnered many times with the same firm.	1	2	3	4	5	6	7
Forming alliances with new firms is important to our business unit.	1	2	3	4	5	6	7

Please complete the percentages in each box based on the descriptions provided below:

New Market Products: create an entirely new market for the company and involve relatively minor changes to existing products (e.g., adult diapers).

Incremental New Products: are products that provide new features, benefits, or improvements to the existing technology in the existing market. These involve minor changes in technology (e.g., new model of hand drill).

New Technology Products: involve major changes in technology and changes consumption behavior but not necessarily consumption patterns (e.g., electric tooth brush).

Radical New Products: these products often do not address a recognized demand but instead create a demand previously unrecognized. They incorporate substantially different technology from existing products, establish new consumption patterns and behavior changes that have not previously been available to either customers or producers. They create an entirely new product category and/or delivery system (e.g., digital camera).

Based on the above descriptions, write in each quadrant the percent of NPD **projects** your business unit has in process or has developed during the last 3 years (Four quadrants should total to 100%):

Market	New	New Market _____ % of all NPD **projects**	Radical _____ % of all NPD **projects**
	Current	_____ % of all NPD **projects** Incremental	_____ % of all NPD **projects** New Technology
		Minor Change	Major Change
		Technology	

Based on the above descriptions, write in each quadrant the percent of NPD **budget allocated** by your business unit during the last 3 years (Four quadrants should total to 100%):

Market	New	New Market _____ % of all NPD **budget**	Radical _____ % of all NPD **budget**
	Current	_____ % of all NPD **budget** Incremental	_____ % of all NPD **budget** New Technology
		Minor Change	Major Change
		Technology	

Based on the above descriptions, please tell us the percent of NPD **projects**, in each quadrant, your business has in process or completed with **alliance partners** (suppliers, competitors, or customers), during the last 3 years (should total to 100%):

Market	New	New Market _____ % with **alliance partners** _____ % on **your own**	Radical _____ % with **alliance partners** _____ % on **your own**
	Current	_____ % with **alliance partners** _____ % on **your own** Incremental	_____ % with **alliance partners** _____ % on **your own** New Technology
		Minor Change	Major Change
		Technology	

Please mark the number that best reflects your level of agreement with each of the following statements about your business unit:	Strongly Disagree						Strongly Agree
We regularly meet customers to learn about their *current* needs for new products.	1	2	3	4	5	6	7
We regularly meet customers to learn about their *potential* needs for new products.	1	2	3	4	5	6	7
We constantly monitor and reinforce our understanding of the *current* needs of the customers	1	2	3	4	5	6	7
We constantly monitor and reinforce our understanding of the *future* needs of the customers.	1	2	3	4	5	6	7
We have a thorough knowledge about emerging customers and their needs.	1	2	3	4	5	6	7
Information about *current* customers is integrated into our plans and strategies.	1	2	3	4	5	6	7
Information about *future* customers is integrated into our plans and strategies.	1	2	3	4	5	6	7
We regularly use research techniques such as focus groups, surveys, and observations to gather customer information.	1	2	3	4	5	6	7
We have developed effective relationships with **customers** to fully understand new technological development that affect customers' needs.	1	2	3	4	5	6	7
We have developed effective relationships with **suppliers** to fully understand new technological development that affect customers' needs.	1	2	3	4	5	6	7
We systematically process and analyze customer information to fully understand their implications for our business.	1	2	3	4	5	6	7
We regularly collect and integrate information about the products and strategies of our *current* competitors.	1	2	3	4	5	6	7
We systematically collect and analyze information about *potential* competitor activities.	1	2	3	4	5	6	7
Managers in this business unit regularly share information about current and future competitors within the company.	1	2	3	4	5	6	7
Our knowledge of current and potential competitors' strengths and weakness is very thorough.	1	2	3	4	5	6	7
The activities of functional units are tightly coordinated to ensure better use of our market knowledge.	1	2	3	4	5	6	7
Functions such as R&D, marketing, sales, and manufacturing are tightly integrated in cross-functional teams in the product development processes.	1	2	3	4	5	6	7
R&D, marketing, sales and other functions regularly share market information about customers, technologies, and competitors.	1	2	3	4	5	6	7
There is a high level of cooperation and coordination among functional units in setting the goals and priorities for the organization to ensure effective response to market conditions.	1	2	3	4	5	6	7
Top management promotes communication and cooperation among R&D, marketing, and manufacturing in market information acquisition and use.	1	2	3	4	5	6	7
People from marketing, R&D, and other functions play important roles in major strategic decisions.	1	2	3	4	5	6	7
We help our customers anticipate developments in their markets.	1	2	3	4	5	6	7
We continuously try to discover additional needs of our customers of which they are unaware.	1	2	3	4	5	6	7
We incorporate solutions to unarticulated customer needs in our new product and services.	1	2	3	4	5	6	7
We brainstorm on how customers use our products and services.	1	2	3	4	5	6	7
We innovate even at the risk of making our products obsolete.	1	2	3	4	5	6	7
We search for opportunities in areas where customers have a difficult time expressing their needs	1	2	3	4	5	6	7

Please mark the number that best reflects your level of agreement with each of the following statements about your business unit:	Strongly Disagree						Strongly Agree
We work closely with lead users who try to recognize customer needs months or even years before majority of the market may recognize them.	1	2	3	4	5	6	7
We extrapolate key trends to gain insight into what users in a current market will need in the future.	1	2	3	4	5	6	7
We use sophisticated technologies in our new product development.	1	2	3	4	5	6	7
We actively build our capacity to react effectively to market changes in regards to product demand.	1	2	3	4	5	6	7
Technological innovation based on research results is readily accepted in our organization.	1	2	3	4	5	6	7
Technological innovation is readily accepted by our program/project management.	1	2	3	4	5	6	7
Our new products always use state-of-the-art technology.	1	2	3	4	5	6	7
We ensure that our advantages can withstand changes in the industry.	1	2	3	4	5	6	7
We are ready to face the challenges brought by the e-commerce trend for suppliers and customers.	1	2	3	4	5	6	7
We actively prepare for the changes brought by market.	1	2	3	4	5	6	7
We often visit other companies to improve our knowledge of production, marketing, and/or management.	1	2	3	4	5	6	7
We often attend all sorts of expert presentations to improve our knowledge of production, marketing, and/or management.	1	2	3	4	5	6	7
We often attend training programs to improve our knowledge of production, marketing, and/or management.	1	2	3	4	5	6	7
We often exchange ideas on learned knowledge to improve our knowledge of production, marketing, and/or management.	1	2	3	4	5	6	7
Our employees often share learned knowledge with top managers.	1	2	3	4	5	6	7
We encourage teamwork, team decision making, and internal communication.	1	2	3	4	5	6	7
We are good at resolving conflicts among the staff.	1	2	3	4	5	6	7
Conflicts among the staff affect the new product development.	1	2	3	4	5	6	7
We have extensive knowledge and experience in developing new products.	1	2	3	4	5	6	7
We have extensive experience in formulating new production processes.	1	2	3	4	5	6	7
Our R&D department is adequately staffed.	1	2	3	4	5	6	7
Our R&D department has employees with doctorates.	1	2	3	4	5	6	7
Our R&D department is engaged in fundamental research.	1	2	3	4	5	6	7

Please answer the following questions about your **most recent alliance** in new product development (If you had more than one partner, please answer all questions for *major* or *most important* partner). Would you describe your alliance partner as:	Strongly Disagree						Strongly Agree
Partner was a competitor in the **same** industry	1	2	3	4	5	6	7
Partner was a competitor in a **different** industry	1	2	3	4	5	6	7
Partner was a non-competitor (supplier or customer) who manufactured a different product	1	2	3	4	5	6	7
Other, please explain_____							

Please tell us about yourself and your business unit:

How *involved* are you with the NPD program of this business unit?

                                      Not at all   1   2   3   4   5   6   7   Highly

How *knowledgeable* are you about the new products being developed by this business unit?

                                        Not at all   1   2   3   4   5   6   7   Highly

What is your business unit's principal industry as identified by four digit SIC code_____ or NAICS code_____

Your position _____

Years in current position _____

How long have you been employed with this business unit? _____ years

How long have you been employed in this industry? _____ years

What is your highest level of education (please check one)?
       ☐ High School   ☐ College Degree   ☐ Master's Degree   ☐ Doctoral Degree

Gender: ☐ Female   ☐ Male

Approximately how much was your **average annual** R&D expenditure for the last three years? $_____/Year

Approximately how long has your business unit been in existence? _____ years

What is the approximate number of employees in your **business unit** (Please check one)?
☐ Less than 25	☐ 101-200	☐ 501-800	☐ 1001-5000
☐ 25-100	☐ 201-500	☐ 801-1000	☐ More than 5000

If applicable, what is the approximate number of employees in your **parent organization** (Please check one)?
☐ Less than 25	☐ 101-500	☐ 1,000-5,000	☐ 10,001-20,000
☐ 25-100	☐ 501-1,000	☐ 5,001-10,000	☐ More than 20,000

What is the approximate annual sales of your **business unit** (Please check one)?
☐ Less than $250,000	☐ $10 m - Less than $20 m
☐ $250,000 - $499,999	☐ $20 m - Less than $50 m
☐ $500,000 - $999,999	☐ $50 m - Less than $100 m
☐ $1m - Less than $5 m	☐ $100 m - Less than $500 m
☐ $5 m - Less than $10m	☐ More than $500 million

If applicable, what is the approximate annual sales of your **parent organization** (Please check one)?
☐ Less than $500,000	☐ $100 m - Less than $500 m
☐ $500,000 - $999,999	☐ $500 m - Less than $1 b
☐ $1 m - Less than $10 m	☐ $1 b - Less than $10 b
☐ $10 m - Less than $50 m	☐ $10 b - Less than $50 b
☐ $50 m - Less than $100 m	☐ More than $50 billion

Please check **one** description below which best represents your business unit's strategy:

_____ This business unit has a stable domain (market). We develop single-core technology that is highly cost-efficient, with the aim of cornering a narrow segment of the total potential market. There is little scanning of the environment for new opportunities and the administrative system is concerned mainly with intensive planning, cost efficiency, centralized control, and the maintaining of stability through a functional structure. We grow through market penetration and perhaps some limited product development.

_____ This business unit maintains a broad and continuously developing domain, while monitoring a wide range of environmental conditions and events, in search of new product and market opportunities. We create changes in industry through sporadic product and market development, while flexible, prototypical, multiple technologies are used with a low degree of routinization. We have low formalization and decentralized control.

_____ This business unit is interested in locating and exploiting new product and market opportunities, while maintaining a firm base of traditional products and customers, and has, therefore, a dual technological core encompassing a stable and a flexible component. We embark upon new product and customer ventures only after their visibility has been demonstrated. In this business unit, marketing, sales, engineering, and production play an important role.

WE THANK YOU FOR YOUR PARTICIPATION. IT IS IMPORTANT FOR OUR RESEARCH AND WELL APPRECIATED.

Please return the completed questionnaire by email or to the address or fax number below:

Dr. Gary L. Frankwick
Department of Marketing
Spears School of Business
Oklahoma State University
Stillwater, OK 74078-4011
Fax: (405) 744-5180

If you have questions regarding your rights as a participant in this research please contact Dr. Sue Jacobs, IRB Chair, 415 Whitehurst Hall, 405-744-1676. If you have any questions about this research, please contact me, Prashant Srivastava at (405-744-5947 or prashant.srivastava@okstate.edu) or Dr. Gary L. Frankwick at (405-744-5192 or mktgglf@okstate.edu).

If you like, please provide your address and phone number below or attach a business card so that we can send you the results of this study.

Name: _____

Company: _____

Address: _____

_____

Phone: (_____)_____ Fax:(_____)_____

Email: _____

APPENDIX C

Institutional Review Board Approval Form

Oklahoma State University Institutional Review Board

Date: Friday, February 10, 2006

IRB Application No BU0619

Proposal Title: The Effect of New Product Development Project Portfolio Mix on New Product Development Program Performance

Reviewed and Processed as: Exempt

Status Recommended by Reviewer(s): Approved   Protocol Expires: 2/9/2007

Principal Investigator(s

Prashant Srivastava
312 Business
Stillwater, OK 74078

Gary Frankwick
312 College of Business
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☑ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

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APPENDIX D

Descriptive Statistics

NPD Project Portfolio Mix and NPD Partnership Mix

NPD PROJECT PORTFOLIO MIX

NPD Project	N	Mean	Standard Deviation	Range
Incremental	172	54.91	27.54	5 to 100
New Market	133	20.64	14.65	1 to 75
New Technology	137	27.28	20.67	2 to 100
Radical	101	23.50	20.90	1 to 100

NPD PARTNERSHIP MIX

NPD Project	N	Mean	Standard Deviation	Range
Incremental	166	25.54	32.64	0 to 100
New Market	127	33.17	37.54	0 to 100
New Technology	131	38.75	38.59	0 to 100
Radical	97	38.08	40.43	0 to 100

VITA

Prashant Srivastava

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE EFFECT OF NEW PRODUCT DEVELOPMENT PROJECT
          PORTFOLIO MIX ON NEW PRODUCT DEVELOPMENT PROGRAM
          PERFORMANCE

Major Field: Business Administration (Marketing)

Biographical:

   Education: Graduated from University of Mumbai, India in June, 1992 with a
      Bachelor of Science degree in Nautical Sciences. Received a Masters of
      Business Administration degree in May, 2000 from Oklahoma State
      University. Completed the requirements for the degree of Doctor of
      Philosophy in Business Administration (Marketing) at Oklahoma State
      University in December, 2006.

   Experience: Served as a deck officer in various capacities in merchant marine
      from August, 1992 to June, 1998. Worked as a marine business
      consultant for Poten & Partners from August, 2000 to December, 2001.
      Employed as a graduate teaching associate in the department of
      marketing, Oklahoma State University, Stillwater, Oklahoma, from
      January, 2002 to July, 2006. Employed as an Assistant Professor in the
      department of marketing at The University of Akron, Akron, Ohio from
      August, 2006 - current.

   Professional Memberships: American Marketing Association, Direct Marketing
      Association, Society for Marketing Advances, Academy of Collegiate
      Marketing Educators.

Name: Prashant Srivastava   Date of Degree: December, 2006

Institution: Oklahoma State University   Location: Stillwater, Oklahoma

Title of Study: THE EFFECT OF NEW PRODUCT DEVELOPMENT PROJECT
                PORTFOLIO MIX ON NEW PRODUCT DEVELOPMENT PROGRAM
                PERFORMANCE

Pages in Study: 114   Candidate for the Degree of Doctor of Philosophy

Major Field: Business Administration

Scope and Method of Study: A review of the previous research on new product
development indicates that for a firm to remain successful over the long-term, it
needs to be ambidextrous. Though the previous research discusses the importance
of ambidexterity, to my knowledge, no research has tried to examine this
phenomenon empirically. This dissertation is a step in that direction. This
research also integrates new product development literature with strategic alliance
literature. This research develops a conceptual framework and empirically tests it
using a sample of U.S. firms. More specifically, the study proposes that the
proportion of radical new product development (NPD) projects in a firm's new
product development project portfolio mix has a positive effect on its NPD
program performance. Also, it is proposed that the level of environment
turbulence as well as the firm's partnership mix effect this relationship. Research
hypotheses are empirically tested by collecting survey data from senior executives
of U.S firms.

Findings and Conclusions: The results of the analyses indicate a significant relationship
between NPD project portfolio mix and NPD program performance. Also,
environmental turbulence has a moderating effect on this relationship. More
specifically, when perceived environmental turbulence is high and firms have a
greater proportion of radical NPD projects in their portfolio, their NPD program
performance is higher compared to when they have smaller proportions of radical
NPD projects in the portfolio. It was also proposed that when firms have higher
proportion of radical projects in their portfolio, they should form alliances to
develop these products to increase their performance. But results of this research
failed to support this argument. At the end, theoretical and managerial
significance, limitations, and future research directions of the study are discussed.

ADVISER'S APPROVAL: Gary L. Frankwick