Heading : An Examination of Organizational Factors Influencing New Product Success in Internal and Alliance-Based Processes

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New products provide increased sales, profits, and competitive strength for most organizations. However, nearly 50% of the new products that are introduced each year fail. Organizations thus find themselves in a double bind. On the one hand they must innovate consistently to remain competitive, but on the other hand innovation is risky and expensive. Many organizations are forming business alliances to quicken the pace of and reduce risks associated with innovation. Yet by some estimates, 70% of these alliances fail. Many of the prescriptions for successful alliance management clash with recommendations for effective innovation management. The authors develop testable hypotheses by integrating the new products and alliance literature. A construct—cooperative competency—derived from related concepts of mutual adjustment, absorptive capacity, and relational capability is posited as the key factor affecting new product development success, regardless of whether it is an intra- or interfirm endeavor. The authors test the model with data from a sample survey in the semiconductor manufacturing context and replicate it in the health care sector. The antecedents of cooperative competency—formalized and clannish administration, mutual dependence, and institutional support—are revealed empirically and substantiated. The authors identify the importance and means of developing interfirm cooperation.

New products provide increased sales, profits, and competitive strength for most organizations. Many successful corporations, such as JVC (which pioneered the VHS format for home videocassette recorders) and Apple Computer, owe their fortunes to new products they developed (Cooper 1993). A study of more than 700 of the *Fortune* 1000 companies indicates that new products would provide approximately one-third of their profits over the next five years (Booz, Allen & Hamilton 1982).

However, nearly 50% of the new products that are introduced in the marketplace each year fail, causing considerable financial loss and embarrassment to their promoters (*BusinessWeek* 1993; Zirger and Maidique 1990). At the extreme, Ford Motor Company lost $250 million with the Edsel in 1958 (approximately $1.4 billion in current prices), and RCA's failed VideoDisc player, launched in 1981, cost it $500 million (approximately $875 million in present prices; Salmans 1984). R.J. Reynolds lost approximately $500 million in 1989 trying to develop a cigarette that would preserve the pleasures of smoking without any of its health hazards (*Across the Board* 1998). Recently, Campbell's Soup scrapped its Intelligent Quisine meal program, launched in 1997, aimed at consumers suffering from various ailments, such as high blood pressure and diabetes (*Food Processing* 1998).

Many organizations are entering business alliances to overcome the inherent risks associated with new product development (NPD) and to manage the innovation process and outcome better. A *business alliance* is an "ongoing, formal, business relationship between two or more independent organizations to achieve common goals" (Sheth and Parvatiyar 1992, p. 72). Organizations enter alliances to quicken the pace of innovation, overcome budgetary constraints, spread out risks, and gain access to resources (e.g., technological, financial) not otherwise available to them (Bleeke and Ernst 1993; Varadarajan and Cunningham 1995). For example, Intel has entered into an alliance with Hewlett-Packard to develop a single computer chip capable of running software in both personal computers (PCs) and large computers (*The Wall Street Journal* 1994). Companies are announcing strategic alliances every day. Recently, SBE Inc., a designer of data communication products for the networking market, announced an alliance with Deterministic Networks to provide integrated hardware and software solutions for networking policy management using a PC card (*PR Newswire* 1998a). Other recent technology alliances in-

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clude the alliance between Zevco and PTC to develop fuel cells. Zevco will provide alkaline fuel cell technology, and PTC will contribute its manufacturing, system, and fuel processing technology (*PR Newswire* 1998c). Mayo Clinic and Millennium Predictive Medicine (MPM) have announced a five-year alliance to identify and characterize novel gene targets and markers important for diagnosis and treatment of diseases (*PR Newswire* 1998b). The alliance will capitalize on Mayo Clinic's expertise in clinical research and MPM's expertise in pharmacogenomics.

Nevertheless, many alliances tend to be unstable, and a large number of them fail (Gates 1993). Some estimates put the failure rate of alliances as high as 70% (*BusinessWeek* 1986; Parkhe 1993). The potential for conflict and a clash of interest between alliance partners is inherent. Either party can opportunistically use the alliance to learn the other's business or technological secrets (Bucklin and Sengupta 1993). Furthermore, because alliances are largely self-governing, there are no practical higher authorities that can ensure that errant partners will be brought into line (Parkhe 1993).

There is some speculation that administrative mechanisms that manage these uncertainties in alliances impair the NPD objectives. Bidault and Cummings (1994) suggest that there is a fundamental clash between the "logic of innovation" and the "logic of alliances." Alliances succeed when the goals and responsibilities of partners are detailed clearly (Hausler, Hohn, and Lutz 1994; Lorange and Roos 1992). Innovation, however, requires that a measure of flexibility be granted to those directly involved with the project. Alliance partners seek joint control of a project, and departures from prior agreements may involve renegotiation, which thus may impede the flexibility required for effective innovation. Organizations enter into alliances to take advantage of partners' knowledge and strength, but most alliances are characterized by lack of trust (Lorange and Roos 1992). This restricts the free flow of information critical for new product success (e.g., Barclay 1992a, b). These and other requirements regarded as essential to NPD success are difficult to accomplish within the context of alliances (Bidault and Cummings 1994).

Contribution

The literature in both the alliance and NPD fields tends to rely on a bevy of theoretical perspectives and results in models that resemble checklists. Drawing on both organizational theory and strategic management literature and the related concepts of reciprocal interdependence, mutual adjustment, and absorptive capacity, we develop and test a new construct we call "cooperative competency." The result is a parsimonious framework for NPD success that connects the research on alliances. In this article, we provide two empirical tests of the model and show that cooperative competency has a profound association with NPD success, regardless of whether the NPD effort is an intra- or interfirm endeavor, along with the fit of the project to the core competencies of the players. We reveal the antecedents of cooperative competency empirically and largely substantiate them in a second research context. In doing so, we identify and examine factors that enhance NPD in alliances, show the importance and means of developing interfirm cooperation, and discuss the implications for managing NPD and alliances in general.

Conceptual Model and Hypotheses

The study of alliances is relatively recent, yet a body of empirical understanding has begun to accumulate. Although alliances have been formed for distribution, product bundling, technology sharing, and assorted other purposes, we presume for the time being that the factors of alliance success generalize to NPD goals. Thus, we try to link the checklist of factors for alliance success to the model of new product success. Success factors fall into seven categories of variables: (1) trust, communication, and coordination; (2) governance and administrative mechanisms; (3) partner type; (4) dependence; (5) type of innovation; (6) institutional support; and (7) complementarity of partner competencies. Because the literature in both the alliance and NPD fields underscores the importance of trust, communication, and coordination, we begin there.

Trust, Communication, and Coordination (Cooperative Competency)

Alliances. Organizations in alliances become vulnerable to the actions of partners whose behavior is not under their control (Parkhe 1993). Participants in an alliance might not share one paramount goal. Because partners enter into an alliance to maximize their own gains, it may be advantageous for them to seek gains at the expense of the other partner (Parkhe 1993; Williamson 1985). Lack of trust is inherent and the primary concern in alliances (Wolff 1994).

Trust exists when "one party has confidence in an exchange partner's reliability and integrity" (Morgan and Hunt 1994, p. 23). Predictability, dependability, and faith are three key components of trust (Andaleeb 1992). In a study of vertical partnerships between manufacturers and dealers, Mohr and Spekman (1994) find that successful partnerships were characterized by greater levels of trust. Kanter (1994) studies 37 companies from 11 countries and likewise finds trust to be a key element in alliance success. Similarly, Sherman (1992) finds lack of trust to be a major cause of alliance failure.

Effective communication between partners is essential for alliance success. Communication refers to "the formal as well as informal sharing of meaningful and timely information between firms" (Anderson and Narus 1990, p. 44). It enables goal adjustment, task coordination, and interfirm learning. Mohr and Spekman (1994) find that successful partnerships exhibited better communication quality and information sharing.

No alliance can succeed unless the partners can coordinate their activities competently. Coordination is the specification and execution of roles with minimal redundancy and verification and refers to the extent to which different "units" function according to the requirements of other units and the overall system (see Georgopoulos and Mann 1962; Mohr and Spekman 1994). It requires the parties to be focused on the mission, competent, and reliable. It also de-

mands a good measure of empathy because a great deal of coordination is tacit (Schelling 1957).

New product development. The NPD literature points to the significance of these variables as well. For example, Souder (1981) contends that a spirit of candor, teamwork, and reliance among members of different units is vital to the NPD process. Song, Montoya-Weiss, and Schmidt (1997) contend that, to enable successful NPD, companies must break down the walls between the various departments. They point out that cross-functional cooperation is perceived as critical to NPD success by various departments, including research and development (R&D), marketing, and manufacturing. Conflicts can arise from differences in departmental cultures, differing responsibilities, and reward structures. Vested interests can prevent effective progress on a good project (Urban and Hauser 1980). Therefore, trust is a critical ingredient for interfunctional cooperation, which is critical for NPD success.

Cooper (1993) has noted that, as companies strive to bridge the barriers between functional areas, information critical to the product's formation and function can get withheld, misunderstood, or lost. Sometimes participants may even withhold information because of a lack of trust. These communication difficulties must be resolved for successful NPD. Good communication has long been viewed as a critical element in NPD success (Barclay 1992a; Cooper 1993; Rothwell 1992).

The criticality of cross-functional coordination in NPD comes through clearly in Zirger and Maidique's (1990) research. They rely on strategic management theory in their propositions that strong R&D and marketing–manufacturing prowess and coordination are essential for NPD success. Lack of familiarity with another unit's procedures and personnel can result in the neglect of some tasks and the repetition of others. No one department alone possesses the expertise to develop a product that will meet the requirements of the organization. Innovators need some mechanism to connect departmental "thought worlds" so that insights possessed by individual departments can be combined to develop new products that harness the collective wisdom of all involved. In the absence of proper coordination, efficiency suffers and goal attainment is delayed or thwarted.

Cooperative competency. We use the term *cooperative competency* to refer to the midrange variable composed of three interrelated facets: trust, communication, and coordination. Cooperative competency is a property of the relationship among the organizational entities participating in NPD. We do not claim that these three variables exhaust the domain of this cooperative competency but regard them as three compelling facets of this relationship attribute. Regardless of whether the NPD effort is an intra- or interorganizational enterprise, its success hinges on the cooperative competency of the units involved.

The conceptual foundations for cooperative competency are well established in organization theory. Thompson (1967) points out that effective exchange agreements, such as those among departmental units for internal NPD or between firms in alliances, rely on prior consensus regarding the responsibilities of the parties involved and a clear understanding of what each partner will do. The situation involves "reciprocal interdependence," in which each unit involved depends on the other. In situations of such interdependence, a shared commitment is necessary to achieve goals, and "concerted actions come about through coordination" (Thompson 1967, p. 55), particularly "coordination by mutual adjustment" (Thompson 1967, p. 56). Naturally, the negotiation and ordering of behaviors involves communication and feedback. Furthermore, Thompson argues, mutuality of commitment in situations of reciprocal interdependence reduces uncertainty for the parties. It provides a basis for joint decision making and bridles opportunistic tendencies. Thus, there is the basis for trust. It is difficult to imagine meaningful communication and bona fide adjustment in the absence of trust.

The need for cooperative competency in a relationship arises from reciprocal dependence in NPD and the constraints imposed by the need for mutual adjustment. The constraints impel information sharing and feedback, as well as trustworthy and trusting behaviors by the participants. The concept of cooperative competency relates to Cohen and Levinthal's (1990) concept of absorptive capacity (the ability of firms to assimilate and make use of new information or technologies), as well as Dyer and Singh's (1998) notion of relational capability (the competitive advantage from the ability to forge, develop, and govern partnerships). We suspect that the make-up and skill sets of the units in NPD can affect the cooperative competency of the relationship, but our focus here centers on relationship antecedents. It follows, however, that if we have specified the pivotal role of cooperative competency in NPD success correctly, the organizational capability to relate must rest on the organization's understanding of the relationship characteristics that affect cooperative competency.

To summarize, the literature clearly shows that successful alliances hinge on the ability of the partners to trust, communicate, and coordinate. As Brouthers, Brouthers, and Wilkinson (1995) point out, alliances without cooperative cultures tend to fail. We should not be surprised to find that the same factors are identified as requisites to NPD success because, whether or not NPD is undertaken jointly with another organization, it is a cooperative enterprise with other functional units—R&D, marketing, and manufacturing (see Song, Montoya-Weiss, and Schmidt 1997). Moreover, as Dyer and Singh (1998) point out, alliance partners must generate and enhance their knowledge-absorbing capacities and generate routines that facilitate sharing of information. Thus, the parties involved in an NPD project, be it conducted internally or externally, must share, digest, and act on information. It is this transfer and recombination of information that allows for the creation of new knowledge.

Cooperative competency manifests itself through the effective exchange of information (communication) and the negotiation and design of activities and roles (coordination). Without trust, there can be little sharing of information, only minimal regard for system requirements, weak follow-through, and low goal attainment. Cooperative competency is the ability of interacting units (within or across firms) to adjust mutually. It is manifested in trust, communication, and coordination and is greater than any of

these three constructs considered independently. Cooperative competency is a relationship property, very much in accord with Thompson's (1967) theoretical development of mutual interdependence.

By regarding trust, communication, and cooperation as facets of the second-order variable cooperative competency and NPD success as the objective of interfunctional and interfirm cooperation, we can hypothesize the following:

H_{1a}: Cooperative competency among the departmental units involved is related positively to internal NPD success.

H_{1b}: Cooperative competency among the partners is related positively to alliance NPD success.

Governance and Administrative Mechanisms

A strategic alliance is fundamentally an interorganizational system applied to the process of NPD. Thus, we should observe the effects of alliances, as a governance mode, on NPD success primarily through cooperative competency. Following institutional economics (see Williamson 1985), the internalization of complex tasks involving performance ambiguity and hazards of opportunism generally is favored over interfirm exchanges because it provides for common goals, auditability, more frequent and richer communications, and attitudinal solidarity. Generalizing from limited empirical work (see Boyle et al. 1992) that shows higher communication frequency and stronger relational norms in corporate channel systems than in other interfirm arrangements, internal NPD should outperform alliances on trust, communication, and coordination, the facets of cooperative competency.

New knowledge in firms is created through a combination of individuals' tacit and objective knowledge (Tucker, Meyer, and Westerman 1996). Although objective knowledge is observable and explicit, tacit knowledge, "the unexpected knowing that precedes and underpins" (Spender 1993, p. 7) any communication, is based on the shared set of experiences of the individuals. Tacit knowledge is communicated through a set of roles and interaction patterns specific to an organization. Thus, effective and efficient tacit knowledge integration results from a communication system that facilitates shared experience among individuals. The kind of knowledge that alliance partners seek to exchange is of a tacit nature and is rather difficult to codify (Dyer and Singh 1998; Kogut and Zander 1992). People who work together accumulate a shared set of information and know-how, and this proximity enables them to understand who possesses what type of expertise (Asanuma 1989; Dyer and Singh 1998). Consequently, this enhances the quality of communication and cooperation and enables superior performance on innovation projects (von Hippel 1988). Participants in alliance innovation belonging to different organizations might not share the same organizational culture and therefore lack the same extent of history and proximity of working together and the tacit knowledge that personnel who work together on internally conducted projects have. In terms of our model, we have the following:

H_2: Cooperative competency is affected by governance structures, in that internally conducted innovation processes provide higher levels of cooperative competency than those in the NPD efforts of alliances.

Multifunction teams and alliances need administrative mechanisms that provide the parties with a measure of certainty regarding roles and procedures for making decisions and determining the scope of participants who provide input. Three commonly used administrative mechanisms are formalization, centralization, or clannish mechanisms.

Formalization, the use of explicit rules in the relationship, has been identified as an impediment to the spontaneity and flexibility needed for internal innovation (Bidault and Cummings 1994). However, between firms, formalization tends to enhance effectiveness and cooperation (see Dahlstrom, Dwyer, and Chandrashekaran 1995).

Centralization, the concentration of decision-making authority, typically impairs effectiveness, because it increases perceptions of bureaucratic structuring, which decreases the favorability of participants' attitudes toward the project and results in increased opportunism (see John 1984). Centralization creates a nonparticipatory environment that reduces communication among participants, commitment, and involvement with projects and is associated negatively with innovation success (Damanpour 1991; Moenaert et al. 1994).

A *clan system* is governed by shared values and norms. This common ground limits the needs for monitoring and other bureaucratic devices and should enhance the abilities of the parties to work cooperatively, because it is a set of common values that governs their behavior (Ouchi 1980).

Thus, we hypothesize the following:

H_{3a}: Cooperative competency is affected positively by administrative mechanisms that are formalized.

H_{3b}: Cooperative competency is affected positively by administrative mechanisms that are decentralized.

H_{3c}: Cooperative competency is affected positively by administrative mechanisms that are clannish.

Partner Type

The success of strategic alliances depends on the strategic fit among the partners' products, markets, and objectives (see Gates 1993; Harrigan 1988). When organizations enter into an alliance with similar but not complementary motives, conflict is likely to arise because of the clash of interests and consequent opportunism and lack of trust.

In the alliance literature, one aspect of fit refers to the relationship the partners have outside the alliance. One concrete question looms large: Are the partners competitors? Competitors are apt to hold many common understandings of the market, product development, and production. This shared understanding of markets and technology makes for a good fit, but partners might be suspicious of each other. Concerns about zero-sum opportunities, long-term partner motives, and the vulnerability of proprietary know-how may not make for a good match and thus seriously impair fit (see Sheth and Parvatiyar 1992). Companies should not enter into alliances with others that have competing goals, and alliances are likely to fail if they do not advance both companies' strategic goals (Brouthers, Brouthers, and Wilkinson 1995). On balance, it would seem difficult for competitors to cooperate.

H_4: Noncompetitor alliances foster higher cooperative competency than competitor alliances.

Mutual Dependence

Alliances that are dominated by a single partner typically have a high rate of failure (Gates 1993). The dominated partner typically stands to lose from such arrangements and hence the high failure rate. Partners should safeguard their core competencies (Lorange and Roos 1992) to discourage partners from breaking the rules governing the alliance. But as McAlister, Bazerman, and Fader (1986) explain, asymmetrical dependence interferes with joint problem solving because the weaker party guards against exploitation while the stronger tends to probe the boundaries of exploitation or guard against the appearance of intentions to exploit. This combination of pressures on the relationship severely taxes the ability of the parties to cooperate in unbalanced power contexts. Parties that do not depend on each other have little motivation to cooperate (Harrigan 1988). Both Harrigan (1988) and Brouthers, Brouthers, and Wilkinson (1995) point out that alliances last longer between partners of similar size. Brouthers, Brouthers, and Wilkinson (1995) suggest that symmetrical partnerships tend to foster a cooperative culture and that alliances without cooperative cultures tend to fail. We therefore have the following:

H_5: Highly mutually dependent alliances foster higher cooperative competency than otherwise, namely, when dependence is skewed or minimal.

Innovation Type

A central issue is the nature of the innovation sought in the alliance. Radical innovations may tax existing systems of communication and patterns of collaboration more than incremental innovation. Radical innovations require a greater outlay of resources and are riskier than incremental advances (Kotler 1997). Radical innovations are inherently more unpredictable and uncertain (Rice et al. 1998). The stage-gate approach, in which product development occurs in clearly defined and formally approved stages, is difficult to accomplish in radical innovation projects (Song and Xie 1995). Radical innovations require participants to engage in more learning and unlearning and to develop new capabilities. Consequently, there is greater need for reorientation of existing structures and processes (Nord and Tucker 1987). Long-standing patterns of informal communication might be absent in radical innovation projects. In contrast, incremental innovations benefit greatly from existing competencies, and organizational relationships and demands placed on participants are comparatively lower (Nord and Tucker 1987).

The higher stakes, demands, unfamiliarity, and unpredictability of radical innovation make these projects more prone to communication breakdowns and make the task of coordinating the projects more difficult. However, radical innovation projects tend to be "star projects," and consequently participants tend to be more committed to them (Schmidt and Calantone 1998). Radical innovations may benefit from a Hawthorne effect, because participants give extra effort to a project in the limelight.

Thus, we hypothesize the following:

H_6: Incremental innovation projects foster higher cooperative competency than radical innovation projects do.

Institutional Support

Many alliance researchers have suggested that "effective institutional rules or social controls for facilitating agreements" would improve alliance success (Dyer and Singh 1998, p. 673; North 1990). As Zirger and Maidique (1990), relying on rudimentary leadership theory, point out, favorable top management support can be the impetus for overcoming implicit barriers between functions, providing the requisite organizational resources, and sparking a spirit of commitment to NPD. Cooper and Kleinschmidt (1995) also identify both top management support and good teamwork as critical to new product success. Kuczmarski (1988) argues that top management support can create a positive environment that facilitates the overcoming of barriers to new product success. This positive climate fosters greater dedication for the project.

Dyer and Singh (1998) note that institutionally embedded arrangements control opportunistic behavior. Top management support is reflected, for example, in the creation of a position called Director of Strategic Alliances at several *Fortune* 100 companies, whose job it is to identify and evaluate alliance potentialities and possibilities (Dyer and Singh 1998). We examine the effectiveness of top management in creating a climate for the success of the alliance. Top management can create such a climate by clarifying the responsibilities and contribution of the parties involved in the alliance, because this is at the heart of the exchange process (see Thompson 1967). Dyer and Singh (1998) classify such arrangements as third-party arrangements that minimize transaction costs and increase alliance effectiveness. Dyer and Singh note the importance of arrangements that promote or at least do not hinder "goodwill." We suggest that goodwill will be hindered when key players try to resist or sabotage the alliance.

Therefore, we hypothesize the following:

H_7: Cooperative competency among the alliance partners involved derives from favorable institutional support (clarity of agreement and lack of resistance) for the alliance NPD effort.

Complementarity of Partner Competencies and NPD Success

In the innovation literature, Cooper (1979), Tushman and Romanelli (1985), and others have argued that products are more likely to be successful if they build on a firm's existing technologies and market strengths. The logic of this factor of NPD pivots on the intersection of population ecology and learning theory: Firms enhance their survivability by doing what they do best in the ecosystem that favors them. At the same time, new systems, technologies, personnel, and customers can disrupt patterns of work and impair the speed of the project. Maidique and Zirger (1984, 1985; Zirger and Maidique 1990) have shown empirically the relationship between NPD success and connection to the firm's competen-

cies (see Barclay 1992a; Calantone, di Benedetto, and Divine 1992). Dyer and Singh (1998) and Harrigan (1985) point out that firms that combine resources can gain a competitive advantage over firms that are unable to do so, and this is viewed as one of the key benefits of strategic alliances. As Harrigan (1985; Harrigan and Newman 1990) suggests, the primary impetus for firms to cooperate emerges because partners can add resources that a firm does not have access to internally and may find difficult or too expensive to acquire on its own. Harrigan further suggests that partners will be inclined to cooperate when their resources and objectives complement each other, because this will permit the creation of new products that each party may find difficult or time-consuming to create individually.

H_8: NPD success is related positively to activities that complement and build on partners' core competencies.

In Figure 1, we summarize this discussion and provide a reference point for the eight formal hypotheses. New product development success is our ultimate criterion variable in the model, and its direct antecedents include the new midrange variable we call cooperative competency. As a second-order variable reflected by interunit trust, communication, and coordination, cooperative competency has essential elements identified in both the alliance and NPD literature. The effect of alliances on the NPD effort is hypothesized to work through NPD's tendency to impair cooperative competency. Similarly, five other variables regarded as factors of alliance success are logically modeled as antecedents of cooperative competency. We also examine the moderating role of governance structures on cooperative competency and NPD success.

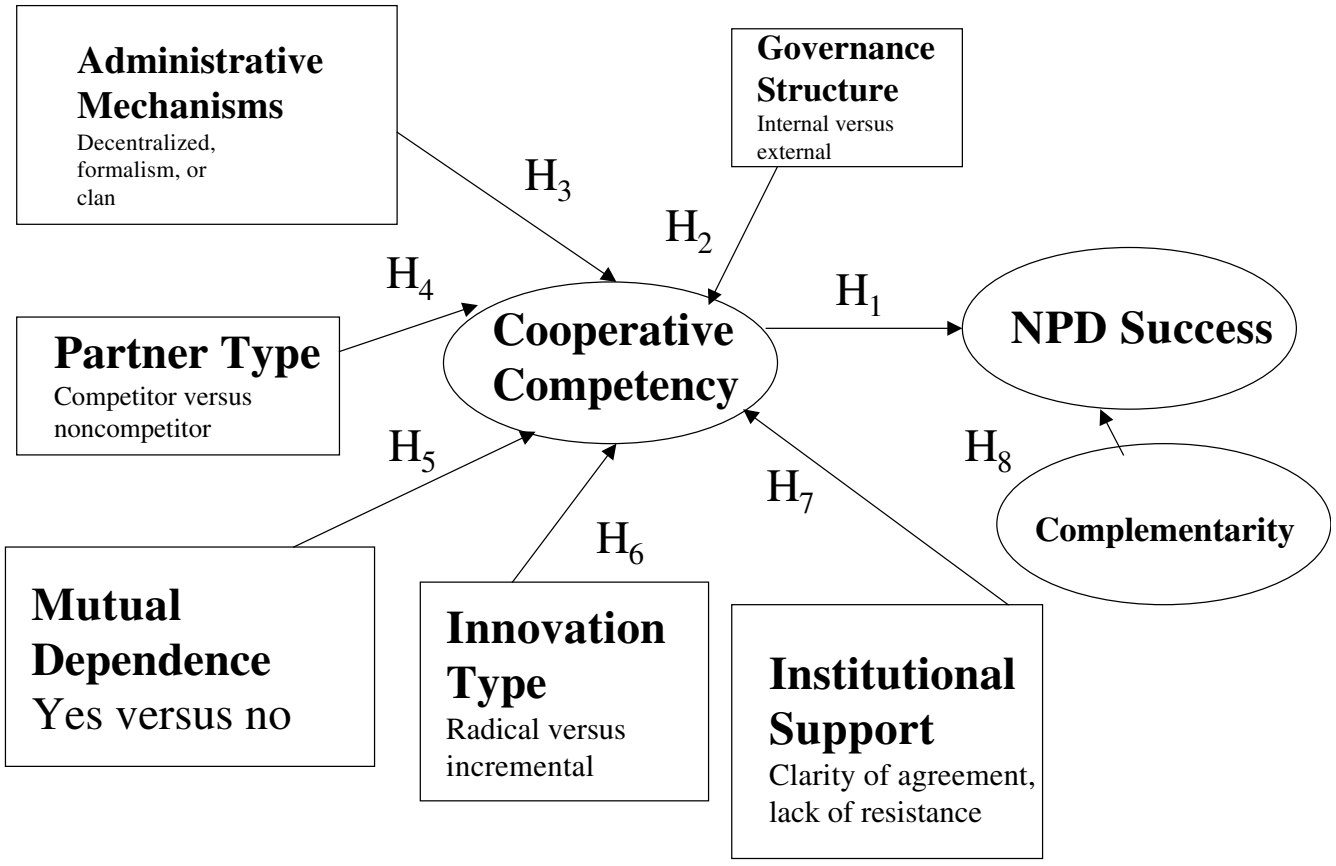
Method

The Contexts for Theory Testing

Semiconductor industry. We chose the semiconductor industry as the primary context for our research. The semiconductor industry (standard industrial classification [SIC] code 3674) includes approximately 400 firms, including Digital Equipment Corporation, Intel, Motorola, and Texas Instruments. This industry tends to be innovative and enters into a variety of partnership agreements (Dutta and Weiss 1994). Technological innovation was identified as a top concern for the 1990s by chief executive officers (CEOs) of the U.S. electronics industry, and 50% of those surveyed indicated that they were looking for research partnerships (Rayner 1991).

In one year alone, 130 alliance partnerships were reported in the semiconductor industry (*U.S. Industrial Outlook* 1993). For example, Advanced Micro Devices and Fu-

FIGURE 1
Factors Affecting Cooperative Competency and New Product Success



jitsu entered into an alliance to develop a chip that can replace the hard disk drive in computers (*New York Times* 1992).

Demands from telecommunications, computer networking, automobile electronics, high-definition television, smart credit cards, and the PC industry make the semiconductor industry competitive, innovative, and high growth. The Semiconductor Chip Protection Act of 1984 protects a semiconductor's design for up to ten years, which thus provides an added incentive for innovation (*Standard and Poor's Industry Surveys* 1994).

The health care sector. The health care sector, or more specifically, "General Medical and Surgical Hospitals" (SIC code 8062), was used as a second context to replicate the hypotheses relating specifically to the introduction of new services by alliances. Approximately 30% of U.S. hospitals are members of alliances (Zuckerman and D'Aunno 1990). Resource crunch, need for cost containment, need to be innovative, increased interdependency between research and clinical service, and changing disease patterns are prompting hospitals to engage in alliances (Kaluzny and Sheps 1992). Their NPD efforts are exemplified by innovations in ambulatory care and home health care and acquisition of new medical technology (Halverson, Kaluzny, and Young 1997).

Wrenn, Latour, and Calder (1994, p. 353) point out that "the belief that hospitals are fundamentally different in function and structure from for-profit, product producing companies has existed for some time." Mintzberg (1979) refers to hospitals as professional bureaucracies in which professionals enjoy a great degree of autonomy and power. Control in such organizations is based on bureaucracy and a system of shared values. Thus, a replication in the hospital sector is a reasonable test of the generality of the theory.

Measures

Measures were developed and refined on the basis of the guidelines provided by Churchill (1979) and Gerbing and Anderson (1988). The relationship between alliance partners (for external NPD) and departments (for internal NPD) are the units of analysis for the study. Our 12-page questionnaire consisted of two sections, the first focused on an internally conducted NPD project. The latter part of the questionnaire focused on experiences with NPD projects conducted through alliances. Respondents (heads of R&D at semiconductor firms and chief operating officers at hospitals) were asked to select projects that came to their attention most recently (not a successful, failed, or typical project but one that they worked on most recently; for example, they might have attended a meeting to review the project). The Appendix presents the measures used in the study.

Product success refers to a product's successful development. Product success was measured using a five-item scale that evaluates the new product on quality, time taken, market share, speed to market, and meeting of target costs. Three additional items were used to measure the financial success and market share for this product. Although marketplace success was correlated highly with development success in both the semiconductor and health care sectors, because of the focus of our research, we analyze only development success. We used Cooper's (1993) work as a guide to help specify the domain of this construct.

We combined three related variables—trust, communication, and coordination—to develop the higher-order construct we call cooperative competency. Our measure of cooperative competency is a summated measure of trust, communication, and coordination. *Trust* is defined as the confidence an organization (or department) has in the ability and motivation of the alliance partner (or other departments) to produce positive outcomes for the organization. Our six-item measure of trust builds on Mohr and Spekman's (1994) and Morgan and Hunt's (1994) work but includes an ability item and a reliability item.

Communication is conceptualized to include the formal and informal sharing of timely, adequate, critical, and proprietary information among alliance partners. We use a set of items modified from Mohr and Spekman's (1994) instrument. The communication measure is a five-item, five-point Likert-type scale that reflects communication quality (timeliness and adequacy of information) and information sharing (willingness to exchange critical proprietary information).

"Coordination is often discussed but seldom measured" (Price and Mueller 1986, p. 108); we define c*oordination* as the extent to which activities, people, routines, and assignments work together to accomplish overall objectives. This is consistent with Georgopoulos and Mann's (1962) notion of intraorganizational coordination as the extent to which the alliance members (or departments) function according to the needs and requirements of the other parts and the total system. Similarly, Mohr and Spekman (1994, p. 138) view coordination as "the set of tasks each party expects the other to perform." A five-item measure borrowed from Georgopoulos and Mann's measure was modified to make it suitable for assessing coordination in both interorganizational and interdepartmental settings.

Three types of alliance control mechanisms are examined in a six-item battery: centralization, the extent of concentration of decision making; formalization, the extent to which explicit rules and procedures govern decision making; and clan control, the degree to which governance is conducted by shared values (Ouchi 1980). These were measured using five-point Likert-type scales (see Dwyer and Welsh 1985).

A competitor alliance is one in which parties to the alliance are in either direct (e.g., an alliance between two automakers) or indirect (e.g., an alliance between a steel and a plastic manufacturer) competition outside the relationship. A noncompetitor alliance is one in which parties to the alliance do not vie for the same customers outside the relationship. A four-item scale was used to classify the alliances on these dimensions. Informants were asked to indicate whether their partner was a competitor in the same or a different industry, a supplier, or a customer.

Mutual dependence among the alliance partners is conceptualized from the Emersonian (1962) perspective; namely, the power of A over B derives from B's dependence on A. Our focus is on an alliance partner's relative dependence, the difference between the dependence of the focal firm and its partner on the alliance. To make it suitable for assessing dependence in alliances, a modified version of the

instruments used by Anderson and Narus (1990) and Boyle and Dwyer (1995) was employed. Two sets of four-item, five-point Likert-type scales (both completed by the same informant) were used to measure the perceived relative dependence of the alliance partners. From these data, we made a dichotomous indicator variable. Partnerships in which both parties depended on the other and exhibited marginal or no asymmetry in dependence (no difference in the dependence of focal firm and its partner in the alliance) were categorized as high mutually dependent relationships. Alliances exhibiting asymmetry in dependence or balanced at an insignificant level (both partners had low levels of power dependence) were classified otherwise.

All innovations lie on a continuum of newness. We adopt the dichotomous classification of innovations presented in the literature and classify all new products as incremental or radical. Radical innovations are new-to-the-world, pioneering products that represent technological breakthroughs. Incremental innovations refer to improvements and revisions to existing products and additions that supplement a company's existing product lines (see Booz, Allen & Hamilton 1982). A four-item measure building on Cooper's (1993) work is employed to classify innovations into one of these categories. An innovation was classified as radical if respondents indicated that the innovation was pioneering and did not build directly on existing technology.

Institutional support for the alliance was measured on a four-item, five-point scale, with two items each for clarity of agreement (extent of clear-cut understanding about financial resources and manpower each side was expected to contribute) and lack of resistance (extent to which there was no resistance from key players in both organizations).

The primary rationale for entering into alliances is that a partner brings resources that are not accessible to a firm internally. Complementarity of partner competencies was measured using a two-item, five-point scale. The items measured the extent of synergy in the objectives and capabilities of the partners.

Measure Purification

The measures were reviewed by two panels. The academic panel consisted of five advanced doctoral students who performed a card-sorting exercise to match items to construct definitions. The professional panel consisted of senior executives in four organizations (two in semiconductor companies and two in the hospital sector). They evaluated the battery for clarity and relevance. Overall, they indicated that the questions were clear and relevant, except for one original trust item, which was dropped. Overall, the favorable comments of the panel and key informants, combined with the prior use of many measures, gave us confidence for the pilot test.

The Sampling Frame: The Semiconductor Context

A list of semiconductor firms with more than 20 employees was purchased on disk from a leading independent list compiler. The list contained names of 718 semiconductor firms, similar to the numbers reported by many other list compilers but far greater than those reported by Darnay (1993) (457 semiconductor companies) and Gale Research's (1994) *Ward's Business Directory* (346 semiconductor companies). After eliminating what appeared to be multiple sites of the same company, sales offices, and small subcontractors, there were 600 companies on the list. These 600 companies (the universe of semiconductor firms) constituted the sampling frame.

The Pilot Test

We selected 150 companies from the sampling frame on a fourth-name basis for the pretest. These companies were contacted by telephone to (1) obtain the name of the key informant (i.e., head of the R&D department) so that the survey could be addressed to that individual, (2) prenotify this key informant about the survey and solicit participation, and (3) verify the mailing address of the firm. Many of the smaller companies did not have a formal R&D department, and that function was assumed by the engineering department. In these cases, the contact person was the president, CEO, or head of the engineering department. The person in the company in charge of the R&D function was the one who completed the survey.

The questionnaires were mailed with a cover letter, a $2 bill as incentive, and a first-class, postage-paid return envelope. The cover letter explained the purpose of the survey and contained a nondisclosure agreement indicating that the responses would be treated confidentially. Following Yu and Cooper (1983), we used appeals that highlighted the importance of each response and the research. We also offered to share the results in summary form if the informants so desired. A reminder/thank you card was mailed ten days after the questionnaire was mailed. After four weeks, 40 completed surveys were received. This 28% response rate is comparable to that reported in other studies on strategic alliances (e.g., Mohr and Spekman 1994; Parkhe 1993).

All measures had very high reliabilities with coefficient alphas greater than .80 in all cases. Using Gerbing and Anderson's (1988) paradigm, all measures survived an exploratory factor analysis. In the confirmatory factor analysis (CFA), the chi-squares were significant, but based on the maximum likelihood factor loadings, goodness-of-fit indexes, root mean squared residuals, and normalized residuals, we appear to have unidimensional, internally consistent, and reliable measures.

Overall, our measures performed well, and we made only minor modifications to some of the measures for the main study. To make the 12-page instrument less burdensome, we trimmed one item from each scale (for trust and communication) with coefficient alphas greater than .90 (DeVellis 1991). We substantially revised the measure for radical versus incremental innovation to enhance its content validity. (The measures retained for the main study are reported in the Appendix.)

The Main Study

After using 150 of the 600 semiconductor firms for the pilot study, we drew 350 for the main study. We used nth-name sampling to draw a representative sample. For the pilot test every fourth company on the list was drawn, whereas for the main study we omitted 100 of the 450 companies remaining on the list. We also wanted to ensure that all major semi-

conductor firms were part of our sample. We ensured this by including all publicly traded semiconductor firms (Compustat PC+, a Standard and Poor database that lists all publicly traded firms, was cross-referenced to identify publicly traded semiconductor firms), then filling in the rest on an nth-name basis, leaving every third of the remaining names out. The protocol for the main study was similar to that of the pilot study, beginning with telephone name verification and prenotification of the surveys.

The prenotification phase eliminated 68 firms for one of the following reasons: (1) the firm was not a semiconductor manufacturer, (2) the telephone number was disconnected, (3) the company was no longer in business, (4) the company was a sales or purchasing outfit only, (5) the R&D facilities were located in a foreign country, or (6) the company had a strict no-survey policy.

We sent 282 questionnaires with a new cover letter that encouraged firms that had not entered into alliances also to respond to the survey. Approximately four weeks after the initial mailing, nonrespondents were mailed a second copy of the questionnaire, thanked if they already had completed the survey, and urged to do so if they had not.

Of the 282 questionnaires mailed, 26 were returned because (1) the key informant declined to participate in the survey, (2) the company was not in the semiconductor business, or (3) the company was in the semiconductor business but did not manufacture semiconductors. In the end, 95 completed responses were received. Our 37% response rate compares favorably with those reported in other studies (e.g., Parkhe 1993). Following the procedure recommended by Armstrong and Overton (1977), we compared early respondents with late respondents to examine nonresponse bias. The tests did not indicate any bias due to nonresponse.

Confirmatory factor analyses. The CFAs provided similar fit values to those reported in the pilot data. Because the measures performed similarly in the pilot and final studies, we pooled the data for hypotheses testing. Initially, separate single-factor models were evaluated for each of the constructs' measures. It was not possible to run CFA on all measures in the study simultaneously because of sample size constraints; the ratio of sample size to the number of free parameters did not approach the minimum 5:1 requirements (see Bagozzi and Baumgartner 1994). Next, we ran two three-factor models for cooperative competency (trust, communication, and coordination) and administrative mechanisms (formalization, centralization, and clan).

We ran a series of second-order factor analyses in both the health care and semiconductor sectors to examine our midrange variable of cooperative competency. We examined convergent validity by examining if each indicator's estimated coefficient was significant (greater than twice its standard error). All the factor loadings were significant, indicating convergent validity (cf. Gerbing and Anderson 1988). The normalized residuals were all less than |2.0|. Next, we examined discriminant validity between cooperative competency and new product success using two methods. First, as recommended by Gerbing and Anderson (1988), we find that the factor correlations were less than 1.0, which indicates discriminant validity. Second, using the criterion set forth by Dillon and Goldstein (1984), we examined whether the average variance extracted for the measures was greater than .50. This test examines whether the variation observed is due to the construct and not to measurement error. The average variance extracted was greater than .50 in all cases and greater than the squared structural link between the constructs, which provides further evidence of discriminant validity. The coefficient alpha reliabilities for the pooled data, along with the CFAs, are reported in Table 1.[1] These results provide evidence of the unidimensionality of the constructs.

[1]The CFA and coefficient alpha were computed only for items retained for the main study; that is, items eliminated after the pilot test were not included in the pooled analysis.

TABLE 1
Confirmatory Factor Analyses Results: Semiconductor Pooled Data

Measure (Object)	Chi-Square	GFI	AGFI	RMSR	Number of Items	Alpha
Trust (internal)	34.38, 9 d.f., $p = .000$	.916	.853	.05	6	.87
Trust (alliance)	35.59, 9 d.f., $p = .000$	.885	.799	.07	6	.85
Communication (internal)	14.22, 5 d.f., $p = .014$	.960	.941	.03	5	.88
Communication (alliance)	27.15, 5 d.f., $p = .000$	.885	.827	.06	5	.85
Coordination (internal)	12.31, 5 d.f., $p = .031$	.967	.950	.02	5	.89
Coordination (alliance)	18.13, 5 d.f., $p = .003$	.924	.886	.05	5	.85
NPD success (internal)	9.67, 5 d.f., $p = .085$	.97	.90	.05	5	.68
NPD success (alliance)	13.78, 5 d.f., $p = .17$	.93	.79	.06	5	.79
Cooperative competency (internal)	5.54, 4 d.f., $p = .24$	.960	.870	.04	16*	.94
Cooperative competency (alliance)	12.65, 4 d.f., $p = .01$	.920	.710	.06	16*	.91
Administrative mechanisms (formal, central, clan)	2.26, 6 d.f., $p = .89$	.99	.96	.04	6	—

Notes: All items for internal and external were parallel phrased. GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, RMSR = root mean squared residual, and d.f. = degrees of freedom.
*Second-order factor analysis.

Sample Frame and Protocol: Health Care Context

As we indicated previously, health care was used as a second context to test the hypotheses to make possible greater generalizability of the theory. Resource constraints enabled us to administer only a truncated version of the semiconductor questionnaire for the health care context. Questions pertained to experiences with alliance innovation only; no questions were asked about internal innovation processes for health care.

Using the same protocol as in the semiconductor industry, 250 questionnaires were mailed to chief operating officers in hospitals. We received 117 responses, of which 52 were from organizations that had partaken in alliances. The measures performed well in the health care context also; all measures showed unidimensionality and reliability (coefficient alpha greater than .70).

Findings

Tables 2, Parts A and B, report correlations among the variables previously presented. On examining the correlation matrices, we find that there is a significant association between cooperative competency and NPD success in both the health care (r = .29, p = .04) and semiconductor (r = .30, p = .004) sectors. As we discussed previously, in the semiconductor sector, we had examined both internal and alliance-based innovation by asking respondents to share their experience with both an internal and an alliance-based project. As is shown in Table 2, Part A, there is a significant association between successful management of internal and alliance-based innovation process (r = .38, p = .000) and between cooperative competencies in internally and externally conducted projects (r = .37, p = .000). Thus, it appears that at some level both cooperative competency and NPD success are firm-specific competencies.

The data were analyzed using a series of ordinary least squares regression analyses. Our model suggests that (1) cooperative competency and complementarity of partner competencies affect NPD success and (2) governance structure, administrative mechanisms, type of partner and innovation, mutual dependence, and institutional support affect cooperative competency. These models are written out as follows:

NPD success = f{cooperative competency, complementarity of partners}.

Cooperative competency = f{formalization, centralization, clan, partner type (competitor or noncompetitor), innovation type (radical or incremental), mutual dependence, institutional support (clarity of agreement and lack of resistance)}.

Relevant to the tests of H_1, NPD success = f(cooperative competency), we find that NPD success is associated positively with cooperative competency in both internally (b = .375, p < .01) and externally (b = .301, p < .01) conducted projects in the semiconductor industry. These results are replicated for the health care sector (b = .293, p < .05). See Table 3.

H_2 examines whether cooperative competency is affected by governance structure (innovation is conducted internally versus externally). We began our analysis with a paired samples t-test, which indicated that a higher level of cooperative competency is observed in internal ($\overline{X}$ = 10.72) as opposed to external ($\overline{X}$ = 10.21) NPD projects (t = 2.54, p = .01). We then used moderator analysis to examine whether governance structure (innovation was internal or external) significantly moderated the impact of cooperative competency on NPD success. Using the procedure recommended by Cohen and Cohen (1975) and Baron and Kenny (1986), we do not find evidence of moderation. (The procedure is to regress both cooperative competency and mode of governance and their interaction on NPD success.) The interaction term (between governance structure and cooperative competency) in the regression model was not significant, thus indicating that, though cooperative competency is significantly higher in internal NPD projects, governance structure (internal or externally conducted innovation) per se does not appear to affect the impact of cooperative competency on NPD success.

The antecedents of cooperative competency were examined in the multiple regression analysis summarized in Table 4. With cooperative competency as the dependent variable, we tested H_3–H_7 by examining the statistical significance of the coefficients in the two models, one for semiconductor and one for health care. Because of sample size constraints and the dichotomous nature of many of the variables examined, it was not possible to test the hypotheses using a full information maximum likelihood model. Nevertheless, because of the high reliabilities of our measures, the inability to partial out measurement error is not a substantial drawback. The use of multiple regression provides a more conservative test of the hypotheses.

As hypothesized in H_3, cooperative competency is associated positively with formalized (b = .252, p < .05) relations. Furthermore, as hypothesized, there appears to be a positive relationship between clan-oriented administrative mechanisms and cooperative competency (b = .236, p < .05). Although there appears to be a negative relationship between centralized mechanisms and cooperative competency (b = –.1146, p = .17), the results are not statistically significant. In the health care sector, cooperative competencies are associated positively with clan-oriented relations (b = .257, p < .05) but not with formalized or decentralized administrative mechanisms. Thus, overall H_3 is partially supported. Although not formally hypothesized, we examined the interaction among these administrative mechanisms. Although such examination brings forth problems of multicollinearity, we find evidence of interaction between formalized and clan-oriented mechanisms in the semiconductor sector. Thus, a combination of value- and rule-based exchanges promotes cooperative competency. In the health care sector, there is no evidence of interactions among these administrative mechanisms.

H_4 was not supported. The type of partner (competitor versus noncompetitor) does not appear to affect cooperative competency. H_4 was not statistically significant in the semiconductor sector (approximately 38% of alliances were competitor and the rest were noncompetitor alliances) and

TABLE 2
Correlation Among Constructs

A: Semiconductor Industry (Pooled Data)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. NPD success (Internal)	1.00	.38*	.38*	.05	.12	.20	.01	.10	.04	.12	.13	.13	–.08
2. NPD success (Alliance)		1.00	.29*	.30*	.35*	.24**	.08	.08	–.12	.25**	–.001	.007	–.26*
3. Cooperative competence (Internal)			1.00	.37*	.22	.15	.01	.20	–.10	.21	.20	.05	–.17
4. Cooperative competence (Alliance)				1.00	.57*	.38*	.40*	.21	–.23	.48*	.35*	.16	.36*
5. Complementarity					1.00	.29**	.57*	–.09	–.16	.34*	.52*	.15	.40*
6. Clarity						1.00	.34*	.19	–.11	.40*	.09	.04	.13
7. Lack of resistance							1.00	–.08	–.36*	.39*	.28**	.04	.49*
8. Formalization								1.00	.31*	.03	.03	.08	–.19
9. Centralization									1.00	–.19	–.20	.09	.04
10. Clan										1.00	.12	–.06	.12
11. Mutual dependence											1.00	.14	.15
12. Radical/incremental												1.00	.32*
13. Competitor/noncompetitor													1.00

*Indicates significance at $p = .01$.
**Indicates significance at $p = .05$.
Notes: Sample sizes range from 118 (for the internal measures) to 62 (for formalization, centralization, and clan).

B: Health Care Industry

	1	2	3	4	5	6	7	8	9	10
1. NPD success	1.00	.30**	.12	.29**	–.19	.005	–.14	.08	.10	.10
2. Cooperative competency		1.00	.47*	.44*	.49*	.09	.12	.23***	.13	–.26***
3. Complementarity			1.00	.23***	.41*	–.03	.15	–.37*	.21	–.26***
4. Clarity				1.00	.29**	.28**	.19	.20	.01	–.10
5. Lack of resistance					1.00	.23	.41*	.05	–.04	–.22
6. Formalization						1.00	.40*	.33*	–.02	.21
7. Centralization							1.00	.007	.22	.03
8. Clan								1.00	–.22	.19
9. Mutual dependence									1.00	–.05
10. Radical/incremental										1.00

*Indicates significance at $p = .01$.
**Indicates significance at $p = .05$.
***Indicates significance at $p = .10$.
Notes: Sample sizes range from 50 to 52.

TABLE 3
New Product Development Success: Cooperative Competency

	b (t) *p*	R^2	F(*p*)
Semiconductor NPD success internal (n = 118)	.375 (4.36) .000	.14	19.03, $p = .000$
Semiconductor NPD success alliance (n = 89)	.301 (2.94) .004	.09	8.65, $p = .004$
Healthcare NPD success alliance (n = 50)	.293 (2.12) .039	.086	4.49, $p = .039$

could not be tested in the health care sector because only two of the alliances were characterized by respondents as competitor alliances. Thus, we cannot conclude that cooperative competency is affected by partner status as a competitor or noncompetitor.

H_5, which examined the impact of mutual dependence on alliances, was supported in both contexts. This hypothesis was supported in both semiconductor (b = .297, $p < .05$) and health care (b = .214, $p = .05$) sectors. Overall there is strong support that mutual dependence influences cooperative competency.

H_6, the type of innovation (radical versus incremental), does not appear to affect cooperative competency directly. H_7, that cooperative competency derives from the institutional support accorded to the project, was partially supported (refer to Table 4). Institutional support is reflected in the quality of resources and personnel allocated and the priority accorded to the project by top management. We studied institutional support by examining clarity of agreement about resources to be provided to the project, as well as the (lack of) resistance of senior management to the project. Clarity of agreement about inputs (b = .272, $p < .05$) significantly enhances cooperative competency in the semiconductor industry as well as in health care (b = .287, $p < .05$). However, lack of resistance from key players did not significantly contribute to cooperative competency in the semiconductor sector. In the health care sector, lack of resistance strongly influences cooperative competency (b = .337, $p < .05$). Overall H_7 is supported in both contexts.

H_8 examined the direct impact of complementarity of partner competencies on NPD success. This hypothesis is supported in the semiconductor sector, but results were not statistically significant in the health care context (see Table 5).

In addition, our model implies that the organizational factors posited to affect cooperative competencies affect NPD success through their impact on cooperative competencies; that is, cooperative competency acts a mediator.

As can be seen in Table 6, in both the health care and semiconductor sectors, only cooperative competency had a significant impact on NPD success. In the semiconductor sector type of innovation and in the health care sector lack of resistance had significant but reverse (to what was posited) impact on NPD success. Thus, most antecedents of cooperative competency do not have a direct impact on NPD success and only affect NPD success through their impact on cooperative competency.

Discussion

Nearly 20,000 alliances were formed by U.S. companies between 1988 and 1992 (Pekar and Allio 1994). Given the growing popularity of alliances and the importance of managing the innovation process, this attempt to integrate two different research streams is timely and significant. The central objective was to identify ways in which alliance NPD could be made more successful.

Recap

We find that, irrespective of whether NPD is conducted internally or externally, cooperative competency is an important construct that contributes to NPD success. As hypothesized in H_1, cooperative competency (a combination of trust, communication, and coordination) contributes significantly to new product success for products developed in two distinct contexts: the semiconductor and health care sectors.

The notion of cooperative competency follows from Thompson's (1967) concept of coordination by mutual adjustment. Because it is similar to Cohen and Levinthal's (1990) concept of absorptive capacity and Dyer and Singh's (1998) notion of relational capability, these two constructs may suggest avenues for more sophisticated conceptual development. For example, absorptive capacity illuminates a dimension of the ability of firms to assimilate and make use of information obtained from partners, whereas Dyer and Singh's notion of relational capability reflects the willingness and ability of partners to engage in partnerships. Although more work should be done to delineate the boundaries of cooperative competency, this construct is rich in meaning and can enhance our understanding of partnership arrangements in a variety of contexts.

Cooperative competency is higher in internal than in external NPD projects. These results are consistent with the tenets of institutional economics, namely, that the internalization of complex and difficult-to-monitor activities offers savings on costs of running the system by e-mail. Firms that use interfirm arrangements for NPD should recognize that the promise of synergy, access to resources, or shared risk rests atop a latticework of abilities to cooperate, a latticework that might not be as sound as that which supports interdepartmental efforts.

We do not find support for the conjecture that the mode of governance (internal versus external) moderates the relationship between cooperative competency and NPD success. Table 2 reveals that in both the semiconductor and health care contexts there is a strong correlation between internal and external cooperative competency. This suggests the possibility that, to some extent at least, some firms are better at fostering cooperative competency than others. This would tend to be corroborated by Dyer and Singh's (1998) admonition to develop partnering capability as a strategic asset likely to yield "relational rents." Further research could examine the role of organizational learning, leadership, and culture in fostering cooperative competency.

TABLE 4
Multiple Regression Model of Hypothesized Predictors of Cooperative Competency in Alliances
Standardized Coefficients (t-value) *p*-value

Criterion Variables	Administrative Mechanisms			Competitor/ Noncompetitor	Mutual Dependence	Radical/ Incremental	Institutional Support		R^2	F (*p*)
	H_{3a} Formalization	H_{3b} Centralization	H_{3c} Clan	H_4	H_5	H_6	H_{7a} Clarity	H_{7b} Lack of Resistance		
Semiconductor (n = 56) cooperative competency	.252 (2.16) *p* = .018	–.116 (–.942) *p* = .175	.236 (1.99) *p* = .026	.037 (.334) *p* = .37	.297 (2.64) *p* = .005	–.047 (–.432) *p* = .66	.272 (2.18) *p* = .017	.014 (.108) *p* = .45	.48	5.34 (.000)
Health care (n = 50) cooperative competency	–.064 (–.461) *p* = .67	–.074 (–.496) *p* = .32	.257 (1.90) *p* = .03	not tested	.214 (1.64) *p* = .05	–.133 (–.989) *p* = .84	.287 (2.04) *p* = .023	.337 (2.23) *p* = .015	.37	3.61 (.004)

Notes: One-tailed *p*-values are reported. Only two of the health care alliances were competitor alliances, and therefore this was not tested. Sample sizes for semiconductor is (n = 56) because administrative mechanisms were measured only in the main study and not in the pilot study. Also, items with missing values were excluded from the analysis. We obtained similar results when we replaced missing values with means.

TABLE 5
New Product Development Success: Complementarity

	b (t) *p*	R^2	F (*p*)
Semiconductor NPD success alliance (n = 66)	.345 (2.94) .005	.12	8.63, $p = .005$
Healthcare NPD success alliance (n = 51)	.116 (.816) .418	.013	.666, $p = .418$

TABLE 6
Multiple Regression of Direct Effect on NPD Success
Standardized Coefficients

Predictor Variables	
Semiconductor (n = 55)	
[$R^2 = .36$, F = 2.84, $p = .001$]	
Cooperative competency	b = .473, $p = .003$
Centralization	b = .119, $p = .80$
Formalization	b = –.027, $p = .58$
Clan	b = –.089, $p = .74$
Competitor/noncompetitor	b = –.043, $p = .64$
Radical/incremental	b = –.262, $p = .98$
Mutual dependence	b = –.065, $p = .69$
Institutional support (lack of resistance)	b = .161, $p = .13$
Institutional support (clarity)	b = .142, $p = .17$
Health care (n = 50)	
[$R^2 = .24$, F = 1.66, $p = .14$]	
Cooperative competency	b = .405, $p = .01$
Centralization	b = –.144, $p = .20$
Formalization	b = –.013, $p = .53$
Clan	b = –.068, $p = .67$
Radical/incremental	b = .088, $p = .28$
Mutual dependence	b = .02, $p = .45$
Institutional support (lack of resistance)	b = –.328, $p = .96$
Institutional support (clarity)	b = .176, $p = .14$

Notes: One-tailed *p*-values are reported.

Our analysis of alliances in both the semiconductor and health care industries indicates that cooperative competency can be enhanced by several means. Through their impact on cooperative competency, control mechanisms of the clan type contribute to new product success for projects conducted within alliances. In the semiconductor sector, furthermore, formalization also contributes to NPD success. Plausibly, centralization impairs cooperative competency, but its impact is too subtle to detect in our design without doubling the sample size. This partial support for H_3 suggests that a shared vision of the goals and objectives of those undertaking the project is important to overall project success. We suggest that the mechanism at work is the type of control mechanism. Clan-type mechanisms best reflect a shared vision and values used to guide behavior. Formalization uses explicit procedures to guide behavior. We suspect that formalization in this context is a result of bilateral agreement rather than an imposition by authority. The nature of mutual interdependencies seems to favor the joint coordination observed here.

We were unable to conclude that cooperative competencies are higher in noncompetitor than in competitor alliances. H_4 was not supported in the semiconductor sector and could not be tested in the health care sector because only two alliances were identified as competitor alliances. Seemingly, advantages from alliances with competitors (common market understanding and shared product know-how) are offset by the impediments to cooperation (conflict of interest and perhaps a history or culture of rivalry). Alternatively, we may have encountered response effects arising from the phenomenon of local rivals that forge an alliance and no longer regard themselves as competitors.

H_5 provides the expectation of positive association between cooperative competency and mutual dependence by relying on an indicator variable formed from two global measures of dependence. The classification variable shows strong association with cooperative competency in both research contexts. We have compelling evidence for positive effects from mutual dependence on cooperative competency and significant nomological support for the construct of cooperative competency. Our notion of mutual dependence is richer than the notion of power from which it is derived. Although dependence of others on a party is the source of that party's power, it is its dependence on others that reins in its ability to use this power. Asymmetrical dependence or situations in which the parties are not dependent on each other are not conducive to a climate of cooperation. In the former case, the weaker might be guarding against exploitation while the stronger tries to mask or exploit the advantage. In the situation of minimal mutual dependence, the commitment the parties have toward the alliance is absent (Harrigan 1988). It is easier for minimally dependent parties to ignore or walk away from challenges than to hash out the means to continue to cooperate.

Regarding H_6, no significant differences are observed in cooperative competencies in radical versus incremental innovations. But this issue also merits further study. It is possible that, though radical innovations may limit cooperative competencies because of the unpredictability and greater risk of such enterprises, certain countervailing forces may operate to neutralize the tendency to limit cooperation. For example, radical innovation projects tend to be star projects and take longer to complete and thus may provide unique mechanisms for building cooperative competencies. Similarly, participants tend to be more committed to radical innovation projects (Schmidt and Calantone 1998).

Institutional support can help foster cooperative competency, and therefore H_7 is supported. In our study, institutional support was operationalized to include clarity of agreement and lack of resistance from key players in both organizations. We find that clarity of agreement fosters cooperative competency in both semiconductor and health care contexts. Lack of resistance appears to play a greater role in the health care sector. This may be attributed to the

nature of innovations and alliances undertaken by hospitals, which typically engage in alliances to offer new, innovative services that they may not have the resources to offer alone. Resistance from key players may be the major impediment in getting such arrangements off the ground. In the semiconductor sector, lack of resistance from key players is not enough to induce participants to cooperate. Plausibly, organizational forms and cultures vary in their propensity to cooperate. This may be a key antecedent to cooperative competency or a conceptual component to be developed in Dyer and Singh's (1998) notion of relational competency.

As hypothesized in H_8, projects that build on and complement partners' core competencies have a better chance of succeeding than those that do not. The logic of this factor stems from population ecology and learning theory: New systems can impair coordination patterns, and firms enhance survivability by doing what they do best.

An issue to examine is what impact the partnering capabilities of the alliance partners has on the cooperative competency exhibited in the alliance. To put it differently, does high partnering capability of the parties ensure a high cooperative competency, or can high partnering capability of partners go hand-in-hand with low levels of cooperative competency? We conjecture that high partnering capability would involve, among other things, knowledge of Figure 1 (selecting the right kind of partner, using appropriate administrative mechanisms, and providing appropriate institutional support), which would foster greater cooperative competency.

But high partnering capability alone will not ensure high levels of cooperative competency and NPD success. It is possible for two units with high partnering capabilities to exhibit low cooperative competency due to the dynamics and characteristics of the interfacing units because the locus of cooperative competency is of the dyad. The alliance will have an organizational culture and characteristics distinct from the organizational culture of the firms that are parties to the alliance. Partnering capability will interact with other variables that might impinge on cooperative competency. These variables might include ability: Does the partner deliver and bring to the table what it promised? External pressures and environmental factors also might affect cooperative competency. We have studied this problem from a static as opposed to dynamic, longitudinal perspective, and this is something worth addressing in additional research.

We might conjecture that partners with low cooperative competency are doomed to fail. In the case in which one partner has high partnering capability and the other has low, the party with high partnering capability might be able to use these skills to salvage the alliance, perhaps schooling its counterpart on communication, forthrightness, and the requisite roles.

Managerial Implications

Innovations conducted internally have higher cooperative competencies and NPD success rates than those conducted by alliances. Thus, though external NPD projects may allow for greater access to resources and spread out risks (by sharing resources), such projects have lower success rates. Alliance NPD projects should focus on ways to improve cooperative competencies in innovation projects and, consequently, to enhance the success of these projects. Clarity of agreement, engaging in mutually dependent partnerships, and fostering clan and formalized relationships are some mechanisms that organizations must pursue to maximize the chances of successful NPD in alliances. As Bidault and Cummings (1994) suggest, some of the variables that limit cooperative competency, and consequently NPD success, seem related to the increased managerial hurdles and project costs that tend to characterize alliances. These managerial hurdles can include reduced project speed, increased costs of coordination, and reduced new product success. They derive from lack of flexibility of those involved with the project (centralization), conflicting priorities of senior management personnel within the companies (lack of adequate top management support), and a champion unable to influence personnel and systems in both organizations. Institutional support was among the key drivers of cooperative competency and merits further study.

Although clear agreements, clans, formalization, and mutually dependent relationships directly affect cooperative competencies, these variables by themselves do not have a direct impact on NPD success in either the semiconductor or health care contexts. Thus, the key to NPD success in alliances seems to be to build cooperative competencies. The key to building cooperative competencies is to have clear-cut agreements, use clan and formalized control mechanisms, and engage in partnerships that pivot on mutual dependencies.

While examining the antecedents or key drivers of cooperative competency, we focused on alliance-based innovation. Our study does not examine the antecedents of cooperative competency in internal NPD projects. However, we believe that the same variables found to affect cooperative competency in alliance-based projects (administrative mechanisms, institutional support, and mutual dependence) are likely to affect cooperative competency in internal NPD projects.

Limitations

This study used the key informant method. Limitations of the key informant method have been documented elsewhere (Philips 1981). Our respondents (senior R&D personnel in semiconductor firms and chief administrators of hospitals) were well qualified to answer the research questions. But talking to more than one informant within each organization might have yielded additional insights on interdepartmental interactions during the NPD process. In the case of alliances, we interviewed one partner in the alliance. Talking to both partners, though a logistical challenge, would have yielded richer insights and provided a more complete and balanced picture.

The alliances were evaluated after the fact by respondents. The study is based on the assumption that trust, communication, and the other variables studied lead to new product success. We might make a case for the reverse, that success could have lead to inferences about trust and other variables studied (see Ganesan 1994). We attempted to control for this by trying to introduce variability in the type of project selected. Respondents were asked to select the pro-

ject that came to their attention most recently, not just successful, unsuccessful, or typical projects. However, it is possible that successful projects carry with them a halo of good feeling, which could explain the relationship between cooperative competency and NPD success.

The overall sample size of the study was limited for the health care context. In retrospect, because it would have been more meaningful to have fully matched comparisons of internal versus external alliances in two contexts, we lament our inability to secure the resources for a full replication in the health care sector. Finally, most of our measures performed well, but a different approach to measuring the environment and top management support might have yielded additional insights.

Directions for Research

Studies in NPD can be classified as (1) generalist studies that identify key variables that contribute to the success and failure of NPD projects or (2) specific studies that examine in depth one or more variables identified by the generalist studies (Craig and Hart 1992). This research follows the generalist style, in that it has tested a broad set of variables that contribute to the success and failure of NPD carried out under technology alliances. Substantive issues must be tackled in future studies of both types. For example, how can asymmetrically dependent alliances be made to work for either or both partners? Can information technologies or third parties enhance cooperative competency in alliances? What about transnational alliances? Is a more detailed development and analysis of the cooperative competency construct a prerequisite for cross-cultural studies? What prompts alliance partners to use certain types of administrative mechanisms and not other types? Can we find other key drivers of cooperative competency in internal NPD projects? Do other factors impede development of cooperative competency? Bleeke and Ernst (1995) contend that unbalanced power and competitor alliances are doomed to fail. However, because of the sparkling promise of differential advantages, many organizations are charmed into such alliances. Future research efforts should focus on partner selection mechanisms undertaken by companies and on the ways organizations can improve the performance of competitor and unbalanced power alliances.

We also recommend that future studies focus on the favorability of the environment rather than on mere knowledge of environmental conditions. If it is a less than munificent environment that draws companies to form alliances, an understanding of the impact of environmental factors on the behaviors of partners when they form an alliance would be valuable. Other issues include how prior experience with partnerships influences alliance management and what effects various structural arrangements (e.g., alliance located at own company or partner's site, equity partnering, contractual elements, communication systems) have on the success of technology alliances. The work ahead calls for many hands.

APPENDIX
Measures Used

Cooperative Competency

Trust Items
Had the ability to contribute to the NPD effort.
Was capable of doing their part.
Had high integrity.
Could be counted on to do the right thing.
Motives could never be questioned.
We trusted that they would act in company's best interests.

Communication Items
Alliance partner informed us of changing project needs.
Partner shared proprietary information with us.
Partner provided information that would help us.
Alliance partner provided us with adequate information.
Alliance partner provided us with timely information.

Coordination Items
The different job and work activities around the new product development activity fit together very well.
People from different organizations who had to work together did their jobs properly and efficiently.
All related things and activities were well timed in the everyday routine of the innovation process.
The work assignments of the people from the different organizations who worked together were well planned.
In general, the routines of the different organizations that had to work with one another were well established.

Institutional Support

Clarity of Agreement
The amount of financial resources each partner in the alliance was expected to contribute toward the new product development effort was clearly laid out.
The amount of manpower each partner in the alliance was expected to contribute toward the new product development effort was clearly laid out.

Resistance from Key Players
There was no resistance to this alliance from key players in your organization.
There was no resistance to this alliance from key players in your alliance partner's organization.

Complementarity with Partner Competencies
In retrospect, there was a good match between your company's objectives for developing the new product and that of your partner's in developing the new product.
The product development effort benefited from its closeness to both company's existing products.

Mutual Power Dependence
My alliance partner provided vital resources I would have found difficult to obtain elsewhere.
Much of the success or failure of the new product development effort can be attributed to my alliance partner.
It would have been difficult to replace my alliance partner.
The new product development effort would have suffered greatly if I had lost my alliance partner.

APPENDIX
Continued

Radical/Incremental
This was a unique new product project that did *not* directly build on technology of an existing product line.
This project capitalized on existing technology but represents a significant extension of technology existing within the company.
The product was pioneering, first of its kind (e.g., the first PC, portable stereo, or diet soda ever introduced in the market).
Similar products were available in the market when we introduced our product into the market.

NPD Success
Product had superior quality and reliability.
Product was killed, never went to the market.
Product was released on time.

(How would you rate the product on):
Time taken to introduce product into the market (idea to market).
Meeting of target costs.

Centralization
Problems in alliances are resolved hierarchically.
Even small matters in the alliance must be referred to someone higher up for an answer.

Formalization
We rely extensively upon contractual rules and policies in controlling day-to-day operation of the alliance.
We follow written procedures in most aspects of business in the alliance.

Clan
We trust the values and experiences of alliance members in controlling day-to-day activity.
We rely upon common values to guide day-to-day performance by alliance members.

Notes: All measures were parallel phrased for internal and external NPD. All items were phrased in a Likert-type ("strongly agree" to "strongly disagree") five-point scale format except the last four NPD success items, which were measured on a five-point ("very successful" to "very unsuccessful") scale.

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