Innovation Generation in Supply Chain Relationships: A Conceptual Model and Research Propositions

Subroto Roy
University of New Haven

K. Sivakumar
Lehigh University

Ian Wilkinson
University of New South Wales, Australia

Innovation generation has increasingly been recognized as an outcome of interaction between a firm and various outside entities. According to this view, supplier involvement and alliances are routes to innovation generation. Despite this realization, there is a dearth of research, both conceptual and empirical, focusing on innovation generation in buyer-seller relationships in supply chains. In an attempt to fill this void, this article develops a conceptual model of innovation generation in buyer-seller relationships in upstream supply chains. The authors propose that innovation generation in supply chain relationships, both incremental and radical, is a consequence of interactions between buyers and sellers. They also delineate factors internal and external to the relationship that moderate the link between interaction and innovation generation. Finally, the authors discuss managerial implications of their research and offer guidelines for future empirical research.

Keywords: *supply chain; innovation; new product development; buyer-seller interaction; knowledge-based; business-to-business*

Journal of the Academy of Marketing Science.
Volume XX, No. X, pages 1-.
DOI: 10.1177/0092070303255470

How are innovations generated in organizations, and who generates these innovations? For several decades, researchers and managers have asked and attempted to answer these important questions. Recently, a number of scholars have challenged the conventional notion that innovations in supply chain contexts originate from the buyer alone (Hakansson 1987; von Hippel 1987, 1988). In a complex technological era, innovation generation is increasingly viewed as a multidisciplinary activity spanning a multiplicity of organizations, circumstances, and settings (Hakansson 1987; Leonard-Barton 1995; Nonaka and Takeuchi 1995; von Hippel 1994; Wind and Mahajan 1997).

Flowing from this conceptualization is the growing recognition that innovation results from interactions within buyer-seller relations (Dodgson and Rothwell 1994; Millson, Raj, and Wilemon 1996; Robertson and Gatignon 1998; Sivadas and Dwyer 2000). Scholars agree that a substantial part of the innovation process occurs between buyers and sellers in the supply chain (Hakansson 1987; Lundvall 1985a, 1985b). Accordingly, a large body of strategy-level research on buyer-seller interaction and technical development has emerged (Athaide, Meyers, and Wilemon 1996; Hakansson 1987).

With the advent of information technology (IT) in business processes, the enterprise has been linked internally through enterprise resource planning systems, externally to the customer through customer relationship management systems, and suppliers have been integrated backwards with supply chain management systems. Academics and practitioners have shown great interest in improved supply chain performance and have called for more research in the area (Day 1994; Srivastava, Shervani, and Fahey 1999). For example, Day (1994) noted, "Suppliers must also be prepared to participate in the customer's development processes, even before the product specifications are established" (p. 45).

Upstream sections of the supply chain involve manufacturing activities that occur before the product moves to the distribution channel. Extant research on innovations in supply chains relationships has primarily been conducted in the auto industry (e.g., Clark and Fujimoto 1990, 1991); the focus of such research has been on operations and total quality management rather than marketing. In addition, theory building in supply chains has lagged behind advances in IT and business-to-business electronic integration (Hammer 2001; Mentzer and Kahn 1995). For instance, Sheth (1996) noted that studies of organizational buying behavior have focused too much on empiricism and too little on theory. Indeed, a number of influential innovation studies, despite offering interesting data-based insights, have been criticized for being atheoretical (Brown and Eisenhardt 1995; Taylor and Lowe 1997). Although a number of researchers have investigated factors influencing innovation generation (Chandrashekaran, Mehta, Chandrashekaran, and Grewal 1999; Cooper 1998; Cooper, Edgett, and Kleinschmidt 1998; Griffin 1997), a comprehensive conceptual examination of upstream supply chain relationship factors in innovation generation has not been attempted.

To reduce these important gaps in the literature, this article develops a conceptual model of innovation generation in buyer-seller relationships in upstream supply chains. We argue that buyer-seller interactions in upstream manufacturing sections of the supply chain generate both incremental and radical innovations. From an academic perspective, this new framework would facilitate a better understanding of the innovation process, shedding theoretical light on issues such as *why* interactions between buyers and sellers facilitate innovation, *how* buyer-seller relations become important sites of innovation, and *what types* of innovations are fostered under given circumstances. Managerially, the framework would offer some guideposts to facilitate better management of innovation generation in supply chain relationships. In addition to the increasing importance given to supply chain issues in the popular press (e.g., *Business Week*, *Information Week*, and so on) and academic publications, the growing academic and research programs within business faculties in several universities (further demonstrated by the proposed 2003 American Marketing Association faculty consortium's theme of supply and value chain management) underscore the importance of investigating innovation generation in supply chains.

The next section presents the article's conceptual underpinnings and examines the nature of innovation in supply chain relationships. In the third section, we explain the centrality of interactions for innovation generation and develop our two main propositions. In the fourth section, we examine several factors that moderate the relationship between interaction and innovation generation. We develop additional research propositions by integrating a wide array of literature in related fields. The concluding section of the article provides guidelines for measures and empirical testing, offers managerial implications, and delineates future research directions.

CONCEPTUAL FRAMEWORK

Innovation generation occurs in the "development" phase of a new product, which includes idea generation, idea screening, concept testing, development, and launch (see, e.g., Crawford and Di Benedetto 2000). In addition, when there is a fundamental change in the configuration of an existing product, we may consider such innovation as radical for the concerned supply chain members. If the innovation involves less radical changes (say, quicker delivery periods, or reduction of material thickness and cost), the concerned supply chain members may consider the innovation to be incremental. Innovation generation in a supply chain context involves changes in product, process, or service that either reduce cost or improve efficiency; the notion of efficiency includes increased end-of-chain customer satisfaction.

Innovations are conceptualized as a sequence of S curves (representing reduced cost, increased performance, or both, across time), with each S curve representing a distinct type (in some cases, a radically different type) of base technology with its own stream of incremental innovations (e.g., Asthana 1995; Chandy and Tellis 2000; Foster 1986). For ease of exposition, we denote incremental innovations as moving along the same S curve and radical innovations as moving from one S curve to another. We develop the position that rising on a particular S curve involves close teamwork with the concerned supplier based on interactions and a set of moderating factors. Such close teamwork involves relationships in which both the strength of the relationship and a high degree of shared knowledge allow very specific technical development work to be undertaken. Jumping across S curves involves new knowledge domains that increase the possibility of radical innovation generation. More rapid movements across S curves are designated as "increased generation of radical innovations."

A jump to a new S curve involves some sacrifice of current cost/efficiency outcomes on the existing S curve.

Although initially disadvantageous, the jump to a new S curve is the type of radical innovation with which we are concerned. If buyers and sellers are able to undertake such a jump, we define this as radical innovation generation, with more S curves jumped as more radical innovations are created. The space between S curves is conceptually similar to the notion of "structural holes" (Burt 1992). Structural holes represent both the social-relationship distance as well as the knowledge-technology distance that must be bridged for the relationship to lead to a new S curve. Progressions from radio valves to transistors or from analog to digital recording are universally understood as radical innovations, involving changes in "architecture" (Henderson and Clark 1990). By contrast, the computer industry may view a change in hard disk drive sizes as a radical innovation (Bower and Christensen 1995), but industry outsiders (or even some customers) may not view them as such. The firm-level innovation literature (e.g., Chandy and Tellis 2000; von Hippel 1988) generally uses an industry poll method to identify historically "radical" innovations. Movement across S curves can be accomplished by initiatives such as broadening the interactions with existing suppliers (new projects, new strategic business units [SBUs], new sales team, lead user, and so on) (von Hippel 1988) or initiating relationships with new suppliers. Thus, a new S curve may have to begin at a cost-benefit point lower than that of the existing S curve, but with the promise of far surpassing the current curve. Unlike relationships on existing S curves, radical innovations are likely to take place within relationships that contain new and emerging knowledge domains. Such divergent knowledge domains may make the move to a new S curve less threatening to the relationship as it lacks preconceived norms and expectations.

We note three issues related to our use of S curves in the context of innovation classification. First, our conceptual focus is on incremental and radical innovations; the use of S curves is only a useful graphic depiction of the phenomenon. Thus, alternative conceptualizations of incremental versus radical innovations will also be consistent with our theorizing. Second, our classification of innovations into incremental and radical has long been accepted in the academic and managerial literature. However, consistent with the broader interpretation and conceptualization of innovation in the literature of the past several years, the radical versus incremental division is flexible enough to accommodate a wide variety of scenarios (e.g., improvements in analog cell phones vs. the transition to digital cell phones, modifying an existing software vs. developing an entirely new software, and so on). Finally, if a researcher is interested in conceptualizing radical and incremental innovations as points on the same continuum, our conceptual framework can easily support such a characterization. Thus, our objective is to offer a conceptually justifiable but flexible approach toward understanding innovation generation in supply chain relationships.

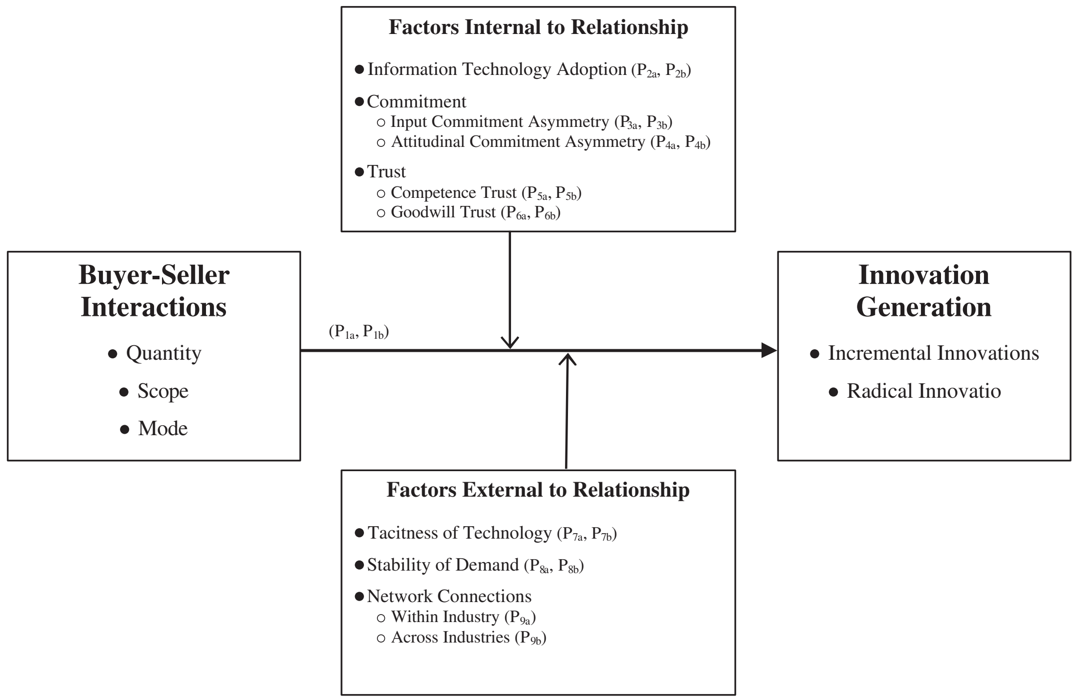
Upstream supply chain relationships are buyer-seller relationships in which the buyer undertakes some conversion or adds value before supplying the product to the next point in the chain. In this instance, we are concerned with the relationship that a disk-drive supplier may have with Dell or an auto-part supplier with Ford, rather than with relationships at the customer end (i.e., between an institutional customer and Dell or between Ford and its dealers). The final consumer may be unaware of the various innovations that have taken place in the upstream sections of the supply chain.

Interaction theory, at its dyadic form, attempts to explain relationship outcomes such as innovation, relationship performance, and profitability (Hakansson 1987; Hakansson and IMP Project Group 1982; Lundvall 1985a, 1985b). We consider buyer-seller interaction as the primary independent variable that generates innovation in supply chain relationships and consider other salient factors, such as network connections, as moderating the impact of interaction on innovation generation.

A Model of Innovation Generation in Supply Chain Relationships

Our conceptual framework, presented in Figure 1, posits that buyer-seller interactions in supply chain relationships generate incremental and radical innovations. The link between interactions and innovation generation is moderated by several factors, which can be grouped into two categories: (1) those that are internal or dyadic to the interfirm buyer-seller relationship and that can be managed bilaterally through managerial action on either side (IT adoption, commitment, and trust) and (2) those that are external to the relationship and are generally not under the control of the dyad (tacitness of technology, stability of demand, and network connections). The primary rationale for dividing the factors into these two groups is the degree of managerial control that can be exercised over them by the firms. In the interest of parsimony, we have restricted ourselves to those factors that are well established and highly relevant to the supply chain context. Thus, internal factors include IT adoption, which is largely responsible for placing the supply chain at center stage in recent years (Hammer 2001). Other internal factors are the classical relationship factors trust and commitment, which have become central explicators of buyer-seller relationships in the literature. The three external factors are tacit technology, nature of demand, and network connections. While tacitness of technology is fundamental to understanding applied knowledge and innovation, the nature of demand dictates how agile the supply chain must be. Network connections are important because in any buyer-seller dyad,

FIGURE 1
A Model of Innovation Generation in Supply Chain Relationships



NOTE: P_1-P_9 = Propositions 1-9.

each party's networks help to determine innovation generation. We will first establish the centrality of interactions in the innovation process and formulate our two central propositions. Then, we will explain the moderating role of internal and external factors on the relationship between interaction and innovation generation.

BUYER-SELLER INTERACTIONS AND INNOVATION GENERATION

Interactions are similar to and yet different from communication. By definition, communication involves a sender with a communication goal. In contrast, interactions may not have a business communication goal (Mohr and Nevin 1990; Mohr, Fisher, and Nevin 1996), but all interactions build the atmosphere of the relationship (Hakannson and IMP Project Group 1982). A cordial "What's up?" to a supplier technician on the shop floor can start a conversation that may not have had any communication objective yet may lead to discussion of innovative ideas.

Interactions could commence with precontract awareness and meetings (as in Dwyer, Schurr, and Oh 1987), from the formal legal contract at one extreme to the informal cafeteria coffee that buyer-supplier technicians may have together on the other extreme (following Orr 1990). Between these extremes may lie letters, faxes, e-mails, meetings, electronic data interchange, and Web-enabled business-to-business systems. Before a written contract is finalized, buyer-seller interactions would include the much-investigated industrial buying behavior, such as the buyer deciding on a buy task (Robinson, Farris, and Wind 1967) and setting up a buying center and the seller organizing an account manager and developing relationships (Wilson 1995).

Buyer-seller interactions may be broken down into three subdimensions: quantity, scope, and mode. The first dimension, *quantity* of interaction, has been widely examined (Dwyer et al. 1987; Ford 1980; Hakansson 1987; Saxenian 1991); almost all sales force control systems track the number (and sometimes duration) of customer meetings and in many cases report on the topics discussed. These field reports form the basis of further discussions within the sales organization. On the buyer side, it is common for purchasing, engineering, or R&D staff to consider what was learned from the interaction with supplier representatives (e.g., Jap and Ganesan 2000). Interactions among team members increase as joint projects reach a critical mass (Leonard-Barton 1993).

Interaction *scope* signifies the quality and nature of interaction that facilitates innovation generation. It includes meetings between different hierarchies (scope increases when different levels of personnel are involved), between different divisions (scope increases if interactions span several divisions), and the level of coordination between buyer and seller (Alderson and Halbert 1968). Saxenian (1991) reported that the CEO of Flextronics met with Sun's vice president of operations once a month for breakfast while planning, engineering, purchasing, and marketing personnel on both sides continued to meet on a regular basis. Laage-Hellman (1997) noted that the Cummins-Toshiba collaboration for ceramic components was successful partly because of a cultural fit that included interactions at multiple levels. In the buyer-seller context, multiple levels of interaction within the auto industry enable close coordination between the part supplier, the assembly line, and the factory itself (e.g., Bidault, Despres, and Butler 1998a, 1998b; Clark and Fujimoto 1990; Sako 1994).

We use the term *mode* of interaction to denote the richness of the interactions not covered by the quantity and scope of interactions (e.g., certain communication modes are more preferable in certain contexts). Interactions that include informal relationships are richer than those confined to formal relationships (e.g., Hakansson 1987). Certain informal interactions, such as Xerox technicians meeting in a cafeteria over copier machine breakdowns (Orr 1990), have been proven to be extremely powerful in generating innovation. Similarly, in the communication domain, scholars have begun working on concepts such as media richness and the effectiveness of communications. Clearly, being an emerging research area, greater efforts are needed to move the measurement of the subdimensions of interactions forward. Since the purpose of our article is to develop a theory of interaction as a key construct in explaining innovation generation in supply chain relationships, we take a conceptually parsimonious view of interaction. Specifically, we combine the three dimensions of quantity, scope, and mode and call this the extent of interaction.

Buyer-seller interactions are fundamental to the adaptive learning process (Tyre and von Hippel 1997), forming the basis of knowledge transfer. That interaction with outsiders is a sine qua non for generating innovation is evidenced by the European Commission's (1996) conceptualization of innovation in a recent survey. According to the European Commission (1996), "Innovation is a result of an interactive learning process that involves often several actors from inside and outside the companies" (p. 54). This interactive process is particularly useful if the participants are physically closely situated.

Physical location can have a strong impact on knowledge transfer and innovation generation because knowledge tends to be "sticky" (Ogawa 1998; Tyre and von Hippel 1997). Interaction theorists (e.g., Hakansson 1987) maintain that adaptation and technological development occur in networks through interactions. These improvements and innovations can be later supplied to other customers in the market.

The interaction perspective offers convenient explanations of networks and interactions in the age of the electronically linked supply chain (e.g., Achrol 1991; Achrol and Kotler 1999; Anderson, Hakansson, and Johanson 1994; Hakansson 1987; Hakansson and IMP Project Group 1982; Hakansson and Snehota 1995). Network theory, such as the industrial marketing and purchasing (IMP) theory in the industrial context, posits that technical development in industry takes place through interactions between individuals (actors), resources, and bonds (relationships) (Hakansson 1987; Hakansson and IMP Project Group 1982). These interactions occur not only in the dyadic interfirm context of buyers and sellers but also across networks that may span several countries. Therefore, network theory is eminently applicable in the Internet economy (Achrol and Kotler 1999; Sheth and Sisodia 1999). Interactions, including electronic interactions, form the "process" and "how to" aspects of our theoretical model of innovation generation in supply chains.

A first-time supplier learns of a buyer's requirements through interactions (Hallen, Johanson, and Seyed-Mohamed 1991). Teams working on new product development use interactions to clarify issues and usage patterns and to preempt problems in application (Clark and Fujimoto 1990; Leonard- Barton 1995). Upon learning sufficiently about each other's needs and capabilities, "creative abrasion" (Leonard-Barton 1993, 1995) and technical interactions occur between buyer and seller (Athaide et al. 1996; Hallen et al. 1991), leading to knowledge creation and innovation generation.

In supply chain contexts, interactions between buyers and sellers form ties that allow for high relational embeddedness (Granovetter 1973; Gulati 1998; Uzzi 1997). Relational embeddedness refers to the norms that form as well as the "sense" parties make of their innovation attempts (Dwyer et al. 1987; Weick 1990). As buyer-seller personnel get to know each other, a short e-mail or a quick cell phone call may be enough to communicate the latest concerns surrounding an innovation. In conceptual terms, given that both buyer and seller have high domain-specific knowledge, innovation attempts are marked by a high degree of knowledge overlap (Burt 1987, 1992). Such knowledge overlap is invaluable to facilitate movement on a given S curve; in addition, more efficient interaction and more focused efforts by both buyer and seller will enable the move up a particular S curve. Such focus has been called "exploiting" the relationship, as opposed to "exploring" possibilities (March 1991). Buyers and sellers are able to exploit the relationship and move up the S curve, as both relationship and knowledge overlap facilitate and encourage this progression. Over time, relationships allow interactions to be fine-tuned, enabling the specific work needed to improve cost-performance.

Proposition 1a: The greater the extent of buyer-seller interaction, the greater the generation of incremental innovations in supply chain relationships.

Radical innovation generation is accomplished when a company breaks out of the groove of the existing and comfortable S curve. In the context of supply chain relationships, the buyer or seller does so by commencing work on a new S curve (Seiko in Chandy and Tellis 2000; Matsushita in Nonaka and Takeuchi 1995; Boeing in Schrage 2000; scientists in von Hippel 1988). Many of these projects fail, while others result in new and radical innovations (Morone 1993).

Buyer-seller relationships in supply chain contexts involve interactions with suppliers, customers, or their employees, who may be trying to find a venue to bring a radical idea to fruition. Once interactions lead to commencement of a new S curve, the radical innovation is on its way to commercialization. To allow generation of new domains of knowledge and hence new S curves, both buyers and sellers need to interact in a context of new knowledge domains (Truffer and Durrenberger 1997). New knowledge domains may commence from interactions between new employees, lead users, new customers, or new suppliers. Increased buyer-seller interactions will facilitate the creation of new knowledge, resulting in radical innovations.

Proposition 1b: The greater the extent of buyer-seller interaction, the greater the generation of radical innovations in supply chain relationships.

FACTORS MODERATING THE INTERACTION-INNOVATION LINK

Factors Internal to the Relationship

IT Adoption by Buyer and Seller

IT adoption refers to the extent to which the internal processes of the buyer and seller are IT enabled and the extent to which IT systems are integrated between buyer and seller. The differential adoption of IT by buyers and sellers can have a significant impact on their interactions and innovation generation. Within the same industry, a continuum of IT adoption will result in different platforms used by buyers for communication with suppliers (Bowersox, Closs, and Stank 2000; Cachon and Fisher 2000). For example, at one end are Dell Computers' Web-enabled supply chains (Kalakota and Robinson 1999); at the other end would be a small manufacturer of generic personal computers that communicates with a variety of component suppliers via media such as e-mail and telephone.

Compatibility of IT systems affects buyer-seller interaction. When complete system integration exists between buyers and sellers, most routine communication will be conducted online, thereby freeing up time for knowledge creation, particularly of the tacit type. Relationship theory (e.g., Dwyer et al. 1987) suggests that for relationships in which norms and expectations are well developed, interactions can help to improve the cost-performance of an existing S curve, provided interactions are not exclusively spent on routine issues such as ordering, delivery, and payments. The redundant knowledge between buyers and sellers can be captured through IT systems that link the buyer and the seller on routine issues such as forecasting, production planning, order processing, deliveries, and payments. When routine information can be picked up from computer systems, the quality and effectiveness of interactions such as meetings and messages can be developmental in nature. Situated learning theory (Brown and Duguid 1991; Lave and Wenger 1991) suggests that in instances where most routine interactions are in the IT system, on-site face-to-face interactions will involve new learning and developmental efforts on existing S curves.

Proposition 2a: The greater the IT adoption and integration between the buyer and seller, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

Given the initial messiness and unattractiveness of a new S curve, IT integration can be a deterrent to radical innovation generation. IT integration between the buyer and seller in the supply chain involves agreed-upon codes and procedures to literally straitjacket transactions of plans, materials, and funds (e.g., Perry, Cavaye, and Coote 2002). Only when both parties identically understand the other's position does IT integration work. For a jump to a new S curve to occur, new knowledge domains must be cultivated in a relationship. When buyers and sellers commence work on such new knowledge domains in a bid to create radical innovations, IT integration may hinder the process; the effort might involve high degrees of waste, such as the rejection costs of prototypes. Thus, for example, IT systems with a high degree of ERP-related management control are undesirable if radical innovation is desired, because the new S curve will appear as a potential loss, thereby negating it as a viable alternative to the existing S curve (Chandy and Tellis 2000).

If buyer-seller relationships involve new knowledge domains, then both parties would need to spend time defining a radical innovation including various technical specifications. Without structured IT-based invoicing and approvals, buyers and sellers are facilitated to treat the new project and radical innovation as nonroutine; interactions have both a commercial and a technical component (Kalakota and Whinston 1999). As the new S curve progresses through prototypes and test markets, the curve gradually resembles an existing S curve and requires similar treatment, including IT systems, for incremental improvements to occur. Thus, during the initial stages of development of radical innovations, relationships and projects must be nonstructured, lest they be killed at the outset by the rigidity of IT integration.

Relationships require interactions over time in which the possibilities and modalities of commencing a new S curve can be explored. Transaction cost theory suggests that suppliers working toward a radical innovation will be highly motivated to prove themselves, in the hope that the buyer will continue to offer future business once the innovation is fruitfully developed. If every relationship were fit immediately into a rigid IT format, flexibility and opportunities for broad-based interaction would be reduced. Thus, suppliers trying to supply a radically new product should conduct personalized interactions in addition to using IT systems.

Proposition 2b: The greater the IT adoption and integration between the buyer and seller, the lesser the impact of interaction on the generation of radical innovations in supply chain relationships.

Commitment

According to Morgan and Hunt (1994), commitment exists when an exchange partner believes that "an ongoing relationship with another is so important as to warrant *maximum efforts* [italics added] at maintaining it; that is, the committed party believes the relationship is worth working on to ensure that it endures indefinitely" (p. 37). Commitment in buyer-seller relationships involves "stability and sacrifice" and allows the coordination advantages of vertical relationships and the entrepreneurial advantages of separate ownership (Anderson and Weitz 1992). Asymmetry in commitment exists in relationships where one partner shows more commitment than the other.

Commitment is an increasingly important component in innovation in the networked environment (Gundlach, Achrol, and Mentzer 1995). It is demonstrated by a willingness to dedicate specialized assets for a particular relationship, thus demonstrating that the buyer and seller can be relied upon for future support. Commitments involve pledges, credible commitments, idiosyncratic investments, and the dedicated allocation of resources, which become specific to a relationship (Anderson and Weitz 1992; Williamson 1985). Commitment is demonstrated in three ways: idiosyncratic or customized effort, attitude, and the long-term intention of the parties to remain in the relationship (Gundlach, Achrol, and Mentzer 1995). Sustained communication between parties is useful in shaping positively viewed commitment in terms of investments, attitude, and long-term orientation. In other words, commitment will facilitate two-way communication (Anderson and Weitz 1992) based on interactions. Input commitment and attitudinal commitment are the most relevant to our discussion of innovation generation in supply chain contexts (Gundlach et al. 1995).

Input commitment asymmetry. Inputs include access to proprietary information, technology, and R&D facilities. Input commitment involves resources as visualized by the IMP school (Hakansson 1987; Hakansson and IMP Project Group 1982). Physical, nontransferable, and idiosyncratic assets created by the seller and buyer constitute an assurance that the buyer and seller are committed to each other, and more important, that they have invested in technical assets such as plants, machinery, and skills to provide value to each other. Relationship theory (Dwyer et al. 1987; Morgan and Hunt 1994) suggests that the greater the idiosyncratic input commitments of a partner, the more unilaterally motivated that partner is to make interactions effective. On an existing S curve, unilateral input commitment (i.e., greater asymmetry in input commitment) would not produce improvements given the ongoing nature of the activity related to the S curve.

Thus, if a supplier builds a conveyor plant from its factory to the buyer's factory and cannot easily move the conveyor line to another buyer, we might expect the seller to participate more actively in the interactions with the buyer simply because of the input commitments already made. Unless the buyer has made a similar input commitment, the buyer has no incentive to make interactions more effective to move along a given S curve, thereby impeding the generation of incremental innovations.

Recent research suggests that dedicated suppliers tend to be squeezed for lower prices and pushed up the S curve (e.g., Ford and Wal-Mart have asked their suppliers to reduce prices). In such instances, the supplier's options are to either reduce price or allow the buyer to choose a supplier who can supply at lower cost on the same S curve (Wathne, Biong, and Heide 2001). Thus, asymmetry in input commitment, in which one party has invested more in the relationship than the other, can be problematic, as interactions will not effectively generate incremental innovations. Asymmetries in input commitment will not promote situated learning (Brown and Duguid 1991; Lave and Wenger 1991); the party with lower stakes will tend to care less and interactions will be less effective in generating incremental innovations.

Proposition 3a: The greater the asymmetry in input commitment between the buyer and the seller, the lesser the impact of interaction on the generation of incremental innovations in supply chain relationships.

Asymmetry in input commitment can have a positive impact on interactions for radical innovation. In buyer-seller relationships involving new knowledge domains, at least one party must make disproportionately larger initial input commitments than the other, and interactions will aid the commencement of a new S curve (following Jap 1999). Relationships on a new S curve will have a small window of opportunity to establish promise and viability. Corresponding to the awareness phase in relationship theory, high-knowledge creation will occur in this small window of asymmetric input commitment. If the initial results are promising, both buyer and seller would increase their input commitments and interaction quantity; in addition, quality would increase as the new S curve is established. Partners will make efforts to ensure that interactions are high in quantity and quality. As an example, consider a situation in which a supplier brings in a prototype for trial, as did the new hard disk suppliers described by Christensen (1997). Until trial results are available, only the supplier has made the input commitments (i.e., the asymmetry in input commitment is greater). As trials become successful, the buyer will switch one line of production to the new component. Therefore, initial asymmetry in input commitment can be expected to facilitate the role of interaction in relationships to create radical innovations.

Proposition 3b: The greater the asymmetry in input commitment between the buyer and the seller, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Attitudinal commitment asymmetry. The attitudinal component of commitment indicates goal congruence, sharing of values, and commonality in approach and attitude (Gundlach et al. 1995). This affective attachment is independent of immediate "instrumental" benefit, which either party may derive from the relationship. Instead, attitudinal commitment refers to the behavioral intention of committing time and resources coterminous with the buyer's plans (following O'Reilly and Chatman 1986). Although attitudinal commitment does not depend on immediate economic cost-benefit expectations, it sets the background for the mutual dependence and cooperation required for innovation generation. When both parties have equal attitudinal commitment, interactions can be expected to be of high quality and thus effective in the context of a knowledge domain and S curve with which both buyer and seller are familiar.

Asymmetry of attitudinal commitment indicates either that one exchange partner does not share the goals of the other or that one partner lacks identification, loyalty, and the involvement necessary to help facilitate the other partner's goals (Gundlach et al. 1995; Jap 1999). Such asymmetry is detrimental to the sharing of the within-domain knowledge crucial for the generation of incremental innovations. Even if interactions take place, needed follow-through action may not materialize, thereby impeding the generation of incremental innovations.

Proposition 4a: The lesser the asymmetry in attitudinal commitment between the buyer and the seller, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

The jump to a new S curve amounts to a literal "leap of faith," as a new S curve might look considerably less attractive than movement on an existing S curve (Jap 1999). During these situations, attitudinal commitment on both sides is critical; some members on both sides of the buyer-seller dyad must believe in the possibility of the new S curve greatly surpassing the existing S curve. This shared attitudinal commitment must exist before interactions result in a new S curve. For example, in developing smaller and more powerful disk drives for the computer industry, computer manufacturers had an attitudinal commitment matching that of new suppliers, fostering innovation (Christensen 1997).

High attitudinal commitment on the part of buyer and seller representatives does not require financial clearances or approvals from their respective organizations. Rather, attitudinal commitment is based on a sincere desire to attempt to make an S curve work. "Lead users" have been identified in von Hippel's (1988) classic studies as those buyers who are high in attitudinal commitment. Interactions with such buyers, under conditions of mutual attitudinal commitment, are likely to be of high quality and to lead to knowledge creation. Such interactions are also likely to create situated and new learning and thus facilitate both a jump to a new S curve and set the stage for a more productive relationship.

Proposition 4b: The lesser the asymmetry in attitudinal commitment between the buyer and the seller, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Trust

Trust refers to the extent to which one partner may depend on another to look after its business interests. Many studies have shown that trust is a vital element of a business relationship (Dodgson 1993; Morgan and Hunt 1994). A slow and sustained process, trust building is an important factor affecting the extent and character of interactions in a relationship (Dodgson 1993; Gambetta 1988; Gulati 1995; Joshi and Stump 1999; Morgan and Hunt 1994; Sako 1992). The degree of trust will determine the extent to which organizations are willing and able to interact (Athaide et al. 1996; Dodgson 1993). Trust within supply chains concerns the reputations of organizations (Ganesan 1994), while "trustworthiness" is an individual characteristic that facilitates interaction at the community level (Orr 1990). According to Sako (1992), there are three kinds of trust: contractual trust, competence trust, and goodwill trust. Contractual trust operates on the principle that the buyer and seller will be true to the contract. Since innovation generation cannot be contracted out (Nooteboom 2000), we focus on the other two types of trust, which are relevant to innovation generation in supply chain relationship.

Competence trust. Competence trust refers to a firm's expectations about the ability of the other party to carry out particular activities relevant to its role. In the context of new product development, Madhavan and Grover (1998) offered a similar construct, "trust in team member's technical competence." A team member must not only feel confident of the other members' technical abilities to resolve the current problem but also must feel confident that the team member would be able to solve new problems as they emerge. Madhavan and Grover (1998) suggested that trust in technical competence grows with past experiences and feedback about small but progressive project successes.

Given the interorganizational nature of innovation generation, the buyer and seller must have mutual technical confidence: the buyer that the seller will be able to supply and the seller that the buyer will be able to use the product and/or service ordered (e.g., Frazier 1999). A mismatch in competence trust would lower the chances of innovation generation in the relationship. The greater the amount of competence trust in a relationship, the less the need for repeated explanations. Such "proven competence" would mean less frequent but more high-quality, valuable interactions, resulting in increased generation of incremental innovations (Nooteboom, Berger, and Noorderhaven 1997).

Proposition 5a: The greater the competence trust between the buyer and the seller, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

Partners must have competence trust in each other to start doing business with each other (Lambe, Spekman, and Hunt 2000). Trust might be obtained through market reputation or past positive experience with another division of the firm. In contrast to the proven and personally experienced competence of relationships in existing knowledge domains related to incremental innovations, relationships involving new knowledge domains needed for radical innovations would depend largely on each partner's reputation for competence (Nooteboom, De Jong, Vossen, Helper, and Sako 2000). For example, a maverick start-up might have no corporate reputation and only the credentials of the promoters. For radical innovation to commence, the buyer and seller must interact in an atmosphere with a minimum threshold level of perceived mutual competence trust, so that a prototype can be developed and pilot trials taken for the move to a new S curve. The greater the competence trust parties have in each other, the more effective the effect of interaction on radical innovation generation.

Proposition 5b: The greater the competence trust between the buyer and seller, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Goodwill trust. Goodwill trust refers to the degree to which one partner trusts the other to look after its interests without explicitly asking for such help (Sako 1992). The greater the goodwill trust, the more likely interactions are to be valued by the participants, hence leading to more frequent interactions. The parties will do each other favors with the understanding that neither will take undue advantage and that both will assume new initiatives with respect to an existing innovation. Hakansson (1987) called the outcome of this goodwill trust an informal arrangement for technological development. For comparable levels of technical trust, we expect that a buyer would innovate more with a supplier when goodwill trust is higher, resulting in incremental innovations. Interactions will be more informal, and knowledge creation and transfer will be at the tacit level. Goodwill trust facilitates the sharing of information that is proprietary and yet critical to the generation of incremental innovation on a given S curve.

In contrast to teams working within the company on one new product development (Madhavan and Grover 1998), innovation generation in supply chains may involve parallel development activities with several suppliers or vendors (Quayle 2000). When there are multiple suppliers and buyers and when technical competence is similar, we believe that more interaction and innovation generation will occur where goodwill trust is high. The interactions will be more informal, leading to the creation and sharing of tacit knowledge within a specific domain, resulting in the generation of incremental innovations.

Proposition 6a: The greater the goodwill trust between the buyer and seller, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

For radical innovations to be generated in supply chain contexts, the buyer-seller relationship must focus on new knowledge domains often unrelated to an existing S curve. The new knowledge domain would become available to the relationship from injection of new knowledge to one or more of the dyads or the associated individuals in the dyads. There might be new individuals, new departments, or entirely new partners who might bring the needed knowledge variety into the interactions to create radical innovation. Such radical innovation is generated, for instance, in von Hippel's (1988) laboratory equipment development, in which the user works with the equipment maker to create a prototype. It is easy to visualize the equipment maker going back to its upstream suppliers to develop the appropriate requirement of the lead user. In all of these cases, the goodwill trust that one party has for the other will facilitate the impact of interaction on radical innovation. Without goodwill trust, interactions will often serve only a limited purpose that will not result in radical innovations.

Goodwill trust would be particularly important when the perceived risk of trying something is high, as in the case of radical innovations. If high goodwill trust exists between the partners, then interactions would be more effective in starting the new S curve and sustaining initial losses with the hope of high performance in the future.

Proposition 6b: The greater the goodwill trust between the buyer and the seller, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Factors External to the Relationship

Tacitness of Technology

Tacit technology refers to the know-how needed at the buyer's position in the supply chain for the seller to produce and market the desired output at the next point in the supply chain (Polanyi 1967; von Hippel 1994). Explicit technology might refer to the detailed specifications that a buyer would draw up in a tender document for the seller to bid on. While such a bid document could include very detailed technical information on such things as materials and standards, the selection of a supplier and maintenance of a productive relationship requires large amounts of shared tacit technology and supplier knowledge. For example, a supplier might, over time and with interactions on a given S curve, fine-tune batch size and time of delivery and respond to any usage problems.

Although technology has been viewed as a "socially constructed reality" (Goodman and Sproull 1990:259), aspects that define it as such remain little understood. However, with respect to innovation, technology characteristics have been studied extensively (Scott 1990; Weick and Roberts 1993). There is an increasing awareness that socially constructed aspects of technology have a critical effect on the generation of technological innovations (Meyers, Sivakumar, and Nakata 1999) and the buyer-seller relationship (Scott 1990).

When it comes to innovation sources outside the firm, technology plays an important role in the evolution of supply chain relationships. The conversion of tacit knowledge to explicit knowledge and new knowledge illustrates this dimension of technology. Software programming changes (an example of incremental innovation) require increasingly high levels of tacit technology and knowledge, as well as a wide repertoire of skills to cope with new situations at the implementation stage (Weick and Roberts 1993).

A product often embodies the knowledge embedded in the relationship between buyer and seller. For example, in software development, the supplier's programmers interact with the buyer to develop a keen understanding of the organization's processes. This understanding is specific to particular personnel in the supplier organization and the specific context of the software application; customers prefer to work with those programmers who have already demonstrated an understanding of their organization (Mohamed 1992). Existing and past suppliers of related items are considered more dependable than new suppliers (Athaide et al. 1996; Weiss and Heide 1993). Thus, the tacit knowledge of the programmer is embedded in the specific business relationship. In such cases, adaptation will be both continuous and ongoing.

In sum, when tacit technology is high, and the innovation is on the existing S curve, both parties have large knowledge overlap, particularly of the tacit type. Interactions between the buyer and seller will be more efficient and more effective in the backdrop of high-shared tacit technology between buyer and seller, resulting in increased innovation generation along an existing S curve.

Proposition 7a: The greater the tacitness of technology associated with an innovation, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

When the tacit component of new technology (a new S curve) is high, buyers and sellers will make the time and effort to physically work together to make sure that they understand each other (Badaracco 1991), thereby enhancing the effect of interactions on the generation of major improvements (Nonaka and Takeuchi 1995; von Hippel 1994). Each interaction will allow for the sharing and development of tacit knowledge; differences in tacit knowledge will encourage buyer and seller to increase the quantity of interaction to bridge the knowledge gap. In the supply chain context, it may be clarified that once a supply is incorporated into a buyer's offering, it is the buyer who must be the overall supplier to the next buyer in the supply chain. Consider a Tier 2 auto part supplier that comes up with a new component for a Tier 1 supplier. Both suppliers must understand as much of the tacit technology that is needed to address the concerns and issues at the carmaker plant. Both tier suppliers also would need to ensure that they understand the implications for the automaker before moving forward with the component change. In fact, it is likely that the Tier 1 supplier might actually involve or in-form the automaker of such changes. Significantly, the component may be a radical innovation for the Tier 1 and Tier 2 business but could be only an incremental innovation for the automaker. Such understanding would emerge from a high quantity of interactions. Following Dwyer et al. (1987), partners would try to bridge the unfamiliarity involved in radical innovations through higher interactions to make them more effective.

Proposition 7b: The greater the tacitness of technology associated with an innovation, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Stability of Demand

Demand stability refers to the need for a product or service at the end point of the supply chain (final customer) in the context of a given S curve. For example, while consumers may want their cars to get better mileage, they do not all switch to hybrids when these become available. As long as the demand is stable at the next point of the supply chain, buyers and sellers have an incentive to continue to generate incremental innovations. As long as the demand is stable for gas-only automobiles, buyers and sellers would continue to interact to produce minor improvements in automobiles (incremental innovations). As soon as the next point demand alters (recall the computer disk drive example from Christensen 1997), there is no longer an incentive for minor improvements in an old technology, and entire industries can be wiped out.

Tushman and Rosenkopf (1992) and Laage-Hellman (1997) noted that innovations arising from interactions can be substantial in numerous industries, including canning and steel, due to their relatively stable demand. In the canning industry, for example, incremental innovations might include improving can printing and reducing can thickness. For existing products with stable consumer demand, agility on an existing S curve is an increasing requirement of the supply chain. In such cases, supply chain members are experienced in fulfilling their tasks and may be able to create innovations in the context of their existing tasks. If demand is stable and the product is routine, the buyer and seller will have the opportunity of interacting together to improve the cost performance of the existing product. Such minor incremental innovations are regularly introduced in many mature consumer product categories.

Proposition 8a: The greater the stability of the final consumer demand, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

In the case of new products, once a product concept is finalized, supply chain management creates the process innovations necessary to deliver it. From NutraSweet (Lynn, Morone, and Paulson 1996) to the Pez dispenser to Ebay (Hanson 2000), entire businesses have been built on the upstream supply chain based on concept testing followed by rapid development of the supply side. All of these product developments have been associated with drastic changes in consumer demand. We argue that as soon as consumer demand changes significantly and suddenly (or, at least, as soon as the concerned supply chain members anticipate changes in demand), distributors at the front end of the supply chain report back upstream and put rapid interactions with new upstream suppliers in place. These new suppliers are melded into a new supply chain. The creation of such a supply chain would call for intense adaptation and interaction during the early development stage of radical innovations (Hakansson 1987).

For relationships focused on radical innovations, uncertainty of demand will facilitate more interactions in a bid to assess the future demand and market requirements in terms of product and service features. By aligning its efforts, the supply chain becomes capable of meeting changing market demand. Unlike a product in its maturity stage, the uncertainty associated with the demand in the early stage offers an incentive for buyers and sellers to interact effectively and generate more radical innovations.

Proposition 8b: The lesser the stability of final consumer demand, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

Network Connections

Network connections include the buyer and seller firms' formal and informal networks outside the dyad. *Formal* relationships include relationships with the government, universities, and consultants and other contacts with more distant links in the supply chain. *Informal* networks are professional bonds that specialists have across several firms in communities of practice (COPs).

In the marketing literature, network theory (Achrol 1991; Anderson et al. 1994) maintains that network connections are important for innovation in supply chain contexts (Blankenburg-Holm, Eriksson, and Johanson 1996; Hakansson and Snehota 1995). Networks are efficient vehicles of organizational learning and flexible adaptability in turbulent environments (Achrol and Kotler 1999; Wilkinson 2001; Young and Wilkinson 1997). This effect is made possible by "loose coupling" (Weick 1976), which allows partners to interact and check out different understandings of the usage phenomena of the supplied product, often by going beyond the specific dyadic relationships. This loose coupling enables a better fit between those who can understand and create knowledge of a specific kind and those who can provide specific input knowledge at the work locale. Empirical studies in the automotive industry confirm that competence and knowledge creation occur in networks spanning buyers and sellers (e.g., Nooteboom et al. 2000), thereby resulting in incremental innovations.

Connected formal organizations directly concerned with innovation generation require meetings and interactions (e.g., Hovercraft in Rothwell and Gardiner 1985). Governments play a role by creating policy or by facilitating innovation generation (Shaw 1985). Similarly, universities work with organizations to generate innovation (Mowery 1998). Relationship theory suggests that buyers and sellers in such relationships will be committed to each other's success and will likely use these network connections to resolve issues as they arise on existing S curves.

In contrast to formal networks, professional networks are frequently very specific, with members sharing idiosyncratic and sometimes tacit knowledge. The main mechanism by which connected informal groups work in technical development and innovation generation is the COP. COPs are typically informal networks that capture the tacit know-how apart from the explicit knowledge of a particular discipline or knowledge domain (Orr 1990). Difficult to identify and measure directly (Millar, Demaid, and Quintas 1997), they include amorphous associations such as e-mail lists. They are sociotechnical in nature and include members of both the buyer and seller firms. The COP draws on the research of Orr (1990), who studied the manner in which Xerox service technicians solve copier problems on customer premises. Orr found that the technicians would gather among themselves to resolve error codes not explained by the machine's service manual. The community of technicians had a storehouse of tacit knowledge that could be extricated and combined on-site. The interaction between buyer and seller is enriched by the knowledge gained by the firms from their respective professional communities. Such enrichment can be effectively used to improve existing innovations.

COPs have flourished on the Internet, as in the case of interest groups that interact to solve problems without charging fees (e.g., SEMNET, the Structural Equation Modeling Internet Group and ELMAR [Electronic Marketing] of the American Marketing Association for Marketing Academics). The problems discussed are often so idiosyncratic and specific that only professional colleagues have the level of situated learning necessary to address them (Orr 1990). Nonetheless, people do respond with remarkably constructive suggestions that can very often resolve a bottleneck in an existing innovation to generate improvements (i.e., incremental innovations).

Proposition 9a: The greater the network connections of the buyer and seller *within* an industry group, the greater the impact of interaction on the generation of incremental innovations in supply chain relationships.

Each distinctive S curve is likely to have a domain-specific knowledge network (Almeida and Kogut 1997). For instance, consider the formal network connections of a steel part manufacturer versus those of a manufacturer that makes the same part out of engineering plastics. It is likely that the steel part manufacturer would have connections with people who majored in metallurgy, while the plastic part manufacturer might have stronger university connections to chemical engineering departments. Similarly, lobbying activity and government support might be very different for the two manufacturers, even when they are producing the same item for the same supply chain buyer. Relationships on new S curves will create access to such new networks, leading buyer-seller interactions to bring about radical innovations (Leifer, Colarelli O'Connor, and Rice 2001).

In the case of relationships involving a jump to a new S curve, the informal networks involved will be different from those that exist in relationships focused on making improvements on a given S curve (Leifer et al. 2001). For instance, consider a cookie maker that can use one of two packaging products, wax-coated paper or plastic-coated paper. Some professional communities will specialize in paper, wax, and wax-coated paper, while others will concentrate on paper, plastic, and plastic-coated paper. These communities in turn interact with machinery suppliers that belong to separate domain-specific knowledge communities. A cookie maker moving from wax-coated wrappers (one S curve) to the testing of a new plastic-coated cookie wrapper (a new S curve) is likely to encounter professional communities belonging to different technical associations. These associations will have different trade fairs and trade journals; members may have attended different technical schools than those connected with waxed paper and thus may have very different perspectives (Braun 2002). In short, such relationships involve divergent professional communities. Such divergence in knowledge domains is likely to facilitate the interaction needed for knowledge creation across domains and for radical innovation on a new S curve.

Proposition 9b: The greater the network connections of the buyer and the seller *across* industry groups, the greater the impact of interaction on the generation of radical innovations in supply chain relationships.

DISCUSSION

Buyer-seller relationships have been typically conceptualized as "vertical," conveying a sense of permanence, rigidity, and information redundancy (Achrol 1997). Meanwhile, horizontal alliances with competitors have been considered a rich source of new knowledge, although lacking the *motivation* for knowledge exchange (Rindfleisch and Moorman 2001). Our thesis is that buyer-seller relationships in supply chains, involving *new to the buyer* technology, bring benefits similar to those of the competitor alliances advocated in the literature. More important, because the supplier is motivated to gain new business and derives competitive strength from upstream supply chain innovation, the relationship is thus more sustainable (e.g., it is difficult to duplicate Dell and Toyota supply chains).

The relationship literature has studied dyadic issues such as trust and commitment, yet very few innovation studies have focused on individual dyads. Thus, a contribution of our work is to link the relationship and innovation literatures to help understand the innovation phenomenon at the dyadic, supply chain context. In doing so, we explicate the central importance of interaction in the generation of innovations. We contribute to the IMP perspective and that of Leonard-Barton (1993, 1995), Nonaka and Takeuchi (1995), and others by descending to the locale of work—that is, adjacent points of the supply chain. While these scholars have examined innovation in buyer-seller relationships at a strategic level, we examine the innovation phenomena at the operational level.

Managerial Implications

The proposed conceptual model and resulting research propositions have a number of important implications for managers. First, managers must appreciate that effective management of buyer-seller relationships is vital for increasing cost-efficiency and quality on the same S curve (incremental innovations) and for moving to new S curves (radical innovations). By sustaining relationships with existing suppliers, beginning relationships with new SBUs of current suppliers, and initiating relationships with entirely new suppliers and customers, the knowledge interface between buyers and sellers can be managed to bring about a variety of innovations necessary for the long-term success of firms.

Second, consistent with emerging discoveries by researchers and managers, our research proposes a useful framework to demonstrate that innovation is generated through the effective management of interface between various entities involved in the business's supply chain. However, unlike in business-to-business settings among other outsiders, suppliers are motivated to innovate and to help their buyers innovate. There must be a culture of continuous improvement or rise on a particular S curve as well as incentives to move to a new S curve. It is for the sake of radical innovation that buyers and sellers need to look beyond exploiting relationships into exploring new dimensions of a relationship or new relationships altogether.

Third, the growth in business-to-business e-commerce in supply chains is going to significantly exceed business-to-consumer e-commerce growth (Nagendra 2000). Most supply chain e-commerce models and interorganizational interfaces involve new processes that must be conceptualized, fine-tuned, and implemented. Our conceptual model is highly relevant to this important and emerging domain of business process innovations.

Finally, a firm must often balance incremental and radical innovation by creating appropriate environments. While some variables (e.g., trust) encourage both types of innovations, others (e.g., technology adoption) may affect one type positively and the other negatively. In the case of the latter variables, the challenge for the organization is not maximizing a given variable but optimizing it to maximize the benefits to the firm. The desired level of these organizational factors may depend on the strategic positioning of the organization and the demand dynamics.

Guidelines for Empirical Testing

Measurement Issues

To empirically test our model, appropriate measures for the constructs in our framework must be developed and purified. Table 1 presents the various constructs used in our work and guidelines for their measurement. These measures are suggested as potential starting points for detailed empirical work in this area. Our model contains two sets of variables: one set specific to the dyadic relationship and the other not under the control of the dyad. It may be worthwhile to test the dyadic factors of the model using data collected in one industry (or closely related industries) and to test the other factors by collecting data from several industries.

Unit of Analysis

Research on innovations in supply chain relationship entails use of the dyad as the unit of analysis. Such a unit has both drawbacks and benefits. While some independence will be lost between samples (the same organization can have multiple suppliers and vice versa), further detailed research can be adapted to address different research objectives. For example, several interactions within a large company can be studied to control for the variation in the seller's characteristics and to focus exclusively on supplier characteristics. As mentioned previously, some factors not specific to the dyads may also be common for entire industries; to test those relationships, data must be collected from several industries.

We realize that modifications in data collection procedures will be warranted based on the specific nature of the empirical testing, the nature of the industry (industries) that is (are) the focus of the analysis, as well as other data collection constraints and issues. Thus, in certain cases described subsequently, the unit of data collection may be different from the unit of data analysis.

TABLE 1
Variables, Definitions, and Illustrative Measures

Proposition	*Variable*	*Conceptual Definition*	*Exemplars of Operational Measure Items*	*Relevant References*
Propositions 1-9	Innovation generation	Movement up a specific S curve (incremental) and movement from one S curve to another S curve (radical)	Time taken to achieve product adaptations/ improvements (incremental); number of product adaptations/improvements during a given time period (incremental); managerial judgment on the nature of innovative activity (minor—incremental; major—radical); presence of drastic changes in technology platform or production processes (radical); speed of introduction of new technology (radical)	Chandrashekaran, Mehta, Chandrashekaran, and Grewal (1999); von Hippel (1988); Bower and Christensen (1995)
Propositions 1-9	Interaction	Quantity, scope, and mode of communication between buyer and seller	Number of messages exchanged between buyers and sellers during a given time (quantity); total time spent communicating during a given time (quantity); different levels of employees involved in information exchanges (scope); different divisions involved in information exchange (scope); nature of focus (narrow vs. broad) of the topic of communication (scope); formal versus informal nature of exchanges (mode); exchanges classified according to media such as e-mail, telephone, face-to-face, and mail (mode)	Hakansson and IMP Project Group (1982); Hakansson (1987); Leonard-Barton (1993); Shaw (1985); Saxenian (1991)
Proposition 2	Information technology (IT) Adoption	Extent to which business processes of the buyer and seller are IT enabled; extent to which the IT systems are integrated between the buyer and seller	Presence and extent of implementation of a material resource planning (MRP) system, electronic data interchange (EDI), and so on; ability of the supplier to have electronic access to parts of the production planning system of the buyer and vice versa; overlap in technology skills and usage in business processes of buyer and seller	Kalakota and Whinston (1999); Srivastava, Shervani, and Fahey (1999)
Proposition 3	Input commitment asymmetry	Difference between resource commitments by the buyer and seller	Difference in the presence and number of designated managers to handle a firm's account; difference in the extent of modifications in manufacturing system to suit particular requirements between seller and buyer; managerial perceptions of differences in dedicated inputs by buyer and seller	Anderson and Weitz (1992); Gundlach, Achrol, and Mentzer (1995)
Proposition 4	Attitudinal commitment asymmetry	Difference between buyer and seller organizations' identification with the goals for the dyad	Difference in willingness to allow participation in each other's technical development and marketing planning; managerial perception of the difference in the willingness of buyer and seller to identify with the firm's goals	Gundlach et al. (1995); O'Reilly and Chatman (1986)
Proposition 5	Competence trust	Confidence in the competence of the other party to execute the work at a high level of skill	Expectations of the quality and timeliness of supply of components, parts, and service; extent of backup arrangements to manage situations of failure to perform	Sako (1992); Joshi and Stump (1999)
Proposition 6	Goodwill trust	"Human" comfort element that the buyer and seller develop for each other	A firm's degree of expectation that the supplier will take care of the firm's interests without recourse to legal agreements; willingness to believe in the supplier/buyer not to reveal business plans to competitors	Barclay and Smith (1997); Gulati (1995)
Proposition 7	Tacitness of technology	Degree to which the technology is tacit (as opposed to explicit)	The extent of technical knowledge (regarding the supplied item) that is embedded in the minds and skills of supplier's technical people; the ability of new people to pick up new skills from the manuals and data available on files	Nonaka and Takeuchi (1995); Scott (1990); Weick and Roberts (1993)
Proposition 8	Stability of demand	Stability of consumer demand versus rapid changes in final consumer demand	Degree of variation in the final consumer demand for the converted end product of supply chain (daily, weekly, or monthly based on the product); frequency of change in consumer specifications and demand	Bowersox, Closs, and Stank (2000); Dyer, Cho, and Chu (1998)

(continued)

TABLE 1 (continued)

Proposition	*Variable*	*Conceptual Definition*	*Exemplars of Operational Measure Items*	*Relevant References*
Proposition 9	Network connections	Formal and informal network connections within an industry; formal and informal network connections across industries	The number of third parties (e.g., consultants, government) that are connected to the buyer and the supplier; extent of these organizations' ability to specify new product development approaches (e.g., governmental environmental agencies); professional/trade association memberships of buyer/supplier executives/technicians; attendance at professional conferences, trade shows, and so on; acceptance of professional certifications	Anderson, Hakansson, and Johanson (1994); Blankenburg-Holm, Eriksson, and Johanson (1996); Millar, Demaid, and Quintas (1997); Orr (1990); Shaw (1985)

Depending on how radical innovation is defined in a particular empirical dyadic supply chain context, almost any firm will have what it considers radical innovations that occurred in its role as a supplier or buyer in a supply chain. Therefore, one approach is to focus on a few companies, identify all of the radical and incremental innovations associated with that company's buyer-seller relationships in different supply chains, and work backward regarding the particular buyer-seller relationships. In this case, while the focus of data collection is the individual firm, the unit of analysis for empirical validation remains at the level of the buyer-seller dyad. Although the data collection procedure would be more involved in certain industries, it may be necessary to achieve a reasonable sample size. For example, a researcher may choose to begin with a list of radical innovations in the software industry. The researcher can then work backward by identifying the buyer-seller dyads involved in these innovations (following von Hippel 1988). Thus, in this case, although the innovation is the primary sampling unit for data collection, the dyad is still the unit of data analysis (we sincerely thank an anonymous reviewer for suggesting this possibility).

In other instances, to facilitate data collection and respondent cooperation, especially in the case of large companies with several SBUs and several instances of innovation generation in each of the different supply chain memberships, a researcher may be interested in selecting a few companies as the primary sampling unit for data collection. The secondary sampling unit could be the individual innovations (as described previously), and data associated with dyads could then be collected; alternatively, the secondary sampling unit for data collection could be the dyads. In either case, it must be noted that although the unit of "data collection" may be different, the unit of "data analysis" is the dyad, as proposed in our conceptual framework.

It is also likely that we may observe that an innovation does not result exclusively from one dyad but from multiple buyer-seller interactions. In such instances, although the basic premise of our framework is still valid, the empirical testing of our propositions needs to be modified (we are grateful to an anonymous reviewer for pointing this out). Although we did not include this possibility in our conceptual framework due to space constraints, we do offer the following guidelines on treating this issue at the empirical level. In contrast to the nature of the business-to-consumer marketplace, in which consumer heterogeneity exists but is not extreme, the business-to-business marketplace is often characterized by extreme heterogeneity of demand, which in turn is reflected in differential strategic importance of the dyad, differential proportion of revenue generation, and so on. For example, a supplier of printed cartons will supply a much larger quantity of cartons to Kellogg Cereals than to a small food products manufacturer. Clearly, giving all dyads, the same level of importance may not be appropriate as firms are bound to treat different customers differently (these differences are normally less pronounced in consumer marketing than in business-to-business marketing).

One way to handle this problem empirically is to identify the most important dyad for each innovation and to use the data in the empirical analysis. Another way is to identify a few of the most important dyads (e.g., the top three dyads), to take their mean value, and to conduct the analysis. In this case, the individual innovation becomes the primary sampling unit, the three dyads become the secondary sampling unit for data collection, and the mean value of the three dyads becomes the unit for data analysis. A third method would be to use buyer firms as the primary sampling unit, to identify several of their important dyadic relationships, to identify the innovations generated in those relationships, and to either consider the innovations as individual data points or take the average across the dyads or across the innovations for data analysis.

A related issue that is relevant but not addressed in this manuscript, in the interest of space, is the explicit role of strategic importance of a dyad for the firm. We believe that there are conceptual rationales for proposing that the link between interaction and innovation generation will be strengthened when the strategic importance of the dyad increases. This is because both the buyer and the seller will be conscious of their interdependence; such interdependence will spur them to be more alert in attaining the full benefits of interaction in innovation generation. Empirically, this issue can be addressed either by using strategic importance as a control variable or as another moderator of the link between interaction and innovation generation. A more detailed treatment of this variable is left for future research.

Operational Details of Data Collection

In this section, we present some pointers to guide empirical research but note that there are other ways to conduct empirical research in this area. Like business-to-business relationship researchers (Chandy and Tellis 1998), we recommend that researchers address their questionnaires to either (a) buyers or buying agents of organizations at the SBU level or (b) industrial marketing managers or account managers (following, e.g., the IMP researchers including Hakansson 1987). Since our purpose is not to predict purchase but to investigate the nature of innovation generation and its determinants, in our selection and screening of respondents, we are more concerned with buyer-seller relationships and innovation generation than with market share or profits.

Several variations are possible in the design of the data collection method. Industry lists for specific industries may be purchased (following Sivadas and Dwyer 2000); firms from a variety of industries can be used (following Chandy and Tellis 1998); or a list relevant to innovation generation, such as the membership of the Product Development and Management Association (PDMA) (as in Griffin 1997), can be used. Given the boom in global outsourcing of goods and services reported in the business press, we also see tremendous possibilities in surveying global supply chain partners to empirically test aspects of our conceptual framework.

Future Research Directions

One relevant future research direction would be to arrive at the relative magnitudes of the impact of the various factors considered in this article. Although our work represents an important attempt at conceptualization of innovation generation in supply chain contexts, the relative importance of the various factors in fostering innovation generation remains an empirical question. It is also possible that the relative role of the factors will depend on internal and external characteristics of the seller-buyer dyad. We believe researchers must develop contingency frameworks to arrive at clearer conceptions of the domain.

A second future research direction is to develop a normative model for organizational decision making to facilitate innovation generation. This will allow certain questions to be answered, such as, "What levels of various factors are needed to achieve optimal innovation generation in supply chain relationships?" and "What is the quantitative impact of changing an organizational decision variable on innovation generation?" These and other important questions must await further conceptual development and empirical research.

Finally, researchers could develop frameworks and methodologies to relate the role of innovation generation factors in supply chains to a firm's ultimate performance. Clearly, success in innovation generation is often not a firm's final destination. The effect of these innovations on the overall performance of the company is the next logical question to consider. We believe researchers will become interested in a comprehensive understanding of the factors related to overall organizational performance.

CONCLUSION

We proposed that interactions between the buyer and seller in supply chain relationships can lead to both incremental and radical innovations. Our article attempted to meld several dominant theoretical developments of our time into a combined field of scholarly inquiry and managerial practice with regard to innovation management in supply chain relationships. By focusing on upstream supply chain relationships, we contributed to the theoretical discourse that is relevant in the context of the rapid growth in global supply chains, not only in manufacturing firms but also in service firms and knowledge intensive firms. From a managerial perspective, by explicating the link between interaction and innovation generation and the effect of several moderating factors, our framework offers managers a way of more thoughtfully managing innovations in supply chain relationships.

ACKNOWLEDGMENTS

The authors appreciate funding from the Institute for the Study of Business Markets (ISBM) of the Pennsylvania State University for conducting this research. An earlier version of the article appeared as ISBM Working Paper 9-2000. The authors are deeply grateful to the editor and reviewers for their insightful comments and detailed guidelines on earlier versions of this article. The authors also thank Kwaku Atuahene-Gima, Gloria Barczak, David Cravens, Erwin Danneels, Sangphet Hanvanich, Gary Lilien, and Rodney Stump for comments on previous versions of the article.

REFERENCES

Achrol, Ravi S. 1991. "Evolution of the Marketing Organization: New Forms for Dynamic Environments." *Journal of Marketing* 55 (October): 77-93.

———. 1997. "Changes in the Theory of Inter-Organizational Relations in Marketing: Toward a Network Paradigm." *Journal of the Academy of Marketing Science* 25 (1): 56-71.

——— and Philip Kotler. 1999. "Marketing in the Network Economy." *Journal of Marketing* 63 (July): 146-163.

Alderson, Wroe and Michael H. Halbert. 1968. *Men, Motives, and Markets*. Englewood Cliffs, NJ: Prentice Hall.

Almeida, Paul and Bruce Kogut. 1997. "The Exploration of Technological Diversity and Geographic Localization of Innovation." *Small Business Economics* 9 (1): 21-31.

Anderson, Erin and Barton Weitz. 1992. "The Use of Pledges to Build and Sustain Commitment in Distribution Channels." *Journal of Marketing Research* 29 (February): 18-34.

Anderson, James C., Hakan Hakansson, and Jan Johanson. 1994. "Dyadic Business Relationships Within a Business Network Context." *Journal of Marketing* 58 (1): 1-15.

Asthana, Praveen. 1995. "Jumping the Technology S-Curve." *IEEE Spectrum* 32 (6): 49-55.

Athaide, Gerard A., Patricia W. Meyers, and David L. Wilemon. 1996. "Seller-Buyer Interactions During the Commercialization of Technological Process Innovations." *Journal of Product Innovation Management* 13 (5): 406-421.

Badaracco, Joseph L. 1991. *The Knowledge Link: How Firms Compete Through Strategic Alliances*. Boston: Harvard Business School Press.

Barclay, Donald W. and J. Brock Smith. 1997. "The Effects of Organizational Differences and Trust on the Effectiveness of Selling Partner Relationships." *Journal of Marketing* 61 (January): 3-21.

Bidault, Francis, Charles Despres, and Christina Butler. 1998a. "The Drivers of Cooperation Between Buyers and Suppliers for Product Innovation." *Research Policy* 26 (7-8): 719-732.

———, ———, and ———. 1998b. "New Product Development and Early Supplier Involvement (ESI): The Drivers of ESI Adoption." *International Journal of Technology Management* 15 (1-2): 49-67.

Blankenburg-Holm, Desiree, Kent Eriksson, and Jan Johanson. 1996. "Business Networks and Cooperation in International Business Relationships." *Journal of International Business Studies* 27 (5): 1033-1053.

Bower, Joseph L. and Clayton M. Christensen. 1995. "Disruptive Technologies: Catching the Wave." *Harvard Business Review* 73 (January/February): 43-53.

Bowersox, Donald J., David J. Closs, and Theodore P. Stank. 2000. "Ten Mega-Trends That Will Revolutionize Supply Chain Logistics." *Journal of Business Logistics* 21 (2): 1-16.

Braun, Patrice. 2002. "Digital Knowledge Networks: Linking Communities of Practice With Innovation." *Journal of Business Strategies* 19 (1): 43-54.

Brown, John Seely and Paul Duguid. 1991. "Organizational Learning and Communities of Practice: Towards a Unified view of Working, Learning and Innovation." *Organization Science* 2 (1): 40-45.

Brown, Shona L. and Kathleen M. Eisenhardt. 1995. "Product Development: Past Research, Present Findings and Future Directions." *Academy of Management Review* 20 (2): 343-378.

Burt, Ronald S. 1987. "Social Contagion and Innovation: Cohesion Versus Structural Equivalence." *American Journal of Sociology* 92 (6): 1287-1335.

———. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.

Cachon, Gerard P. and Marshall Fisher. 2000. "Supply Chain Inventory Management and the Value of Shared Information." *Management Science* 46 (8): 1032-1048.

Chandrashekaran, Murali, Raj Mehta, Rajesh Chandrashekaran, and Rajdeep Grewal. 1999. "Market Motives, Distinctive Capabilities, and Domestic Inertia: A Hybrid Model of Innovation Generation." *Journal of Marketing Research* 36 (February): 95-112.

Chandy, Rajesh K. and Gerard J. Tellis. 1998. "Organizing for Radical Product Innovation: The Overlooked Role of Willingness to Cannibalize." *Journal of Marketing Research* 35 (November): 474-487.

——— and ———. 2000. "The Incumbent's Curse? Incumbency, Size, and Radical Product Innovation." *Journal of Marketing* 64 (July): 1-17.

Christensen, Clayton M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Cambridge, MA: Harvard Business School Press.

Clark, Kim B. and Takahiro Fujimoto. 1990. "The Power of Product Integrity." *Harvard Business Review* 68 (6): 107-118.

——— and ———. 1991. *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Boston: Harvard Business School Press.

Cooper, Robert G. 1998. *Product Leadership Creating and Launching Superior New Products*. Reading, MA: Perseus Books.

———, Scott J. Edgett, and Elko J. Kleinschmidt. 1998. "Best Practices for Managing R&D Portfolios." *Research Technology Management* 41 (4): 20-33.

Crawford, C. Merle and C. Anthony Di Benedetto. 2000. *New Product Management*. Boston: McGraw-Hill.

Day, George S. 1994. "The Capabilities of Market-Driven Organizations." *Journal of Marketing* 58 (October): 37-52.

Dodgson, Mark. 1993. "Learning, Trust and Technological Collaboration." *Human Relations* 46 (1): 77-95.

——— and Roy Rothwell, eds. 1994. *The Handbook of Industrial Innovation*. Hants, UK: Edward Elgar.

Dwyer, F. Robert, Paul H. Schurr, and Sejo Oh. 1987. "Developing Buyer Seller Relationships." *Journal of Marketing* 51 (April): 11-27.

Dyer, Jeffrey H., Dong Sung Cho, and Wujin Chu. 1998. "Strategic Supplier Segmentation: The Next "Best Practice" in Supply Chain Management." *California Management Review* 40 (2): 57-77.

European Commission. 1996. *RITTS and RIS Guidebook*: *Regional Actions for Innovation*. Brussels, Belgium: European Commission.

Ford, David. 1980. "The Development of Buyer-Seller Relationships in Industrial Markets." *European Journal of Marketing* 14 (5-6): 339-354.

Foster, Richard. 1986. *Innovation: The Attacker's Advantage*. New York: Summit Books.

Frazier, Gary L. 1999. "Organizing and Managing Channels of Distribution." *Journal of the Academy of Marketing Science* 27 (Spring): 226-240.

Gambetta, Diego. 1988. "Can We Trust Trust?" In *Trust: Making and Breaking Cooperative Relations*. Ed. Diego Gambetta. New York: Basil Blackwell, 213-237.

Ganesan, Shankar. 1994. "Determinants of Long-Term Orientation in Buyer-Seller Relationships." *Journal of Marketing* 58 (April): 1-18.

Goodman, Paul and Lee Sproull. 1990. *Technology and Organizations*. San Francisco: Jossey-Bass.

Granovetter, Mark. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78 (May): 1360-1380.

Griffin, Abbie. 1997. "The Effect of Project and Process Characteristics on Product Development Cycle Time." *Journal of Marketing Research* 34 (February): 24-35.

Gulati, Ranjay. 1995. "Does Familiarity Breed Trust? The Implications of Repeated Ties for Contractual Choice in Alliances." *Academy of Management Journal* 38 (February): 85-112.

———. 1998. "Alliances and Networks." *Strategic Management Journal* 19 (4): 293-317.

Gundlach, Gregory, Ravi Achrol, and John Mentzer. 1995. "The Structure of Commitment in Exchange." *Journal of Marketing* 59 (January): 78-92.

Hakansson, Hakan. 1987. *Industrial Technological Development: A Network Approach*. Kent, UK: Croom Helm.

——— and IMP Project Group. 1982. *International Marketing and Purchasing of Industrial Goods*. Chichester, NY: John Wiley.

——— and Ivan Snehota, eds. 1995. *Developing Relationships in Business Networks*. London: Routledge.

Hallen, Lars, Jan Johanson, and Nazeem Seyed-Mohamed. 1991. "Inter-Firm Adaptation in Business Relationships." *Journal of Marketing* 55 (April): 29-37.

Hammer, Michael. 2001. "The Super-Efficient Company." *Harvard Business Review* 77 (September): 82-91.

Hanson, Ward. 2000. *Principles of Internet Marketing*. Cincinnati, OH: South-Western College Publishing.

Henderson, Rebecca M. and Kim B. Clark. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." *Administrative Science Quarterly* 35 (March): 9-30.

Jap, Sandy D. 1999. "Pie-Expansion" Efforts: Collaboration in Buyer-Supplier Relationships." *Journal of Marketing Research* 36 (4): 461-475.

——— and Shankar Ganesan. 2000. "Control Mechanisms and the Relationship Life Cycle: Implications for Safeguarding Specific Investments and Developing Commitment." *Journal of Marketing Research* 37 (May): 227-245.

Joshi, Ashwin W. and Rodney L. Stump. 1999. "The Contingent Effect of Specific Asset Investments on Joint Action in Manufacturer-Supplier Relationships: An Empirical Test of the Moderating Role of Reciprocal Asset Investments, Uncertainty, and Trust." *Journal of the Academy of Marketing Science* 27 (3): 291-305.

Kalakota, Ravi and Marcia Robinson. 1999. *E-Business: Roadmap for Success*. Reading, MA: Addison-Wesley.

——— and Andrew B. Whinston. 1999. *Frontiers of Electronic Commerce*. Reading, MA: Addison-Wesley.

Laage-Hellman, Jens. 1997. *Business Networks in Japan Supplier-Customer Interaction in Product Development*. London: Routledge.

Lambe, C. Jay, Robert E. Spekman, and Shelby D. Hunt. 2000. "Interimistic Relational Exchange: Conceptualization and Propositional Development." *Journal of the Academy of Marketing Science* 28 (2): 212-225.

Lave, Jean and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge, UK: Cambridge University Press.

Leifer, Richard, Gina Colarelli O'Connor, and Mark Rice. 2001. "Implementing Radical Innovation in Mature Firms: The Role of Hubs." *Academy of Management Executive* 15 (3): 102-113.

Leonard-Barton, Dorothy. 1993. "Developer-User Interaction and User Satisfaction in Internal Technology Transfer." *Academy of Management Journal* 36 (5): 1125-1139.

———. 1995. *Wellsprings of Knowledge-Building and Sustaining the Sources of Innovation*. Boston: Harvard Business School Press.

Lundvall, Bengt-Ake. 1985a. "Innovation as an Inter-Active Process: From User-Producer Interaction to the National System of Innovation." In *Technical Change and Economic Theory*. Eds. Giovanni Dosi, Christopher Freeman, Richard Nelson, Gerald Silverberg, and Luc Soete. London: Pinter, 349-369.

———. 1985b. *Product Innovation and User-Producer Interaction*. Aalborg, Denmark: Aalborg University Press.

Lynn, Gary S., Joseph G. Morone, and Albert S. Paulson. 1996. "Marketing and Discontinuous Innovation: The Probe and Learn Process." *California Management Review* 38 (3): 8-37.

Madhavan, Ravindranath and Rajiv Grover. 1998. "From Embedded Knowledge to Embodied Knowledge." *Journal of Marketing* 62 (October): 1-12.

March, James G. 1991. "Exploration and Exploitation in Organizational Learning." *Organizational Science* 2 (February): 71-87.

Mentzer, John T. and Kenneth B. Kahn. 1995. "A Framework of Logistics Research." *Journal of Business Logistics* 16 (1): 231-250.

Meyers, Patricia W., K. Sivakumar, and Cheryl Nakata. 1999. "Implementation of Industrial Process Innovations: Factors, Effects, and Marketing Implications." *Journal of Product Innovation Management* 16 (3): 295-311.

Millar, Jane, Adrian Demaid, and Paul Quintas. 1997. "Trans-Organizational Innovation: A Framework for Research." *Technology Analysis & Strategic Management* 9 (4): 399-418.

Millson, Murray R., S. P. Raj, and David Wilemon. 1996. "Strategic Partnering for Developing New Products." *Research Technology Management* 12 (May/June): 41-49.

Mohamed, Zairi. 1992. "Managing User-Supplier Interactions: Management of R&D Activity." *Management Decision* 30 (August): 49-57.

Mohr, Jakki J., Robert J. Fisher, and John R. Nevin. 1996. "Collaborative Communication in Inter-Firm Relationships: Moderating Effects of Integration and Control." *Journal of Marketing* 60 (July): 103-115.

——— and John R. Nevin. 1990. "Communication Strategies in Marketing Channels: A Theoretical Perspective." *Journal of Marketing* 54 (4): 36-52.

Morgan, Robert M. and Shelby D. Hunt. 1994. "The Commitment-Trust Theory of Relationship Marketing." *Journal of Marketing* 58 (July): 20-38.

Morone, Joseph. 1993. *Winning in High-Tech Markets*. Cambridge, MA: Harvard Business School Press.

Mowery, David C. 1998. "Collaborative R&D: How Effective Is it?" *Issues in Science and Technology* 15 (1): 37-44.

Nagendra, Prashanth B. 2000. "The B2b E-Commerce Challenge." *International Journal of Commerce and Management* 10 (1): 1-3.

Nonaka, Ikujiro and Hirotaka Takeuchi. 1995. *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York: Oxford University Press.

Nooteboom, Bart. 2000. "Institutions and Forms of Co-Ordination in Innovation Systems." *Organization Studies* 21 (5): 915-939.

———, Hans Berger, and Niels G. Noorderhaven. 1997. "Effects of Trust and Governance on Relational Risk." *Academy of Management Journal* 40 (2): 308-338.

———, Gjalt De Jong, Robert W. Vossen, Susan Helper, and Mari Sako. 2000. "Network Interactions and Mutual Dependence: A Test in the Car Industry." *Industry and Innovation* 7 (1): 117-144.

Ogawa, Susumu. 1998. "Does Sticky Information Affect the Locus of Innovation? Evidence From the Japanese Convenience-Store Industry." *Research Policy* 26 (7-8): 777-790.

O'Reilly, Charles, III and Jennifer Chatman. 1986. "Organizational Commitment and Psychological Attachment: The Effects of Compliance, Identification, and Internalization on Prosocial Behavior." *Journal of Applied Psychology* 71 (3): 492-499.

Orr, Julian E. 1990. "Sharing Knowledge, Celebrating Identity: Community Memory in a Service Culture." In *Collective Remembering*. Eds. David Middleton and Derek Edwards. London: Sage, 169-189.

Perry, Chad, Angele Cavaye, and Len Coote. 2002. "Technical and Social Bonds Within Business-to-Business Relationships." *Journal of Business & Industrial Marketing* 17 (1): 75-86.

Polanyi, Michael. 1967. *The Tacit Dimension*. New York: Doubleday.

Quayle, Michael. 2000. "Supplier Development for UK Small and Medium-Sized Enterprises." *Journal of Applied Management Studies* 9 (1): 117-133.

Rindfleisch, Aric and Christine Moorman. 2001. "The Acquisition and Utilization of Information in New Product Alliances: A Strength-of-Ties Perspective." *Journal of Marketing* 65 (April): 1-18.

Robertson, Thomas S. and Hubert Gatignon. 1998. "Technology Development Mode: A Transaction Cost Conceptualization." *Strategic Management Journal* 19 (6): 515-531.

Robinson, Patrick J., Paul W. Farris, and Yoram Wind. 1967. *Industrial Buying and Creative Marketing*. Boston: Allyn & Bacon.

Rothwell, Roy and Paul Gardiner. 1985. "Invention, Innovation, Re-Innovation and the Role of the User: A Case Study of the British Hovercraft Development." *Technovation* 3 (4): 167-186.

Sako, Mari. 1992. *Prices, Quality and Trust: Inter-Firm Relations in Britain and Japan*. Cambridge, UK: Cambridge University Press.

———. 1994. "Supplier Relationships and Innovation." In *The Handbook of Industrial Innovation*. Eds. Mark Dodgson and Roy Rothwell. London: Edward Elgar.

Saxenian, Anna Lee. 1991. "The Origins and Dynamics of Production Networks in Silicon Valley." *Research Policy* 20 (5): 423-437.

Schrage, Michael. 2000. *Serious Play*. Boston: Harvard Business School Press.

Scott, W. Richard. 1990. "Technology and Structure. An Organizational Level Perspective." In *Technology and Organizations*. Eds. Paul S. Goodman, Lee S. Sproull, and Associates. San Francisco: Jossey-Bass, 109-143.

Shaw, Brian. 1985. "The Role of the Interaction Between the User and the Manufacturer in Medical Equipment Innovation." *R&D Management* 15 (4): 283-292.

Sheth, Jagdish N. 1996. "Organizational Buying Behavior: Past Performance and Future Expectations." *Journal of Business & Industrial Marketing* 11 (3): 7-24.
——— and Rajendra S. Sisodia. 1999. "Revisiting Marketing's Lawlike Generalizations." *Journal of the Academy of Marketing Science* 27 (1): 71-87.
Sivadas, Eugene and F. Robert Dwyer. 2000. "An Examination of Organizational Factors Influencing New Product Success in Internal and Alliance-Based Processes." *Journal of Marketing* 64 (January): 31-49.
Srivastava, Rajendra K., Tasadduq A. Shervani, and Liam Fahey. 1999. "Marketing, Business Processes, and Shareholder Value: An Organizationally Embedded View of Marketing Activities and the Discipline of Marketing." *Journal of Marketing* 63 (Special Issue): 168-179.
Taylor, Peter and Julian Lowe. 1997. "Are Functional Assets or Knowledge Assets the Basis of New Products." *Technology Analysis and Strategic Management* 9 (4): 473-488.
Truffer, Bernhard and Gregor Durrenberger. 1997. "Outsider Initiatives in the Reconstruction of the Car: The Case of Lightweight Vehicle Milieus in Switzerland." *Science, Technology, & Human Values* 22 (2): 207-234.
Tushman, Michael L. and Lori Rosenkopf. 1992. "Organizational Determinants of Technological Change: Toward a Sociology of Technological Evolution." *Research in Organizational Behavior* 14 (4): 311-347.
Tyre, Marcie J. and Eric von Hippel. 1997. "The Situated Nature of Adaptive Learning in Organizations." *Organization Science* 8 (January/February): 71-83.
Uzzi, Brian. 1997. "Social Structure and Competition in Inter-Firm Networks: The Paradox of Embeddedness." *Administrative Science Quarterly* 42:35-67.
von Hippel, Eric. 1987. "Cooperation Between Rivals: Informal Know-How Trading." *Research Policy* 16 (December): 291-302.
———. 1988. *The Sources of Innovation*. New York: Oxford University Press.
———. 1994. "'Sticky Information' and the Locus of Problem Solving: Implications for Innovation." *Management Science* 40 (April): 429-439.
Wathne, Kenneth H., Harald Biong, and Jan B. Heide. 2001. "Choice of Supplier in Embedded Markets: Relationship and Marketing Program Effects." *Journal of Marketing* 65 (April): 54-66.
Weick, Karl E. 1976. "Educational Organizations as Loosely Coupled Systems." *Administrative Science Quarterly* 21 (1): 1-25.
———. 1990. "Technology as Equivoque: Sensemaking in New Technologies." In *Technology and Organizations*. Eds. Paul S. Goodman, Lee Sproull, and Associates. San Francisco: Jossey-Bass, 1-44.
——— and Karlene H. Roberts. 1993. "Collective Mind in Organizations: Heedful Interrelating on Flight Decks." *Administrative Science Quarterly* 38 (3): 357-381.
Weiss, Alan M. and Jan Heide. 1993. "The Nature of Organizational Search in High Technology Markets." *Journal of Marketing Research* 30 (2): 220-233.
Wilkinson, Ian. 2001. "History of Channels and Network Thinking in Marketing in the 20th Century." *Australasian Marketing Journal* 9 (2): 23-53.
Williamson, Oliver E. 1985. *The Economic Institutions of Capitalism*. New York: Free Press.
Wilson, David T. 1995. "An Integrated Model of Buyer-Seller Relationships." *Journal of the Academy of Marketing Science* 23 (Fall): 335-345.
Wind, Jerry and Vijay Mahajan. 1997. "Issues and Opportunities in New Product Development: An Introduction to the Special Issue." *Journal of Marketing Research* 34 (February): 1-12.
Young, Louise and Ian Wilkinson. 1997. "The Space Between: Towards a Typology of Inter-Firm Relations." *Journal of Business-to-Business Marketing* 4 (2): 53-97.

ABOUT THE AUTHORS

Subroto Roy (sroy@newhaven.edu) (Ph.D., University of Western Sydney, 2002) is an assistant professor of marketing and international business at the University of New Haven since 2001. Prior to his Ph.D., he had more than 12 years of experience in packaging industry (Tetra Pak) marketing and sales. Involved with several upstream industrial new product development projects he helped clients launch more than 100 brands. Current research interests include global supply chains, technology adoption, and knowledge outsourcing. His work has appeared in *American Marketing Association Educators Conferences* and is forthcoming in *Industrial Marketing Management*, among others. He is a co–guest editor of a special issue of the *Journal of Business and Industrial Marketing* and has consulted with leading companies in Australia and Asia. See http://www.newhaven.edu/faculty/roy.

K. Sivakumar (k.sivakumar@lehigh.edu) (Ph.D., Syracuse University, 1992) is the Arthur Tauck Professor of International Marketing & Logistics and a professor of marketing at Lehigh University. His research interests include pricing, global marketing, innovation management, and supply/value chain management. His research has been published in the *Journal of the Academy of Marketing Science*, the *Journal of Marketing*, the *Journal of International Business Studies*, *Marketing Letters*, the *Journal of Business Research*, *International Marketing Review*, *Pricing Strategy & Practice: An International Journal*, and other publications. He has won several awards for research. He is on the editorial board of six journals. Home page: www.lehigh.edu/~kasg.

Ian F. Wilkinson (i.wilkinsonunsw.edu.au) is a professor in the school of marketing at the university of new south wales since 2001. His current research focuses on interfirm relations and networks in domestic and international markets and the dynamics and evolution of markets, including applications of complexity theory. His research has appeared in many journals including the *Journal of the Academy of Marketing Science*, the *Journal of Business Research*, the *Journal of World Business*, the *Journal of International Marketing*, the *European Journal of Marketing*, *Industrial Marketing Management*, the *Journal of Industrial and Business Marketing*, and the *Journal of Applied Psychology.* He is on the editorial board of 12 scholarly journals. See http://www.marketing.unsw.edu.au/PEOPLE/HTML/IWilkinson.html.