A Social-Cognitive Perspective on Firm Innovation

Yang Xu
Penn State University, New Kensington

Innovation is the central value of economic behavior, and this paper proposes a social-cognitive perspective for studying the sources of firm innovation. In the context of firm innovation, the cognitions of top management teams or an entrepreneur shape the way they use the social structure available to them, while the social structures influence the embedded actors' cognitions and ultimately their strategic actions. Managers and entrepreneurs form collaborative partnerships designed to achieve innovation and competitiveness. During this dynamic social learning process, cognitive differences influence the formation of social capital and its realized benefits. The impact of social capital on innovation can hardly be evaluated without understanding individual cognitive characteristics first. By distinguishing between cognitive structures, as well as social capital characteristics, and by investigating their effects on firm innovation, this paper extends the literature on organization theory and innovation research.

INTRODUCTION

Innovation is the driving force of economic growth, but much confusion centers on how to encourage it. This paper reviews the literature on social networks and organizational learning and incorporates the cognitive and social factors that influence innovation research. A firm's social capital constitutes an important source of its innovation, and the cognitive understanding of a firm's management team or its entrepreneurs of innovation also contribute to this initiative. Accordingly, this paper addresses three related questions regarding cognition, social capital, and innovation. First, how do external social capital and internal cognitive structure influence each other in the process of undertaking innovation? Second, how does social capital influence a firm's innovation? Third, how do cognitive structures influence innovation? In examining these questions, I addresses one fundamental question in strategic management: How do firms achieve innovation?

Innovation involves both the generation and the exploitation of new products, processes, services and business practices. As a special kind of economic activity, innovation requires special kinds of informational and coordination mechanisms (Teece, 1992). Technological innovation is, of course, an important source of differentiation in organizations (Nelson & Winter, 1982). A firm's competitive advantage rests both on exploiting current technologies and resources so as to achieve efficiency, and on exploring new opportunities (March, 1991; Teece, Pisano, & Shuen, 1997).

Meanwhile, social capital has been defined as networks of relationships and assets located in these networks (Batjargal, 2003; Bourdieu, 1986; Burt, 1997; Coleman, 1988; Lin, 2001a). Dynamic industries find social capital crucially necessary to support innovative activities. In a competitive marketplace, the profitable commercialization of technology requires timely access to complementary assets, and the study of the effects of various social networks on innovation output can provide insights into this process. In a

homogeneous social network, firms focus on logical extensions of their past successes. In a diverse social network, a firm's access to external heterogeneous knowledge and ideas can enhance its explorative innovations.

Cognition has been defined as the knowledge structures or mental templates that actors impose on an information domain to give it form and meaning (Lyles & Schwenk, 1992; Walsh, 1995). The process of innovation is influenced by the cognitive mechanisms through which people acquire, store, transform and use information. Innovative activities arise from the actors' actions; therefore, understanding why and how these persons act as they do becomes essential to understanding the innovation process itself. Since minds propel actions, managerial cognition lies at the center of the strategic management process (Stubbart, 1989). This paper incorporates the top management team's or the entrepreneur's cognitions in the creation of a firm's social capital and explores their effects on innovation output.

RESEARCH ON INNOVATION, SOCIAL CAPITAL AND COGNITIONS

Next I present a focused literature review of innovation research, social capital studies of innovation, and cognition studies of innovation. I then build a theoretical model based on the representative works reviewed in this section.

Innovation Research

Product and process innovations constantly disturbed the evolutionary process of enterprises (Nelson & Winter, 1982; Schumpeter, 1934). Innovative behavior is a strategic activity by which organizations gain and lose competitive advantage (Jelinek & Schoonhoven, 1990; Von Hippel, 1988). Innovation can involve the implementation of new combinations of different resources in a firm (Drucker, 1998; Hargadon, 2002). Two principal types of innovation include technological innovation and social innovation. At the firm level, this paper focuses on technological innovation.

In technological innovation, firms conduct exploratory and exploitative search activities. Exploration and exploitation have been shown as fundamentally different search behaviors (Benner & Tushman, 2002; Katila & Ahuja, 2002; March, 1991). In exploitative search, a firm builds on its existing technological capabilities, whereas in exploratory search, a firm looks for new capabilities. This is a two-dimensional construct. A firm could leverage its existing knowledge base and explore new technological trajectories simultaneously (Christensen, 1997; Rosenkopf & Nerkar, 2001; Sorenson & Stuart, 2000).

In the organization learning literature, exploitation – or incremental improvements to knowledge – results in greater rates of success through practice; exploration – or radical extensions of knowledge – results in increased variation with reduced probability of success from each effort (March, 1991; McGrath, 2001). Knowledge is a strategic resource the firm can possess and upon which it can build a sustainable competitive advantage (Marsh & Ranft, 1999; Nonaka, 1994; Simonin, 1999). Learning promotes comparative innovative efficiency, and firms must be able to identify, create and continuously manage knowledge, technological knowledge in particular, to generate value (Hitt, Ireland, & Lee, 2000). Technology is a form of knowledge, and one can understand technological change by examining knowledge development (Bettis & Hitt, 1995; Garud & Nayyar, 1994; Mokyr, 1990). Organizational arrangements that provide access to knowledge quickly and reliably produce competitive advantages (Nelson, 1990; Stinchcombe, 1990). In organizational sociology, the system within which one finds economic or social exchanges generates value and meaning apart from the instrumental worth (Rumelt, Schendel, & Teece, 1994). The embedded members of a network engage in reciprocal exchanges without expecting immediate benefits in return. Network exchange need be neither simultaneous nor subject to the short-term rational calculations of a market transaction (Gopalakrishnan & Damanpour, 1997). In the process of innovation, shared values and mutual trust facilitate economic exchanges.

Strategic decisions and managerial controls also shape innovation. Managers make strategic choices among competing research ideas so as to advance them into product innovations. A strategy of concentrating innovation in new areas unrelated to the existing customer base or existing technologies is purely exploratory, whereas focusing new product innovation entirely around existing complementary

assets is essentially exploitative (Danneels, 2002). In other words, exploitation builds on or extends a firm's existing knowledge while exploration requires new knowledge and capabilities. New entrants typically conduct exploration (Foster, 1986; Sull, Tedlow, & Rosenbloom, 1997). By contrast, established incumbents often choose exploitation (Abernathy & Utterback, 1978; Tushman & Anderson, 1986). The balance between exploration and exploitation is driven by strategic decisions to become an inventor or an early imitator, or a strategy to reduce risk by "sticking to the knitting" of existing core competences (Dosi, 1988). Managers control the innovation novelty path by selecting among those ideas to be advanced into innovations, with an underlying dependence on the firm's strategy to stick to existing competences and resources or to take risks in new areas.

Social Capital Studies of Innovation

Social capital refers to the resources a firm's contacts possess and the structure of those contacts in a network (Burt, 1992). These actual or potential resources are embedded in social networks accessed and used by actors for actions (Lin, 2001a). These actions are linked to the possession of a durable network of relationships, mutual acquaintances and recognition (Bourdieu, 1986). The term social capital was first used to describe the social networks one finds in mixed-use neighborhoods in large cities (Jacobs, 1961). The term expanded to acquire a general application to economic development (Coleman, 1986; Coleman, 1988). Different from physical capital and human capital, social capital exists in the structure of relations between and among associated actors, facilitating cooperation among them.

An actor's social capital has three dimensions: (1) structural embeddedness, (2) relational embeddedness, and (3) resource embeddedness. Structural embeddedness is the structure of the overall network of relations (Granovetter, 1990). Its structural properties include network size, density and diversity. Relational embeddedness is the extent to which the quality of an actor's personal relations affects economic actions (Granovetter, 1990). The relational dimensions of dyadic ties include relational content (Burt, 1983; Burt, 1997; Podolny & Baron, 1997); tie strength (Marsden & Campbell, 1984); and relational trust (Tsai & Ghoshal, 1998). Resource embeddedness is the degree to which network contacts possess valuable resources (Bourdieu, 1986; Lai, Lin, & Leung, 1998; Lin & Dumin, 1986; Marsden & Hurlbert, 1988). Various resources must be available for instrumental mobilization (Granovetter, 1982; Lin, 2001a, 2001b). Actors must know of the existing resources embedded in the network, and their business partners must put those resources at each other's service. A firm's unique portfolio of tangible and intangible resources influences the rate and direction of its growth and diversification (Barney, 1991; Mahoney & Pandian, 1992; Penrose, 1959; Peteraf, 1993). A firm can achieve sustainable growth if its core competences (Hamel & Prahalad, 1994) cannot be easily imitated by competitors (Barney, 1991; Lippman & Rumelt, 1982). The heterogeneous structural, relational and resource properties of networks lead to different firm performance (Batjargal, 2003). This paper focuses on two characteristics of social capital: density and diversity.

Previous research has studied the role of social capital in the social and economic phenomena. Gargiulo and Benassi's study shows managers with cohesive communication networks to be less likely to adapt these networks to the change in coordination requirements prompted by their new assignments (Gargiulo & Benassi, 2000). Kale, Singh, and Perlmutter's research suggested that one of the main reasons that firms participate in alliances is to learn know-how and capabilities from their alliance partners. At the same time firms want to protect themselves from any opportunistic behavior of their partners in order to retain their own core proprietary assets (Kale, Singh, & Perlmutter, 2000). Their study provided empirical evidence that when firms build relational capital in conjunction with an integrative approach to managing conflict, they often achieve both objectives simultaneously. Relational capital based on mutual trust and interaction at the individual level between alliance partners creates a basis for learning and know-how transfer. At the same time, it curbs any incentive for opportunistic behavior among alliance partners, thus preventing critical know-how leakage.

Reagans and Zuckerman (2001) reframed demographic diversity in terms of the network variables that reflect distinct forms of social capital. They predicted that decreased network density would lower a

team's capacity for coordination, whereas high network heterogeneity would enjoy an enhanced learning capability. Their findings support most of the hypotheses (Reagans & Zuckerman, 2001).

Recent work on social networks emphasizes the importance of social capital or business networks for innovativeness. With increasingly modular products and distributed knowledge (Baldwin & Clark, 2000), firms recognize a need to collaborate with other firms both formally and informally. With knowledge broadly distributed, the locus of innovation resides in a network of inter-organizational relationships (Powell, Koput, & Smith-Doerr, 1996). Many scientific and technological breakthroughs result from numerous contributions of many actors working in networks (Bougrain & Haudeville, 2002). Furthermore, an emerging research stream looks to patterns of relationships as predictors of innovation, focusing on whom an individual knows rather than on his or her personal characteristics. For example, the value of collaboration for innovation has appeared in the biotechnology industry (Baum, Calabrese, & Silverman, 2000; Shan, Walker, & Kogut, 1994); in the global chemicals industries (Ahuja, 2000); and in other high-tech industries (Coles, Harris, & Dickson, 2003; Frenken, 2000; Reed & Walsh, 2002; Streb, 2003).

In conclusion, the evidence shows that the innovation process, particularly the exploratory innovation processes, benefits from engagement with a diverse range of partners. This engagement invites the integration of different information, knowledge bases, behaviors and ways of thinking. Formal and informal communication between people with different information, skills and values increases the possibility of novel combinations of knowledge (Conway, 1995). The more risk-averse firms, however, tend to link their innovation activities and networking relationships to customers, because a knowledge of clients' demands reduces the risk of failure for the innovating firm. In this case, innovation is more exploitative, and productivity gains are more modest. This pattern suggests a direct relationship between differences in networking activity and technological innovation.

Cognitive Studies of Innovation

Cognitive psychology (Neisser, 1967) helps explain the mental processes by which individuals interact with other people and the embedded environment. Social cognition theory (Bandura, 1986; Fiske & Taylor, 1984) developed as a specific way to explain the individual behavior in this person-environment interaction. This theory introduced the idea of knowledge structures: mental models ordered so as to optimize personal effectiveness within given situations.

Cognitive studies explore the cognitive processes that govern strategic choices. Complementing the theory of rational choice, cognitive science attempts to explain why or how economic decisions happen in an uncertain and subjective world (Kahneman, Slovic, & Tversky, 1982; Simon, 1957; Smircich & Stubbart, 1985). As thinking drives strategy formation, managerial cognition lies at the core of the strategic management process (Stubbart, 1989). Managers take strategic action intentionally to respond to a changing environment.

Managerial cognitive structures shape firm growth strategies because the management team's conceptualization and employment of its firm's resource base influence the direction of expansion. Managers pursue competitive actions and deploy resources in a way consistent with their mental models of the firm's capabilities and with the competitive threats they believe it faces. The determinants of the growth and direction of a firm include the productive capabilities engendered by resources interacting with managerial cognitive frameworks instead of the actual resources themselves (Mahoney & Pandian, 1992; Penrose, 1959; Porac, Thomas, Wilson, Paton, & Kanfer, 1995).

Innovation is a dynamic social learning process; actors continuously assimilate information and knowledge from those they interact with. As learning depends on experimentation and feedback, learning opportunities tend to grow directly from previous knowledge (Teece, et al., 1997). Actors with more training and experience diversity will create ideas with greater novelty than those with access to a narrower range of knowledge. Demographic differences that help explain the origins of homogeneous and diverse network performance generally appear to reflect underlining differences in cognition (Lawrence, 1997). The innovation period abounds in information about the definition of identities and the

establishment of social roles (Harrisson & Laberge, 2002). Social interaction plays a critical role in such firm innovation as technology adoption (Fulk, 1993; Pinch & Bijker, 1986; Wilkinson, 1983).

Scholars have studied the role of management cognition in shaping organizational actions. Weick (1990), for example, contended that new technologies are subject to a variety of interpretations and require "sensemaking" in order to be managed (Weick, 1990). Lowstedt (1985) suggested that researchers looking for direct relations between technology and organization tend to ignore the cognitions of the principal actors, which are crucial in mediating these relations. Since the people that describe and interpret organizations socially construct organizations and technologies, no objective "real" organization or technology independent of the cognitions of the people involved exists. People design technology and organization in keeping with their perceptions and explanatory frameworks (Lowstedt, 1985).

Swan (1995) described the nature and importance of knowledge bases and cognitions for decisions about technological innovation and suggested how to use process research to explore knowledge and cognitions (Swan, 1995). In an earlier study, Swan and Newell (1994) used a cognitive mapping methodology to reveal managers' beliefs about the causes of and effects of a particular type of technological innovation. They compared these beliefs with suggestions made in the literature about the factors that influence a firm's level of innovation. The factors the literature found to increase the likelihood of innovation the managers believed to be unimportant direct causes. These managers considered involvement in professional associations to be a causal factor crucial to innovation in production and inventory control. Other factors seen to be direct causes included the ratio of professional and technical staff to others in the firm, the promotion activities of vendors, and the competitors' levels of technology (Swan & Newell, 1994). Swan (1997) also emphasized the importance of cognition in decisions about technological innovation. But a lack of research tools and techniques has led to a low emphasis on cognitive processes in the empirical studies of technological innovation. She reviewed the cognitive mapping methodologies, evaluated their limitations, and concluded that one should distinguish between cognitive maps and the output of mapping techniques (Swan, 1997).

Kaplan, Murray and Henderson (2003) attempted to link management mental models to strategic choices in the face of discontinuous innovation. They drew upon 23 years of data covering 15 major pharmaceutical firms to ascertain the degree to which each firm's responses to the revolution in biotechnology was shaped by the senior team's recognition of biotechnology's importance. Their findings suggest that cognition at the most senior level can play a critical role in shaping the established firm's response to discontinuities (Kaplan, Murray, & Henderson, 2003). Jelinek and Litterer (1994) proposed a cognitive theory of organizations that links individual level phenomena (e.g. cognitions and actions) with organizational level phenomena (e.g. output, coordinated actions, organizational change and organizational learning). An individual's beliefs may be just noise in the organizational decision-making process but sometimes they may actually guide the direction of an organizational decision, and the actions that occur as a result of that decision shape and modify the beliefs of the individual (Jelinek & Litterer, 1994).

A SOCIAL-COGNITIVE PERSPECTIVE ON FIRM INNOVATION

Innovation is the generation and the exploitation of new products, processes, services and business practices. During the process of acquiring and translating new ideas into practice, people's internal cognitions and external relations play important roles. The primary interest in this paper is to integrate managerial cognition studies with social networks studies so as to investigate the origins of innovation.

Social Capital and Cognitive Structure

Social capital derives from a firm's business network where reciprocal exchange occurs. I characterize networks along two dimensions: structure and content. Network structure refers to the way in which the relationships between the embedded actors are arranged. A structural property is network density – that is, the extent to which the actors are connected to each other. Network content refers to the characteristics or attributes of the members embedded in the network. At the network level, heterogeneity or diversity

describes the extent to which each member's attributes differ from those of other members. The content and structure of networks being conceptually distinct, both can influence the nature and the transfer of resources. Despite this conceptual distinction, however, network structures correlate with their contents. Dense networks correlate with homogeneity whereas sparse networks appear more likely to correlate with diversity. This discussion treats the dense and homogeneous networks together and the sparse and diverse networks together.

Members of a network form both strong and weak ties as they transmit knowledge. Homogeneous networks of cohesive and frequent social relationships improve cooperation and optimize network tasks; however, they lack the flexibility essential for creative problem solving (Reagans & Zuckerman, 2001). On the other hand, diverse networks of sparse and infrequent social relationships are responsive to changing market conditions, provide access to new resources and ideas, and promote innovation (Gargiulo & Benassi, 2000; Reagans & Zuckerman, 2001); however, diverse networks lack the cohesiveness, trust, coordination and task specializations available in homogeneous networks.

Cognitions are actors' mental reflections upon a certain phenomenon – innovation in this study. With only a limited information processing capability, managers of an embedded network find themselves unable to perceive the environment precisely and interpret information perfectly, particularly in a complex and uncertain environment. Their mental models change with learning and adaptation. Two cognitive characteristics apply to strategic flexibility: complexity and centrality. Complexity reflects the level of differentiation and integration in an actor's mental model (Walsh, 1995). Centrality reflects the level of focus and hierarchy in an actor's mental model (Eden, Ackermann, & Cropper, 1992). Complexity measures an actor's information-processing capability – his or her ability to capture a broad collection of environmental, strategic and organizational concepts. Centrality measures an actor's tendency to centralize a strategy frame around a few core concepts.

In a social network, actors outsource the cognitive tasks to their associates (Clark, 1997). An actor's social network serves as a decision-making entity, providing the fact and value premises upon which the actors rely in decision-making. Knowledge and information become dispersed among the actors embedded in the network. In a homogeneous social network, groups diffuse shared beliefs and social norms. Actors embedded in this network learn and share similar information and knowledge, promoting efficient and specialized use of resources. For example, managers in the same industry demonstrate similar cognition (Huff, 1982; Porac, et al., 1995; Reger & Huff, 1993; Spender, 1989). Two mechanisms explain why managers think and act similarly: (1) such collectively established "scaffolding" as industry standards (Clark, 1997); (2) identical solutions provided by such outside organizations as consulting, market research, and accounting firms. By contrast, actors embedded in a diverse network are more likely to maximize the non-redundant information received from contacts. This information diversity increases the possibility of an actor's comprehension of a business context or phenomenon from multiple perspectives. Furthermore, this information diversity enhances an actor's ability to differentiate core concepts from peripheral concepts. Diverse information and knowledge assimilated from different social relations may, however, create information overload. When this occurs, an actor tends to develop a hierarchical cognitive structure to process efficiently this diverse information and knowledge.

Proposition 1a: In a sparse and diverse social network, the embedded actor's cognitive structure is more likely to be more complex and more centralized.

Proposition 1b: In a dense and homogeneous social network, the embedded actor's cognitive structure is more likely to be less complex and less centralized.

Simultaneously, an actor actively searches for new relationships to outsource cognitive tasks. A network is a series of social relations with a specific content (Emirbayer & Goodwin, 1994). Actors' narratives describe links in this network (White, 1992). Only an approach that brings human agency into a network analysis can adequately explain the formation, reproduction, and transformation of networks themselves. In the high technology industries, business networks constantly change to respond to the new environments. Meanwhile, interacting individuals influence each other to produce a homogeneity of belief (Carley, 1991; Friedkin & Johnsen, 1990, 1999; Kilduff, Angelmar, & Mehra, 2000).

An actor's cognitive characteristics influence his/her networking process, and thinking drives strategy making. A key strategic action, networking becomes a process of an individual's interacting with the environment. Resources flow through social ties (Lin, 2001a; Snijders & Bosker, 1999). An actor, such as an entrepreneur (Baron & Markman, 2003; Shane & Cable, 2002; Shane & Stuart, 2002), actively establishes ties through which information and aid flow.

People differ in discovering the benefits of network homogeneity and diversity, and human actors with different cognitive structures play a critical role in the formation of different types of social networks. An actor with increasingly complex cognitions is more likely to discover and access the new productive resource opportunities from his/her contacts. This greater heterogeneity of resource choices motivates the actor to construct a diverse social network. Reciprocally, the development of a diverse network can positively reinforce the complexity that initiated this network structure. Therefore, an actor with more complex cognitions is more likely to construct a diverse network, and create new resource opportunities because heterogeneous knowledge stimulates persistent innovations. Furthermore, actors with more centralized cognitive structures are more efficient to establish ties with diverse social contacts because they can differentiate the key social relations from the other social relations for the peripheral factors.

Proposition 2a: An actor with a more complex and more centralized cognitive structure is more likely to construct a sparse and diverse social network.

By contrast, an actor with a less complex and less centralized cognitive structure is more likely to form a dense and homogeneous social network because he/she is less able to differentiate the key social relations from the other social relations. These individuals are more likely to form cohesive network relationships with others having similar knowledge and experience than with individuals of differing knowledge and experience (Coleman, 1988; Granovetter, 1983; Mcpherson, Popielarz, & Drobnic, 1992). A less complex cognitive structure means these actors are less likely to interact with others with different knowledge and experience. Furthermore, a less centralized cognitive structure means these actors are less efficient in establishing diverse social relations. This inefficiency leaves them more likely to interact with similar others.

Proposition 2b: An actor with a less complex and less centralized cognitive structure is more likely to construct a dense and homogeneous social network.

Social Capital, Cognitive Structures, and Firm Innovation: a Theoretical Model

The organizational learning literature differentiate innovations along two dimensions: exploration and exploitation (Benner & Tushman, 2002; Katila & Ahuja, 2002; March, 1991). Exploitation refers to the refinement and extension of existing competencies; exploration refers to experimentation with new alternatives (March & Simon, 1958; Weick, 1979). This construct has two dimensions. A firm could leverage its existing knowledge base and explore new technological trajectories simultaneously (Christensen, 1997; Rosenkopf & Nerkar, 2001; Sorenson & Stuart, 2000). Different innovation activities require different information, reference points, and work routines. The discussion turns now to how a firm's external social ties and internal cognitive structures influence these latent factors.

In firm innovation, forms of exchange depend more on relationships and partners' reputation, and are guided less by authority and price (Cohen & Fields, 2000). Networks are better suited to coordinating knowledge-intensive, high-technology production than are either markets or hierarchies (Adler, 2001; Powell, 1990). Markets fail to function well in the allocation of knowledge because of the incomplete information problem, and the public goods aspect of knowledge (Robertson & Langlois, 1995; Stiglitz, 1994). Hierarchies lend themselves well to mass production and distribution, but it is difficult for authority to bring widely spread and individually held knowledge to the center. Instead, networks lend themselves particularly well to the exchange of commodities whose value is difficult to measure, such as knowledge and technological know-how. In an entrepreneurial context, contact resources together with structural and relational dimensions of networks can exert a significant impact on firm performance (Batjargal, 2003).

Actions of economic agents tend to become solidified, ongoing systems of social relations, and these relations can both facilitate and constrain profit- and rent-seeking actions (Granovetter, 1985). Members

of a network learn through networks to stay current in rapidly changing environments. Collaboration enhances organizational learning (Dodgson, 1993; Hamel, 1991). In a homogeneous network, actors' business contacts provide similar information about the product, supply markets, technology, and changes in the external environment. Every actor is directly or indirectly connected to every other by frequent and cohesive social interactions (Coleman, 1988; Gargiulo & Benassi, 2000; Kilduff, et al., 2000; Reagans & Zuckerman, 2001). This familiarity creates a high density of social relationships that produces homogenous and clustering behaviors (Gargiulo & Benassi, 2000; Granovetter, 1983).

Moreover, the business network provides a context in which the managers can observe and emulate similar firms. When facing a choice with limited information, one common heuristic is to emulate the behavior of others (Gigerenzer & Todd, 1999). In a homogeneous network, a firm tends to imitate the strategies of similar firms and focus on increasing efficiencies in resource use. Such an organization is routine based, history dependent, and target oriented (Levitt & March, 1988). A business network provides routines that can be made part of or adapted to a firm's current routines. Meanwhile, an employee's tasks and responsibilities tend to become formalized, often in a written job description, and technical standards often go beyond design specifications to mandate specific steps. A standard business routine is likely to emerge in a homogeneous business network, and its members are inclined to adopt it. However, a standardized business process management inhibits a firm's exploratory innovation output (Benner & Tushman, 2002).

By sharing similar information and resources, imitating similar firms, and standardizing organizational routines, a firm embedded in a homogeneous network is more likely to be exploitative in its innovation activities.

Proposition 3a: A firm embedded in a dense and homogeneous network is more likely to conduct exploitative search in technological innovations.

Structural-hole theory suggests, however, that the benefits of diverse information connections outweigh the mutual coordination and specialization benefits of homogeneous networks (Burt, 1997; Gargiulo & Benassi, 2000; Perry-Smith & Shalley, 2003). In a diverse social network, members share non-redundant information and knowledge. Diverse networks benefit from brokering dispersed knowledge and information sources. Actors encounter information, ideas and resources unavailable in a homogeneous network (Burt, 1997; Gargiulo & Benassi, 2000; Perry-Smith & Shalley, 2003). Because information transmitted through diverse networks tends to be novel, diverse networks have a greater capacity to discover new productive opportunities and relationships (Burt, 1997; Powell, Koput, & Smith-Doerr, 1996). Since new ideas and knowledge can be accessed and recombined from non-redundant sources, diverse networks provide benefits of creativity and innovation (Granovetter, 1983; Perry-Smith & Shalley, 2003; Reagans & Zuckerman, 2001). In industries like biotechnology with rapid technological developments, frontier research can be more quickly adopted in networks consisting of diverse collaborations (Powell, et al., 1996).

Finally, a firm with diverse networks has various companies to imitate. Multiple reference points can help a company explore new productive resource opportunities. Furthermore, a standard business routine is less likely to emerge in a diverse social network, and a lack of a standardized business process management encourages a firm's exploratory innovation output (Benner & Tushman, 2002).

Proposition 3b: A firm embedded in a sparse and diverse network is more likely to conduct exploratory search in technological innovations.

In any event, actors construct their innovation networks, and innovation results from exchanges of knowledge and ideas by individual actors or groups mobilized through legitimization activities and influenced by given internal and external contexts (Pettigrew, 1985, 1990). People tend to operate first in local situations in the initiation of their interactions (Knorr-Cetina, 1981). To understand the sources and processes of innovation, one should incorporate cognitive factors into the social network studies. An actor's cognitive characteristics influence the process of receiving information, seeking reference points, and establishing work routines.

Actors construct knowledge structures consisting of organized knowledge about an information environment. These knowledge structures help the actors interpret this environment and take responsive

actions (Walsh, 1995). Knowledge structures are discussed in terms of frames of reference (March & Simon, 1958), cognitive maps (Axelrod, 1976), and industry recipes (Spender, 1989). Managers and entrepreneurs create models of the world in their minds and then use these models to simplify a complex environment. Based on the assumption that actors' mental representations guide cognition and actions relative to strategic choices, an actor with increasingly complex cognitions tends to be alert to various types of information and new productive resources opportunities. During the process of interacting with a technology, actors' cognitions help them construct different interpretations of the technology (Bijker, Pinch, & Hughes, 1990; Bloomfield, 1986; Woolgar, 1981). This social construction of technologies influences the process of firm innovation.

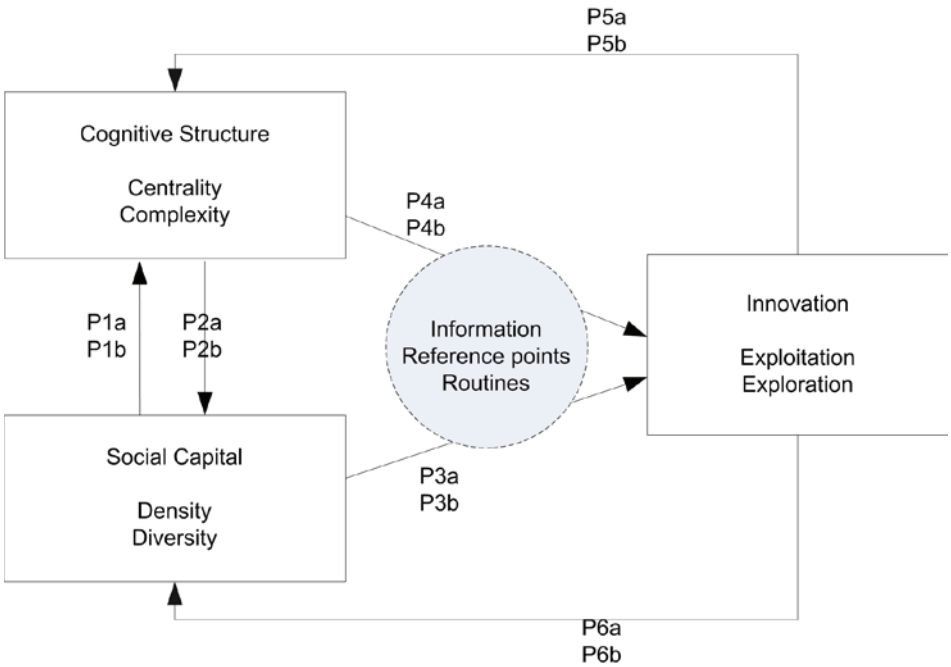
An actor with complex cognitions tends to pay more attention to different reference firms. Learning from diverse sources enables a firm to build a diverse knowledge base and ultimately create new technologies. In addition, actors who perceive firm innovation from multiple perspectives tend to feel less constrained by standard routines. They behave flexibly with process management; therefore, they tend to resist standardized work routines. Diverse information flow, multiple reference points, and flexible process management ultimately allow a firm to be more exploratory in its innovations.

Proposition 4a: An actor's cognitive complexity is associated positively with the firm's exploratory search in technological innovations.

Finally, an actor with a centralized cognitive structure receives certain information and knowledge relevant to the core concepts and peripheral concepts selectively. This efficiency enhances the actor's ability to assimilate more information and knowledge en route to exploring new productive resources. This hierarchical cognitive structure enables an actor to imitate diverse reference companies to adduce different factors. These actors tend to be alert to environmental changes, while the ability to differentiate factors enables them to change current organizational routines quickly.

Proposition 4b: An actor's cognitive centrality is associated positively with the firm's exploratory search in technological innovations

FIGURE 1
SOCIAL CAPITAL, COGNITIONS AND INNOVATION: A THEORETICAL MODEL



Feedback Loop

Figure 1 provides a schematic presentation of the theoretical model under discussion. The model illustrates a two-way relationship as the feedback loop. In the feedback loop, as independent variable, firm innovation influences the actors' cognitive structures and social capital. The managers' mental models change through adaptation and learning. As managers receive feedback about organizational performance, they correct their mental models to keep up with the environment. An organization can learn from its own experience and borrow experience from others (Huff, 1982). A firm's performance triggers the adaptive learning process (Greve, 1998; Lant & Hewlin, 2002; Lant & Hurley, 1999; Lant, Milliken, & Batra, 1992). Organizational change is based on interpretations of experience, and performance feedback serves routinely to determine whether past performance is satisfactory and to detect problems (Cyert & March, 1963; Levitt & March, 1988). An increase in exploitative searches will send the routines, information flow, and reference points in different directions. To refine and extend the existing competencies, a flexible and chaotic organizational routine has to become better ordered. Information flow becomes more top-down rather than bottom-up and firms are more likely to look to their competitors with superior capabilities of exploiting the existing innovations.

During this feedback process, increasingly exploratory searches reinforce the actors' cognitive complexity because managers or entrepreneurs are forced to diversify their points of view and establish causal relationships between more diverse factors. An increase in exploratory searches change established routines and information flow in a firm. A rigid organizational routine becomes more flexible, and the decision-making authority becomes more decentralized. More information is generated from the bottom of a firm, and information flow is more diversified. Meanwhile, the firm changes its reference points to more innovative firms or institutions.

Proposition 5a: A firm's exploratory search in technological innovations is associated positively with the actors' cognitive complexity.

Furthermore, the increasing exploratory searches reinforce the actors' cognitive centrality because managers or entrepreneurs become more efficient at differentiating the core factors from the peripheral factors in exploring new productive opportunities. Hence,

Proposition 5b: A firm's exploratory search in technological innovations is associated positively with the actors' cognitive centrality.

Simultaneously, a firm's social network changes with different innovation output. With more exploratory search activities, managers or entrepreneurs adapt to new requirements by building business ties with diverse businesses. The positive feedback will reinforce this tendency to build a diverse social network. Meanwhile, with more exploitative search activities, firms are more likely to focus on their existing competencies and look to the current business network for information and knowledge. Positive performance will also reinforce this tendency to build a dense social network. Accordingly, two propositions emerge:

Proposition 6a: A firm's exploitative search in technological innovations is associated positively with the density of its social capital.

Proposition 6b: A firm's exploratory search in technological innovations is associated positively with the diversity of its social capital.

DISCUSSION

I derived twelve propositions linking social capital (density and diversity), cognitive structures (centrality and complexity), and technological innovation (exploitation and exploration). This social-cognitive perspective integrates social network studies and managerial cognition studies to evaluate the business phenomenon of firm innovation. The proposed theoretical model describes the mechanisms by which social capital and cognitions influence the innovation process. These propositions have important implications for managerial practice, especially in market domains where innovation success largely determines firm performance. Meanwhile, this research makes important theoretical contributions, and it extends the literature on organization theory and firm innovation.

Organization Theory

Social capital exerts significant effects on the embedded actors' cognitive structures, and a firm's search activities in technological innovation. First, this paper established a link between social networks and managerial cognitions. In the strategic management research, few known studies have explicitly linked managerial cognitions research with social networks studies, and no previous research has enunciated the effects of social networks and managerial cognitions on technological innovations at the same time. The propositions illustrate the decision process in the selection of relationships, a concept heretofore taken for granted in social network studies. Existing social network research treats individuals as identical, and has not considered the role of individual differences that influence the realized benefits of social networks (Gargiulo & Benassi, 2000; Kilduff, et al., 2000; Reagans & Zuckerman, 2001). An adequate analysis of social network should include the ability of the actors to transform or reproduce long-term structures (Harrisson & Laberge, 2002). By incorporating the actors' cognitions into their social capital in order to study the business phenomenon of firm innovation, this paper develops a theory of action that connects individual interests with social structure (Coleman, 1986; Poole & Vandeven, 1989).

Firm Innovation

Depending on the embedded actors' cognitive idiosyncrasies, social capital exerts contingent effects on firm innovation. This research contributes to a richer understanding of the sources and process of firm innovation, and it provides a comprehensive examination of the role of external social capital and internal cognitive structure in firm innovation. Firms face challenges in initiating and sustaining exploration into new domains when their business networks are homogeneous and when their top management team focuses on extremely limited strategic factors. Accordingly, this social-cognitive perspective on firm innovation has broad implications for practitioners in technology firms and their support networks consisting of venture capitalists, lawyers, accountants, and other policy makers, and it helps managers focus on the specific aspects of their cognitive structures and social capital in the process of innovation.

REFERENCES

Abernathy, W.J., & Utterback, J. (1978). Patterns of Industrial Innovation. *Technology Review,* 80, (7), 40-47.

Adler, P.S. (2001). Market, Hierarchy, and Trust: The Knowledge Economy and the Future of Capitalism. *Organization Science,* 12, (2), 215-234.

Axelrod, R. (1976). *The Structure of Decision: The Cognitive Maps of Political Elites*. Princeton, NJ: Princeton University Press.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management,* 17, (1), 99-120.

Baron, R.A., & Markman, G.D. (2003). Beyond Social Capital: The Role of Entrepreneurs' Social Competence in Their Financial Success. *Journal of Business Venturing,* 18, (1), 41-60.

Batjargal, B. (2003). Social Capital and Entrepreneurial Performance in Russia: A Longitudinal Study. *Organization Studies,* 24, (4), 535-556.

Benner, M.J., & Tushman, M. (2002). Process Management and Technological Innovation: A Longitudinal Study of the Photography and Paint Industries. *Administrative Science Quarterly,* 47, (4), 676-709.

Bettis, R.A., & Hitt, M.A. (1995). The New Competitive Landscape. *Strategic Management Journal,* 16, (Special Issue), 7–19.

Bijker, W.E., Pinch, T.J., & Hughes, T.P. (1990). *The Social Construction of Technology*. Cambridge, MA: MIT Press.

Bloomfield, B.P. (1986). *Modeling the World: The Social Constructions of Systems Analysts*. Oxford: Basil Blackwell.

Bourdieu, P. (1986). The Forms of Capital *Handbook of Theory and Research for the Sociology of Education* (pp. 241–258). New York: Greenwood.

Burt, R. (1983). Distinguishing Relational Contents. In R. Burt & M. Minor (Eds.), *Applied Network Analysis: A Methodological Introduction* (pp. 35–74). London: Sage.

Burt, R. (1992). *Structural Holes*. Cambridge, MA: Harvard University Press.

Burt, R.S. (1997). The Contingent Value of Social Capital. *Administrative Science Quarterly,* 42, (2), 339-365.

Carley, K. (1991). A Theory of Group Stability. *American Sociological Review,* 56, (3), 331-354.

Christensen, C.M. (1997). *The Innovator's Dilemma*. Boston: Harvard University Press.

Clark, A. (1997). *Being There: Putting Brain, Body, and World Together Again*. New Jersey: Prentice Hall.

Cohen, S.S., & Fields, G. (2000). Social Capital and Capital Gains: An Examination of Social Capital in Silicon Valley. In M. Kenney (Ed.), *Understanding Silicon Valley* (pp. 190-217). Stanford, California: Stanford University Press.

Coleman, J.S. (1986). Social Theory, Social Research, and a Theory of Action. *American Journal of Sociology,* 91, (6), 1309-1335.

Coleman, J.S. (1988). Social Capital in the Creation of Human Capital. *The American Journal of Sociology,* 94, (S1), 95-120.

Cyert, R.M., & March, J.G. (1963). *Behavioral Theory of the Firm*. New Jersey: Prentice Hall.

Danneels, E. (2002). The Dynamics of Product Innovation and Firm Competences. *Strategic Management Journal,* 23, (12), 1095-1121.

Dodgson, M. (1993). Learning, Trust, and Technological Collaboration. *Human Relations,* 46, (1), 77-94.

Dosi, G. (1988). Sources, Procedures, and Microeconomic Effects of Innovation. *Journal of Economic Literature,* 26, (3), 1120-1171.

Eden, C., Ackermann, F., & Cropper, S. (1992). The Analysis of Cause Maps. *The Journal of Management Studies,* 29, (3), 309-324.

Emirbayer, M., & Goodwin, J. (1994). Network Anlaysis, Culture and the Problem of Agency. *The American Journal of Sociology,* 99, (6), 1411.

Fiske, S.T., & Taylor, S.E. (1984). *Social Cognition*. Reading, MA: Addison-Wesley.

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

Friedkin, N.E., & Johnsen, E.C. (1990). Social Influence and Opinions. *Journal of Mathematical Sociology,* 15, 193-205.

Friedkin, N.E., & Johnsen, E.C. (1999). Social Influence Networks and Opinion Change. *Advances in Group Processes,* 16, 1-29.

Gargiulo, M., & Benassi, M. (2000). Trapped in Your Own Net? Network Cohesion, Structural Holes, and the Adaptation of Social Capital. *Organization Science,* 11, (2), 183-196.

Garud, R., & Nayyar, P.R. (1994). Transformative Capacity: Continual Structuring by Intertemporal Technology Transfer. *Strategic Management Journal,* 15, 365–385.

Gigerenzer, G., & Todd, P.M. (1999). *Simple Heuristics That Make Us Smart.* New York: Oxford University Press.

Gopalakrishnan, S., & Damanpour, F. (1997). A Review of Innovation Research in Economics, Sociology and Technology Management. *Omega,* 25, (1), 15-28.

Granovetter, M. (1982). The Strength of Weak Ties: A Network Theory Revisited. In P. Marsden & N. Lin (Eds.), *Social Structure and Network Analysis* (pp. 105–130). Beverly Hills, CA: Sage.

Granovetter, M. (1983). The Strength of Weak Ties: A Network Theory Revisited. *Sociological Theory,* 1, 201-233.

Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *The American Journal of Sociology,* 91, (3), 481-510.

Granovetter, M. (1990). The Old and the New Economic Sociology: A History and an Agenda. In R. Friedland & A. Robertson (Eds.), *Beyond the Market Place: Rethinking Economy and Society* (pp. 89–112). New York: Walter de Gruyter.

Greve, H.R. (1998). Managerial Cognition and the Mimetic Adoption of Market Positions: What You See Is What You Do. *Strategic Management Journal,* 19, (10), 967-988.

Hamel, G. (1991). Competition for Competence and Inter-Partner Learning within International Strategic Alliances. *Strategic Management Journal,* 12, 83-103.

Hamel, G., & Prahalad, C.K. (1994). *Competing for the Future*. Cambridge, MA: Harvard Business School Press.

Harrisson, D., & Laberge, M. (2002). Innovation, Identities and Resistance: The Social Construction of an Innovation Network. *Journal of Management Studies,* 39, (4), 497-521.

Hitt, M.A., Ireland, R.D., & Lee, H.U. (2000). Technological Learning, Knowledge Management, Firm Growth and Performance: An Introductory Essay. *Journal of Engineering and Technology Management,* 17, (3-4), 231-246.

Huff, A.S. (1982). Industry Influences on Strategy Reformulation. *Strategic Management Journal,* 3, 119-131.

Jacobs, J. (1961). *The Death and Life of Great American Cities*. New York: Random House.

Jelinek, M., & Schoonhoven, C.B. (1990). *The Innovation Marathon: Lessons from Hightechnology Firms*. Cambridge, MA.: Basil Blackwell.

Kahneman, D., Slovic, P., & Tversky, A. (Eds.). (1982). *Judgment under Uncertainty: Heuristics and Biases.* Cambridge, MA: Cambridge University Press.

Katila, R., & Ahuja, G. (2002). Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction. *Academy of Management Journal,* 45, (6), 1183-1194.

Kilduff, M., Angelmar, R., & Mehra, A. (2000). Top Management-Team Diversity and Firm Performance: Examining the Role of Cognitions. *Organization Science,* 11, (1), 21-34.

Knorr-Cetina, K.D. (1981). *The Manufacture of Knowledge: An Essay on the Constructivists and Contextual Nature of Science.* Oxford: Pergamon.

Lai, G.N., Lin, N., & Leung, S.Y. (1998). Network Resources, Contact Resources, and Status Attainment. *Social Networks,* 20, (2), 159-178.

Lant, T.K., & Hewlin, P.F. (2002). Information Cues and Decision Making - the Effects of Learning, Momentum, and Social Comparison in Competing Teams. *Group & Organization Management,* 27, (3), 374-407.

Lant, T.K., & Hurley, A. (1999). A Contingency Mode of Response to Performance Feedback: Escalation of Commitment and Incremental Adaptation in Resource Investment Decisions. *Group & Organization Management,* 24, (4), 421-437.

Lant, T.K., Milliken, F.J., & Batra, B. (1992). The Role of Managerial Learning and Interpretation in Strategic Persistence and Reorientation - an Empirical Exploration. *Strategic Management Journal,* 13, (8), 585-608.

Lawrence, B.S. (1997). The Black Box of Organizational Demography. *Organization Science,* 8, (1), 1-22.

Levitt, B., & March, J. (1988). Organizational Learning. *ARS,* 14, 319-340.

Lin, N. (2001a). Building a Network Theory of Social Capital. In K.C.a.R.B. N. Lin (Ed.), *Social Capital, Theory and Research* (pp. 3–29). New York: Aldine de Gruyter.

Lin, N. (2001b). *Social Capital: A Theory of Social Structure and Action*. Cambridge: Cambridge University Press.

Lin, N., & Dumin, M. (1986). Access to Occupations through Social Ties. *Social Networks,* 8, (4), 365-385.

Lippman, S.A., & Rumelt, R.P. (1982). Uncertain Imitability - an Analysis of Interfirm Differences in Efficiency under Competition. *Bell Journal of Economics,* 13, (2), 418-438.

Lyles, M.A., & Schwenk, C.R. (1992). Top Management, Strategy and Organizational Knowledge Structures. *Journal of Management Studies,* 29, (2), 155-174.

Mahoney, J., & Pandian, J.R. (1992). The Resource-Based View within the Conversation of Strategic Management. *Strategic Management Journal,* 13, 363-380.

March, J. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science,* 2, 71-87.

March, J., & Simon, H. (1958). *Organizations*. New York: Wiley.

Marsden, P.V., & Campbell, K.E. (1984). Measuring Tie Strength. *Social Forces,* 63, (2), 482-501.

Marsden, P.V., & Hurlbert, J.S. (1988). Social Resources and Mobility Outcomes - a Replication and Extension. *Social Forces,* 66, (4), 1038-1059.

Marsh, S.J., & Ranft, A.L. (1999). Why Resources Matter: An Empirical Study of the Influence of Knowledge-Based Resources on New Market Entry. In M.A. Hitt, R.G. Clifford, R.D. Nixon & K.P. Coyne (Eds.), *Dynamic Strategic Resources* (pp. 43–66). Chichester: Wiley.

McPherson, M.J., Popielarz, P., & Drobnic, S. (1992). Social Networks and Organizational Dynamics. *American Sociological Review,* 57, (2), 153–170.

Mokyr, J. (1990). *The Lever of Riches: Technological Creativity and Technological Progress*. New York: Oxford University Press.

Neisser, U. (1967). *Cognitive Psychology*. New York: Appleton-Century-Crafts.

Nelson, R.R. (1990). Capitalism as an Engine of Progress. *Research Policy,* 19, 193-214.

Nelson, R.R., & Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science,* 5, (1), 14-37.

Penrose, E.T. (1959). The Theory of the Growth of the Firm. Oxford: Basil Blackwell.

Perry-Smith, J.E., & Shalley, C.E. (2003). The Social Side of Creativity: A Static and Dynamic Social Network Perspective. *Academy of Management. The Academy of Management Review,* 28, (1), 89-106.

Peteraf, M.A. (1993). The Cornerstones of Competitive Advantage - a Resource-Based View. *Strategic Management Journal,* 14, (3), 179-191.

Pettigrew, A.M. (1985). Contextualist Research: A Natural Way to Link Theory and Practice. In E.E. Lawler (Ed.), *Doing Research That Is Useful in Theory and Practice.* San Francisco, CA: Jossey Bass.

Pettigrew, A.M. (1990). Longitudinal Field Research on Change: Theory and Practice. *Organization Science,* 1, (3), 267-292.

Podolny, J., & Baron, J. (1997). Resources and Relationships: Social Networks and Mobility in Organizations. *American Sociological Review,* 62, 673-693.

Poole, M.S., & Vandeven, A.H. (1989). Using Paradox to Build Management and Organization Theories. *Academy of Management Review,* 14, (4), 562-578.

Porac, J.F., Thomas, H., Wilson, F., Paton, D., & Kanfer, A. (1995). Rivalry and the Industry Model of Scottish Knitwear Producers. *Administrative Science Quarterly,* 40, (2), 203-227.

Powell, W.W. (1990). Neither Market nor Hierarchy: Network Forms of Organization. *Research in Organizational Behavior,* 12, 295-336.

Powell, W.W., Koput, K.W., & Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly,* 41, (1), 116-145.

Reagans, R., & Zuckerman, E.W. (2001). Networks, Diversity, and Productivity: The Social Capital of Corporate R&D Teams. *Organization Science,* 12, (4), 502-517.

Reger, R.K., & Huff, A.S. (1993). Strategic Groups - a Cognitive Perspective. *Strategic Management Journal,* 14, (2), 103-123.

Robertson, P.L., & Langlois, R.N. (1995). Innovation, Networks, and Vertical Integration. *Research Policy,* 24, (4), 543-562.

Rosenkopf, L., & Nerkar, A. (2001). Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disc Industry. *Strategic Management Journal,* 22, 287-306.

Rumelt, R.P., Schendel, D.E., & Teece, D.J. (1994). Fundamental Issues in Strategy. In R.P. Rumelt, D.E. Schendel & D.J. Teece (Eds.), *Fundamental Issues in Strategy: A Research Agenda* (pp. 9-47). Boston, MA: Harvard Business School Press.

Schumpeter, J. (1934). *The Theory of Economic Development*. Boston: Harvard University Press.

Shane, S., & Cable, D. (2002). Network Ties, Reputation, and the Financing of New Ventures. *Management Science,* 48, (3), 364-381.

Shane, S., & Stuart, T. (2002). Organizational Endowments and the Performance of University Start-Ups. *Management Science,* 48, (1), 154-170.

Simon, H. (1957). *Models of Man*. New York: John Wiley.

Simonin, B.L. (1999). Ambiguity and the Process of Knowledge Transfer in Strategic Alliances. *Strategic Management Journal,* 20, (7), 595-623.

Smircich, L., & Stubbart, C. (1985). Strategic Management in an Enacted World. *Academy of Management Review,* 10, (4), 724-736.

Snijders, T., & Bosker, R. (1999). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. Thousand Oaks, CA: Sage Publications.

Sorenson, J., & Stuart, T.E. (2000). Aging, Obsolescence, and Organizational Innovation. *Administrative Science Quarterly,* 45, 81-112.

Spender, J.C. (1989). *Industry Recipes: An Enquiry into the Nature and Sources of Managerial Judgement*. Oxford: Basil Blackwell.

Stiglitz, J.E. (1994). *Whither Socialism?* Cambridge, MA: The MIT Press.

Stinchcombe (1990). *Information and Organizations*.

Stubbart, C.I. (1989). Managerial Cognition: A Missing Link in Strategic Management Research. *The Journal of Management Studies,* 26, (4), 325-347.

Sull, D., Tedlow, R., & Rosenbloom, R. (1997). Managerial Commitments and Technology Change in the U.S. Tire Industry. *Industrial and Corporate Change,* 6, 461-500.

Teece, D.J. (1992). Competition, Cooperation, and Innovation - Organizational Arrangements for Regimes of Rapid Technological-Progress. *Journal of Economic Behavior & Organization,* 18, (1), 1-25.

Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal,* 18, (7), 509-533.

Tsai, W., & Ghoshal, S. (1998). Social Capital and Value Creation: The Role of Intrafirm Networks. *Academy of Management Journal,* 41, (4), 464-476.

Tushman, M.L., & Anderson, P. (1986). Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly,* 31, (3), 439-465.

von Hippel, E. (1988). *Sources of Innovation*. New York: Oxford University Press.

Walsh, J.P. (1995). Managerial and Organizational Cognition - Notes from a Trip Down Memory Lane. *Organization Science,* 6, (3), 280-321.

Weick, K.E. (1979). *The Social Psychology of Organizing*. Reading, MA: Addison and Wesley.

White, H.C. (1992). *Identity and Control: A Structural Theory of Social Action*. Princeton, NJ: Princeton University Press.

Woolgar, S. (1981). Interests and Explanation in the Social Study of Science. *Social Studies of Science,* 11, (3), 365-394.