A Distributed Knowledge Approach to Managing Innovation

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The purpose of this paper is to discuss how organizations can manage innovation in a distributed environment where knowledge emerges from connections between actors and is never complete. Although this might may appear to be a daunting task, managing innovation in a distributed knowledge system is possible using the brain as a metaphor along with connectionist architecture. Integrating these two approaches improve innovation by enabling managers to model an organization's knowledge management strategies to contain brain-like connections that include redundancy and requisite variety, communications, and a decentralized control structure. These factors support knowledge transfer, trust, and heedful relationships among geographically and cognitively (functionally) distributed employees.

INTRODUCTION

In response to the rapidly changing competitive environment, firms of all sizes and dispositions now seek to employ their knowledge assets in a variety of innovative activities. The knowledge and innovation link grows stronger "as companies in most industries are experiencing a fundamental shift in the way the game of competition is played" (Illinitch, D'Aveni, & Lewin, 1996, p. 211). Even as the rules of competition change, organizations continue to employ knowledge management strategies based on the computer metaphor, which employs a "fetch-operate-store framework" (Fiol, 2002, p. 119). Knowledge management computer-metaphor strategies assume that employees (1) can access, store, and retrieve knowledge as needed and (2) must share the same cognitive structures and schema to interact and to perform. Using the computer metaphor, knowledge is managed like other assets; this treatment ignores the sociological composition of knowledge, which plays a critical role in its creation, transfer, and application (Nonaka, 1991; Wenger & Snyder, 2000).

Although traditional theories favoring a symbolic architecture are still dominant in knowledge management literature (Fiol, 2002), there is a growing awareness of the duality of knowledge. Specifically, knowledge consists of symbolic structures as well as social cues. Many scholars (Fiol, 2002; Hutchins, 1991; Weick & Roberts, 1993) propose that knowledge in the firm is dispersed (i.e., it is situated in many different places in the firm) and no single actor could probably know it all (Larsen, 2001, p. 84). Knowledge is distributed in the sense that it emerges only through social interactions, which occur at various locations within the organization. Symbolic and connectionist architectures (i.e., knowledge exists in connections) do not exist on opposite ends of the spectrum. Rather, they are complementary, and in fact, both are used by the brain to make sense of and create new knowledge. This paper puts forth the notion that organizations can blend these architectures to develop more robust innovation and knowledge management strategies.

The purpose of this paper is to discuss how organizations can manage innovation in a distributed knowledge environment. This paper focuses on distributed knowledge because it presents a more robust approach to knowledge management, it leads to a new set of challenges involving sense-making and knowledge creation processes. For example, innovation emerges to solve a problem. If employees do not possess the knowledge they need, then it will be challenging to make sense of a problem. Managing the structure of the distributed knowledge such as the brain's connections, communications, and decentralized control structure enables the organization to leverage distributed knowledge and promotes flexibility, which are important innovation characteristics.

The motivation for this paper is twofold. First, organizations that focus solely on managing content (e.g., symbols) may overlook opportunities that arise from managing knowledge that emerges during relationships. We suggest that organizations modify their innovation management strategies to capture the knowledge, which emerges through socially distributed work activities (Rogers & Ellis, 1996, p. 120), as well as content. Second, managing distributed knowledge is challenging. Technological advances are changing the way employees work. As organizations become more virtual, managers must identify ways to foster interactions among dispersed group members to support group cognition and knowledge creation. The following discussion reviews extant connectionist theories, then explores how distributed knowledge influences sense-making and knowledge creation, and presents a framework to manage distribute knowledge.

LITERATURE REVIEW

Connectionist Architecture

By using the brain as a metaphor for the organization, connectionist architecture models explain how information might occur through interconnected neurons that mutually excite and inhibit (Anderson, 1991). Connectionist-based architecture assumes that knowledge is distributed among various resources and neuron-like processing units that enable information to flow where needed (Fiol, 2002; Weick & Roberts, 1993. This model proposes that collective knowledge may thus exist as highly shared symbolic schemata among members and it may exist as unevenly distributed knowledge among participants (Fiol, 2002, p. 132). This conceptualization of knowledge describes how people retain knowledge not only in the form of symbols expressed through language, but also as cues embedded in actions and interactions Eden & Spender, 1998).

The brain as a metaphor and connectionist-based architecture are not new concepts in organization management research. The brain as a metaphor has been featured in Morgan's (1997) research on learning organizations, Van de Ven's (1986) exploration of central problems in innovation management, Garud and Kotha's (1994) examination of flexible manufacturing systems, and Garud and Karnøe's (2003) study of technology entrepreneurship. In addition, connectionist architecture appears in the research of Weick (1995), Tsoukas (1996), and Eden and Spender (1998). Connectionist-based research addresses the limitations of symbolic architecture, which "implies limited and fixed cognitive capacity" (Fiol, 2002) and focuses on "how knowledge is created" through social interactions.

THE INNOVATION PROCESS

The primary goal of the innovation process is to "enable companies to identify customer needs, and then generate ideas and solutions to address them" (McAdams & McClelland, 2002, p. 86). Consequently, innovations emerge when they solve a problem or fill a need that can be exploited. To create a product that meets customers' needs, an organization must make sense of those needs and generate new ideas to fulfill them. This discussion puts forth the notion that sense-making and knowledge creation are important activities that are influenced by distributed knowledge.

Sense-Making

It is a common theme among scholars to identify problem-based activities as the locus of innovative activities. Few important inventions have been the result of spontaneous creative activity by technologists; rather, almost all inventions result from grappling with practical problems (Grant, 1995, p. 281). Roberts and Fusfield (1997) and Glynn (1996) have used innovation process models that center on problem-based activities. Typically, a path-based problem-solving model includes sensing the problem, defining the problem, generating a solution, evaluating the solutions, choosing a solution plan, and implementing the plan theorem (cf. Lipshitz & Bar-Ilan, 1996). An organization's sense-making guides its innovative activities. It frames how groups interpret cues from their internal and external environment and make innovative decisions. Groups and teams that participate in the innovation process must make sense of internal and external factors in order to set the problem, make decisions to solve the problem, and create an innovation that fulfills the customers' needs.

Weick (1979) proposed a recipe for sense-making in which the "external environment literally bends around the enactments of people, and much of the activity of sense-making involves an effort to separate the externality from the action" (p. 131). As groups interact with the environment to make sense of the customer's problem, their distributed cognition or beliefs intertwine with environmental factors. Due to confirmation bias, this entanglement can erode the organization's ability to make sense of its environment and provide customers with a product that fulfills their needs. Confirmation bias occurs when an individual or group gives greater weight to information that supports their view than information that does not. When individual cognition is incomplete, a person searches their network or group to make sense (Fiol, 2002).

Hutchins (1991) used a naval narrative to describe an accident that occurred aboard a Coast Guard ship due to faulty navigation resulting from distributed cognition. In this narrative, four members of the Coast Guard vessel saw another ship approaching on the radar and did not act to avoid a collision. Eleven sailors died because each sailor who saw the ship approaching believed that it was another sailor's responsibility to act. The first sailor who noticed the impending collision tried to make sense of the information on the radar by relying on a set of assumptions that led to his inaction. This initial inaction served as a cue that was followed by other sailors. In this case, sense-making involves taking whatever is clearer, whether it be a belief (symbolic schema) or an action (connectionist cue), and linking it with that which is less clear (Fiol, 2002, p. 133).

Hutchins (1991) sought to establish a connection between individual and collective cognition, whereas Weick and Roberts (1993) created a concept called the collective mind, which describes how "action constructs mental processes rather than how mental processes construct action" (p. 374). The collective mind explains how a group can engage in organized activities when each member holds different beliefs. One of the most important aspects of the collective mind is that it is emergent. Thus, it only manifests during heedful interrelating. Being an emergent phenomenon, the collective mind is known in its entirety to no one, although portions of it are known to all (Tsoukas, 1996 p. 15).

The collective mind is not a control unit that guides employees' actions. It manifests in the manner in which individuals interrelate their actions (Tsoukas, 1996). Interrelations are not given but are constructed continually by individuals (Blumer, 1969) through the ongoing activities of contributing, representing, and subordinating (Weick & Roberts, 1993). When people make efforts to interrelate, these efforts can range from heedful to heedless (Weick & Roberts, 1993, p.366). Heed is not an action but the manner in which actions are undertaken. Heedful interactions reflect a disposition to act with consideration, carefulness, purpose, and conscientiousness (Druskat & Pescosolido, 2002). Heedful interactions among coworkers foster trust, which is the foundation of knowledge creation (Nonaka & Toyama, 2003).

Functional departments are an example of a setting that supports the emergence of the collective mind. As an organization segregates into different functional areas, intra-organizational cultures may develop when employees are socialized into a functional area, and these cultures then shape employees' cognitive frames (Lessard & Zaheer, 1996). Unfortunately, hierarchical structures such as departments encourage myopic perspectives by allowing each employee to see only a small piece of the puzzle. Locked in their silos or thought worlds, "employees' imagine their role and their units' obligations apart

from those of others in the organization, and apart from the situated complexities of a particular task" (Dougherty, 2001, p. 614). Consequently, the same interactions that promote knowledge creation can also stifle innovation.

In addition, cultural differences also facilitate distributed cognitions. Cultural distance describes "the difference in culture between a home country and each individual target country" (cf. Brouthers & Brouthers, 2000, p. 91). Individuals bring cultural values into the organization (Kirkman & Shapiro, 1997). Depending on the cultural distance between the individual and the organization, cultural distance can decrease managerial effectiveness (Brouthers & Brouthers, 2000, p. 91). Consider, a heterogeneous group may be unable to leverage its knowledge because that knowledge is distributed among culturally distributed members due to geographical or cultural differences. The challenge for organizations is to find ways to leverage distributed knowledge.

Knowledge Creation

Knowledge creation lies at the heart of every innovative activity (Drucker, 1985). To innovate, organizations must identify the customers' needs and then generate ideas and solutions to address those needs (McAdam & McClelland, 2002). The challenge for organizations is to manage knowledge that is "distributed, in the sense that it is emergent, not possessed by a single agent, partly originates outside the firm, and it is never complete at any point" (Tsoukas, 1996, p. 22). In an organization, knowledge emerges when employees interact across departmental boundaries and, as a result, change themselves, others, and the organization (Nonaka & Toyama, 2005). To support organizational knowledge creation, managers must "analyze the routines and social practices in which the knowledge of the firm is embedded" (Larsen, 2001, p. 101). This section of the paper explores creativity and knowledge creation in a distributed knowledge environment and examines the challenges managing the front end of the innovation process given the decentralized structure and uncertainty associated with a distributed knowledge system.

In a distributed knowledge system, organizations must focus their attention toward generating creativity by including individuals who can use their creative abilities to promote innovative activities. Some inventive activities occur within an isolated domain such R&D. Although these employees can adequately handle the challenges of the idea generation process, the exploitative process requires the efforts of the entire organization. Inventors or engineers who are responsible for generating ideas as a part of their work activities may become narrowly focused. This myopic focus results from isolation from others during working hours.

The group innovation process requires more attention from management than does an individual working alone in an innovative capacity. Diverse teams are more creative than homogenous teams; however, these teams are more likely to fail if their diversity is not positively managed (McAdam & McClelland, 2002). Although empirical evidence is mixed on whether group diversity is beneficial, it certainly must be managed to help team members respect differences and feel comfortable participating and sharing ideas.

Furthermore, individuals may produce fewer ideas in group activities such as brainstorming (Woodman, Sawyer, & Griffin, 1993). Because groups support creative activities, their structure, processes, and organization reflect an environment that facilitates or impedes member participation. Managers must coordinate and balance more factors and potential interactions that have a direct effect on the innovation process being managed in order to move an idea beyond the conception stage.

Innovation Management Solution: The Brain as a Metaphor

Distributed knowledge presents many challenges for the innovative organization and consists of three categories: connections, communication, and control. One potential solution to the problem of distributed knowledge as it relates to innovation sense-making and knowledge creation is to manage innovation using the brain as a metaphor for the organization. The brain incorporates symbolic and connectionist architectures. These architectures are complementary, and together they enable the firm to access

symbolic and cue-based knowledge. The following discussion outlines the use of the brain as a metaphor by focusing on the communication, connection, and control of distributed knowledge.

Communication

The design of the brain reflects its distinct capability to recognize changes in its environment and instantaneously create, share, and distribute this new knowledge to the appropriate areas. The neurons in the brain are able to adapt to and create new information because of the social structure or the network that exists between the neurons. This information system is termed "networked intelligence." It is a structure that can be accessed from multiple points of view, which creates the potential for individuals throughout the enterprise, even those in remote locations, to become full participants in the evolving system of organizational memory and intelligence (Morgan, 1997). By using a networked-based information system, managers become aware of ideas and idea generators who may have remained isolated from the innovative process. In addition, the organization can transform innovation from being the domain of a few to being the responsibility of the entire organization.

Connections

Redundancy and requisite variety address the challenges of managing distributed knowledge. Redundancy minimizes functional segregation and helps eliminate barriers, thus enabling groups to create and share new knowledge that resides locally in functional silos. Requisite variety enables groups to make sense of their environment and solve innovative problems. This section will highlight how both of these factors support managing innovation in a distributed environment.

Redundancy is defined as "a kind of excess capacity that can create room for innovation and development to occur" (Morgan, 1997, p. 110). A strategy of redundancy moves employees out of their silos to establish connections with employees in other departments, creating an overlap of knowledge and information (Merrill et al., 2008). Redundancy is important because it encourages frequent dialogue and communication, which creates a medium that can be used to transfer tacit knowledge (Nonaka, 1994). Furthermore, redundancy can support the creation of deep levels of tacit understanding that extend beyond the cognitive and intellectual realm (Morgan, 1997).

Many managers may believe that redundancy is an inefficient management technique because it involves the duplication of resources. Although this is true, managers who hold this view miss the larger picture. Excess information clarifies the meaning of the specific requisite information held by distinct individuals and groups (Nonaka, 1991). Redundancy promotes the establishment of internal connections among groups, thereby reducing the functional and geographical distributed knowledge problems that exist in the organization.

Organizations that possess requisite variety are capable of confronting the external challenges that exist in their environment. Requisite variety connects the organization with its external environment, just as redundancy connects the components of its internal environment. The principle of requisite variety is important because if a unit or team is to be successful in dealing with the challenges of a complex task or difficult environment, it is vital that the unit be allowed to possess sufficient internal complexity (Morgan, 1997). Requisite variety enables organizations to switch gears and to leverage different capabilities based on the requirements of the environment.

In an uncertain and turbulent global business environment, it is important for an organization to possess a distributed portfolio of resources and capabilities in order to successfully face external and internal environmental challenges. Redundancy and requisite variety ensure that teams are able to survive the challenges they face and evolve as new knowledge is created as they resolve internal conflicts and converge on potential innovative ideas. These two characteristics encourage heedful relationship within the organization.

Teams that have requisite variety generate new knowledge to solve the complex issues that emerge in their environment. As new knowledge is created, the group develops new capabilities and awareness, and it evolves through the process of trial-and-error learning. Redundancy and replication eliminate the need for a shared cognition among employees who participate in the innovation process. In addition, these

attributes provide the organization with the capabilities to adapt and respond to external stimuli and grasp opportunities ahead of competitors or release old patterns of working that no longer fit the business environment. In addition, redundancy and requisite variety establish connections and cooperation among groups, thus reducing the possibility of cognitive bias.

Control

The power of the brain lies in its ability to process information in a parallel yet distributed manner using a cooperative computation process. This process enables the brain to operate decentralized structures without a centralized control mechanism. Cooperative computation provides the brain with the flexibility to change its communication patterns in order to respond to external stimuli. This process reveals how the brain uses different schemas that possess localized knowledge, as well as iterative communication patterns between localized schemas, to arrive at a consensus course of action (Garud & Kotha, 1994). The cornerstone of cooperative computation is self-replication. An organization can counteract the effects of the distributed knowledge that emerges within the innovative process by building the whole into the parts (Morgan, 1997).

An organization can achieve this goal by ensuring that its culture, norms, and values transfer to its subsidiaries and subunits. The visions, values, and sense of purpose that bind an organization together can be used as a way of helping every individual understand and absorb the organization's mission (Morgan, 1997). Employees learn the cultures and values of the larger organization by participating in social interactions in their subunit. Although the subunit is distinguishable from the whole, it remains connected to the organization and contains its culture, norms, and values.

CONCLUSION

Given the growing complexity and increased competitiveness of the global business environment, organizations might consider adjusting their paradigms to focus on leveraging local knowledge assets but also begin to understand and exploit the social connections that influence their work activities.

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