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Knowledge Transfer: A Basis for Competitive Advantage in Firms

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This concluding article in the special issue of *Organizational Behavior and Human Decision Processes* on the foundations of knowledge transfer in organizations argues that the creation and transfer of knowledge are a basis for competitive advantage in firms. The article builds on a framework of knowledge reservoirs to show why knowledge transfer can be difficult and to identify the kinds of knowledge that are most difficult to transfer to different contexts. The article develops the proposition that interactions among people, tasks, and tools are least likely to fit the new context and hence are the most difficult to transfer. This theoretical result illuminates how organizations can derive competitive advantage by transferring knowledge internally while preventing its external transfer to competitors. Because people are more similar within than between organizations, interactions involving people transfer more readily within than between firms. By embedding knowledge in interactions involving people, organizations can both effect knowledge transfer internally and impede knowledge transfer externally. Thus, knowledge embedded in the interactions of people, tools, and tasks provides a basis for competitive advantage in firms. © 2000 Academic Press

The ability to transfer knowledge from one unit to another has been found to contribute to the organizational performance of firms in both the manufacturing

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(Epple, Argote, & Murphy, 1996; Galbraith, 1990) and service sectors (Baum & Ingram, 1998; Darr, Argote, & Epple, 1995). Although the benefits of knowledge transfer have been documented in many settings, the effectiveness of knowledge transfer varies considerably among organizations (Argote, 1999; Szulanski, 1996).

The current article, the concluding article in this special issue of *Organizational Behavior and Human Decision Processes* on the psychological foundations of knowledge transfer in organizations, presents a conceptual framework for analyzing knowledge transfer in organizations. The article begins by defining knowledge transfer and discussing its measurement. A framework of knowledge reservoirs (repositories where knowledge is embedded in organizations) that was developed by McGrath and Argote (in press) is used to demonstrate why knowledge transfer can be difficult and to organize the evidence on the kinds of knowledge that are more readily transferred. The article argues that the creation and transfer of knowledge in organizations provide a basis for competitive advantage in firms.

KNOWLEDGE TRANSFER DEFINED

Knowledge transfer in organizations is the process through which one unit (e.g., group, department, or division) is affected by the experience of another. This definition is similar to definitions of transfer at the individual level of analysis in cognitive psychology. For example, Singley and Anderson (1989, p. 1) defined transfer at the individual level as "how knowledge acquired in one situation applies (or fails to apply) to another." Although knowledge transfer in organizations involves transfer at the individual level, the problem of knowledge transfer in organizations transcends the individual level to include transfer at higher levels of analysis, such as the group, product line, department, or division. For example, one manufacturing team may learn from another how to better assemble a product or a geographical division may learn a different approach to product design from its counterpart in another division.

Knowledge transfer in organizations manifests itself through changes in the knowledge or performance of the recipient units. Thus, knowledge transfer can be measured by measuring changes in knowledge or changes in performance. For example, a performance-based approach to measuring knowledge was used by Darr, Argote, and Epple (1995) to estimate the extent to which the productivity of fast-food stores was affected by the experience of the other stores in their franchise. Similarly, Baum and Ingram (1998) analyzed the extent to which the survival of hotels was affected by the experience of other hotels in their chain. Benkard (in press) analyzed the extent to which experience producing one model of a product affected the amount of labor required to produce a subsequent model. A particular challenge in assessing transfer through measuring changes in performance is controlling for factors in addition to the experience of other units that may affect the performance of the recipient unit (see Argote, 1999).

Knowledge transfer in organizations can also be assessed through measuring

changes in the knowledge of the recipient unit, although this approach also poses challenges. A significant component of the knowledge that organizations acquire may be tacit and not easily articulated (Nonaka, 1991). Tacit knowledge may not be captured through the verbal reports often used to measure knowledge. Performance-based measurement approaches are better suited to capture tacit knowledge than approaches that attempt to measure the knowledge more directly. For example, a series of studies by Berry and Broadbent (1984, 1987) showed that individuals were able to transfer their experience from one management simulation to another: The performance of participants with significant experience on a previous simulation was better than that of participants with little or no experience. Although experienced participants performed better on a subsequent simulation, they were not able to articulate why they performed better. Neither self-report questionnaire measures nor verbal protocols showed differences in the knowledge of experienced and inexperienced participants. Thus, unlike performance-based measures, verbal measures of knowledge were not able to capture the knowledge that experienced participants had acquired.

Another challenge to measuring knowledge transfer in organizations through measuring changes in knowledge is that knowledge in organizations resides in multiple repositories (Levitt & March, 1988; Starbuck, 1992; Walsh & Ungson, 1991). For example, Walsh and Ungson posited that there are five retention bins or repositories for knowledge in organizations: (a) individual members, (b) roles and organizational structures, (c) the organization's standard operating procedures and practices, (d) its culture, and (e) the physical structure of the workplace. In order to measure transfer through changes in knowledge, one must capture changes in knowledge in these different repositories.

Most existing techniques for measuring knowledge, such as questionnaires or verbal protocols, measure changes in knowledge embedded in individuals. Although knowledge change is initially mediated through individuals in organizations, subsequent knowledge change can occur without individual involvement. For example, an individual in one branch of a firm may learn through experience how to modify a piece of software to produce a better quality product. The software may then be transferred to another site in the organization where it may improve the performance of the recipient unit without any individual at the recipient unit being able to articulate why the performance improved. Attempts to measure changes in knowledge at the recipient site through measuring the knowledge of individuals would not be informative in this example because individuals' knowledge did not change. Knowledge embedded in other repositories, however, changed with the introduction of the new software.

The knowledge repositories play a dual role in knowledge transfer in organizations. On the one hand, the knowledge repositories are changed when knowledge transfer occurs. Thus, changes in the knowledge repositories reflect the outcomes of knowledge transfer. On the other hand, the state of the knowledge repositories affects the processes and outcomes of knowledge transfer. Just as an individual's readiness and past knowledge affect his or her ability to acquire

new knowledge (e.g., see Goldstein, 1991), an organization's current knowledge affects its ability to assimilate new knowledge (Cohen & Levinthal, 1990).

RESERVOIRS OF KNOWLEDGE IN ORGANIZATIONS

The framework of knowledge reservoirs used here was developed by McGrath and Argote (in press). We use the term "reservoir" here, derived from the French "reserver" meaning "to keep for future use," because it connotes that the knowledge can be used again. The McGrath and Argote framework builds on previous theoretical frameworks (Argote, 1999; Argote & McGrath, 1993; Arrow, McGrath, & Berdahl, 2000; Levitt & March, 1988; McGrath, 1991; Starbuck, 1992; Walsh & Ungson, 1991). According to the framework of McGrath and Argote, knowledge is embedded in the three basic elements of organizations—members, tools, and tasks—and the various subnetworks formed by combining or crossing the basic elements. Members are the human components of organizations. Tools, including both hardware and software, are the technological component. Tasks reflect the organization's goals, intentions, and purposes.

The basic elements of organizations combine to form subnetworks (McGrath & Argote, in press). The member–member network is the organization's social network. The task–task network is the sequence of tasks or routines the organization uses. The tool–tool network is the combination of technologies used by the organization. The member–task network (or the division of labor) maps members onto tasks. The member–tool network assigns members to tools. The task–tool network specifies which tools are used to perform which tasks. The member–task–tool network specifies which members perform which tasks with which tools.

According to the framework, organizational performance improves with increases in both the internal compatibility of the networks and their external compatibility with other networks (McGrath & Argote, in press). For example, organizational performance is enhanced when the member–task network allocates tasks to the members most qualified to perform them. Similarly, when members have the appropriate tools to perform the tasks allocated to them, the member–task network is compatible with the member–tool network. The former is an example of internal compatibility of the networks, while the latter is an example of external compatibility or compatibility between the different networks. Other researchers have also emphasized the importance of the compatibility or congruence of organizational components as a contributor to organizational effectiveness (e.g., Argote, 1982; Leavitt, 1965; Nadler & Tushman, 1980).

A significant component of the knowledge that organizations acquire, especially tacit knowledge, is embedded in individual members. For example, Engeström, Brown, Engeström, and Koistinen (1990) described a urology clinic where most of the organization's knowledge was embedded in one administrator. Similarly, Starbuck (1992) argued that in professional service organizations,

such as law firms or consulting firms, a significant component of the organization's knowledge is embedded in individual members.

Knowledge can also be embedded in an organization's tools and technology. For example, Argote (1999) described how the software of a truck assembly plant was modified to capture knowledge about how to apply paint with less scrap material. Similarly, Argote and Darr (in press) analyzed how fast-food franchises adapted their tools to capture knowledge about how to produce products more cost effectively.

Knowledge can also be embedded in an organization's tasks and their interrelationships. The task network is the sequence of tasks or the routines and standard operating procedures the organization uses (see Gersick & Hackman, 1990; Nelson & Winter, 1982, for discussions of routines). Argote (1999) described how a truck assembly plant developed a more cost-effective method for painting trucks that was embedded in a routine or task sequence that all workers used. Similarly, Darr, Argote and Epple (1995) analyzed how the knowledge acquired at a fast-food franchise about how to produce a higher quality product was embedded in a routine.

Finally, knowledge can be embedded in the various networks formed by combining members, tools, and tasks. The member–task network or the division of labor specifies which member performs which tasks in the organization. Knowledge of who in the organization is good at which task is embedded in the member–task network. Studies of organizational learning have shown that an important source of the productivity benefits that organizations typically gain with experience is learning which member is good at which tasks and assigning tasks accordingly (Argote, 1993). Studies have also shown that, with experience working together, dyads and small groups improve their performance by acquiring knowledge of who knows what (e.g., see Hollingshead, 1998; Liang, Moreland, & Argote, 1995). The term "transactive memory" was coined to capture this concept of who knows what (Wegner, 1986). Transactive memory systems embed knowledge of who is proficient at which tasks (the member–task network) and who is proficient with which tools (the member–tool network). As organizations acquire knowledge, they also learn which tasks are best performed by people and those which are best performed by tools or automation. The latter knowledge is embedded in the task–tool network that also contains information about which tasks are best performed by which tools. Last, organizations acquire information about which members best perform which tasks with which tools. This knowledge is embedded in the coordination network.

Knowledge transfer occurs when experience in one unit of an organization affects another unit. Knowledge transfer can occur explicitly when, for example, a unit communicates with another unit about a practice that it has found to improve performance. Knowledge transfer can also occur implicitly without the recipient unit being able to articulate the knowledge it has acquired. For example, if an individual uses a tool that has been modified to improve its performance, the individual can benefit from the productivity enhancement in the tool without necessarily understanding the modifications or being able to

articulate why the modifications improved the tool's performance. Similarly, norms or routines can be transmitted to group members without the members being able to articulate the norm or being aware of the knowledge embedded in it.

In general terms, knowledge can be transferred by moving a knowledge reservoir from one unit to another or by modifying a knowledge reservoir at a recipient site. Members can be moved from one unit to another. Similarly, technology can be moved and routines can be transported from one organization to another. The reservoirs at the recipient unit can also be modified through communication and training.

KNOWLEDGE AS A BASIS OF COMPETITIVE ADVANTAGE

Our goal is now to show how the framework of knowledge reservoirs can be combined with behavioral evidence on knowledge transfer to understand the differential performance of organizations. First, we describe the emerging role of knowledge as a basis for the competitive advantage of organizations. Then we apply our framework to explain why successful knowledge transfer is difficult and to organize the evidence regarding knowledge that is more easily transferable. Finally, we present evidence indicating how organizations can develop the knowledge that is a basis for competitive advantage.

The recent trend in the field of strategic management has been to emphasize the role of organizational knowledge as a basis of the competitive advantage of particular organizations. Explanations of competitive advantage that rely primarily on the positioning of organizations in an industry (e.g., Porter, 1980) or the deployment of organizational assets through competitive interaction with rival firms (e.g., Dixit, 1980; Shapiro, 1989) have been relatively deemphasized. Novel work continues on industry structure, but that work integrates organizational knowledge perspectives with industry (Williams, 1998) or rivalry perspectives (e.g., Korn & Baum, 1999). Empirical findings have shown that differences between organizations may account for more variance in firm performance than differences between industries (Rumelt, 1991). Although important industry effects may be present (e.g., see McGahan & Porter, 1997), organizational-level differences are now acknowledged as a critical source of variation in firm performance over and above industry differences.

Although empirical findings make the case for organizational resources as a basis of competitive advantage, theoretical arguments have been powerful for identifying the types of resources that are key. Barney (1986) pointed out that for resources acquired through competitive markets, the value that the resource brings to the organization should be reflected in its price to the organization. For this reason, the focus for competitive advantage should be on resources developed or made valuable inside the organization rather than those purchased from outside it. The set of relevant resources is further limited by the recognition that resources cannot be the source of competitive advantage if many competitors have them. Therefore, to be the source of competitive

advantage, resources must also be difficult for competitors to imitate (Lippman & Rumelt, 1982).

The focus on resources that are developed within the organization and difficult to imitate puts organizational knowledge in a preeminent position as the principal source of competitive advantage (Spender & Grant, 1996; Teece, Pisano, & Shuen, 1997). Despite variance in terminology for organizational knowledge (competencies, capabilities, routines, or innovations), there is growing agreement that it is what the organization comes to know that explains its performance. The problem for those who want to develop competitive advantage for their organizations, however, is that, in the field of business strategy, more effort has gone into identifying knowledge as the basis of competitive advantage than into explaining how organizations can develop, retain, and transfer that knowledge. As Spender and Grant (1996, p. 6) observed, "The surge of interest into organizational capabilities and competencies has directed attention to organizationally embedded knowledge, but has made only limited progress in understanding its anatomy and creation." To the extent there has been progress, it has been at the level of identifying consistencies in organizations' knowledge development paths (e.g., Teece, 1988) and almost never at the level of the human interactions that are the primary source of knowledge and knowledge transfer.

Against this backdrop, there is a clear opportunity for the research effort represented in this special issue to contribute to the understanding of how organizations gain competitive advantage through knowledge. The framework of knowledge reservoirs outlined in this article represents the "anatomy" of knowledge in organizations. We show how the framework can be applied to illuminate the problem of knowledge transfer, indicating when organizations can be expected to derive competitive advantage by transferring knowledge internally and preventing its transfer to competitors. Other articles in this special issue, and the literature they build on, illuminate the process by which organizations can create knowledge. We describe how the articles contribute social-psychological guidance for the task of developing competitive advantage in firms.

MOVING KNOWLEDGE BY MOVING RESERVOIRS AND NETWORKS

The framework of knowledge reservoirs and their interconnecting networks provides insight into why some types of knowledge are difficult to transfer within the organization and to imitate outside the organization. In principle, knowledge can be moved by moving the networks in which it is embedded. In practice, however, this is difficult to accomplish. As noted previously, organizational performance depends on the internal and external compatibility of the networks. Compatibility of members, tools, and tasks moved from one unit to another can be problematic. In order for members, tools, and tasks to be effective at the new unit, they may have to adapt or be adapted to the new context. The issue of compatibility in moving the networks from one site to another, however, is even more complex than moving the basic elements of people, tools, or tasks.

For example, a division of labor developed in one organizational unit that fits the skills of its members may not work in another unit where members have different skills and areas of expertise. Thus, moving networks is difficult to do effectively because they embody interactions that may not fit the new context. It is less likely that the networks will fit the new contexts than the basic elements (member, tools, and tasks) because the networks consist of more components that must be internally compatible, compatible with one another, and compatible with the new context in order for the transfer to be successful.

Strategy scholars have also recognized that the interdependence of various components of knowledge inhibits transfer (Teece, Pisano, & Shuen, 1997). The advantage of the framework we present is that it highlights the fact that interdependencies between knowledge reservoirs may vary, making some types of knowledge easier to transfer than others. Research may then proceed to examine the transfer success of particular networks.

More research has been done on moving members and moving tools or technology than on moving the other knowledge reservoirs. Moving members is generally seen as a powerful mechanism for facilitating knowledge transfer in organizations (Galbraith, 1990; Rothwell, 1978). Individuals are able to adapt and restructure knowledge so that it applies to new contexts (Allen, 1977). Individuals are also able to transfer both tacit and explicit knowledge to new contexts (Berry & Broadbent, 1984,1987). A recent empirical study of the effect of moving members found that the mobility of engineers between firms contributed to the transfer of knowledge about innovations in the semiconductor industry (Almeida & Kogut, 1999).

Gruenfeld, Martorena, and Fan (2000) demonstrated that moving individual members can have subtle effects on knowledge transfer across groups. Moving members did not result in ideas moving directly from one group to another in their study. On the contrary, the ideas of "itinerants" who changed groups were not particularly influential in the new groups and were used significantly less often than the ideas of "indigenous" members after the itinerants returned to their groups of origin. New knowledge, however, was generated in groups upon their itinerant members' return from sojourns in other groups: Both "itinerant" and "indigenous" members generated significantly more unique ideas after the itinerants returned to their groups of origin than before or during the period of membership change.

Considerable research has been done on technology transfer to study the effect of moving tools from one site to another on outcomes at the organizational, interorganizational, and societal levels (see Zhao & Reisman, 1992, for an overview). Although transferring knowledge through moving technology can be effective, the success of technology transfer attempts varies considerably. The technology often needs to be adapted to the context at the recipient site in order to be effective (Leonard-Barton, 1988).

Explicit, codifiable knowledge that is embedded in technology has been found to transfer more readily than knowledge not embedded in technology (e.g., see Zander & Kogut, 1995). Similarly, technology transfer attempts have been found to be more successful when the technology is not complex and is well

understood (Galbraith, 1990). In addition, attempts to move knowledge by transferring technology within firms have been found to be more effective when they are accompanied by moving personnel (e.g., see Galbraith, 1990).

Although embedding knowledge in technology is an effective way to transfer knowledge within the firm, it is also a way to facilitate knowledge transfer externally. Studies of how rapidly knowledge "leaks out" to competitors have found that technological knowledge embedded in products spills over to other firms more quickly than knowledge embedded in organizational processes or routines (Mansfield, 1985). Making knowledge explicit enough to be embedded in technology eases its internal transfer but also speeds its spillover to other organizations.

Many studies of knowledge transfer recognize the relevance of knowledge embedded in tasks when they invoke the concept of routines. Only a few studies, however, have attempted to explicitly examine or describe the routines or task sequences used by organizations (e.g., see Argote & Darr, in press; Baum & Berta, 1999; Gersick & Hackman, 1990; Szulanski, in press) and to analyze their transfer to new settings. A major theme in these studies is that transferring knowledge through moving routines can be effective, although specific characteristics of the routine, as well as features and interrelationships of the originating and receiving units of the organization, influence the likelihood of successful knowledge transfer.

Similarly, only a few studies have examined knowledge transfer through moving subnetworks. The results of these studies document the difficulty of transferring knowledge through moving subnetworks that involve members. For example, Moreland, Argote, and Krishnan (1996) examined whether a "transactive memory system" (a network of member–task relations and member–tool relations) transferred from the group in which it was developed to a group composed of different members. Results indicated that these transactive memory systems that embodied knowledge about which group members were good at which tasks did not transfer to groups composed of different members. Devadas and Argote (1995) found that membership change was harmful for groups when the member–task network and the member–tool network did not fit the skill and expertise of the new member. Similarly, Wegner, Erber, and Raymond (1991) found that imposing a division of labor (a member–task network) on an ongoing dyad that had already developed its own knowledge about who was good at what hurt the performance of the dyad. By contrast, imposing a division of labor on a newly formed dyad improved the dyad's performance.

These findings provide insights into the observation that new organizations seem particularly open to learning from the experience of others (e.g., see Argote, Beckman, & Epple, 1990; Ingram & Baum, 1997). Knowledge provided to an established organization may not be as useful because it conflicts with networks already in place at the organization. By contrast, knowledge provided at the start of operation is less likely to create such conflict because networks of knowledge are not yet fully established.

In contrast to the emerging evidence on the effects of moving subnetworks

involving people, evidence suggests that moving the task–tool network can be an effective way to transfer knowledge. One study found that the knowledge embedded in the task–tool network of a plant transferred quickly and effectively to new members (Epple, Argote, & Murphy, 1996). The study analyzed the productivity of a manufacturing plant that added a second shift almost 2 years after operating with one shift. The second shift, composed primarily of members who were new to the organization, used the same tools and task sequences embedded in the assembly line that the first shift had used. The second shift achieved a level of productivity in a couple of weeks that the first shift took many months to achieve. The second shift benefited from knowledge embedded by the first shift in the tools and tasks sequences.

Several theoretical results emerge from our analysis of knowledge transfer through moving the knowledge reservoirs and subnetworks. The strengths of moving people as a knowledge-transfer mechanism complement the strengths of moving tools or technology. People are able to transfer tacit as well as explicit knowledge when they move and to adapt their knowledge to new contexts. Although tools lack the sensitivity and flexibility of people, they provide consistency and enable the organization to transfer knowledge on a large scale in a way that is relatively independent of the idiosyncrasies of individual members. The effects of transferring knowledge through moving tasks are similar to those of moving tools. Tasks, however, usually require people to perform them, whereas tools may require less human intervention. Thus, transferring knowledge through moving tasks or task–task subnetworks is somewhat more flexible and somewhat less consistent than transferring knowledge through moving technology.

In order for knowledge transfer to be successful, the reservoirs or subnetworks that are moved must fit or be compatible with the new context. As noted previously, the compatibility of members, tools, and tasks moved from one unit to another cannot be taken for granted. In order for these elements to be effective knowledge conduits, they may have to adapt or be adapted to the new context. Attaining compatibility between subnetworks moved from one site to another, however, is even more problematic than attaining compatibility of people, tools, or tasks moved to the new context because the subnetworks consist of more elements and involve interactions among them. It is less likely that the interactions will fit the new contexts than the single elements will.

Further, interactions involving people are more problematic than those involving tools or tasks. People are likely to vary more across sites than tools or tasks. Thus, it is more difficult to transfer knowledge by moving the member–member, member–task, member–tool, or member–task–tool network to a new setting than it is to transfer knowledge through moving the other knowledge reservoirs.

Our analysis indicates that the most problematic knowledge conduits are the subnetworks involving people and not the people in them per se. Although social psychological processes mediate the effect of moving people on knowledge transfer (e.g., see Gruenfeld et al., 2000), people can be effective knowledge

conduits. People are likely to be especially effective conduits of general principles or abstract knowledge that is relatively invariant to context, such as that embedded in patents (e.g., see Almedia & Kogut, 1999).

The observation that it is difficult to transfer knowledge from one organization to another by moving the subnetworks involving members has important managerial and strategic implications: It suggests that embedding knowledge in the member–member, member–task, member–tool, or member–task–tool network minimizes knowledge spillover to other firms because knowledge in these networks is the most difficult to transfer or copy. Further, to the extent that people are more similar within than between organizations (which seems likely, in light of the selection, socialization, training, and communication that go on within organizations, e.g., see Jackson, Brett, Sessa, Cooper, Julin, & Peyronnin, 1991), moving the subnetworks involving people will be a more effective way to transfer knowledge within than between organizations. Thus, embedding knowledge in the subnetworks that involve people makes it difficult for external knowledge transfer to occur while permitting some (albeit challenging) internal knowledge transfer.

MOVING KNOWLEDGE BY MODIFYING RESERVOIRS AND NETWORKS

In addition to moving a knowledge reservoir from one unit to another, the other main method of knowledge transfer is to modify the knowledge reservoirs of the recipient unit, primarily through communication or training. Several articles in this volume examine how communication and training can modify the knowledge of the recipient.

Building on work on analogical reasoning, Thompson, Gentner, and Lowenstein (2000) found that dyads who were trained to compare across cases and abstract a common principle performed better on a subsequent task than dyads who were trained to give advice about the cases. These results provide important insights into how organizations can facilitate the codification of knowledge into principles. As noted previously, codified knowledge transfers more readily than knowledge that is not codified.

Two studies in the special issue examined how communication affected the development of knowledge of "who knows what" in groups and organizations. Moreland and Myaskovsky (2000) compared the effect of providing opportunities to communicate and providing feedback about individual group members' skills on the creation of transactive memory systems in groups. These transactive memory systems embed knowledge of who is good at performing which tasks (the member–task network) and who is good at operating which tools (the member–tool network). Providing feedback about individual skills and providing opportunities to communicate were found to be equally effective (and more effective than training individuals) in creating transactive memory systems with compatible member–task and member–tool networks. Further, the performance of groups with well-developed transactive memory systems exceeded that of groups lacking such memory systems.

Rulke, Zaheer, and Anderson (2000) also examined the creation of knowledge

about who knows what. Focusing at the organizational level of analysis, the researchers contrasted the effect of communication channels on an organization's knowledge of its own capabilities. They found that relational channels both inside and outside the organization and nonrelational internal channels (e.g., company newsletters, formal training programs) contributed more to knowledge of an organization's capabilities than external nonrelational channels, such as trade association publications and newsletters. These findings underscore the importance of relationships in knowledge transfer.

Two articles in this special issue analyzed how the task network affected the generation and transfer of knowledge. Paulus and Yang (2000) found that procedures for sharing knowledge that exposed group members to the ideas of others while allowing them to generate ideas continuously and maintain their own identity led to the creation of more novel ideas than did procedures that simply pooled the ideas of individual group members. Levine, Higgins, and Choi (2000) demonstrated that task instructions shaped the development of a shared reality in groups that affected their problem-solving strategies.

Stasser, Vaughan, and Stewart (2000) provided evidence on how member–task networks affected knowledge sharing in groups. This study replicated previous work demonstrating that during group discussion, groups focused more on shared information that members held in common than on unshared information that members uniquely possessed. Further, the bias favoring shared information was reduced by publicly identifying members' expertise at the onset of group discussion but not by forewarning individual members of their areas of expertise before they prepared for the group discussion. Thus, awareness of the member–task network by all groups members improved group performance.

FACTORS AFFECTING KNOWLEDGE TRANSFER

Articles in this special issue as well as other research identify factors that affect knowledge transfer in organizations. Darr and Kurtzberg (2000) examined how the similarity between tasks affected the transfer of knowledge between fast-food stores. "Strategic similarity" (similarity of the stores' strategies and tasks) positively affected transfer of knowledge, whereas similarity of customers or location had no effect.

Szulanski (2000) analyzed how characteristics of the source of knowledge, the recipient, the context, and the knowledge itself affected transfer. Szulanski found that the importance of these factors varied over stages of the transfer process. Factors that affected the perception of an opportunity to transfer knowledge, such as the reliability of the source, predicted difficulty of transfer during the early initiation stage, whereas factors that affected the execution of transfer, such as the recipient's ability to absorb knowledge, affected difficulty during the implementation phases. The "causal ambiguity" of the knowledge or the extent to which it was not well understood predicted the difficulty of transfer throughout all phases of the transfer process.

Other research has examined the factors affecting knowledge transfer in

organizations (see Argote, 1999, for a review). Research has been done, for instance, on how characteristics of individual members, such as their ability and motivation, affect the transfer of knowledge from training to transfer contexts (see Baldwin & Ford, 1989, for a review).

The question of how characteristics of the member–member or social network affect knowledge transfer is receiving increasing attention. One important finding to emerge from this work is that knowledge transfers more readily across organizations that are embedded in a network or superordinate relationship, such as a franchise, chain, or alliance, than across independent organizations (Baum & Ingram, 1998; Darr, Argote, & Epple, 1995; Greve, 1999; Ingram & Simons, 1999; Powell, Koput, & Smith-Doerr, 1996). For example, Darr, Argote, and Epple (1995) found that fast-food stores benefited from the experience of other stores in the same franchise but not from that of stores in different franchises (see also Darr & Kurtzberg, 2000). Similarly, Baum and Ingram (1998) found that hotels benefited from the experience of local hotels (but not nonlocal hotels) that belonged to the same chain. Ingram and Simons (1999) found that kibbutzim were positively affected by the experience of other kibbutzim in the same federation.

Studies have also found that characteristics of the social network affect the extent of knowledge transfer. For example, in a study of knowledge transfer among small manufacturers, McEvily and Zaheer (1999) found that, consistent with structural hole theory (Burt, 1992), nonredundancy in organizations' social networks predicted their ability to acquire knowledge and new capabilities. Organizations with nonredundant social ties to other organizations had access to more information that enabled them to acquire more new capabilities than organizations whose ties to other organizations were redundant or overlapping.

Research has also shown that the nature of the social ties interacts with characteristics of the knowledge being transferred to affect transfer outcomes. In a study of new product development projects, Hansen (1999) found that "weak ties," characterized by infrequent and distant relationships between units, facilitated the search for knowledge in other units and reduced the time to complete projects when knowledge was not complex and could be codified. By contrast, when knowledge was not codified, strong ties that allowed for repeated interaction promoted knowledge acquisition and shortened project-completion times. Along similar lines, Baum and Berta (1999) found that learning between student groups in a business simulation was higher when there was a higher degree of social contact between them.

Characteristics of the task have also been found to affect knowledge transfer. The most fundamental task characteristic found to affect transfer is the similarity across tasks in different contexts. The more similar the number of elements across the tasks, the greater the likelihood of transfer (Thorndike, 1906). The finding that similarity increases the likelihood of transfer has been found at different levels of analysis, ranging from the individual (Singley & Anderson, 1989) to the organizational (Darr & Kurtzberg, 2000). At the individual level, research has also been done on the effect of other task characteristics such as the amount of feedback that participants receive or the conditions of their

practice on knowledge transfer (see Baldwin & Ford, 1989, for a review). At the organizational level, research has been done on the extent to which the task was well understood on knowledge transfer.

Characteristics of the technology or tools being transferred have also been found to affect the success of the transfer. Galbraith (1990) compared the productivity at the "recipient" site to the productivity of the "source" at the time the technology was transferred. Galbraith found that the recipient's productivity recovered faster when the technology was not complex, when the source and recipient were close geographically, when coproduction continued at the donor site, and when the engineering team at the source organization moved for a significant time period to the recipient site. Continuing production at the source site and moving personnel may have facilitated transfer by enabling the recipient to access tacit knowledge at the source that was not written down or embedded in documents, plans, tools, and products.

Our framework of knowledge reservoirs also provides insights into when knowledge transfer can negatively affect the performance of the recipient unit. If the knowledge to be transferred is inappropriate for and cannot be adapted to the new context, negative effects on performance can occur (e.g., Baum & Ingram, 1998; Greve, 1999). For example, Greve provided evidence of how knowledge acquired outside the local market of radio stations can negatively affect their performance. Following Baum and Ingram, Greve suggested that the negative effect occurred because routines imported from other markets were not appropriate for the local markets, where competitors were different.

The framework of knowledge reservoirs also provides insights into "situated cognition" (Lant, 1999; Lave, 1993), the research tradition that views cognition as dependent on particular features of the context. Because cognition is so dependent on the context, knowledge transfer from other contexts is conceived as playing little or no role in learning. By providing a more fine-grained framework for analyzing where knowledge is embedded in organizational contexts, our analysis identifies when knowledge will be relatively easy to transfer from one context to another and when such transfer will be problematic. Thus, the framework provided here is positioned between frameworks that posit virtually no transfer across contexts and those that posit virtually instantaneous and complete transfer across contexts.

CONCLUSION

The more nuanced view of knowledge transfer presented in our framework is more consistent with empirical evidence on knowledge transfer, which shows both that transfer often occurs and that it is often incomplete. The more fine-grained framework presented here provides a deeper understanding of the conditions under which knowledge transfer occurs and the conditions under which knowledge transfer is problematic or incomplete. Thus, the framework advances theory about knowledge transfer in organizations and provides practical insights for the management of knowledge in firms.

Our framework illuminates the dual role of people in knowledge transfer.

On the one hand, differences in the subnetworks involving people across contexts make knowledge transfer problematic. As noted previously, in order for knowledge transfer to be successful, the knowledge reservoirs or subnetworks imported from one context must be compatible with or fit the new context. Compatibility across contexts of the subnetworks involving people is more problematic than compatibility of the other subnetworks because people are likely to vary more across contexts than tools or tasks.

On the other hand, people are capable of adapting knowledge from one context to another. As noted previously, moving technology or tasks from one site to another has been found to be more effective when accompanied by moving people because people are capable of adapting the tools and technology to the new context. Thus, although adapting to differences in people across contexts poses challenges to knowledge transfer, people's ability to adapt knowledge they possess facilitates transfer.

Because people play the most critical role in the success of technology transfer, further research on the role of members and the subnetworks involving them is needed. A fundamental question is identifying the conditions under which moving people will result in knowledge transfer. As noted in the Gruenfeld et al. article in this special issue, the success of knowledge transfer through moving people is not automatic and depends on social influence processes. When people are moved to a new context to transfer knowledge, they often become "minorities" in the context of the majority at the new site (see Levine & Thompson, 1996; Wood, Lundgren, Ouelette, Busceme, & Blackstone, 1994, for discussions of minority influence). Thus, understanding how minorities who are moved to new sites can influence knowledge transfer should be a fruitful area for future research.

As noted previously, "modifying" people is also an important general mechanism for transferring knowledge. A greater understanding is needed of the socialization and training processes that modify, or change, people and how they affect knowledge transfer. Because differences in context pose particular challenges to knowledge transfer, research on socialization and training that takes context into account is likely to be especially promising.

The member–member or the social network also plays an important role in knowledge transfer. The social network can link organizational units to new sources of knowledge and aid interpretation of the new knowledge. More research is needed on the properties of social networks that facilitate (or impede) transfer. Future research should also examine the strong group identities that are often associated with dense social networks in organizations. The identification with a social unit can lead to in-group favoritism where the members of one's own group are perceived much more favorably than members of other groups (Kramer, 1991; Messick & Mackie, 1989). Research is needed on how this in-group favoritism can affect knowledge transfer in organizations.

Research is also needed on the implications of the many levels of potential identification for knowledge transfer in organizations. For example, members may identify primarily with their own work group, with the department in which their group is embedded, with the larger division of which the department

is a part, or with the firm (Moreland & Levine, 2000). An organization where members identify most strongly with their work groups may have more difficulty transferring knowledge across groups than an organization where members identify mainly with the superordinate organization. Understanding factors that lead members to identify with one level over another as well as the consequences of their identification for knowledge transfer is an important area for future research.

More generally, future empirical studies should examine the conditions under which knowledge is embedded in the various reservoirs. For example, how do the member–member, the member–task, and the member–tool networks develop? Research should also empirically determine the extent to which knowledge in the various reservoirs transfers to new contexts. Factors that support or impede such transfer should be identified. Information about these issues will greatly advance our understanding of knowledge transfer in organizations.

The framework of knowledge reservoirs discussed here provides insights into the reasons why it is difficult to transfer knowledge and into the conditions under which knowledge transfer is most likely. We have shown here that attaining compatibility between the subnetworks moved from one site to another is even more problematic than attaining compatibility of the basic elements of people, tools, or tasks. The subnetworks consist of two or three elements that have coevolved to fit their current context and are less likely than the basic elements to fit the new context.

The observation that the subnetworks involving people are the most problematic from a knowledge-transfer perspective provides important insights into the fundamental paradox of knowledge management in firms: Firms are most effective when they manage both to facilitate internal knowledge transfer and to block external knowledge spillover. The framework described here provides insights into how firms can accomplish both. Embedding knowledge in the subnetworks that involve people minimizes the likelihood of transfer to external organizations because knowledge in these reservoirs is least likely to fit other contexts. Because selection, socialization, training, and communication processes within organizations make people more similar within than between firms, the subnetworks involving people are more likely to be compatible with other subnetworks internal to the organization than with external subnetworks. Thus, achieving transfer through moving the subnetworks involving people is more problematic between than within organizations. Our framework shows how organizations can minimize transfer to external organizations while they achieve internal knowledge transfer. Thus, the processes underlying knowledge transfer provide a basis for understanding the competitive advantage of firms.

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