Organizational Dynamics, Vol. 30, No. 2, pp. 100–120, 2001

www.organizational-dynamics.com
ISSN 0090-2616/01/$–see frontmatter
PII S0090-2616(01)00046-8

Knowing What We Know:

Supporting Knowledge Creation and Sharing in Social Networks

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Crafting an Answer

"So the call came in late on Thursday afternoon and right away I wished I hadn't answered the phone. We had received a last-second opportunity to bid on a sizable piece of work that the Partner on the other end of the line really wanted to pursue. I had no clue how to even begin looking for relevant methodologies or case examples, so my first move was to tap into my network to find some relevant info and leads to other people or databases. And I relied pretty heavily on this group over the next couple of days. Seth was great for pointing me to other people and relevant information, Paul provided ideas on the technical content of the project while Jeff really helped in showing me how to frame the client's issues in ways that we could sell. He also helped navigate and get buy-in from the client given his knowledge of their operations and politics. . . I mean the whole game is just being the person that can get the client what they need with [the firm's] resources behind you. This almost always seems to mean knowing who knows what and figuring out a way to bring them to bear on your client's issue."

—Anonymous Interviewee

The way in which this manager relied on his network to obtain information and knowledge critical to the success of an important project is common and likely resonates with your own experience. Usually when we think of where people turn for information or knowledge we think of databases, the Web, intranets and portals or other, more traditional, repositories such as file cabinets or policy and procedure manuals. However, a significant component of a person's information environment consists of the relationships he or she can tap for various informational needs. For example, in summarizing a decade worth of studies, Tom Allen of Massachusetts Institute of Technology (MIT) found that engineers and scientists were roughly five times more likely to turn to a person for information than to an impersonal source such as a database or a file cabinet. In other settings, research has consistently shown that who you know has a significant impact on what you come to know, as relationships are critical for obtaining information, solving problems and learning how to do your work.

Particularly in knowledge intensive work, creating an informational environment that helps employees solve increasingly complex and often ambiguous problems holds significant performance implications. Frequently such efforts entail knowledge management initiatives focusing on the capture and sharing of codified knowledge and reusable work products. To be sure, these so-called knowledge bases hold pragmatic benefits. They bridge boundaries of time and space,

allow for potential reuse of tools or work products employed successfully in other areas of an organization, and provide a means of reducing organizational "forgetting" as a function of employee turnover. However, such initiatives often undervalue crucial knowledge held by employees and the web of relationships that help dynamically solve problems and create new knowledge.

As we move further into an economy where collaboration and innovation are increasingly central to organizational effectiveness, we must pay more attention to the sets of relationships that people rely on to accomplish their work. Certainly we can expect emerging collaborative technologies to facilitate virtual work and skill profiling systems to help with the location of relevant expertise. However, as was so poignantly demonstrated by reengineering, technology alone can only accomplish so much in the pursuit of business performance. Improving efficiency and effectiveness in knowledge-intensive work demands more than sophisticated technologies—it requires attending to the often idiosyncratic ways that people seek out knowledge, learn from and solve problems with other people in organizations.

With this in mind, we initiated a research program to determine means of improving employees' ability to create and share knowledge in important social networks. In the first phase of our research, we assessed the characteristics of relationships that 40 managers relied on for learning and knowledge sharing in important projects. In the second phase, we systematically employed social network analysis to map these dimensions of relationships among strategically important networks of people in various organizations. Working with a consortium of Fortune 500 companies and government organizations, we developed empirical support for relational characteristics that facilitate knowledge creation and sharing in social networks as well as insight into social and technical interventions to facilitate knowledge flow in these networks.

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SUPPORTING KNOWLEDGE CREATION AND SHARING IN SOCIAL NETWORKS

In the first phase of our research we asked 40 managers to reflect on a recent project that was important to their careers and indicate where they obtained information critical to the project's success. As can be seen in Fig. 1, these managers overwhelmingly indicated (and supported with vivid stories) that they received this information from other people far more frequently than impersonal sources such as their personal computer archives, the Internet or the organization's knowledge management database. And we found this in an organization that most industry analysts heralded as a knowledge management exemplar because of its investment in technology. This is not to say that the firm's leading edge technical platform and organizational practices for capturing, screening and archiving knowledge were not helpful. Just to point out that "impersonal" information sources were primarily leveraged only after the managers had been unsuccessful in obtaining relevant knowledge from colleagues (or when directed to a point in the database by a colleague).

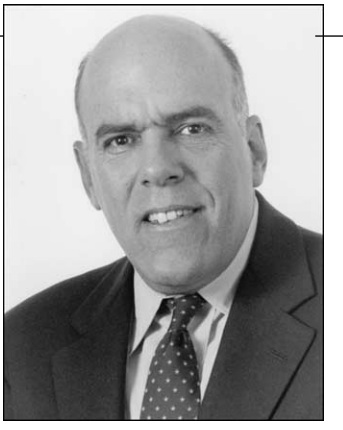
We also asked the managers to identify the people most important to them in terms of information or knowledge acquired for that project, and had them carefully describe these relationships. Four features emerged that distinguished effective from ineffective relationships: (1) knowing what another person knows and thus when to turn to them; (2) being able to gain timely access to that person; (3) willingness of the person sought out to engage in problem solving rather than dump information; and (4) a degree of safety in the relationship that promoted learning and creativity. An in-depth review of these dimensions is beyond our scope here; however, a summary of these relational features and representative quotes can be found below in Table 1.

The managers we interviewed indicated that these four dimensions were key characteristics of relationships that were effective

for acquiring information, solving problems or learning. In contrast, they also recounted numerous times when learning or knowledge sharing did not happen because of one of the above dimensions not existing in the relationship (e.g., someone knew what they needed to know, but did not make himself or herself accessible). Further, a separate quantitative study demonstrated that these dimensions consistently predict whom people seek out for informational purposes, even after controlling for such features as education or age similarity, physical proximity, time in organization, and formal hierarchical position. With the importance of these four relational characteristics established, the second step of our research was to use social network analysis to map information flow as well as these relational characteristics among strategically important groups to improve knowledge creation and sharing.

SOCIAL NETWORK ANALYSIS

Social network analysis (SNA) provides a rich and systematic means of assessing informal networks by mapping and analyzing relationships among people, teams, departments or even entire organizations. Though managers are often adamant that they know their organization, studies are showing that they have different levels of accuracy in understanding the networks around them. By virtue of their position in the hierarchy, managers are frequently far removed from the day-to-day work interactions that generate an organization's informal structure, and so may have a very inaccurate understanding of the actual patterns of relationships. And the potential for inaccurate perceptions is only increased by our transition into a world of virtual work and telecommuting, where employees are engaged in work relationships increasingly invisible to superiors. Social network analysis can provide an X-ray of the way in which work is or is not occurring in these informal networks.



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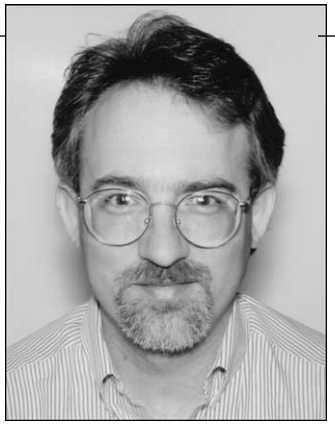


Steve Borgatti is an associate professor of organizational behavior at the Carroll School of Management, Boston College. He is the principal author of UCINET, the leading software package for social network analysis, and past president of INSNA, the professional association for social network researchers. Dr. Borgatti has published more than 50 journal articles in the area of social network theory and methodology.

Mapping Information Flow among Executives

We conducted a social network analysis of executives in the exploration and production division of a large petroleum organization. This group was in the midst of implementing a distributed technology to help transfer knowledge across drilling initiatives and was also interested in assessing their ability as a group to create and share knowledge. As a result, we were asked to conduct a social network analysis of information flow among the top 20 executives within the Exploration and Production Division. As can be seen in Fig. 2, this analysis revealed a striking contrast between the group's formal and informal structure.

Three important points quickly emerged for this group in relation to sharing information and effectively leveraging their collective expertise. First, the social network analysis identified mid-level managers who were critical in terms of information flow within the group. A particular surprise came from the very central role that Cole played in terms of both overall information flow within the group and being the only point of contact between members of the production division and the rest of the network. A facilitated session with this executive team revealed that over time Cole's reputation for expertise and responsiveness had resulted in his becoming a critical source for all sorts of information. Through no fault of his own, the number of informational requests he received and the number of projects he was involved in had grown excessive, which not only caused him stress but also frequently slowed the group as a whole, because Cole had become a bottleneck.

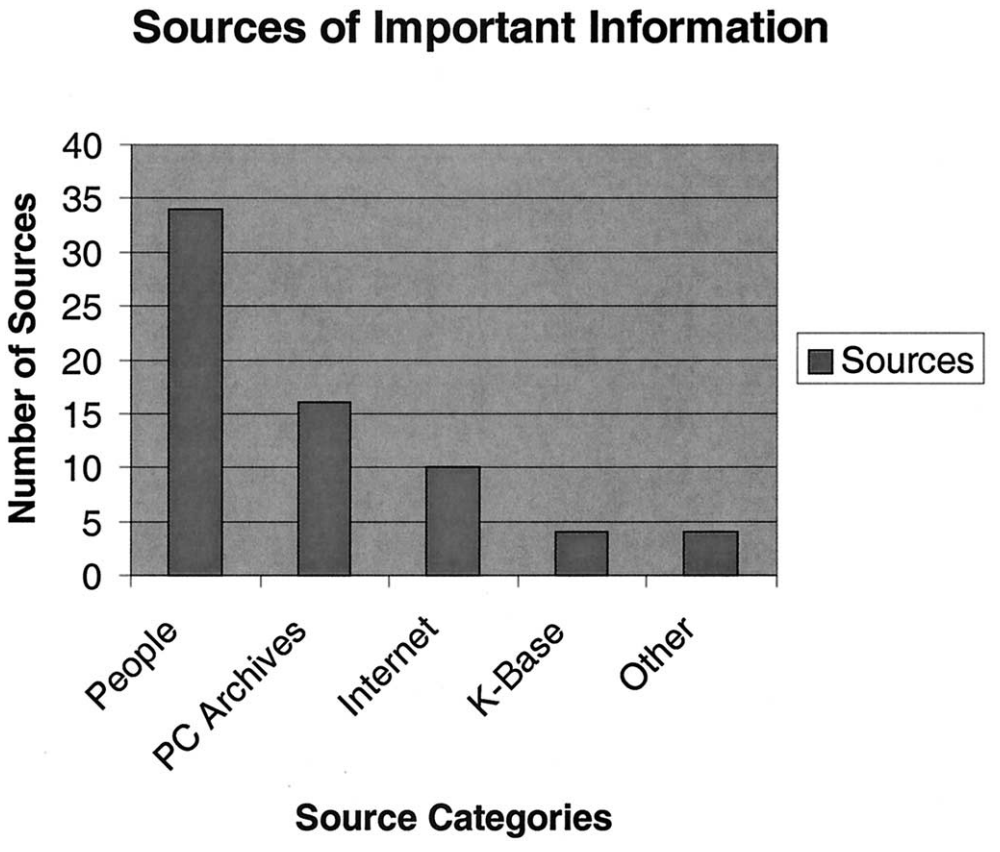
The social network analysis also revealed the extent to which the entire network was disproportionately reliant on Cole. If he were hired away, the efficiency of this group as a whole would be significantly impacted as people in the informal network re-established important informational relationships. Of course, people would find ways to reconnect to obtain necessary information.

TABLE 1 RELATIONAL QUALITIES THAT PROMOTE EFFECTIVE KNOWLEDGE SHARING

Relational Dimensions	Impact on Knowledge Seeking	Representative Quote
Knowledge	Knowing what someone else knows (even if we are initially inaccurate and calibrate over time) is a precursor to seeking a specific person out when we are faced with a problem or opportunity. For other people to be options we must have at least some perception of their expertise.	"At [Company X] we had access to background information and you know lots of case studies and approaches that were really well written up. I had no experience though of actually applying this approach on an engagement. So what was specifically useful to me was to talk with Terry who I knew had done several of these engagements. He helped me work some of the content in the database into a workable approach. I was lucky I knew him and could leverage some of his experience . . ."
Access	However, knowing what someone else knows is only useful if you can get access to their thinking in a sufficiently timely fashion. Access is heavily influenced by the closeness of one's relationship as well as physical proximity, organizational design and collaborative technology.	"I have gotten less frustrated the more I have worked with him because I know how to get ahold of him. It took me a while to figure out that he was a phone guy and not an e-mail guy. And I have also learned how to ask him for help and what I can expect. It was important to learn what I could rely on him for and how to get his attention to make the relationship, which was initially frustrating, an important one for me . . ."
Engagement	People who are helpful in learning interactions actively think with the seeker and engage in problem solving. Rather than dump information, these people first understand the problem *as experienced by the seeker* and then shape their knowledge to the problem at hand.	"Some people will give you their opinion without trying to either understand what your objectives are or understand where you are coming from or be very closed in their answer to you. [She] is the sort of person who first makes sure she understands what the issue is. I have been around people who give you a quick spiel because they think they are smart and that by throwing some framework or angle up they can quickly wow you and get out of the hard work of solving a problem. [She], for all her other responsibilities and stature within the firm, is not like that."
Safety	Finally, those relationships that are safe are often most effective for learning purposes. Being able to admit a lack of knowledge or to diverge in a conversation often results in creativity and learning.	"[he] is always looking for the positive spin on something. I mean even if he thinks that is garbage and if he really thought that, he would make this known but in a positive way. So he might say "Well I think we might be a little off track on that and here's why" and then say why and of course there is learning that comes from that."

However, the social network diagram made it very clear that if Cole left, the company would lose both his valuable knowledge **and** the relationships he had established that in many ways were holding the network together. As a result, a central intervention that came from this analysis was to reallocate many of the informational requests coming to Cole to other members in the group. Simply categorizing various informational requests that Cole received and then allocating ownership of these informational or decision

FIGURE 1 WHERE PEOPLE GO FOR INFORMATION.[1]



domains to other executives served to both unburden Cole and make the overall network more responsive and robust.

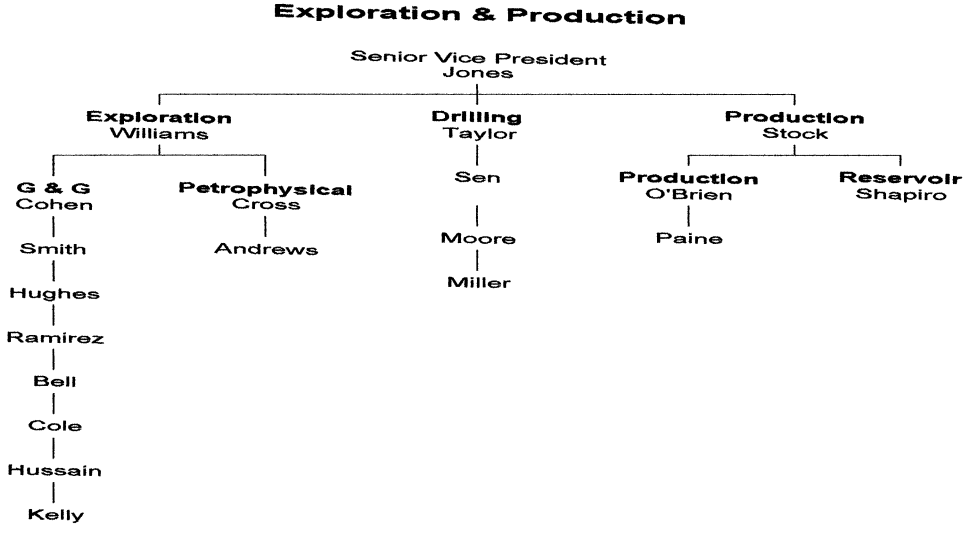
Just as important, the social network analysis helped to identify highly peripheral people who essentially represented untapped expertise and thus underutilized resources for the group. In particular, it became apparent that many of the senior people had become too removed from the day-to-day operations of this group. For example, Fig. 2 reveals that the most senior person (Jones) was one of the most peripheral in the informal network. This is a common finding. As people move higher within an organization, their work begins to entail more administrative tasks that makes them both less accessible and less knowledgeable about the day to day work of their subordinates. However, in this case our debrief session indicated that Jones had become too removed, and his lack of responsiveness frequently held the entire network back when important decisions needed to be made. In this case, the social network diagram helped to make what could have been a potentially difficult conversation with this executive non-confrontational, and resulted in more of his time being committed back to the group.

Finally, the social network analysis demonstrated the extent to which the production

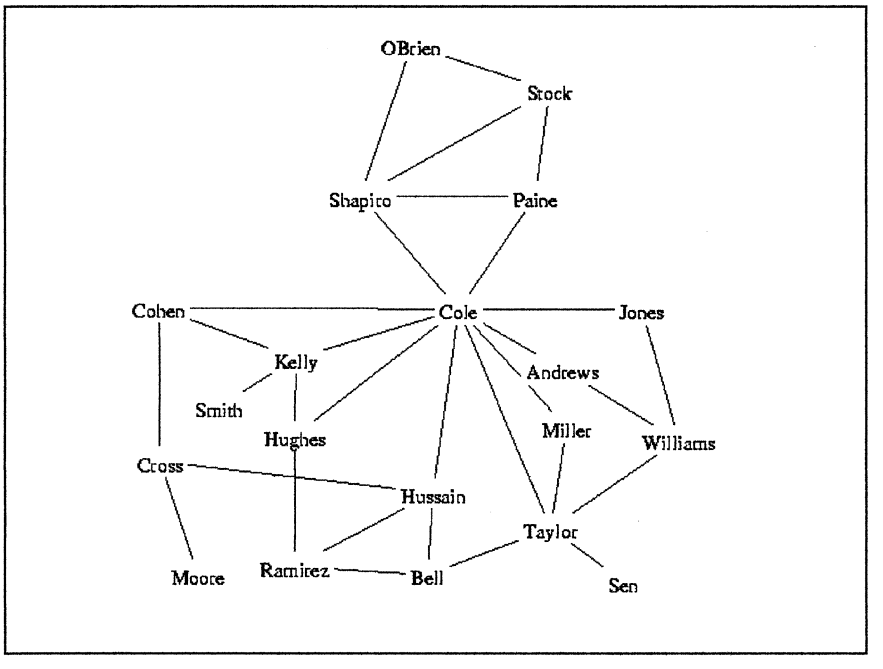
[1] Total sources exceed the number of interviews because several respondents indicated more than one critical source of information. In this case, prior material included computer or paper files or archives that the interviewees had used in prior projects.

FIGURE 2 FORMAL VS. INFORMAL STRUCTURE IN A PETROLEUM ORGANIZATION.[2]

Formal Organizational Structure of Exploration and Production Division



Informal Organizational Structure of Exploration and Production Division



[2]Names have been disguised at the request of the company.

division (the subgroup on the top of the diagram) had become separated from the overall network. Several months before this analysis, these people had been physically moved to a different floor in the building. Upon reviewing the network diagram, many of the executives realized that this physical separation had resulted in loss of a lot of the serendipitous meetings that occurred when they were co-located. In this case, the executives decided that they needed to introduce more structured meetings to compensate for this recent loss of serendipitous communication (and they also adopted an instant messaging system to promote communication).

Beyond Information Flow

In addition to mapping information flow, we also use social network analysis to assess the relational characteristics of *knowledge*, *access*, *engagement*, and *safety* among a group. Sometimes, if we have only mapped an information network and find that certain people are not as connected as they should be, it is difficult to tell what to do. Simply proposing more or better communication is the oldest consulting recommendation in the book—and no one today really needs more meetings. By analyzing the dimensions of relationships that precede or lead to effective knowledge sharing, we can offer more precise ways to improve a network's ability to create and share knowledge. For example, if it is discovered that the *knowledge* network is sparse, it might make sense to consider a skill profiling system or new staffing practices—technical and social interventions designed to help a network know what it knows. In contrast, if the *access* network is sparse, then it might make sense to consider peer feedback or technical means of connecting distributed workers (e.g., video conferencing or instant messaging) to make sure that people within the network have access to each other in a timely fashion.

Throughout our research we have found organizations employing various practices to promote these relational dimensions in important networks. We have summarized some of these initiatives in Fig. 3, and now turn to specific case examples where we used social network analysis to assess these relational dimensions.

Knowledge Dimension: Do We Know What We Know? Other people can only be useful to us in solving problems if we have some awareness of their expertise. Even if we are wrong, our initial perception will determine whether and how we turn to them for information when faced with a new problem or opportunity. The managers we interviewed in the first phase of our research reported that people they turned to for information provided a critical extension to their own knowledge when the manager had at least a semi-accurate understanding of her or his contact's expertise. As a result, assessing this relational knowledge of "who knows what" at a network level provides insight into the potential for members of a network to be able to tap others with relevant expertise when faced with a new problem or opportunity.

Supporting New Product Development

For example, we analyzed a network of immunologists in a Fortune 250 pharmaceutical company. By virtue of effectively integrating highly specialized knowledge in the drug development process, this group of people held the potential to provide strategic advantage to the organization. However, they also dealt with many impediments to effective collaboration, in that they were dispersed across five geographic sites and four hierarchical levels and attempting to integrate very different kinds of expertise. One telling view of this network emerged when we mapped the *knowledge* relation to get a better understanding of who understood and valued other people's expertise in this group.

What we found was that the *knowledge* network was very sparse compared with others that we had seen, indicating that an impediment to this group effectively creating and sharing knowledge was that they did

FIGURE 3 INITIATIVES PROMOTING KNOWLEDGE SHARING IN HUMAN NETWORKS.

Knowledge Dimension: Do we know what we know?

- British Telecommunication's global effort to expand product lines and services was hampered because all of its six industry sectors were acting as silos. Employees in one industry sector were not aware of the knowledge and expertise of employees in the other sectors. To overcome this lack of awareness, they introduced virtual communities of practice that were connected through the Knowledge Interchange Network (KIN). This increased awareness of experts via the distributed technology and improved cross-sector collaboration.

- IBM Global Services, the management consulting division of IBM, has a strategic drive to ensure that the best expertise is brought to bear on client projects. To help employees better understand "who knows what" in this complex and distributed workforce, they have adopted Tacit Systems EKG profiling system. This technology actively mines e-mail (that the employees permit the system to assess) and distributed databases to categorize kinds of knowledge that are being requested/shared and by whom. Though limited to electronic communications, the system is then able to generate and make available a profile of an employee's expertise that others in the organization can then seek out as necessary.

- Recently the World Bank made a strategic decision to reposition itself away from being a lending organization to being a provider of knowledge and services (a "Knowledge Bank"). In order for its employees to meet the needs of its member organizations, it was necessary to increase awareness of the expertise throughout the organization. A critical step in this process has been to hold regular Knowledge Fairs, where people from each department and/or thematic group set up booths which inform others of their expertise. This helps to increase people's awareness of the experience of employees throughout the Bank.

Access Dimension: Can we access what we know in a sufficiently timely fashion?

- Alcoa, the world's leading producer of aluminum, wanted to improve access between its senior executives. When designing their new headquarters they focused on open offices, family-style kitchens in the center of each floor and plenty of open spaces. Previously, top executives would only interact with a couple of people in the elevator and those they had scheduled meetings with. Now, executives bump into each other more often and are more accessible for serendipitous conversations. This change in space has increased general accessibility as well narrowed the gap between top executives and employees.

- Shearman & Sterling, a top New York law firm, wanted to make its attorneys more accessible to each other in order to use the full expertise of staff on client cases. They implemented Same Time, an instant messaging system, throughout the organization. This quickly began to overcome barriers of physical distance that often precluded serendipitous interaction. It also allowed attorneys to send messages to each other while simultaneously being on conference calls with opposing counsel. The increased accessibility of their attorneys meant that the firm's human capital could be more effectively used.

- IBM Global Services has incorporated knowledge creation, sharing and reuse measurements into performance metrics. Performance metrics and incentives, particularly at the executive rank, have driven collaborative behavior into the day-to-day work practices of executive networks. Further, knowledge sharing has been incorporated into personal business commitments, which are required for certification and effect promotion decisions. This encourages employees at all levels to be collaborative with and accessible to each other.

FIGURE 3 CONTINUED.

Engagement Dimension: Do we effectively engage with each other in problem solving?

- Deep sea oil drilling is a very expensive business, with lost production for a day costing up to $250,000. To minimize costs, British Petroleum has initiated a peer assist program that brings experts together to brainstorm with project teams. The peer assist program allows experts with relevant knowledge and experience to collaborate with and advise teams initiating a drilling project (or facing an important milestone). Peer assists facilitate active engagement in problem solving amongst the most current and relevant expertise that this organization has at a given point in time.

- An important issue for Skandia is improving the probability and frequency of innovation. Skandia has "Future Centers" where employees can come together informally and discuss ideas about new products or ideas for the future of the organization. These brainstorming sessions can very often produce new ideas about products and directions for the organization.

- At Aventis, the pharmaceutical company formed with the merger of Rhone- Poulenc Rorer and Hoechst Marion Russel, they employ the GET program (**G**lobal **E**xperience **T**ransfer) to facilitate engagement between the marketing and research and development organizations. Selected employees from the R&D function and the Commercial Operations functions of specific therapeutic units are paired and go through a rotation program in each functional unit (with each employee alternating in the mentoring role). This process facilitates engagement in problem solving by developing a shared context between the functions and integrating social networks at a critical functional boundary.

Safety Dimension: How do we promote safety in relationships?

- Buckman Laboratories, a highly successful chemical company, aspires to support front-line workers with the knowledge they need to help the customer. At Buckman, they have introduced a code of ethics that explicitly states that every employee has the right to talk to any other employee. This has helped build an atmosphere of trust and decreased barriers between hierarchical levels in the organization.

- Russell Reynolds Associates, one of the world's premier executive search firms, believes a large part of its success is derived from the extent to which its recruiters and researchers share knowledge about candidates and openings. In an attempt to counter knowledge hoarding they have created a culture of openness, trust and collaboration. In hiring, the company places a unique emphasis on demonstrated collaboration and trustworthiness. In orientation, all new hires engage in a 3-4 day New Associates Program that promotes cross-office collaboration. On an ongoing basis, weekly meetings within offices, monthly conference calls between the different offices as well as face to face meetings of action committees all serve to promote an environment of trust.

- An important issue for Johnson and Johnson is increasing knowledge sharing throughout a highly decentralized organization that operates in over 50 countries. At Johnson and Johnson they have set up communities of practice around product areas. This has helped create a shared vocabulary around specific activities, a recognition of the knowledge of their peers, a higher degree of trust between employees and communal effort on projects rather than many individuals pulling in separate directions.

not know what each other knew. Two characteristics of this group seemed to result in the sparse pattern. First, the group was physically dispersed, which precluded serendipitous interactions that help people learn colleagues' expertise and skills. Second, the group housed deep specialists who often struggled to find overlap with their colleagues. Stories emerging in interviews indicated that even when there were opportunities to incorporate each other's expertise, this was often not done, because one group of specialists did not know enough about what another group did to be able to "see" a way to involve them in projects.

Conducting the social network analysis provided several intervention opportunities. A facilitated session with leaders allowed them to assess and discuss the relative isolation of the specialties, as well as more pointed concerns about certain members' expertise not being tapped while other members appeared to be bottlenecks in sharing information. As a result of the discussion around this social network, various changes were made to the group's operations. First, a variety of internal projects—ranging from process improvement to a project tracking database—were jointly staffed with people from various locations. This forced people to work together and so begin to develop an appreciation of each other's unique skills and knowledge. Second, several new communication forums were created—including weekly status calls, a short update e-mail done weekly and a project tracking database that helped each person keep up to date on what other members of the group were doing. Finally, some simple changes in project management practices and restructuring of the project leaders' responsibilities helped people to connect around them.

Facilitating Merger Integration

In another scenario we assessed the top leadership network of a Fortune 250 organization (i.e., top 126 executives of this conglomerate). This was an organization that had grown by acquisition over the course of several years, with the strategic intent that acquired companies would combine their expertise in developing and taking to market new products and services. The chief executive officer (CEO) of this organization had become acutely aware of the need to create a leadership network that knew enough of what others in the conglomerate knew to be able to combine the appropriate resources in response to new opportunities. As there was some evidence that this was not happening, he asked us to conduct a social network analysis of his top executives across these acquired organizations.

Mapping information flow among these executives showed that there was only limited collaborative activity in pockets of the organization, and that in general this lack of collaboration was a product of people not knowing what other people knew. In fact, we found that the problem was so significant that a key executive would not only indicate that he or she did not know what a specific person in another division did, but also that the executive did not even know what that division did. Despite alignment of the organization's formal structure, this lack of collective awareness of "who knows what" was having a significant impact on the organization's ability to execute strategically.

Two interventions were undertaken to begin helping to integrate this group. First, on a technical front, a customized technology was introduced for this group that combined a skill-profiling system with a new collaborative environment where executives posted project information. This system was quickly used, as the CEO pushed people into adopting it and also made it the primary forum by which these executives began to get information they needed to run their business. In addition, action learning sets were employed on internal projects. People from across these divisions were staffed together on small teams that each attacked a given project, but did so with reflective exercises, as the point of the initiative was both to solve problems

for the company and to create connections across the executive team.

Creating Awareness of "Who Knows What"

Overall, we are finding that it is important for organizations to pay attention to how strategic networks of employees develop an understanding of their collective knowledge. In more staid times, working relationships developed as a product of interaction over longer time periods. This is not so in today's business environment. Given the rapid turnover many companies experience today, it is important to find ways to help people become better connected so the organization can get the true benefit of their expertise more quickly. This is often a process that can be improved by focusing on the way that new people are brought into a group. Generally what most organizations do when hiring a new person is to hold orientation courses that teach the person about the computer system, benefits and, perhaps, some homilies about the culture and history of the company. It is rare to find practices that teach the group what the newcomers know. This is a critical shortcoming in increasingly project-based work, where people will be brought into the center of the network primarily as a result of what other people understand about their expertise and so how to tap them when new problems or opportunities arise.

However, knowingly or unknowingly, some organizations we worked with were employing different mechanisms that built this awareness of "who knows what." For example, on a technical front many organizations are implementing skill-profiling systems or corporate yellow pages. On an organizational front, organizations such as the World Bank have organized their employees into thematic groups that have Help Desks whom anyone connected with the organization can contact. The individuals staffing the Help Desks are able to route people to others within the thematic group who have expertise on a particular subject. Other companies and government organizations have regular Knowledge Fairs where teams, communities or departments can set up a booth and distribute information about the expertise that they have. Although this has limited scope, it has proven effective in increasing awareness of the projects and knowledge activities taking place within the different departments and communities of the organization.

Access Dimension: Can We Access What We Know in A Sufficiently Timely Fashion? Of course knowing that someone else knows something of relevance does little good if we cannot gain access to their thinking in a timely fashion. Critical issues on which we may turn to others for help or advice often require turnaround within increasingly tight time frames. As with the *knowledge* dimension, we have found it helpful to map the *access* relation at a network level to understand who is able to reach whom in a sufficiently timely fashion.

Assessing Access in a Global Consulting Practice

We conducted a network analysis of the global consumer goods practice within a major consulting firm. One of the more telling networks in this analysis was the diagram reflecting who was sufficiently accessible to whom among this group of 46 people spread through Europe and the U.S. Despite the entire practice reporting to one overall partner and being subject to a common strategy, performance measurement and reward practices, we found significant clustering in the network when we assessed who was accessible to whom. The social network analysis of accessibility showed three tightly knit groups rather than one integrated network—two in North America and one in Europe—that were all highly centralized around different partners. In fact, only three employees served to bridge these fiefdoms, and these were not the people in charge of the group. Rather, they had been through rotating work assignments and so developed relations with many others in the network.

A first intervention for this organization was reconsidering staffing practices to help integrate people from the different locations on both client projects and internal initiatives. A key concern lay with developing relationships throughout the overall practice to improve knowledge sharing and the location of relevant expertise for both sales efforts and client engagements. Further, increasing overall connection within the network also reduced the extent to which the practice was exposed by the potential for any of these three central people leaving. In this and many other examples, we have consistently found that a network view makes it clear that, should certain central people in a network leave, they take more than just what they know—they also fundamentally affect the connectivity of the entire group.

The two groups in the U.S. represented another challenge for management. It turned out that the majority of people in these two groups not only had offices in the same building, but also were interspersed along the same corridor. What we discovered in interviews was a political problem that had emerged and resulted in tensions between two subgroups. While management had suspected there were problems, the visual representation of the network diagram clearly showed the extent to which these issues were impeding the ability of the overall group to effectively leverage the expertise of its members. Various steps were taken to help resolve the problem including: executive coaching, revised performance management practices and an extensive off site planning session and organizational development (OD) interventions to help the group integrate.

Accessibility after a Transition to Teams

Reorganizations often shift the location and concurrently the accessibility of specific expertise. For example, we worked with one commercial lending organization in a transition from a functional to a team-based structure. To minimize inefficiencies resulting from cross-functional hand-offs in the commercial lending process, the organization shifted to a team-based structure that co-located lenders, analysts, and servicers in industry teams. Before the transition, these groups had been housed together on different floors and so were able to tap into each other's functional knowledge with relative ease. With the redesign, it was far more difficult for inexperienced people to learn the basics of their function and also for experienced lenders and analysts to engage in collaborative problem-solving efforts on the more creative aspects of commercial lending (e.g., structuring a specific transaction).

Social network analysis showed that four months after the transition to teams, several key people had become significantly overburdened, as they were heavily sought out by both their past functional colleagues as well as their new team members. In particular, we found that the people who were reputed experts in their area were tapped for advice to such an extent that they were falling behind on their own work. While in the functional department these interactions were more controlled and observable, in the team-based environment it was difficult for management to see how instrumental these opinion leaders really were to the success of the whole system. In fact, from a cursory review of their individual performance metrics (e.g., loans serviced or loans booked) these people experienced a fairly significant decline in productivity. Further, the longer hours that these people were working, in tandem with declining individual performance metrics that influenced their bonus calculations, served to undermine their own morale. As a result of these findings, several steps were taken—such as new staffing practices, better orientation materials (to help bring new people up to speed more effectively) and a reallocation of tasks within teams.

Managing Accessibility

Through the course of our research we have found that many organizations struggle with the notion of accessibility as people increasingly work from diverse locations. By and large, most solutions that companies considered were technical in nature and included such things as e-mail, asynchronous and synchronous collaborative environments, video conferencing and instant messaging. However, we generally find that organizational design considerations and cultural norms are the more powerful indicators of who is accessible to whom.

Performance management systems promoting individualistic behaviors seem to be one of the primary drivers of sparse, disconnected networks. Further, though more of a trait of organizational culture, we often find that hierarchy has a marked impact on who is able to access whom. Again, this is a telling indicator for organizations trying to become more flexible and effective at information sharing. Some organizations have taken interesting steps to promote access across hierarchy, such as making knowledge sharing a part of the mission or code of ethics. At Buckman Laboratories, all associates are empowered to speak with any associate at any level, and this is supported by a communication technology that gives each employee access to all other employees. Others are beginning to turn to creative uses of physical space to promote both intentional and serendipitous interactions among high-end knowledge workers. For example, Chrysler has gone full circle (from dispersion back to co-location) by recently bringing all the people involved in new car development into one building so that they can have face to face access to each other.

Engagement Dimension: How Do We Improve Engagement in Problem Solving? One of the most interesting findings from our interviews with the forty managers in the first phase of our research was the importance of the person sought out for information being willing to cognitively engage with the information seeker. People who were willing to engage in problem solving helped seekers to create knowledge with sufficient understanding and clarity that they could take action on it. And when we say engaging in problem solving, we do not mean a significant time investment on the part of the person sought out. Rather, we mean a simple two-step behavior whereby those contacted for information first ensured that they understood the other person's problem, and then actively shaped what they knew to the problem at hand. In short, these people taught rather than dumped information on the seeker—a behavior that if developed among a network can improve the effectiveness with which people learn from each other.

Integrating Specialized Expertise in Problem Solving

We conducted one network analysis of a specialist group supporting the internal knowledge management efforts of a global computer manufacturer. This group of 18 people was a virtual team that had been formed to combine expertise in both the technical and organizational/strategic aspects of knowledge management. While members of the group claimed to know and have access to each other's expertise, a quick review of the *engagement* network showed that in fact the group was having little success in integrating their expertise. Rather, what became apparent was a strong split in the network because of unique skill bases.

Despite people technically knowing at a high level what the skills and knowledge of people in the other discipline were, there were only two connections between the two groups on the *engagement* relation. This clustering was a significant concern, as it is in engagement in problem solving that true learning takes place and people effectively integrate specialized expertise in projects—rather than just doing what they know or have done before. Interviews revealed that each group's depth of specialization and the fact that they were virtual and so had little

slack, face-to-face time to interact made it difficult for them to find common ground. Aside from the leader of the group, who had experience with both subgroups, there was little common language or occupational values that existed between the two subgroups.

Several organizational learning interventions have been undertaken in this group to help build engagement and trust. As always, a key component of these interventions has been the use of various network diagrams in facilitated sessions to help the group create common awareness and make sense of productive and unproductive dynamics. Further, a shift in performance measurement was made to encourage joint problem solving and de-emphasize individual project metrics. While in the midst of these initiatives, the group plans to periodically assess the *engagement* network and intervene as appropriate to improve their operations over time.

Supporting Engagement of Specialists in New Product Development

In another scenario, we conducted a network analysis of 78 members of a drug development community of practice. The community, which was geographically dispersed across eight sites in the U.S. and Europe, included people from the drug discovery stage all the way to clinical development. The analysis indicated that within this highly dispersed community there were many people who did not know each other. It also became apparent that, although the people within each functional unit engaged with each other on matters relevant to the community, there was little engagement between the functions. This was a critical problem for this group, given the need to combine unique expertise to effectively develop and market a specific drug.

Further, the network proved to be highly centralized around a few individuals. The six most central people resided in the main U.S. site. Although they had many connections to people within the site, they did not engage as often with community members in the European locations. There were also several people who were totally disconnected from the group, which resulted in their skills and expertise being lost to the community. In this instance, a new collaborative technology was introduced that had both synchronous and asynchronous features. Second, different project management practices and a new role within the community were initiated to help bridge functional areas of expertise. Finally, the network diagrams were used to convince management to support staged face-to-face forums focusing on specific problems. These forums helped the different functional areas find common ground, while solving problems critical to the success of a project.

Engagement in Human Networks

Overall, as with the access dimension, we found that many of the things organizations were doing that had an impact on engagement were technical in nature and included synchronous technologies such as VP Buddy, Same Time, or white boarding applications that allow for dispersed engagement in a common problem. In many ways, instant messaging does seem to support the serendipitous kinds of interactions that are lost when employees are not co-located. However, there are limitations in the ability of these applications to richly convey knowledge across media that provide relatively few cues in comparison to face-to-face interactions. Videoconferencing for visual interaction between people in different locations does seem to help. This has been particularly important at British Petroleum, where experts have been able to assist technicians who are working on oil rigs thousands of miles away.

British Petroleum is also unique in its recognition of the importance of engagement in problem solving early in projects where learning from others' experiences can have a disproportionate impact on the trajectory and success of a project. For example, BP has instituted a peer review process in its drilling initiatives as an effective way to tap into

others' knowledge. Before engaging in any significant task, the individual or group invites peers to provide input. Because the focus is performance, those with the most relevant knowledge and recent experiences are tapped to participate. Through this peer review process not only is performance on the task at hand improved, but also people become much more aware of the unique skills and abilities of others. This creates a natural reason for meeting and developing the needed norms of reciprocity and trust that make engagement and sharing of expertise a natural process.

Safety Dimension: How Do We Promote Safety in Relationships? Finally, the managers we interviewed in the first phase of our research indicated that safe relationships offered certain advantages in problem solving. First, they provided more learning, as people were not overly concerned about admitting a lack of knowledge or expertise. Asking someone for help often requires that the seeker have some degree of trust in the person sought out for information. Such trust often shapes the extent to which people will be forthcoming about their lack of knowledge, as defensive behaviors can knowingly and unknowingly block learning in critical interactions. Second, several of the managers indicated that in more safe relationships they could be more creative. An important feature of these relationships was that they were more willing to take risks with their ideas and felt that this often resulted in more creative solutions.

Safety Promotes Learning in High End Knowledge Work

Social network analysis provides us with a means of understanding the extent to which information and knowledge seeking is a safe behavior in important groups. For example, we assessed the safety network in the information resources group supporting a key research and development function of a Fortune 500 manufacturing organization. This group of 34 people was composed of two organizational units that had recently been merged under one leader. The *Safety* network represented an interesting point of intervention here because, unlike many networks we have seen, the *Knowledge*, *Access*, and *Engagement* networks were all very well connected, whereas the safety network was not.

Interestingly enough, the *safety* network split into two groups that reflected the two departments that had been merged several months before this analysis. This is a common finding in both restructuring and merger scenarios. We often have found that communication networks (i.e., network diagrams developed from asking people who they typically communicate with) form quickly in restructuring or merger scenarios. However, what simply assessing communication patterns obscures is the time and effort that must be put into developing trust among a group, if we truly want people to learn from each other. Safety is important and highly predictive of who is sought out when one engages in problem solving and so exposes a lack of knowledge or allows someone else to shape the course of a solution. Relationships that are safe, and therefore useful for deeper levels of knowledge sharing and true learning, take time to develop.

In this specific network analysis, there were two interesting points. First, two people who were low in the hierarchy had become important ambassadors between the groups. Several amusing anecdotes were discovered in our interviews, whereby people that were senior in this group often went to these more junior people when they needed information from a colleague in the other subgroup. A light-hearted but very effective intervention was created by using these anecdotes along with the network diagram in a facilitated session debriefing the overall group. Playfully illuminating the way in which members of each group had stereotyped the other, and the inefficiencies that

this caused, resulted in a productive discussion of a potentially charged issue.

Second, there were different levels of safety between the two groups. In part this seemed to be a product of the physical environment, as the more tightly connected group had all worked in an open space environment that allowed frequent, face to face communication. We also found that leadership style differed in the two groups before the restructuring. In general, creating a greater degree of safety within networks of relationships is often a product of leadership style and organizational (or sometimes occupational) culture. The behaviors that leaders exhibit and those they reward shape the extent to which people will be forthcoming about their lack of knowledge on various topics. This varied widely by organization. In some, safety was never considered a concern, because it was an accepted norm to doggedly seek out the most relevant knowledge for the success of a given project. In others, safety was a critical concern, and employees were very cautious about exposing a lack of knowledge.

Just as important, our interviews indicated that relationships need time and some space (physical, cognitive and social) to develop a sense of safety. Although communication technologies such as e-mail are helpful in maintaining relationships, when creating relationships we have found that it is important to increase the opportunity for face-to-face interactions between people. For example, though often chided, organizations that have instigated a program of brown bag lunches find that this process is effective for the development of safe relationships between people. One organization we worked with encouraged face-to-face contact by monthly meetings between different groups of researchers. These meetings consisted of a discussion session in the morning and a working session in the laboratory in the afternoon and allowed for a free flow of ideas within the context of a real working environment.

A COMBINED NETWORK VIEW AND ORGANIZATIONAL LEARNING

In addition to looking at each of the networks individually, it is also instructive to assess the dimensions cumulatively to get a better understanding of a network's underlying learning potential. In doing this, we can analyze networks where pairs of relationships exist (e.g., both *knowledge* and *access*) or networks where all of the relationships exist (e.g., *knowledge*, *access*, *engagement*, and *safety*). For example, we conducted a social network analysis of 38 employees constituting the telecommunications consulting practice of a Big Five accountancy. We first assessed the *knowledge* network to better understand who in this network of people indicated that they knew and valued other's expertise. Though relatively sparse, we found that the *knowledge* network showed a healthy, integrated pattern without distinct subgroups. However, the network diagram took on added life when we also considered the *access* network, where each person rated his or her colleagues on the extent to which they were accessible in a timeframe sufficient to help solve problems. Ultimately, both *knowledge* and *access* relations must be present for information sharing in a group to be effective. By combining the networks from these two questions, we had a view of the potential of a person to obtain information from others when faced with a new problem or opportunity.

Several things were interesting in this network. First, we noticed a fairly marked decline in the number of connections among the group in comparison to the *knowledge* network. While many central people remained central, several people higher in the hierarchy shifted out to the periphery of the network. As people move higher in an organization, their work begins to entail more administrative tasks, which makes them both less accessible and less knowledgeable about the day-to-day work of their subordinates. What network analysis affords in this picture is an opportunity to assess whether

those in positions of formal authority are sufficiently central to the flow of knowledge, as well as to identify those people that truly are influential knowledge brokers in the group.

The third question asked of the 38 consultants was who in the group they could count on to actively engage in problem solving. When the *engage* network was added we were assessing a network where a line was drawn between two people **only** if all three dimensions of a relationship existed (knowing what the other knows, having access to their thinking and being willing to engage in problem solving). With the addition of the engagement network, we found a significant decrease in connections, which is not trivial in terms of the network's ability to solve problems. As outlined in the initial interviews, it is often those people who are willing to engage in problem solving who help both create actionable knowledge (rather than information overload) and ensure that we are solving the right problem. The final question we asked of this consulting practice determined with whom each person felt safe discussing work-related issues. With the incorporation of the *safety* network there is very little change. This is because the *safety* network in this group was the densest of all the networks. Ultimately, this was a sound indicator of the culture of this group for knowledge creation, and is obviously not a place we would look to intervene. It is also important to note that based on our experiences, a dense safety network is not typical.

Interventions from a Combined Network View

Analyzing the combined network (i.e., *Knowledge* + *Access* + *Engagement* + *Safety*) provides a great deal of insight into who is critical as well as who is currently less utilized within a group in terms of knowledge creation and sharing. Understanding who is central to a group indicates people who might either be bottlenecks or highly valued knowledge resources upon whom the group is reliant. Only interviews providing an in-depth understanding of a network can tell, but these people do pose interesting questions to management. Has the group become too reliant on these people should they decide to leave? Are these people hoarding information and so are bottlenecks in terms of the group's knowledge creation and sharing activities? In contrast, should these people be rewarded for the somewhat invisible role they play in supporting a group from a knowledge perspective?

If we discover that people are central in these networks for legitimate reasons, management has an opportunity to begin acknowledging the work that these people do for the group. In the words of one of the people central in the telecommunications practice, "I spend about an hour and a half every day responding to calls and other informational requests. . . [and] . . . none of that time gets seen in my performance metrics." Network analysis makes such interactions that are critical to a group visible, thus providing an opportunity for management to acknowledge these people and the critical role they play. For example, management might choose to better support knowledge creation and sharing by offering central people such things as:

- Monies for efforts that might stimulate knowledge flow in a group via face-to-face meetings, or to purchase technologies such as groupware.
- Cognitive and social space to allow room for both individual and collective creativity and bonding to occur.
- Executive focus such as rewarding or promoting network enabling people to both acknowledge their efforts and signal the importance of this kind of work to others within the organization.

In addition to central or core individuals, we also find it important to better understand why some people are peripheral in these networks. It might be that people in these positions do not know what we thought they knew when hired. In these cases they are peripheral for a legitimate reason and so reflect development or re-staffing opportunities. Alternatively, it might be that

these people are peripheral because they are relatively new and the organization's assimilation processes do little to help them integrate into a network of colleagues. The important feature of this combined network view is that we can isolate why people are peripheral. Being peripheral because one is inaccessible is a different coaching process than if one is not considered safe.

Finally, on a more conceptual level, the combined network view offers unique purchase on the elusive concept of organizational learning. Some have claimed that an organization has learned when, through its processing of information, its range of potential behaviors has changed. Thus, if we are interested in promoting an organization's ability to react to new opportunities, we need to account for the ways in which people in networks become able to leverage each others' knowledge. Changes in the knowledge, access, engagement, and safety relationships underlying a network's future information processing behavior provide one means of both descriptive and prescriptive traction on organizational learning. Organizations have often been claimed to be path-dependent or constrained by what they know. Such notions as absorptive capacity, core rigidities or architectural knowledge have been claimed to lead to this path dependence over time. While critically important, this work has often been done at a level of abstraction that makes interventions questionable. In contrast, the combined view of these networks provides some idea as to precisely whose knowledge is primarily responsible for what a group is likely to learn over time.

CONCLUSION

A critical resource embedded within organizations is the knowledge that workers bring to work on a day-to-day basis. However, aside from human resource policies targeted to the attraction, development and retention of identified valuable workers, there has been little effort put into systematic ways of working with the knowledge that is embedded in social networks. Given the extent to which people rely on their own knowledge and the knowledge of their contacts to solve problems, this is a significant shortcoming. By introducing social network analysis to understand how a given network of people create and share knowledge, we are able to make these interactions visible and so actionable.

In applying these ideas in various organizations, we have found it particularly important to identify points of knowledge creation and sharing within an organization that hold strategic relevance. Typical domains yielding benefit include senior management networks, communities of practice and collaborative initiatives such as new product development, R&D units or joint ventures and alliances. It is particularly fruitful to map collaborative relationships that cross boundaries of some form. Such boundaries might be hierarchical, functional, geographical, or even organizational, as in joint venture or merger and acquisition scenarios. Understanding how knowledge flows (or more frequently does not flow) across these various boundaries within an organization can yield critical insight into where management should target efforts to promote collaboration that has a strategic payoff for the organization.

SELECTED BIBLIOGRAPHY

Much of the emphasis on organizational knowledge today (at least in terms of practice) is focused on efforts to capture, screen, store and codify knowledge. To get a more popular view of what many organizations are doing under the rubric of knowledge management we suggest some of the following publications: T. Davenport & L. Prusak, *Working Knowledge* (Boston, MA: Harvard Business School Press, 1998); C. O'Dell & C. J. Grayson, *If Only We Knew What We Know* (New York, NY: Free Press, 1998); T. Stewart, *Intellectual Capital: The New Wealth of Organizations* (New York, NY: Doubleday, 1997); and R. Ruggles, "The State of the Notion: Knowledge Management in Practice," *California Management Review,* 1998, 40(3), 80–89.

Of course, our own perspective is that knowledge embedded in human networks is too often overlooked in these initiatives. Two streams of literature heavily influenced our thinking here. First is the rich ethnographic evidence accumulating within the situated learning and community of practice traditions. This work is making clear the large degree to which people learn how to do their work not from impersonal sources of information but through interactions with other people. Some important work in this tradition includes: J. S. Brown & P. Duguid, "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning and Innovation," *Organization Science,* 1991, 2(1), 40–57; J. Brown & P. Duguid, *The Social Life of Information* (Cambridge, MA: Harvard Business School Press, 2000); J. Lave & E. Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge, UK: Cambridge University Press, 1991); J. Orr, *Talking About Machines* (Ithaca, NY: Cornell University Press, 1996); and E. Wenger, *Communities of Practice* (Oxford, UK: Oxford University Press, 1998).

The second stream of literature influential in our thinking came from the social network tradition, which has also shown, with very different methods, the extent to which information that affects what we do largely comes from other people. Some important works on how social networks influence information flow and diffusion in networks include: G. Simmel, *The Sociology of Georg Simmel* (New York, NY: Free Press, 1950); R. Burt, *Structural Holes* (Cambridge, MA: Harvard University Press, 1992); M. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology,* 1973, 78, 1360–1380; T. Allen, *Managing the Flow of Technology* (Cambridge, MA: MIT Press, 1984); P. Monge & N. Contractor, "Emergence of Communication Networks," forthcoming in F. Jablin and L. Putnam (Eds.), *Handbook of Organizational Communication*, 2nd ed. (Thousand Oaks, CA: Sage); and E. Rogers, *Diffusion of Innovations*, 4th ed. (New York, NY: Free Press, 1995).