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Information Technology and the Changing Fabric of Organization

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Technology has been an important theme in the study of organizational form and function since the 1950s. However, organization science's interest in this relationship has declined significantly over the past 30 years, a period during which information technologies have become pervasive in organizations and brought about significant changes in them. Organizing no longer needs to take place around hierarchy and the collection, storage, and distribution of information as was the case with "command and control" bureaucracies in the past. The adoption of innovations in information technology (IT) and organizational practices since the 1990s now make it possible to organize around what can be done with information. These changes are not the result of information technologies per se, but of the combination of their features with organizational arrangements and practices that support their use. Yet concepts and theories of organizational form and function remain remarkably silent about these changes. Our analysis offers five affordances—visualizing entire work processes, real-time/flexible product and service innovation, virtual collaboration, mass collaboration, and simulation/synthetic reality—that can result from the intersection of technology and organizational features. We explore how these affordances can result in new forms of organizing. Examples from the articles in this special issue "Information Technology and Organizational Form and Function" are used to show the kinds of opportunities that are created in our understanding of organizations when the "black boxes" of technology and organization are simultaneously unpacked.

Key words: technology; organizational design; organizational form; organizational structure; organizational processes; information systems; affordances; Web 2.0; IS strategy

The relationship between technology and organizational form and function has been of interest to organization scientists for over 50 years. Within the context of contingency theory, Woodward's (1958, 1965) research and a theoretical article by Thompson and Bates (1957) first called attention to technology as a determinant of organizational structure (Scott 1992). Technology formed one of the three legs of contingency theory as a determinant of organizational structure along with organizational size and the environment. Later models of technology and organization by Thompson (1967) and Perrow (1967, 1970), and Galbraith's (1973, 1977) information processing view of structure, added to a growing understanding of technology's role in shaping organizational form and function.

These models focused on different aspects of organizations' technical systems broadly defined. For instance, Woodward's (1958, 1965) seminal research on manufacturing technology and organizational structure argued that increasing technological complexity required greater structural complexity for effective performance. Thompson (1967) expanded technology's applicability beyond manufacturing organizations with his concept of technological interdependence, focusing on the coordination requirements imposed by different patterns of interdependence between elements of an organization's technical system. Perrow (1967, 1970) examined the relative routineness of work. He suggested that the number of exceptions in a work flow and the extent to which exceptions were analyzable would impact the

location of discretion and power within an organization, the interdependence of work groups, and how they were coordinated.

Galbraith's (1973, 1977) perspective viewed organizational forms as a response to the uncertainty created by the difference between the amount of information required and the amount possessed by an organization for task performance. He suggested that decision-making uncertainty could be reduced by decreasing the amount of information required through the provision of slack resources, by buffering, or by increasing an organization's capacity to process information. Increasing information capacity could be accomplished using formal hierarchical information processes and through lateral integrating mechanisms. Galbraith saw information technology (IT) as a tool to enhance vertical information processing whereas horizontal information processing could be increased by creating linkages between people who possessed part of the information required for a specific decision-making activity. Common to these models is the underlying premise that the structural forms of organization (e.g., functional, divisional, matrix) are defined by hierarchies because they specify authority relationships, determine information flows, and serve as the primary mechanism for the coordination and control of activities. Hierarchy was the original thread from which the fabric of organization was woven.

The contingency theory debate about the relative merit of technology versus size and environment as determinants of organizational structure led to substantial research on the relationship between technology and organizational form and function in the 1960s and 1970s. A count of the articles published in the two leading journals of the period, *Administrative Science Quarterly* (*ASQ*) and the *Academy of Management Journal* (*AMJ*), between 1966 and 1975 shows that 39 (5.8%) of their 664 articles incorporated technology as a major theme, the majority of which fit within the contingency theory framework. However (and much to our surprise), 10 of the 39 articles focused on computer technology's impact on organizations.

The 1970s saw the displacement of contingency theory by several new approaches to the study of organizations. Among the most prominent were seminal works introducing institutional theory (Meyer and Rowan 1977), population ecology (Hannan and Freeman 1977), and resource dependence theory (Pfeffer and Salancik 1978). Within the context of the contingency theory of determinants of structure, the environment "won" because these new approaches focused heavily on its role in shaping organizational form and function. By the mid-1990s, technology had virtually died out as a theme in the study of organizational form and function within the organization science literature.

Between 1996 and 2005, only 14 of 1,187 (1.2%) articles published in three of the field's top journals, *ASQ*, *AMJ*, and the *Academy of Management Review* (*AMR*), focused on technology's relationship to organizational form and function. The content of these articles reflected the demise of contingency theory with only one continuing with contingency theory themes. The remaining 13 articles examined the relationship between IT and organizational phenomena such as communications, teams, learning, the nature of work, and interorganizational relations. In absolute terms, the number of articles on IT and organization appearing in *ASQ*, *AMJ*, and *AMR* between 1996 and 2005 was virtually unchanged from the number of articles on computer technology and organization appearing in *ASQ* and *AMJ* between 1966 and 1975. The only mainstream journal in the field publishing much research on IT and organization between 1996 and 2005 was *Organization Science*. Thirty-one of its 443 (7%) articles examined the relationship between IT and organizational phenomena, such as communications and decision making, cognition and learning, coordination and control, and virtual teams and organizations. In total, only 2.8% of the research published in these four leading journals focused on the relationship between technology and organizational form and function.[1]

While the field's interest in the relationship between technology and organization declined, IT's penetration of everyday life and the world of organizations increased dramatically. Consider the simple fact that the number of Internet hosts (e.g., computers hosting Web pages and/or Internet services) grew from 9,472,000 in January 1996 to 394,991,609 in January 2006.[2] This inverse relationship raises an important question: If the phenomena we study in the organization sciences are changing due to the ubiquitous adoption of information technology by individuals and organizations, do not we run the risk of our theories and research becoming irrelevant unless they reflect the changes in those phenomena? It was this very question that formed the basis for our special issue call.

In the sections below we discuss how the relationship between IT and organization has changed and argue that IT is supplanting hierarchy's role in coordinating and controlling activities. As a result, it has become one of the threads from which the fabric of organization is now woven. As the relationship between IT and organization evolves, the potential for new forms of organizing is continually created. We try to capture the interplay between IT and organization using the term "affordances" in the sense that new combinations of technology and organizational features continually create possibilities that affect organizational form and function. We describe five possible affordances—visualizing entire work processes, real-time/flexible product and service innovation, virtual collaboration, mass collaboration, and simulation/synthetic reality—by outlining their general form, the technical and organizing features that jointly create

them, and some implications they have for the study of organizations. Finally, we examine how each of the seven articles in this special issue speaks to these affordances and the challenges they raise to the traditional ways of thinking about organization.

The Changing Fabric of Organization

The relegation of technology to the background in the organization sciences could be dismissed as simply reflecting the role that information technology played in organizations into the 1980s. IT was primarily used to automate existing operations and to increase the speed of communication. Automation within organizational functions meant that routine information collection and storage tasks were taken over by IT, replacing paper and people with electrons, without fundamentally changing the way work was done. As "automated plumbing," IT reinforced the traditional, bureaucratic approach for handling uncertainty and information complexity. Think about the "bureau" in "bureaucracy" literally as a chest of drawers, each drawer representing a function. Each function collected and stored information relevant to the activities within its own drawer. Marketing developed and held sales information, accounting generated and kept financial information, manufacturing assembled and possessed production information, and so on. What information technology did in this situation was accelerate the existing patterns of operation within each drawer.

Work itself remained understood as functionally organized, jobs continued to be clearly defined within the bureau drawers, and the coordination and control of information and activities was accomplished through managerial hierarchies. When information from one function was needed by another, or activities required the involvement of more than one function, communication and coordination was accomplished using vertical channels, or horizontally through Galbraith's (1973, 1977) lateral integrating mechanisms that were bolted on to the vertical hierarchy. Managers relied on upward flows of information to surface problems with the ongoing operations and downward flows of instructions for making adjustments. As Zuboff's (1988) seminal research demonstrated, automation increased managers' sense of certainty and control over both production and organizational functions, thereby reinforcing hierarchy.

Phenomenally, the "automated plumbing" role may have reinforced the idea that organizational theory did not need to take information technology into account in its conceptualizations of organization. And, to a large extent, this view was supported by research through the late 1980s on the industrywide impact of information technology investment and productivity that showed technology investment had little effect on productivity. Even though there were reports of specific firm-level instances of information technology having a major impact on organizational performance, no general trend was found. This conundrum became known as the "productivity paradox" and suggested that information technology was not significantly affecting organizational form and function as reflected by outcomes.

This situation changed in the 1990s as research began to report a positive relationship between IT investment and productivity in industries and firms, provided there were investments in both information technology *and* organization. The Dedrick et al. (2003, p. 1) review of 55 studies on investment and productivity concluded that "greater investment in IT is associated with greater productivity growth. At the firm level . . . the wide range of performance of IT investments among different organizations can be explained by complementary investments in organizational capital such as decentralized decision making systems, job training, and business process redesign. IT is not simply a tool for automating existing processes, but more importantly is an enabler of organizational changes that can lead to additional productivity gains."

On the information technology side, these new benefits arose from IT's increasing capacity in terms of computing power, communication (e.g., Fulk and DeSanctis 1995), and integration capabilities. The doubling of processing power and storage capacity every couple of years, along with rapid increases in communication bandwidth, increased the speed and decreased the cost of information processing and communications. Coupling these capacity increases with the development of enterprisewide information systems created opportunities to organize around processes, not only their separate steps or functions. Enterprisewide systems create a single database for transactions associated with a standardized business process. Hosted on a server dedicated to the transaction-processing software, enterprise systems provide automated processing and analytic reports accessed by user (client-side) computers with the potential for integration with other processes hosted on other application servers.

The earliest manifestation of enterprise systems was the introduction of manufacturing resource planning (MRP) systems during the 1980s, which integrated information across historically distinct activities within the manufacturing function. MRP systems morphed into enterprise resource planning (ERP) systems during the early 1990s, integrating information across more functional areas. ERP then incorporated supply chain management systems during the late 1990s, which allowed integration to occur across organizational boundaries. Advances in networking and communication technologies made this information widely and easily available. The integrative aspects of these systems reduced the need to use hierarchy to manage information flows and coordinate activities because information was no

longer contained in separate bureau drawers with separate sets of functionaries charged with gathering and maintaining it. As a result, these enterprise systems decreased the need to move information through a hierarchy, allowing people to organize around the work itself and what could be done with the information.

But to gain the potential benefits of process-oriented IT integration, organizations needed to take advantage of what Zuboff (1988, pp. 10–11) referred to as the "informating" power of IT, where, in addition to automating work "activities, events, and objects are translated into and made visible by information." Increasing work's information content set into motion a series of dynamics that changed the nature of work itself and the social relations among the people doing it. The tasks performed by people at the lower organizational levels, including line employees, supervisors, and middle managers, began to change significantly. People were freed to focus on more complex, judgment-related, and creative tasks such as solving customer problems right away with resources at hand rather than seeking information or permission, working on problem-focused teams and task forces (e.g., for new product development, transforming production capabilities), and contributing one's expertise to a larger set of activities.

These changes opened the door to new ways of dealing with complexity and uncertainty because they created opportunities for emergent patterns of interaction or, in other words, new forms of organizing. People no longer had to separate their own work from the work of others, because everyone working on a particular process, be it manufacturing, inventory control, new product development, or product line management, could now use the process-based IT systems to "see" and understand the whole work flow. They no longer had to insist that the problems be shaped to fit into their separate, specialized knowledge, but rather they could see how to shape their specialized knowledge to fit the problem (Iansiti 1993, Leonard and Sensiper 1998). Holistic representations of work flows also enabled what Barley (1996) calls horizontal communities of work. These communities of practice organize work not through static vertical slices, but through emergent horizontal flows of work around core processes (Brown and Duguid 1991).

As IT takes over many coordination and control responsibilities from hierarchy, traditional hierarchical views of organizational form become incomplete. Many forward-looking organization writers have suggested alternatives to the traditional structural forms, including the adhocracy (Mintzberg 1983), the heterarchy (Hedlund 1986), the shamrock (Handy 1989), the boundaryless organization (Devanna and Tichy 1990), the hypertext organization (Nonaka and Takeuchi 1995), and the edge-of-chaos organization (Brown and Eisenhardt 1998), just to mention a few. Although these alternative organizational forms vary in their detail, they all present conceptions of more flexible and less hierarchical forms compared with traditional structures. Their inherent fluidity suggests that a conceptual shift—from "organizational form" to "forms of organizing"—is needed, based on the premise that unpredictable and unanticipated forms of organizing emerge out of the combination of IT and organization features and practices. Viewing the social and technological systems of organizations in concert, which was a critical part of sociotechnical systems theory in the 1950's (Trist 1981), is a perspective that the field needs to rediscover because IT has become inextricably intertwined with social relations to weave the fabric of organization.

Affordances and New Forms of Organizing

One way to explain the increasingly symbiotic relationship between IT and organization is through the lens of "affordances." Gibson (1979) developed the idea of affordances to explain how people and other animals orient to the objects in their world in terms of the possibilities the objects afford for action, and that the particular affordances of an object may be different for different species. Hutchby (2001) adapted the term for the sociology of science and technology, specifically to reconcile the opposing poles of constructivism (technology as a tabula rasa that is only given meaning and structure through people's interpretations) versus determinism (people are caused to act in a certain way by technology). An affordance perspective recognizes how the materiality of an object favors, shapes, or invites, and at the same time constrains, a set of specific uses. This view is also consistent with Weick's (1990) discussion of the new technologies as "parallel technologies involving a technology in the head and a technology on the floor" (p. 17) and Boudreau and Robey's (2005) notion that technology is enacted from an evolving human agency, but may also constrain that agency. Possibilities of action are not given, but depend on the intent of the actors enacting them. Thus, an ERP system (in terms of hardware and software) implemented in a leading-edge manufacturing organization may develop into different practices of organizing than would the same system implemented in a resource-poor organization possessing little experience with IT. We use *affordances for organizing* as a bridging concept that emerges from the intersection of IT systems and organization systems. Our affordances are the result of the confluence or intertwining of IT and organizational features. The technology-organizing possibilities that we refer to as affordances for organizing depend not only on the functionality characterizing the information technology, but also on the expertise, organizational processes and procedures, controls, boundary-spanning approaches, and other social capacities present in the organization. Thus, one cannot talk about a complex technology without reference to the

social setting, just as it makes limited sense to talk about a door handle without discussing the people opening the open doors.

Using an affordance lens suggests that although IT and organization features may exist independently of each other, their value for explaining organizational form and function comes from how they are enacted together. That is, although IT and organizational features may have their own potentials and constraints, theories are needed that elaborate on the affordances that arise when they are woven together. Understanding these affordances requires that the features of both IT and organization be considered simultaneously. Theorizing about affordances ideally would define them using both IT and organization science language to explain how their combined features interact to create new affordances for organizing. At its core, an affordance perspective recognizes that a technological object has some recognized functionality but needs to be recognized as a social object. As a social object, its influence on organizational functioning and performance cannot be separated from expertise, jobs, processes, or structures. We believe such theorizing will help open up the black boxes of IT and organization simultaneously, which was the theme of the special issue's call for papers.[3]

In the paragraphs below, we attempt to inspire organization and information science scholars to open up the black boxes of IT and organization together by offering concrete examples of five affordances for organizing: visualizing entire work processes, real-time/flexible product and service innovation, collaborating virtually, mass collaboration, and simulation/synthetic representation. This list is not exhaustive; the articles in this special issue offer their own affordances as well, some of which overlap with ours. For each of these affordances, we define the affordance using IT and organizational language and show how it is created by the intersection of particular IT and organization design features. We then examine the implications of the affordance for organizational functioning and performance.

Affordance 1: Visualizing Entire Work Processes

We define the "visualizing entire work processes" affordance as the ability to observe the entire work process in action from "end to end," representing it through language, imagery, or physical artifacts to make decisions about next steps when alternative actions can be taken. The broader the work system visualized and the more accurately the entire process can be represented, the more complete the decision-making process will be in an organization. This affordance is enabled by the symbiosis of technology and organizational features. Technologically, business process management tools coupled with dashboards that display the status of the work in process are needed to have real-time visualization capability. In addition, integrated databases, usually through an enterprise system coupled with business intelligence software, are needed if the flow of information through the process is to be monitored. Finally, real-time tracking sensors such as radio frequency identification chips or software cookies are needed to indicate when a product has passed a particular point in the process or when a service has been delivered to a customer's desktop. Wal-Mart, for example, offers its employees and suppliers visualization of the entire work process through its logistics tracking system, which allows them to monitor a product as it moves from the supplier's warehouse into the Wal-Mart store and into the customer's shopping cart.

These technology features need to be coupled with important organizational features to enact the affordance. These organizational features include process standardization and a deep enough understanding of the process to identify key performance indicators and to carry out continual operations reviews to monitor progress (Jelinek and Schoonhoven 1990). Although standardized, processes also include organizing features that enable the ongoing identification of problems and joint problem solving (Clark and Fujimoto 1991), such as simple, decentralized structures with fewer interfaces across job categories (e.g., reduce the number of assistant chiefs and deputy assistant directors), and a reward system that holds people accountable for how well their work fits into the overall process and how well they anticipate other functions' constraints. Process-centered organizational designs that include team norms for helping others, work layouts that help people see how others are doing, and rewards that encourage working across functions to help an entire process are needed as well (Majchrzak and Wang 1996). Process-centered organizing also includes differentiating work into horizontal flows of problem setting and solving (e.g., around product development, R&D/manufacturing/marketing capability building, and business management) that can proceed separately within strategic guidelines (Dougherty 2001). Finally, cultural norms and reward systems that encourage executives to assist each other are needed to ensure that functional subprocesses are not optimized at the expense of the complete process.

The visualization affordance helps to explain organizational performance in ways that examining either IT or organization alone does not. By examining how the entire work process can be visualized by various members in an organization, interdependencies across process steps can be more easily identified (Barki and Pinsonneault 2005). By examining how people use this affordance to respond to dynamics in the entire process, the role of too much and too little job flexibility can be examined. By understanding the organizational, cultural, and cognitive factors that enable different abilities to visualize, despite having access to the same information, the different roles that people play in dynamic problem solving can be better understood.

The visualization affordance has several implications for organizing. First, it enables people to organize around the work itself and helps them to both access and make sense of the requisite information in a collective manner. That is, visualization enables the collective sensemaking people must do as they figure out how to respond to the inevitable but unanticipated problems and glitches that arise in the unfolding of complex work. As such, it allows them to gradually develop patterns about how to react to potential future events, thus growing and changing not just in response but proactively. Second, this affordance makes the organizing process emergent and mutable as people follow the flow of work. Third, it raises issues about how much emergence is possible in various sectors or industries before the work and the organization "fly apart at the seams" as Schon (1963, p. 82) put it. Fourth, this affordance can make organizational boundaries more permeable yet able to be monitored. Once processes are optimized within an organization, visualization of the entire process can quickly expand the boundaries of an organization to include other members of its value chain. As boundaries follow the work, firms and individuals are no longer parts of single value chains, but become parts of networks and ecosystems. The broader purview of visualization, facilitated through the technical and relational use of social network analysis, may also help parties to identify gaps, holes, and opportunities for new businesses, relationships, and roles. Finally, with visualization, people's everyday work practices may become less scripted and more complex, as they apply their expertise to actual work flows rather than enact their jobs as separate functions.

Affordance 2: Real-Time/Flexible Product and Service Creation

We define this affordance as the ability to create software-enhanced products and services by quickly recombining components in new and innovative ways. It is made possible by the existence (either within a company's software catalogue or in cyberspace) of small software-based components that can be integrated in some fashion, and of the organizational system by involving business strategies and practices that emphasize agility. A company can license Google Maps and quickly integrate it with their store locations to help customers find their stores. Book publishers can modularize their books to allow for the ability to create customized texts as products on demand.

Several enabling technology features make possible the integration of components in innovative ways including web-based service-oriented architectures, standardized component designs, and open source software. Service-oriented architectures (SOAs) refer to the notion of breaking up the software in a firm into its various services that can then be reused to rapidly create new applications. Software components for a bank, for example, might include foreign currency exchange, loan application, fund transfer, secure logon, and open an account. The online bank ETrade, for example, used these components in their SOA to rapidly create an application that allowed customers to open accounts securely and transfer funds within ETrade accounts and between ETrade accounts and other banks. These components are often Web based, and may be "integrated" not only by literally being combined, but by having such fast connections that data and rules are transported back and forth between the different components so rapidly that they seem like a single integrated system. As a result, a customer making travel arrangements may actually be using a number of different components (e.g., flight schedules, cost optimizer, credit checker), with each component residing with a different vendor over the Web. Tying these different components together is made possible through standards agreed to by the various key players in the software market. These standards cover everything from how messages are sent to how to describe formats for inputs and outputs of each component, and the format of the code that connects the components. Finally, many of the components are available as open source code, with a set of community-enforced norms of use that include open availability, sharing, and improving upon others' design. Therefore, innovative services created from integrating two open source components could be posted on a webpage to stimulate others to add yet more components to create other innovative services.

Several organizational features are necessary to enable the real-time/flexible product and service creation affordance. The continued creation of a "common ground" of social action that enables people from diverse backgrounds and expertise to come together easily is necessary, and can occur via product concept articulation (Bacon et al. 1994) and shared understandings of the strategic value to be created that are developed and promulgated by managers (Tushman and O'Reilly 1997). Transactive memory systems is one example of shared understanding that must be able to allow for emergent cognitive structures as problem definitions and solutions dynamically evolve (Lewis et al. 2005, Majchrzak et al. 2007). Exposure to ideas from other disciplines (Allen 1977), along with job rotations across boundaries to follow a development process, keeps people mindful of the whole activity and how their part fits in. Fostering the practice of "heedful interrelating" (Weick and Roberts 1993) helps people to quickly create a representation of the situation that fits with those of others, develop their own contribution effectively, and fit it into the collective work (Dougherty and Takacs 2004). Structures are needed to facilitate crossing thought world boundaries such as boundary objects that accommodate the kinds of knowledge being codeveloped among the groups (Carlile 2004), and boundary spanners of varying types to gather up information, scout out opportunities, or ward off unnecessary interference (Ancona

and Caldwell 1992). These roles, coupled with help from intermediaries such as brokers, opportunity recognizers, and translators (Markus et al. 2002, Majchrzak et al. 2004), facilitate more creative mixing of the components.

Attending to either IT or organizational aspects alone would not provide a complete picture. By examining the organization from the perspective of combining components, organizational scholars can begin to understand how different actors within and across organizations define the critical components of organizing, be they intellectual, physical, or software- or resource-based components. Organizational scholars can identify new theories for explaining boundaries by examining how components are differentiated. Finally, by examining the process and outcomes of the combination process and how the organization and IT accommodate and support these combinations, new theories of organizational agility can be created.

Quickly being able to create new products and services has several implications for organizing. First, it grounds peoples' everyday collective sensemaking around understanding the emerging needs of those intended to use the services or products. As such, it could help organizations maintain alignment in the face of constant change. It also introduces a rapid feedback cycle by enabling quick probes and experiments with rapid feedback from potential user communities. Working with users in this way provides a rich and vivid sense of "what we are doing" and why, and keeps the definition of the work itself front and center. Second, this affordance enables people to readily follow, and at times lead, emerging needs and opportunities as these shift and morph into alternate applications and use functions, which allows the boundaries of markets served and products offered to evolve over time. Some organizations may use this affordance to proactively stimulate the market in new and unusual ways, such as when ETrade introduced the Intelligent Cash Optimizer to provide expert-system investment advice over the Internet. Individuals may simply use it to proliferate existing best practices rather than to creatively generate new practices, as when a scientist simply borrows from others' work rather than innovate with it (Majchrzak et al. 2004). For some organizations, the ability to quickly create new products and services will be used primarily internally by IT departments to better service their business units whereas other organizations will use it to develop new customer experiences. Forms of organizing that do not constrain innovation to the organization itself and identify ways to include customers and suppliers within legal umbrellas are needed. This affordance makes many new structures and practices possible now, and in the future promises to facilitate further possibilities.

Affordance 3: Virtual Collaboration

Collaborating virtually refers to the ability to share and integrate others' knowledge when that knowledge is primarily conveyed through virtual media. It can take the form of virtual teams (Cramton 2001, Fiol and O'Connor 2005, Hinds and Mortensen 2005, Majchrzak et al. 2000), online electronic networks of practice (Wasko and Faraj 2005), or new patterns of collaboration (von Hippel and von Krogh 2003). The virtual collaboration affordance is highly dependent upon intertwining technological and organizational features in ways that encourage open knowledge sharing, knowledge acquisition, knowledge maintenance and updating, and knowledge retrieval. For example, the nature of the task will often determine the type of technologies and organizational arrangements needed to enable task completion. Technologies that support contextualizing others' knowledge (e.g., using keywords in subject headers, linking between posts in the workspace to know the connections between documents, etc.) lead to greater knowledge comprehension for nonroutine tasks, but are too complex for routine tasks (Majchrzak et al. 2005). Creating a structure of periodic face-to-face meetings may be needed when parties are unable to, or do not have the technology support to, negotiate virtually (Maznevski and Chudoba 2000). Research on distributed work also suggests several organizational features that can play a role in enacting this affordance. For example, without the effective management of organizational features such as psychological safety (Edmondson 1999) and situational awareness (Cramton 2001), virtual workers tend to not share their unique knowledge (Majchrzak et al. 2000), have greater interpersonal conflict (Hinds and Bailey 2003, Hinds and Mortensen 2005), create subgroups (Fiol and O'Connor 2005, Polzer et al. 2006), and fail to coordinate their work effectively with others (Polzer et al. 2006).

When we open up the black box of the IT system that supports virtual collaboration and combine it with a fine-grained analysis of how people cognitively process and interact with others' knowledge virtually, we can better explain what might happen in the cycles of synchronous and asynchronous virtual interactions over time in such virtual collaborations. In turn, we may be better able to explain the role of diversity in distributed work, the dynamics of knowledge transfer across the full range of virtualness (Griffith et al. 2003), why transactive memory systems can be created in teams that never meet (Moreland and Myaskovsky 2000), why communities that have no boundaries are able to encourage people to volunteer for specific roles (e.g., Fleming and Waguespack 2007), and how engagement of virtual communities is maintained without explicit relationship-building activities.

The virtual collaboration affordance has several implications for organizing. First, with the proper intertwining

of organization and IT, virtual collaboration can broaden participation in an organization's work processes and decision making by including people located at its periphery, such as individuals in developing countries who might not be engaged in a strategy session, the new mother who might otherwise have quit her job but now works ten hours a week telecommuting, or the person who represents a small constituency in a global enterprise. Second, virtual collaboration increases the potential for bringing people from different organizations and disciplines together dynamically for short periods of time who would not otherwise have the opportunity to become engaged in the activity. Such people are able to stay in close contact with their constituencies to obtain localized knowledge as the knowledge of the task evolves, thereby maintaining the unique perspective that the task requires (Sole and Edmundson 2002). Third, virtual collaboration provides the opportunity to capture decision rationales and work processes as work is done, enabling future actors to reuse or learn from past work. Fourth, virtual collaboration enhances the potential for organizations to extend their boundaries temporarily, experimentally, or permanently. For example, by sharing common technologies and work processes for collaborating, two quite different businesses can cocreate and coevolve a unique joint business strategy.

Affordance 4: Mass Collaboration

The mass collaboration affordance is defined as the process by which people interact on a many-to-many basis via the Internet as opposed to a one-to-one basis (e.g., instant messaging), or a one-to-many basis (e.g., list servers). The intention of mass collaboration is to have information seen and used by unknown others (thus distinguishing it from virtual collaboration), creating new unexpected content. At the most basic level, this can simply involve people reading and then creating tags, labels, or links to content that others have posted so that when others view the content they'll see a link to other information that someone else thought was relevant. At the more sophisticated level, mass collaboration refers to cocreation where predictions about stock markets are more accurate when made by the masses than when made by chosen experts, where encyclopedia entries are more up-to-date and as reliable as those written by paid scholars, and where articles are written through a democratic collaborative process with no editor, no webmaster, and no teacher.

The mass collaboration affordance is dependent on the intertwining of both technical and organizational features. For instance, a study of the corporate use of wikis revealed that certain technical features, such as requiring secure logons, providing statistics on the use of the wiki page, allowing for reversions back to old versions, providing a discussion page in addition to the wiki page, and mechanisms to block inappropriate use of the site, were absolutely critical to the success of wiki-based communities (Wagner and Majchrzak 2007). However, the same study found that a relatively complex set of organizational arrangements, such as allowing and encouraging different levels of participation, having a community-owned management structure for monitoring the site, and aligning the work of the wiki with the goals and work of the individual, were needed as well. Organizational design decisions must be made for each community such as who is invited to contribute, what types of contributions are to be encouraged, and the degree to which the collaborations involve open cocreation or simply collating diverse opinions. Maintaining norms of reciprocity so that people will both share problems and advice, providing the opportunity for posters to obtain recognition from others for posting their information, and stimulating contributions with interesting questions and tasks are all affected by the combination of organizational and technological features.

The mass collaboration affordance can help explain organizational performance in ways that examining IT or organization in isolation cannot. By examining how masses collaborate, organizational scholars can begin to bring the dynamics of consumer markets into the dynamics of organizational change, such as by examining how early adopters emerge, the role of supportive structures, and how to manage the balance between imposing encouraging structures and allowing for emergent behavior. Examining how masses collaborate may help to generate new theories of organizational innovation because it may help to explain how to cross functional boundaries among unknown collaborators. Finally, examining how masses collaborate may provide the means for reconceptualizing some organizations as masses where the individual's role is less important than that of the collection of individuals that have been temporarily brought to bear on a problem.

A major implication of the mass collaboration affordance for organizing is that it creates the potential for quickly developing temporary organizations. For example, the KatrinaWiki was started by a student in Amsterdam who felt compelled to help and contacted a small group of people who had created websites during the tsunamis. They created a wiki that within days of the hurricane included thousands of organized entries from hundreds of people who posted missing persons, missing animals, found animals, people needing jobs, companies with jobs, and resources for emergency response and recovery. Some contributing to the KatrinaWiki did so exclusively for days, relaying messages to rescue workers in the field as information was posted to the wiki site. Mass collaboration also affords the possibility of creating parallel structures. Prediction markets are increasingly being seen as a parallel structure to the expertise of fund managers, stockbrokers, investment bankers, and bond traders. Another implication for mass collaboration

is that it affords the possibility of unbounded networks. Networks of music fans or a video on YouTube can create attention that draws more people into a phenomenon. Such networks can also have detrimental effects, as when Slashdot posts a call to bombard a site and the Slashdot community responds. Such networks may also respond in unpredictable ways, as when Digg.com, an open publisher of news posted by anyone, decided to block links to software code for pirating movies. It subsequently suffered a user rebellion and had to reverse its decision. Finally, this affordance raises questions regarding people's everyday activities: how can they enact diverse roles and how many roles can they handle?

Affordance 5: Simulation/Synthetic Representation

The simulation/synthetic representation affordance is defined as the capability to conduct what-if scenarios. Simulations can favor or shape a variety of specific uses, from guiding immediate next steps to challenging past assumptions, from empowering action to information overload, from confident decision making to anxious worrying. Clearly technology plays an important part in simulations. Dashboards coupled with business-process management tools integrate data from a business process's critical junctures in real time and aggregate the data across the process. In this way, users may decide that what may appear to be a problem early in a process has been resolved, and what early indicators suggest is a problem needs to be resolved quickly before it affects steps later in the process. Shifting the dashboard into "what-if" mode allows users to temporarily decouple the metrics from the actual performance of the process and observe the possible impact of alternative actions later in the process.

Business intelligence is another technical feature underlying simulations. Business intelligence is the use of artificial intelligence to identify patterns in data and then extrapolate from those patterns to predictive behavior. When coupled with an enterprise resource planning system, business intelligence allows the user to identify patterns in buying behavior, shipping behavior, returns, supplier relationships, and even competitor and industry-level behavior. With these systems in place, the user can observe changes to the patterns when new factors are injected, such as discounts for buying behavior, rerouting, and incentives for supplier relationships. Although some of these sorts of simulations have always been done, technology now allows anyone with access to conduct them. Simulations have also been used for suggestion systems, such as at Nortel, where employees work through a simulation system that helps them identify the key root causes of a suggestion, the support structure it needs, and the quantifiable benefits it may bestow upon the organization.

The availability of simulation technology will not lead to its widespread use unless necessary organizational features that support it are in place. Simulations imply action. Thus, employees who use them are likely to request changes from their organization and engage in actions emergently as they respond to the simulation results, whether these actions are for experiential learning purposes (Lewis et al. 2005) or for real-world adjustments to dynamic environments (Majchrzak et al. 2007). Therefore, if organizations provide employees access to a simulation capability, they also need to encourage the exploration of alternatives based on simulation results and, just as importantly, be willing to implement or at least seriously examine the resulting recommendations. At one organization that provided a simulation tool to its members, a supervisor became so excited that she used it and found that her process could be improved substantially, but only with the support of the material handling unit (Markus et al. 2002). She put together a proposal for the executive management team; management's response was that the proposal made too many changes and therefore denied the request for action. The simulation capability was never used again in the organization, even when the management team promised to try to implement subsequent proposals. Organizational simulations may find greater acceptance in organizations where there is acceptance of simulation for other purposes. NASA, for example, has effectively used both engineering and organizational design simulations because they are congruent with engineering culture and methods (Carroll et al. 2006).

By understanding the organization and IT characteristics that distinguish overload from empowerment, confidence from anxiety, and refinement from fundamental articulation, organizational scholars can better appreciate how performance can be enabled by empowerment without the overload, enabled with confidence without the anxiety, and enabled by the right balance between refinement and challenge. Virtual worlds can also open the possibility of rapid, low-cost experimentation (Hemp 2006). For example, a marketing person in an organization can pursue an idea for a new style of furniture within a virtual world space at relatively little cost; if the furniture garners attention in the virtual world, the marketing analyst may be able to use the virtual world as evidence for pursuing the new style. Educational institutions have used Second Life to create distance learning courses; Toyota uses Second Life to rapidly configure cars to see how the millions of online participants acquire the car component and use it; Nike uses Second Life to create "shoe" components to observe how the shoes are discussed and traded. Quantitative what-if scenarios can now be relatively easily performed by anyone in an organization with an enterprise system; the worker can simulate what might happen if the mix of materials in a manufacturing process was changed in response to changing supplier availability. Predictive

markets allow for simulating what might happen to a market under qualitatively distinct scenarios.

The simulation affordance has several important organizing implications. First, it can affect the processes and nature of sensemaking that people engage in. Simulations afford in-depth analysis and the opportunity to make sense of new possibilities and discover alternative courses of action, but only if people have localized knowledge to appropriately interpret the results. Coupled with local knowledge, modeling the potential consequences of different courses of action can reduce uncertainty in organizational decision making. Second, this affordance may push organizations to evolve in new directions. By focusing on intelligent action, employees' immediate dependence on others for information, knowledge, and brainstorming may be sufficiently lessened such that employees may be able to view themselves as independent decision makers striving to achieve goals of the organizational collective. As such, traditional organizations could be transformed into collectives of artisans under a single organizational umbrella, an artisanship that is inextricably tied to the intelligent simulation. Third, simulation can affect how people actually go about their work by giving them multiple simultaneous personas to play, e.g., a person may play an avatar at Toyota and a real marketing person at Toyota. Some of these roles are intentionally acted—as when an individual plays the "good cop" to a partner's "bad cop" during negotiations with a difficult client—whereas others are closer to the person's true persona. How these roles play out in a work day and how playing them out affects the forms that organizing takes are interesting research questions.

We see these five affordances as potentials made possible by the combination of technical and organizational features. Whether the affordances manifest themselves when these features are present and how they do so is not a given because there can be no affordance absent actor intent. Although these IT and organizational features may combine in ways that favor or shape specific uses, the range of possibilities in how they are enacted within organizations will define the uses and outcomes associated with them. And because they are defined by intent, affordances continually present opportunities for new forms of organizing. Organization and information systems researchers can explore how affordances emerge, evolve, and shape organizational form and function in novel ways. Such research will bring organization science concepts and theories into a world where IT is a fundamental thread in the fabric of organization.

Developing theoretical perspectives that open the black boxes of IT and organization, be it with the five affordances we suggest or others, requires future research that addresses three issues. First, we need to study how information is socially and organizationally made sense of because organizing takes place around those understandings and subsequent actions, not only around information acquisition and transmission (e.g., Brown and Duguid 2000, Dougherty 2001). Second, we need to study how affordances emerge and evolve with changing technological and organizational features (Majchrzak et al. 2007). Innovations in IT and organization create new options, raising new questions to explore. How do novel combinations of IT and organizational features create new affordances? How do continuous versus discontinuous innovations in either IT or organization change the dynamics (e.g., Rothaermel and Hill 2005) of affordance emergence and evolution? What impact do new combinations of IT and organizational features have on organizational form and function? Which combinations are selected in organizations and why? Organizations and IT are designed, but given their complexity and interaction, the results are mutable and dynamic (e.g., DeSanctis and Poole 1994, Orlikowski 1992, Griffith 1999). Third, we need to study the impact of affordances on organizations' boundaries. Organization theorists (e.g., Kellogg et al. 2006) have argued that boundaries are becoming increasingly permeable and each of the five affordances speaks to changes in boundary conditions. Better understanding the impact of affordances on boundary conditions would improve our ability to understand why boundaries have become less constraining and how interactions across organizations occur. Overall, research that addresses these issues either by continuing theory development or by presenting perspectives elaborating on their underlying dynamics would be valuable. The articles in this special issue provide examples and foundations for such future research.

Summaries of the Special Issue Articles

Our call for the special issue was responded to by 149 abstracts that eventually led to the set of seven peer-reviewed articles in this special issue. These seven were the most fully developed in striving to study the intertwined nature of IT and organizing. Each article tackles the above three issues in a different way and, each in their own way, offers perspectives that incorporate the notion of affordances, although sometimes varying from the ones we mention. They focus on how information is processed, emergence and evolution, dynamics, context, intentions, and actions rather than structures, correlations, boxes, and arrows. It is our hope that they will spur a substantial shift toward studying the conjunction of IT and organization in future research.

Sinan Aral and Peter Weill's article "IT Assets, Organizational Capabilities, and Firm Performance: How Resource Allocations and Organizational Differences Explain Performance Variation" examines why there are variations in the effects of IT investment on firm performance. Their answer focuses on the intersection of IT

investments and organizational capabilities as moderated by strategic intent in generating value. They argue that IT investments are directed by strategic intent that, in turn, leads to uses of information technology that generate different performance outcomes. When taking differences in strategic intent into account, the combination of investment in IT and organizational capabilities explains variations in performance outcomes in a sample of 147 firms across 1997–2002. The article demonstrates the general concept of affordances, where actors' strategic intent shapes the outcomes that can be obtained through the combination of technology and organizational investments. It also highlights the importance of the presence of both organization and technology factors in creating affordances. On a phenomenal level, the article provides a nuanced view of why the "productivity paradox" really isn't a paradox when you unpack the black boxes on both sides of the equation.

Brian Pentland and Martha Feldman's "Narrative Networks: Patterns of Technology and Organization" proposes a way to represent and visualize patterns of technology in use. They suggest that a narrative network is a sociotechnical tapestry that intertwines information and communication technologies (ICTs) and organizes into stories involving people using tools to do tasks. "Narrative" refers to a set of actions or events that embodies coherence or unity of purpose, and "network" refers to an image of many interconnected elements (including people and ICTs) from which particular performances can be constructed. The authors describe how properties (or features) of ICTs such as modularity, recombinability, distributed, and communicative nature provide new and different ways (what we would call affordances) for people to use tools to do tasks across time, space, and participants. These properties shape and expand possible storylines that constitute organizing, because ICTs both participate in and transform networks by evolving in unexpected ways. The authors outline theories of structuration, actor networks, and routines that underlie their narrative network method, show how to construct narrative networks, and suggest possible applications for exploring degrees/types of structure and examining organizational change and organizational thinking through design. The organizing affordances we outline can be narrative networks in their own right because they display broad possibilities for depicting storylines. They can also be narrative fragments that are woven into theories that seek to understand future organizing possibilities.

Gerald Kane and Maryam Alavi's article "Information Technology and Organizational Learning: An Investigation of Exploration and Exploitation Processes" extends March's classic computational model to examine how three IT tools affect organizational learning: knowledge repositories, groupware, and e-mail-assisted electronic communities of practice. They illustrate the power of the simulation affordance, showing how a relatively simple computational model can intertwine various IT and organizing features to explore divergent outcomes on learning (and sensemaking). It also delves into the virtual collaborating affordance, exploring how different kinds of relations among team members using different kinds of IT can lead to more or less organizational learning. Their modeling suggests that e-mail-assisted electronic communities of practice lead to more exploration than knowledge repositories or team rooms because more knowledge variance is introduced. However, blending e-mail with other IT-enabled learning mechanisms has a detrimental effect on knowledge levels, whereas team rooms blended with other mechanisms produces the highest levels of learning. The authors conclude that the right IT-enabled learning mechanisms employed under the right conditions can benefit organizational learning, but that the wrong mechanisms for particular conditions can be severely detrimental.

Paul Leonardi's article "Activating the Informational Capabilities of Information Technology for Organizational Change" moves in the direction of all three issues we raise for future research. The study explores specifically how information that a new IT tool provides can lead to changes in the social structure of an organization. The findings of his ethnographic study of the implementation and use of an IT tool to manage IT services in an organization demonstrate that, as IT is appropriated within an organization by its users, informal advice networks emerge, which in turn lead to new social structures. Informal advice networks then become an affordance that intertwines how the IT is designed to convey and use information and the way that the users' jobs are designed to use that information.

The article by Olga Volkoff, Diane Strong, and Michael Elmes "Technological Embeddedness and Organizational Change" highlights our proposed three themes for future research. Their ethnographic study examined the effect of an ERP implementation on an organization. Using a critical realist perspective, the authors find theoretical traction around considering ERP as consisting of data, routines, and roles, which take on not only a performative and ostensive (i.e., abstract and general) quality, but a material (i.e., concrete and specific) quality as well. Although the material qualities of the data, routines, and roles of the ERP should conceptually be interrelated with each other and with their performative and ostensive qualities, the authors find this not to be the case; at various points in the implementation process, roles, routines, and data were unrelated to each other and at other times the performative, ostensive, and material qualities were unrelated as well. The authors' explanations for these findings provide us with a new vocabulary and level of analysis for studying affordances, as well as caution us to not assume that expected relationships among concepts will be found.

Mark Dodgson, David Gann, and Ammon Salter's article " 'In Case of Fire, Please Use the Elevator': Simulation Technology and Organization in Fire Engineering" examines the impact of simulation technology on the work of fire engineers and show how traditional ways of design are turned on their head. They start with a description of how engineers use simulation technology to accurately create virtual representations and to analyze a large number of situations and generate appropriate solutions. However, the changed way of working afforded by the technology requires higher levels of skills and forces novel ways of exchanging information to validate new engineering knowledge and building designs. Knowing when to simulate and recognizing that modeling assumptions become intertwined with a social process of brokering knowledge between different parties, combining knowledge, and constructing judgment. In the context of our special issue, the paper opens up the black boxes by richly explaining the organizing changes associated with fire engineering simulation.

Arvin Sahaym, H. Kevin Steensma, and Melissa Schilling's article "The Influence of Information Technology on the Use of Loosely Coupled Organizational Forms: An Industry-Level Analysis" explores how contextual factors can affect IT investment's impact on firms' boundaries. They note that IT systems can be used to enhance coordination within *or* across firm boundaries and argue that industry contextual factors will influence whether IT investments lead to loosely or tightly coupled organizational forms. They find that contextual factors, such as established industry standards, asset specificity, technological change, and production input diversity, influence the extent to which firms within industries use loosely coupled organizational forms as represented by alliance formation and the employment of contingent workers. Within the context of our framework, their results suggest that affordances affecting organizational boundary conditions can be enhanced or inhibited by industry context. Thus, researchers need to be aware of how the contextual environment of the organizations they study may impact the types of affordances that emerge and how they are used.

Conclusion

We began with a history highlighting the organizational science's declining interest in the relationship between technology and organizational form and function at a time during which IT has become increasingly pervasive in every day life and work. We also have explained how IT has supplanted many of the coordination and control roles of hierarchy, creating the opportunities for new forms of organizing that focus on process instead of function. This emerging coordinative role of IT has made it one of the threads from which the fabric of organization is woven. It is no longer possible to design or modify organizations without recognizing that IT is part of the fabric. And it does not make sense to study the dynamics of human behavior within organizations without taking into account how information technologies might affect it. Thus the central question raised by this special issue: If the phenomena we study are changing due to the ubiquitous adoption of information technology by individuals and organizations, do not we run the risk of our theories and research becoming irrelevant unless they reflect the changes in those phenomena?

We have offered affordances, created by the conjunction of IT and organization features coupled with managerial intent, as one way of moving forward in developing conceptualizations of organizations appropriate in an IT-intensive world. These affordances push us to stake claims in our theory and research regarding the meaning and use of information, rather than its bureaucratic transmission; how affordances come to be and change; and how organizational boundaries form. Examples of five affordances are presented, but we have not attempted to create a theory of how they develop or evolve or dissolve. We leave this to future research. We also leave to the future the exploration of other intertwinings of IT and organization that result in other affordances, such as IT-strategy affordances.

We hope that by presenting a story of IT and organization in combination, clarifying future research needs, and showcasing seven exemplar articles, this special issue will help move the field forward. As a community of organizational scholars, we have much to offer our students and managers, particularly if we can make our theory and research more applicable to the Information Age. We also urge organization and information science scholars to question research that is not explicit in its consideration of both these foundational components. Leaving either side of the relationship unattended is likely to result in an underspecification of the phenomena being studied.

Just as Perrow (1983) suggested that engineers may need to "marry" human factors specialists to design complex organizations to avoid normal accidents, organizational scientists may need to "marry" information scientists to succeed at opening these black boxes. Whether through marriage, collaboration, or self-training, the affordances that arise from the interweaving of IT and organization need to be explored if our theory and research hopes to reflect the reality of today's organizations, not those of 40 years ago. We hope that both organization and information scientists take up this challenge.

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Endnotes

[1]This lack of theorizing among organizational scientists is not due to a lack of attention across all disciplines. Research

examining the evolving relationship between IT and organizational form and function is the focus of significant research attention by information systems researchers. For example, almost half the articles (24 of 49) published in 2005 in two leading information systems journals, *MIS Quarterly* (*MISQ*) and *Information Systems Research* (*ISR*), focused on the relationship between information technology and organizational form and function. About one-third of these articles focused on aspects of IT and knowledge management, reflecting the theme of a two-volume special issue of *MISQ*. Other articles published in *MISQ* and *ISR* during 2005 explored topics that included IT's impact on strategy and firm performance, interorganizational relations, and the effects of individual, work environment, and industry characteristics on IT use. This information systems research is well informed by the organization science literature. The *ISI Journal Citation Reports* show that articles published in *MISQ* and *ISR* during 2005 cited articles from *ASQ*, *AMR*, *AMJ*, and *Organization Science* (*OS*) a total of 287 times. More generally, articles in *MISQ* and *ISR* cited articles in recognizable organization science journals 632 times, which represented 19.4% of their total citations to journal articles. However, current organization science research is not similarly informed by the information systems field. Articles in *ASQ*, *AMR*, *AMJ*, and *OS* cited articles published in *MISQ* and *ISR* a total of 19 times in 2005. Seventeen of those citations were in *OS*. More broadly, articles in these four journals cited 67 articles *in total* from journals in the broadly recognizable information systems and computer science literatures, which is four-tenths of 1% of their total citations to journal articles during 2005.

[2]Internet Systems Consortium, Inc., http://www.isc.org/index.pl?/ops/ds.

[3]The affordance perspective builds on structurational views of IT and organizations (e.g., DeSanctis and Poole 1994, Orlikowski 1992, Griffith 1999) in its recognition of the duality between action and structure. We lean towards the language of affordances versus structuration (Giddens 1979) given the focus on the materiality of technology (e.g., Hutchby 2001) in the affordances literature.

References

Allen, T. 1977. *Managing the Flow of Technology*. MIT Press, Cambridge, MA.

Ancona, D. G., D. F. Caldwell. 1992. Bridging the boundary: External activity and performance in organizational teams. *Admin. Sci. Quart.* **37** 634–664.

Bacon, G., S. Beckman, D. Mowery, E. Wilson. 1994. Managing product definition in high-technology industries: A pilot study. *California Management Rev.* **36** 34–56.

Barki, H., A. Pinsonneault. 2005. A model of organizational integration, implementation effort, and performance. *Organ. Sci.* **16**(2) 165–179.

Barley, S. 1996. Technicians in the workplace: Ethnographic evidence for bringing work into organization studies. *Admin. Sci. Quart.* **41** 404–441.

Boudreau, M.-C., D. Robey. 2005. Enacting integrated information technology: A human agency perspective. *Organ. Sci.* **16**(1) 3–18.

Brown, J. S., P. Duguid. 1991. Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organ. Sci.* **2**(1) 40–57.

Brown, J. S., P. Duguid. 2000. *The Social Life of Information*. Harvard Business School Press, Boston, MA.

Brown, S., K. Eisenhardt. 1998. *Competing on the Edge*. Harvard Business School Press, Boston, MA.

Carlile, P. 2004. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organ. Sci.* **15**(5) 555–568.

Carroll, T. N., T. J. Gormley, V. J. Bilardo, R. M. Burton, K. L. Woodman. 2006. Designing a new organization at NASA: An organization design process using simulation. *Organ. Sci.* **17**(2) 202–214.

Clark, K., T. Fujimoto. 1991. *Product Development Performance*. Harvard Business School Press, Boston, MA.

Cramton, C. D. 2001. The mutual knowledge problem and its consequences for dispersed collaboration. *Organ. Sci.* **12**(3) 346–371.

Dedrick, D., V. Gurbaxani, K. L. Kraemer. 2003. Information technology and economic performance: A critical review of the empirical evidence. *ACM Comput. Surveys* **35**(1) 1–28.

DeSanctis, G., M. S. Poole. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organ. Sci.* **5**(2) 121–147.

Devanna, M., N. Tichy. 1990. Creating the competitive organization of the 21st century: The boundaryless corporation. *Human Resource Management* **29**(4) 455–471.

Dougherty, D. 2001. Re-imagining the differentiation and integration of work for sustained product innovation. *Organ. Sci.* **12**(5) 612–631.

Dougherty, D., C. H. Takacs. 2004. Team play: Heedful interrelating as the boundary for innovation. *Long Range Planning* **37** 569–590.

Edmondson, A. 1999. Psychological safety and learning behavior in work teams. *Admin. Sci. Quart.* **44**(2) 350–383.

Fiol, C. M., E. J. O'Connor. 2005. Identification in face-to-face, hybrid, and pure virtual teams: Untangling the contradictions. *Organ. Sci.* **16**(1) 19–32.

Fleming, L., D. M. Waguespack. 2007. Brokerage, boundary spanning, and leadership in *open* innovation communities. *Organ. Sci.* **18**(2) 165–180.

Fulk, J., G. DeSanctis. 1995. Electronic communication and changing organizational forms. *Organ. Sci.* **6**(4) 337–349.

Galbraith, J. 1973. *Designing Complex Organizations*. Addison-Wesley, Reading, MA.

Galbraith, J. R. 1977. *Organization Design*. Addison-Wesley, Reading, MA.

Gibson, J. J. 1979. *The Ecological Approach to Visual Perception*. Houghton Mifflin, Boston, MA.

Giddens, A. 1979. *Central Problems in Social Theory: Action, Structure, and Contradiction in Social Analysis*. University of California Press, Berkeley, CA.

Griffith, T. L. 1999. Technology features as triggers for sensemaking. *Acad. Management Rev.* **24**(3) 472–488.

Griffith, T. L., J. E. Sawyer, M. A. Neale. 2003. Virtualness and knowledge in teams: Managing the love triangle of organizations, individuals, and information technology. *MIS Quart.* **27**(2) 265–287.

Handy, C. 1989. *The Age of Unreason*. Harvard Business School Press, Boston, MA.

Hannan, M. T., J. Freeman. 1977. The population ecology of organizations. *Amer. J. Sociol.* **82** 929–964.

Hedlund, G. 1986. The hypermodern mnc—A heterarchy? *Human Resource Management* **25**(1) 9–35.

Hemp, P. 2006. Avatar-based marketing. *Harvard Bus. Rev.* **84**(6) 48–57.

Hinds, P., D. Bailey. 2003. Out of sight, out of sync: Understanding conflict in distributed teams. *Organ. Sci.* **14** 615–632.

Hinds, P. J., M. Mortensen. 2005. Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organ. Sci.* **16**(3) 290–307.

Hutchby, I. 2001. Technologies, texts and affordances. *Sociology* **35**(2) 441–456.

Iansiti, M. 1993. Real-world R&D: Jumping the product generation gap. *Harvard Bus. Rev.* **71**(3) 138–147.

Jelinek, M., C. Schoonhoven. 1990. *The Innovation Marathon*: *Lessons from High Technology Firms*. Basil Blackwell, Oxford, UK.

Kellogg, K. C., W. J. Orlikowski, J. A. Yates. 2006. Life in the trading zone: Structuring coordination across boundaries in postbureaucratic organizations. *Organ. Sci.* **17**(1) 22–44.

Leonard, D., S. Sensiper. 1998. The role of tacit knowledge in group innovation. *California Management Rev.* **40**(3) 112–132.

Lewis, K., D. Lange, L. Gillis. 2005. Transactive memory systems, learning, and learning transfer. *Organ. Sci.* **16**(6) 581–598.

Majchrzak, A., Q. Wang. 1996. Breaking the functional mind-set in process organizations. *Harvard Bus. Rev.* **74**(5) 93–99.

Majchrzak, A., L. Cooper, O. Neece. 2004. Knowledge reuse for innovation. *Management Sci.* **50**(2) 174–188.

Majchrzak, A., S. L. Jarvenpaa, A. B. Hollingshead. 2007. Coordinating expertise among emergent groups responding to disasters. *Organ. Sci.* **18**(1) 147–161.

Majchrzak, A., A. Malhotra, R. John. 2005. Perceived individual collaboration know-how development through information technology-enabled contextualization: Evidence from distributed teams. *Inform. Systems Res.* **16**(1) 9–27.

Majchrzak, A., R. E. Rice, A. Malhotra, N. King, S. Ba. 2000. Technology adaptation: The case of a computer-supported interorganizational virtual team. *MIS Quart.* **24**(4) 569–600.

Markus, M. L., A. Majchrzak, L. Gasser. 2002. A design theory for systems that support emergent knowledge processes. *MIS Quart.* **26**(3) 179–212.

Maznevski, M. L., K. M. Chudoba. 2000. Bridging space over time: Global virtual team dynamics and effectiveness. *Organ. Sci.* **11**(5) 473–492.

Meyer, J. W., B. Rowan. 1977. Institutionalized organizations: Formal structure as myth and ceremony. *Amer. J. Sociol.* **83** 340–363.

Mintzberg, H. 1983. *Structure in Fives*: *Designing Effective Organizations*. Prentice Hall, Englewood Cliffs, NJ.

Moreland, R. L., L. Myaskovsky. 2000. Explaining the performance benefits of group training: Transactive memory or improved communication? *Organ. Behav. Human Decision Processes* **82**(1) 117–133.

Nonaka, I., H. Takeuchi. 1995. *The Knowledge Creating Company*. Oxford University Press, Oxford, UK.

Orlikowski, W. J. 1992. The duality of technology: Rethinking the concept of technology in organizations. *Organ. Sci.* **3** 398–427.

Perrow, C. 1967. A framework for the comparative analysis of organizations. *Amer. Sociol. Rev.* **32** 194–208.

Perrow, C. 1970. *Organizational Analysis: A Sociological View*. Wadsworth, Belmont, CA.

Perrow, C. 1983. The organizational context of human factors engineering. *Admin. Sci. Quart.* **28**(4) 521–541.

Pfeffer, J., G. R. Salancik. 1978. *The External Control of Organizations*. Harper and Row, New York.

Polzer, J. T., C. B. Crisp, S. L. Jarvenpaa, J. W. Kim. 2006. Extending the faultline model to geographical dispersed teams: How co-located subgroups can impair group functioning. *Acad. Management J.* **49**(4) 679–692.

Rothaermel, F. T., C. W. L. Hill. 2005. Technological discontinuities and complementary assets: A longitudinal study of industry and firm performance. *Organ. Sci.* **16**(1) 52–70.

Schon, D. 1963. Champions for radical new inventions. *Harvard Bus. Rev.* **41**(2) 77–86.

Scott, W. R. 1992. *Organizations*: *Rational, Natural, and Open Systems*. Prentice Hall, Englewood Cliffs, NJ.

Sole, D., A. Edmondson. 2002. Situated knowledge and learning in dispersed teams. *British J. Management* **13** S17–S34.

Thompson, J. D. 1967. *Organizations in Action*. McGraw-Hill, New York.

Thompson, J. D., F. L. Bates. 1957. Technology, organization, and administration. *Admin. Sci. Quart.* **2** 325–342.

Trist, E. L. 1981. The sociotechnical perspective: The evolution of sociotechnical systems as a conceptual framework and as an action research program. A. H. Van de Ven, W. F. Joyce, eds. *Perspectives on Organizational Design and Behavior*. John Wiley and Sons, New York.

Tushman, M., C. O'Reilly. 1997. *Winning Through Innovation.* Harvard Business School Press, Boston, MA.

von Hippel, E., G. von Krogh. 2003. Open source software and the "private-collective" innovation model: Issues for Organization Science. *Organ. Sci.* **14**(2) 209–223.

Wagner, C., A. Majchrzak. 2007. Enabling customer-centricity using wikis and the wiki way. *J. Management Inform. Systems* **23**(3) 17–43.

Wasko, M. M., S. Faraj. 2005. Why should Ishare? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quart.* **29**(1) 35–57.

Weick, K. E. 1990. Technology as equivoque: Sensemaking in new technologies. P. S. Goodman, L. S. Sproull, eds. *Technology and Organizations*. Jossey-Bass, San Francisco, CA, 1–44.

Weick, K., K. Roberts. 1993. Collective mind in organizations: Heedful interrelating on flight decks. *Admin. Sci. Quart.* **38**(3) 357–381.

Woodward, J. 1958. *Management and Technology*. H. M. S. O., London, UK.

Woodward, J. 1965. *Industrial Organization*: *Theory and Practice*. Oxford University Press, New York.

Zuboff, S. 1988. *In the Age of the Smart Machine*: *The Future and Power of Work*. Basic Books, New York.