Organizational Ecology and Knowledge Networks

Franklin Becker

In an "information age" in which employees are "knowledge workers" and the amount of "information" expands exponentially, managing knowledge in all its forms has become a major organizational challenge. Just what is knowledge management? Davenport and Prusak as well as Dixon distinguish among three components of the overall concept: data, information, and knowledge.[1] Davenport and Prusak define data as a "set of discrete, objective facts about events."[2] Information transforms data by adding meaning or value to give it "relevant purpose." Dixon defines "information" in more operational terms as "data that has been sorted, analyzed, and displayed, and is communicated through spoken language, graphic displays, or numeric tables."[3] Knowledge draws on both data and information but "is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information."[4] Dixon says much the same thing when she defines knowledge as "the meaningful links people make in their minds between information and its application in action in a specific setting."[5]

Knowledge management seeks to proactively shape how these three related and interdependent forms of knowing develop; how they are captured, stored, and shared; and how they can be applied to help the organization strengthen its competitive advantage over time. The key word is "applied." Soo et al. write that "knowledge, or know-how, has to do with the process of learning, understanding, and applying information."[6] What makes this so challenging, as Soo et al. point out, is that "executives are now confronted with a very serious and currently 'unmanageable' imperative—the management of a completely invisible asset."[7]

Types of Knowledge

In an area of study as amorphous as knowledge management, the types of knowledge of interest to researchers, consultants, and companies vary widely. Capturing best practices and lessons learned often heads the list because these are viewed as most directly contributing to the speed of work (the wheel doesn't have to be constantly reinvented) and improving quality (the benefits of trial and error are captured to reduce the error going forward). These best practices and lessons learned, when not easily catalogued as explicit and discrete processes and procedures, have been called "tacit knowledge"—that is, knowledge primarily in the heads of people.[8] Its flow through an organization more often occurs as the result of informal social networks than formal programs and processes.[9] This kind of information and knowledge can relate to any area of the company's business and operations: accounting practices, marketing, customer relations, facilities, product design, or human resources.

In addition to information and knowledge directly connected to some aspect of work processes or practices is person-related information and knowledge.[10] This kind of knowledge relates to the behaviors, skills, and attitudes of colleagues and managers that indirectly influence informal learning. It is critical for effective collaboration, particularly with regard to trust. Is this a person who will, for example, publicly or privately acknowledge the source of information and knowledge? Will this person share his or her own knowledge and information? As Dixon makes clear, the willingness to "give" information depends in part on the ability to "get" information when needed, as well as just personal recognition in the form of a "thanks."[11] Effective teams depend not just on their members' work-related knowledge and skills, but in being able to tap this treasure trove easily and in a timely fashion. This requires knowing about such things as how well someone holds up under stress and their personal work styles (e.g., at what time of day or night does the person works best? what motivates the person?).

A third type of information and knowledge relates to corporate attitudes, values, and behavior that influence communication and interaction patterns. Like person-related information, these behaviors and attitudes form part of the knowledge infrastructure and act as invisible, uncodified, and unwritten gatekeepers that shape informal learning. They include formal and informal values, policies and practices about who can communicate with whom, and what the preferred communication modalities are (is it, for example, an e-mail or voice mail culture?), and how much emphasis is placed on scheduled versus impromptu and chance meetings and interactions.

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In tracing the evolution of knowledge management, Davenport and Prusak acknowledged the complexity of an area of study that by definition requires looking at the workplace as a complex system.[12] Technology, culture, individual characteristics, and leadership styles cannot, by themselves, describe

or explain how data becomes information and that information is transformed into knowledge. The challenge, however, is not just to identify, generate, and store knowledge. It is to apply it effectively as part of the everyday activities of the enterprise. As the training literature suggests, this is no easy task. Pfeffer and Sutton discuss the "knowing-doing gap"[13] and Davenport et al. emphasize that "all too rarely is that data sifted into the sort of knowledge that can inform business decisions and create positive results."[14] Past experience indicates that the information and knowledge gained from formal training programs, in particular, is often not effectively applied.[15] While assessing (with any precision) the amount of money organizations invest in formal training programs (or the value gained from them) is impossible, some researchers have estimated that from the approximately one hundred billion dollars spent annually on all forms of corporate training (from technical training to leadership and executive development), only about ten percent is actually applied on the job.[16] That is not an attractive ratio.

Given the explosion in the sheer amount of information that exists in organizations—and its importance to surviving, if not thriving, in a fiercely competitive knowledge-based economy—many companies, at least initially, saw the solution to knowledge management as residing in technology. These companies focused on the corporate intranet in particular because of its potential to capture, store, and make vast amounts of information widely accessible anywhere and anytime. Davenport and Prusak note, however, that "the assumption that technology can replace human knowledge or create its equivalent has proven false time and again."[17] Hargadon and Sutton[18] and Hargadon[19] underscore the limitations of technology-based knowledge databases when they argue that knowledge intended to foster creativity and innovation depends not just on a free flow of information in general, but on the recombination of non-obvious knowledge in ways that trigger novel solutions to complex problems.

Hargadon gives the example of Reebok's Pump™ shoe, which combined one designer's knowledge about inflatable splints and another's knowledge of medical IV bags to invent a form-fitting inflatable air bladder into the sides of an athletic shoe.[20] Hargadon concluded that "from this perspective, we may see one answer to why technical knowledge management efforts often fall short of expectations. Formal databases codify knowledge, storing it in ways that could be easily retrieved using known and expected keywords. When problems are well known, these systems provide effective storage of the solutions that are typically associated with those problems. But the very efficiency of database 'deposit-and-withdrawal mechanisms' makes them difficult tools for finding non-obvious links between ideas."[21]

It is not that technology is irrelevant, but that by itself it is insufficient. Dixon notes that "All of the knowledge management systems . . . initially designed as technology systems have evolved toward being a combination of technology and face-to-face meetings."[22] Such systems are, in other words, hybrids.[23] The reason is that informal networking systems are more effective than technology-based systems in generating high performance.[24] This is largely

because, as McDermott argues, knowledge that is neither obvious nor easy to document depends on people to help interpret as well as share.[25]

With the realization that technology by itself is not a panacea, more attention has been paid to factors influencing the extent, nature, and quality of human, and particularly face-to-face, interaction. This, in turn, has led to an interest in "communities of practice" and "communities of interest."[26]

Communities of Practice and Informal Communication and Learning

From the social network perspective, knowledge emerges and is sustained in a social context.[27] The communities of practice framework emphasizes that informal learning and knowledge sharing depend on and exploit networks of connections among people who share a common interest or task.[28] The communities of practice concept emerged from ethnographic analysis of how groups actually worked and communicated in practice. Brown and Duguid found that customer support staff learned the "tricks" of their trade not by attending formal training sessions or reading company manuals, but by drawing on the experience and insights of others with whom they worked.[29] Knowing who to contact, and getting good information, required developing contacts among a wide range of people doing the same kind of work. Communities of practice were the social infrastructure supporting informal learning and communication that generated high-quality performance.

Effective communication, including informal learning, and the active give-and-take among people from different disciplines (that characterizes innovative problem solving) is critical to the development of high-performance teams.[30] In such a community, learning through participation, rather than through more passive acquisition of knowledge, is the primary mode through which learners master the skills and knowledge needed to become competent members of a team.[31] From this network of personal relationships comes the cooperation and trust that forms the social capital that provides community members with the "resources" (e.g., information, support, and training) they need to learn and do their job well.

For the purposes of this article, the ways in which information and knowledge are shared among and across project teams, departments, and other organizational units is considered, generically, as "informal learning." This includes work-related information and knowledge that ranges from technical skills to understanding how the organizational culture works; person-related information that includes an understanding of the skills, abilities, and work styles of others in one's own team and department; and corporate attitudes, values, and behaviors that shape communication and interaction patterns.

Rate of Knowledge Change

Bailey et al. argue that not only the type of information (that needs to flow with an organization to support high performance), but also the communication patterns (that shape how it is informally shared) vary as a function of the rate of knowledge change.[32] They used detailed ethnographic field observations of communication patterns in six firms, three of structural engineers (slower rate of change) and three of chip designers (higher rate of change). They identified and characterized five different types of learning events:

- the social nature of the learning event (dyadic or group exchange);
- the direction in which knowledge was transferred (up or down or sideways across the organizational hierarchy);
- who initiated the learning event (junior or senior members);
- the method of teaching (instruction, helping by working with, providing information, tutoring, and modeling professional behavior); and
- what was learned (technical material, tools, procedures, political factors, and organizational factors).

The researchers characterized the communication patterns in the structural engineering firms with the slower rate of knowledge change as following an "apprenticeship" model, whereas the chip design firms with the higher rate of knowledge change were characterized by a communication pattern that followed a "guru" model.

The key difference was that in the apprenticeship model information flowed from senior engineers to junior engineers, while in the guru model information flowed through a knowledge "web" where chip designers learned from anyone who, independent of seniority, possessed specialized knowledge. In terms of practice, the authors suggest that pairing junior and senior engineers makes sense for the apprenticeship model, and they warn that distributed work patterns in organizations that depend on face-to-face sharing of information (that often involves demonstrating and working with the person learning) may be dysfunctional.

These suggestions have implications for the design, use, and management of the physical setting in which communication occurs. What is largely missing in existing organizational literature related to knowledge management is serious consideration of the role that the physical settings of work plays in various types of informal learning, particularly involving chance or impromptu encounters. The study of the role of the physical settings of work within the social and technological context has been called "organizational ecology."[33]

Defining Organizational Ecology

The concept of "organizational ecology" was coined to capture the fact that all organizations are essentially complex ecological systems characterized by the interdependence of social and physical systems.[34] Changes in any one aspect

of the system reverberate throughout the system. Organizational ecology conceptualizes the workplace as a system in which physical design factors both shape and are shaped by work processes, the organization's culture, workforce demographics, and information technologies.

When this kind of ecosystems framework is applied to organizations, it suggests that one cannot understand organizational performance, including informal learning, by examining any single facet, component, or element of the overall system. It is the interdependencies and the overall pattern that count; not the individual element.

Thus knowing that a company has the "best" information technology and systems, progressive human resource policies and practices, or well-designed offices will not predict effective knowledge management or the long-term success of the organization. A generous compensation plan will not guarantee teamwork, collaboration, and innovation in a company where the language of space speaks about bureaucracy, rules, standardization, and uniformity. However, just as no technological system or human resource policy guarantees preferred outcomes, neither can good design, by itself.

Dynamic Harmony and Dynamic Constraint

What distinguishes organizations that gain competitive advantage over time is that their ecological system works in dynamic harmony. In innovative and successful companies such as Apple Computer and IDEO, the R&D processes, human resources policies and practices, information technology, leadership style, and physical design are *all* given serious attention as they interact with each other.[35] Before Digital Equipment Corporation disappeared in a merger, its national headquarters in Espoo, Finland, illustrated this brilliantly.

DEC Finland's country area president, Pekke Roine, used a truly innovative design to improve the firm's performance along a number of dimensions. The first was to raise public awareness of the brand, which was close to zero in Finland. He also wanted his sixty person sales team to interact and function as a single team. As it was, employees interacted most often with the few people sitting closest to them. Third, he wanted to demonstrate to the marketplace the value and sophistication of DEC's information systems. Fourth, and most important, he wanted to boost sales. To do that, he knew he had to motivate employees—*really* motivate them.

He did this by assembling a group of his most "crazy" and creative employees to come up with a new design for the office that might address all the issues just noted. They did. While there were some conventional workstations, more striking were the leather sofas, reclining easy chairs, decorative water fountains, inexpensive patio furniture, and brightly colorored wall murals. The overall cost was no more than a conventional office because there were no assigned offices or workstations, reducing the overall number of workstations and amount of space needed. The technology systems, including mobile phones, were the best available. There were no formal rules about when or where

employees could or should work, inside or outside the office. The goal was clear: sell more. They did. They were the most successful sales office in the world for DEC. The organizational ecology worked in harmony. Design, human resources, technology, the work processes, and the culture were all aligned.

Hargadon's ethnographic study[36] of the innovation process at IDEO and IDEO's own description of its innovation process[37] reflect this same "dynamic harmony." Hargadon argues that what sets apart firms that sustain innovation over time, such as IDEO and General Electric, is their ability to "brokerage" knowledge from non-obvious sources.[38] At IDEO, individuals learn not only from other people in the firm with very different expertise than their own; they also learn by looking at, playing with, and disassembling products to understand how they work and how they might be combined and/or adapted to serve a new purpose in a product under development. The use of physical artifacts becomes a non-verbal facet of a social network.[39]

At IDEO these products and their mechanisms are prominently displayed in, around, and above workstations throughout the office where anyone can see, handle, and explore them. They are a form of knowledge embedded in the visible physical infrastructure of the office environment. The fact that the company hires people who think visually and whose expertise is enormously broad, that these products are visually available, that the space (the height of the ceilings, the size of the workstations and offices) makes it feasible for them to be prominently displayed, and that the culture (values, reward system, formal and informal policies and practices) encourages both the display of objects and their availability to others are the characteristics of an ecological system in dynamic harmony. People, place, and process are aligned and mutually reinforce each other.

In contrast, many companies organizational ecology can best be described as having "dynamic constraint" on high performance. This was brought home to me soon after a major corporate design center I had been working on was first occupied. The project team had worked hard to generate a design for the new building that would stimulate informal, serendipitous interaction among the staff occupying the new building. They were driven by research and experience that such chance encounters, particularly involving people from different project teams and disciplines than their own, leads to more innovation.[40]

For the first time in this company, the organizational design brought together the marketing, industrial design, and product development departments with the expectation that by sharing the same space, product development innovation and cycle time would be improved.[41] Soon after move-in, a manager spotted two colleagues sitting and talking over a cup of coffee at one of the small tables in common areas put there for that purpose. He glanced at his watch, noted that it was 11am, and asked them why they were not "working." They got the message. "Real work" was when you were sitting in your workstation. They left. Within an hour, the episode and the message it contained about what constituted real work and where that occurred traveled around the build-

ing. Over a hundred million dollars invested in the planning and design of the new building was undermined in a few minutes.

As consultants, we had succeeded in having many of our design recommendations incorporated into the building's design. However, we were unsuccessful in implementing what we called an "enculturation" process. Essentially, this was a process intended to transform the organization's culture in parallel with designing a new building in order to foster dynamic harmony in the organization's ecological system. The old culture, instead, acted as a dynamic constraint. It did so by undermining the employees' ability to use the new building in the way it was designed. The physical design, intended to foster informal communication, was trumped by an entrenched management culture that viewed "real work" as something that happened in an office or workstation.

Dynamic constraint occurs whenever one facet of the organization's ecological system is in conflict with another facet. At one point the late 1980s, the Xerox Corporation spent millions of dollars on employee training to promote teamwork and collaboration. The buildings in Xerox's corporate headquarters in Rochester, New York, unfortunately, were designed in an earlier era. The organizational training encouraged teamwork but there was, literally, no place for teams to meet or interact. Dynamic constraint does not outlaw or prohibit behaviors in the way a locked door cannot be opened without a key. It simply makes some behaviors more difficult to carry out, and it requires more energy and motivation than needed when a system is in dynamic harmony. Water can be pumped up hill, but it flows much easier, with less energy or effort, downhill. The goal of a healthy organizational ecology should not be to test the limits of human adaptability.

Organizational Ecology and Knowledge Management

The danger in this view of organizational ecology is that the "system" under scrutiny becomes so large as to be completely unknowable. Where does one stop or start or intervene in the system to influence it? One point of intervention is the planning, design, and management of the spatial aspects of the organizational ecosystem. The propositions below suggest ways in which the physical design of the workplace affects a variety of types of informal learning. Research and experience suggests that that these design and spatial characteristics are associated with outcomes (such as speed of product development and degree of product/service innovation) because they influence communication and collaboration patterns on which they depend.[42] These behaviors are especially critical in dynamic firms where the rate of change is high and organizational agility is important[43]—that is, in firms that need to quickly react and adapt to changes in the marketplace, in the economy, competitors' behavior, and in technology.[44] It is also critical in environments where uncertainty is rampant and solving a problem quickly requires, by definition, the expertise of a multidisciplinary team. The model for such an organizational environment is not the corporate office, but the hospital.

Five Organizational Ecology Propositions

Five propositions—Eco-Diversity, Spatial Transparency, Unassigned Work-space, Human Scale, and Neutral Zones—link how workspace is designed, used, and managed in dynamic organizations where the rate of change and uncertainty is high.

Eco-Diversity

The more varied the settings in which work occurs, the greater the informal learning.

Graphic designers and network engineers are not cut from the same mold, and so they are likely to have different workstyles and job requirements and prefer different work environments. However, even within the same job functions, individual employees' workstyles vary. To explore how people within the same field might use the same workspace differently for similar types of informal learning, one of my graduate students, Justin Mardex, studied the Johnson Graduate School of Management (JGSM) at Cornell University.[45] We selected the JGSM because its physical design provides literally dozens of distinctly different types of spaces in which students can choose to study and interact. These include several types of individual study carrels, small study rooms, informal seating areas, and 6-8 person tables in the library; a large, open atrium with wooden benches around the perimeter and 4-6 person tables and chairs dotted around the floor area; a café area adjacent to the atrium fitted with power and network connections; rows of computer stations on a lower level where students can check their e-mail; informal lounges with TVs and vending machines; classrooms during non-class hours; and small breakout rooms.

Mardex found that all the areas were used by students, but not by the same students. Nor were all areas used for the same types of informal learning or to the same extent. Students used micro-design features (such as the availability of a network connection in a breakout room) to decide where to meet, depending on what kind of learning was involved (for example, working as a team to analyze a problem). The least likely place where informal learning of any type occurred was in faculty offices.

Lacking a comparison space for a comparable group of MBA students, this study by itself cannot determine whether a building with fewer choices about where to meet and interact informally would lead students to work more on their own, or possibly to rely to a greater extent on electronic media such as e-mail. However, it reflects similar findings from another study one of my students did several years ago on what was then Cornell's new bio-technology building.[46] Its design also included a variety of informal work and meeting areas (e.g., sofas in an atrium area; white boards along the corridors for impromptu working sessions) in addition to conventional seminar rooms. Faculty members were divided into "high" and "low" performers based on a performance index comprised of factors such as number of publications, number of article citations, and number and size of research grants. We found that high-performing faculty used a wider range of places to interact with colleagues and students informally than

did lower-performing faculty who primarily interacted in their own offices or seminar rooms.[47] These findings echo the research of Tom Allen at MIT.[48] Studying design engineers in R&D contexts, Allen found that members of higher-performing teams had more face-to-face contact with people *outside* their own team than did lower-performing members.

The focus on the work settings that are part of the official "office" space by itself may provide a misleading picture of where informal learning occurs. Working with the sales division of a large Japanese automobile company, we are finding that for new hires and relatively inexperienced staff, most informal learning (related to understanding how successful sales staff operate) occurs not in the office, but on the road. Specifically, it involves what this firm calls "windshield time."

Younger and less-experienced sales associates are expected to ask more-experienced sales associates whether they can accompany them as they make visits to a dealer. It is not unusual to organize these trips with a form of deliberate "functional inconvenience."[49] Two associates traveling to, say, Boston but whose home offices are in different places, will—rather than each flying directly to Boston (which would be more convenient)—each travel alone to a point a few hours from Boston to meet and then drive together the rest of the way. This "windshield time" is where both parties are more likely to "tell it like it is." It also provides an opportunity for less-experienced associates to ask questions that they are unlikely to ask as part of a scheduled team meeting or sales gathering.

At a meeting with the dealer, the less-experienced associate has the opportunity to observe how the more experienced associate interacts with the dealer. How does she handle dealers who may be angry, frustrated, or confused? How does she convince the dealer to invest in employee training and to adopt new practices and procedures? Such visits often involve an overnight stay, so in addition to "windshield time" there is plenty of time at shared meals or while having a drink at the end of the day to ask questions about why something was said or done in a particular way or to explore different ways one might handle a particular situation. These kinds of exchanges are a classical form of tacit learning that occurs as part of an informal community of practice.[50] Of relevance here is that such interactions almost never occurred in any settings within the sales office.

They are distinguished not only by their location, but by what might be called "time chunking"—devoting specific chunks of time to these interactions. Chen found that higher-performing faculty members interacted in a wider range of non-typical offices settings but for shorter periods of time than did lower-performing faculty.[51] Similarly, we have found that communication in team clusters is frequent, unscheduled, and of short duration compared to meetings in closed offices.[52] As a result, feedback cycles were faster, and work proceeded with clearer direction and fewer blind alleys. However, for distributed teams (such as the automotive sales teams described above or academic research teams), the chunking of time may go in the other direction—that is, fewer meetings but of longer duration.

Academic scientists, for example, will spend from a few weeks to several months or more working in a colleague's laboratory that may be across the country or on another continent. What characterizes these longer time chunks is the co-mingling of social and work communication and activities. These kinds of extended visits offer a prime opportunity for informal learning about the person, as well as the technical aspects of the work and the organizational culture in general. In particular, the social glue that underlies most effective informal learning is much more likely to be developed as part of these longer time chunks that involve meaningful amounts of time in unofficial work settings.

Spatial Transparency

The greater the opportunity for employees to easily see and hear what others are doing from inside their own workspace (and as they move in and around their team, department, and other unit's workspace as part of their daily activities), the more opportunities for modeling behavior, sharing information, and for fostering trust, cohesion, and feedback in early stages of idea development.

The literature on training documents the importance of modeling behavior.[53] In law firms, this is accomplished by the practice of young lawyers sharing office space with senior members. Teleconference and videoconference meetings in which young lawyers sit in on meetings without actively participating serve the same purpose. They allow less-experienced employees to learn by observing the behavior of the most experienced members of the organization. This is a form of what Lave and Wegner call "legitimate peripheral participation,"[54] and it is an effective way of becoming an "insider" in an informal community of practice.[55] It is precisely the opposite of what happens in many firms, where the least-experienced new hires are located together in an office ghetto, spatially isolated from the most experienced members of the firm from whom they could learn most. The lost opportunities for learning also occur in the reverse direction.[56] More senior members of the firm have few opportunities to learn new skills, often around the use of new technology and analytic tools, from new hires who may not have "deep smarts" but do possess relevant technical skills.[57]

Product and service innovation requires a willingness to explore "crazy" ideas involving recombination of information in non-obvious ways.[58] Such interaction means individuals have to not only be curious, but willing to express uncertainty and ignorance, making them emotionally and professionally vulnerable. Especially among younger employees, this can be viewed as a risky enterprise. Doing that depends "ultimately not on bureaucracy's rules, programs, and manuals but on personal trust, which comes from knowing people well enough to make informed judgments about their intentions and character."[59]

To better understand how office design influences these kinds of communication patterns, we did a study of office design among small start-up firms.[60] Of particular interest was how employees learn *without deliberate effort* both work-related and people-related information and the role it plays in their daily work life. We compared the communication and interaction patterns in closed offices, high-paneled cubicles, and visually transparent team-oriented worksta-

tion clusters (defined by a small number (4-14) of workstations clustered together without panels or walls separating them).

We found that in the more open, visually transparent team-oriented clusters, informal learning of a variety of types occurred "naturally"—that is, without formal policies and practices. For example, a computer engineer commented that:

> "As you are [working], you are picking things up from hopefully everybody you're working with. You're working with them because they bring other talents to the table. So when I'm listening to how other people are working on deals or business negotiations, not only am I working on mine, but I'm learning how they're doing it."[61]

This contrasted with closed offices, where each individual may be personally productive, but the team as a whole is not. Describing what happened at the point where a critical decision had to be made quickly, a software engineer noted the difference between a team cluster and closed offices:

> "When something critical happened [in the team cluster], people swarmed and . . . worked to solve it as a team. Here [closed offices], if something critical happens and we need to solve something, usually what you'll find are three different factions of people working on it from different perspectives . . . we've got one part of it nailed down and two other parts that never even got looked at."[62]

Informal person-related knowing is also easier in team-oriented clusters than in either high-paneled cubes or closed offices:

> "I think we all like each other . . . and we also respect each other. Like I know my strengths and weaknesses, but I think Beth and Nancy [pseudonyms] know them better than I do. And I know their strengths and weaknesses probably better than they do. It's cool. We play off each other very well. You consider you may be taking 20 minutes out of your workday to get to know somebody, but it's worth it."[63]

The value of designs that provide this kind of spatial transparency do not operate in a cultural vacuum. To be effective, they need to be in dynamic harmony with a supportive culture, including managers that value such informal communication as "real work."

Functional Inconvenience

Informal learning will be higher in organizations with space allocation policies that widen the circle of chance encounters.

In the United States, "hoteling" (a space allocation policy in which employees have no personally assigned office or workstation but rather sit wherever they choose within a designated work area) has most often been implemented as a means of reducing operating costs by minimizing the amount of space needed to house a given number of employees.[64] It can, however, also facilitate interaction with a wider range of team and departmental members. Our studies of what Thomas Allen called non-territorial offices suggest that

employees in this kind of unassigned office environment interacted more often with a wider range of team members than they had previously, when sitting in individually assigned space.[65] Such spatial allocation policies are a means of increasing the likelihood of chance encounters among a wider range of co-workers than typically occurs, since the people one sits next to on a given day are likely to be different.

Non-territorial office allocation policies constitute a type of functional inconvenience.[66] Such designs require employees to walk longer distances, for example, than they would if the primary criteria was efficiency—i.e., getting between two points in the shortest amount of time or not having to move at all. Functional inconvenience assumes the journey counts. Walking a slightly longer and circuitous route between one's office and the cafeteria is not a waste of time if the longer journey also creates more opportunities for chance encounters with people outside one's own team or department. Functional inconvenience can be expressed in a number of ways, including deliberately reducing the number of informal break and beverage areas on a floor or in a building, thereby forcing people to walk a little longer but increasing the potential for chance encounters.

Human Scale

Departments and teams organized into smaller areas will engage in more informal learning than the same-sized teams or departments occupying a single large space.

American firms typically seek to collocate all members of a department, however large, on the same floor. It is one reason for enormous floor plates of 30,000-40,000 square feet. The rationale is that co-locating all members of the same department on the same floor will increase face-to-face among departmental members. In practice, people sitting in one corner of such a huge floor rarely, if ever, interact spontaneously with someone from the other side of the building. Allen's data on communication and proximity show, consistently, that the likelihood of interacting with someone else declines dramatically when they are situated more than 30 meters apart.[67] In European companies, which seem to value the importance of face-to-face interaction more than do many large American companies, such large floor plates are less prevalent. When France's Societe Generale bank built a new headquarters in Paris, it deliberately created spaces that would accommodate about twenty-five or so employees despite departments being much larger. Similarly, in Germany and the Netherlands "group rooms" are typically designed to accommodate from 8-25 people regardless of the total size of a department. This is a size, at a team level, where people can get to know each other well socially, as well as learning about their work-related skills and knowledge. Malcolm Gladwell describes a similar principle in Gore Associates' practice of keeping the size of a whole manufacturing plant to around 250 people, despite the fact that some efficiency is lost by duplicating production lines.[68] The benefit is seen is the freer flow of information and knowledge upon which innovation depends.

Related to the overall size of the space is the extent to which functionally connected spaces are co-located or separated. The potential of a medical units'

physical design to transform the way in which a multi-disciplinary care team interacts was described by Gilleard and Tarcisius in a study of a large 1,860 bed acute general hospital in Hong Kong.[69] They found that the introduction of alternative workplace strategies on a pediatric ward of doctors and allied health professionals significantly improved communication patterns, helped resolve conflict and increased cooperation, and resulted in higher levels of service quality from the patients' perspective. Traditionally, the various professional disciplines working on the unit operated independently from each other in providing rehabilitation and clinical support services to patients. The organizational distance was exacerbated by the physical separation of departments on different floors with wide and long corridors separating them. Gilleard and Tarcisius describe the impact of the combination of physical and organizational separation on patients:

> Parents and children frequently had to "knock" on the doors of different departments, disciplines, or even hospitals to seek assessment and treatment. A typical treatment programme might require the child (and their family) to attend the hospital on multiple days. . . . Naturally, patients and parents were often exhausted, discontented, and frustrated by these multiple visits. Treatment was fragmented and communication among medical and allied health professionals disjointed.[70]

The redesign of the pediatric unit created "one-stop shopping." The unit was composed of one large open-plan area and four smaller individual working areas. The "Big Gym" was used by a variety of professionals who worked together as members of an integrated team. Children visited one joint assessment clinic used by all the allied disciplines. Whereas previously the design reflected the professional silos of the different disciplines, the new space was divided with respect to patients' rehabilitation needs. The open plan made it easy for the various disciplines to better understand the work of their colleagues. Of particular relevance here is that because specialists were no longer isolated, transfer of knowledge—both tacit and explicit—became easier. Judgments that had been defined largely within disciplinary medical boundaries became more holistic. Communication among the various disciplines and patients was also enhanced. Information about the social background of patients and their families, which was found to be important in formulating rehabilitation plans, was more easily incorporated into discussion and treatment plans. With the improved communication, mutual trust increased, making it easier to resolve conflicts immediately by compromise and collaboration. This kind of functional integration is based on co-locating different professional disciplines together for the sake both of organizational members whose performance is closely intertwined with other disciplines and for their customers, patients, and their families.

Neutral Zones

The fewer the spatial status distinctions, the greater the unfettered, informal interaction and learning.

When I first walked down the seemingly endless corridors of the U.S. Treasury department in Washington, D.C., I could not figure out the purpose of the small blue and red mats outside some of the doors. I learned that they marked the status of the office occupant. These and other spatial status indicators create, symbolically and deliberately, barriers to the free flow of information and interaction.[71] In the case of executive floors reached by elevators operated only with special keys or codes, the barrier is literally physical. However, the environmental message is clear even without security devices: stay out until explicitly invited in (and don't wait for an invitation). Such environments eliminate opportunities for casual modeling of executive behavior and reduce opportunities for critical debate and speedy but short interchanges. Paul O'Neill, when he became CEO of Alcoa, realized this. One of his first highly visible actions was to eliminate the huge executive offices on a restricted access executive floor and replaced them with open offices and a small, informal kitchen where the management team could gather, informally, in the mornings and throughout the day. His goal was to avoid the situation where members of the executive team, upon returning to the office after being away, would ask their secretary to contact the secretary of another executive to set up a meeting. Often, with full calendars, such meetings could not be scheduled for several days to a week or more. And they were rarely scheduled for less than 30 minutes. The new design made impromptu meetings that might last only a few minutes much more likely.

Status and space works to impede the free flow of ideas and information in a more subtle way as well. Interactions in spaces identified with a particular status level tend to engender behaviors associated with deference to the power and influence associated with status. For example, lower status members who interact with higher status members in space "owned" by the higher status member are more likely to defer to the higher status member, to challenge ideas less, and to have their ideas and information less often acted on. For this reason, corridor conversations—occurring in space that is essentially neutral and not "owned" by any status group—have the potential to stimulate a freer exchange of information across the organization's hierarchical levels.

This is especially critical in a hospital context where research has found that the vast majority of hospital mishaps results from inadequate communication processes among members of health care teams or between health care teams.[72] Much of this multi-disciplinary communication is informal, unplanned, and opportunistic—and it occurs in corridors.[73] It is in strong contrast to the formalized rules of hospital communications, where:

> "case conferences, team meetings, handovers and medical notes have set grammars. In the highly uncertain world of complex clinical care, formal (documented) communications are ideally structured to leave little room for uncertainty. Corridor conversations allow certainty to be, at least temporarily, suspended. In the corridor, there is a tolerance for contingencies, for 'what ifs,' for 'let's go see.' Similarly, corridors provide a space where . . . usual professional hierarchies can be suspended. In other contexts, team members refer to the doctor by his title within the hospital, conversations are not interrupted, and certainly not doctor-conversation by an allied health clinician. . . . As we have shown, the

corridor allows the occupational therapist to interrupt the doctor, the CNC to comment on the doctor's behavior, the peer support worker to interject with an emotional response. Unlike more formal communicative spaces, ignorance can be expressed with safety."[74]

The corridor is, in fact, a neutral zone—not "owned" by any particular professional discipline. In this neutral zone, nurses, doctors, physical therapists, and other health care professionals interact spontaneously and opportunistically. Higher status professionals, such as doctors, also expressed more uncertainty about the diagnosis and treatment than typically occurs in other settings. They sought out, listened to, and acted on other professional staff's views and information in ways that were not typical in other hospital settings, such as doctor's offices or conference rooms. A great deal is known about the formal communication structures that are part of clinical practice. Much less is known about how informal communication and learning is shaped by the physical spaces in which it occurs.

Conclusion

What works for one organization may not work for another. That is why benchmarking—whether of manufacturing processes or an organization's ecology—can generate counterproductive and dysfunctional solutions. In considering what constitutes an appropriate organizational ecology for any specific company or unit within it, factors such as the following need to be considered:

- *Type of Industry*—What works for Apple Computers is not likely to work equally well for the Internal Revenue Service or the Bank of America. Work processes, market and competitive conditions, organizational culture, and workforce demographics (to name but a few) are significantly different.

- *Stage in Organizational Development*—The proverbial high-tech start-up in a charismatic leader's garage, whether Hewlett and Packard's or Jobs and Wozinak's, bears scant resemblance to those same firms decades later. It is not just a matter of size, though that certainly is significant. It is also a matter of organizational priorities and available resources.

- *Organizational Size*—Companies below about 200-250 people operate more like large families than large, formal bureaucracies. Employees typically know and interact with leaders personally. There tends to be few formal rules, policies, and practices. When everyone knows everyone and talks with them frequently, informal communication, interaction, and learning happen naturally. As companies increase in size, standardization of some policies and practices and systems becomes necessary.

- *Job Function*—To understand how the spatial ecology of an organization varies across job functions, one only has to visit the offices of the account executives ("suits") versus those of the creatives ("jeans") in an advertising agency. Sleek modern furniture is likely to give way to everything

An Organizational Ecology Checklist

Five design factors that are likely to increase informal communication, interaction, and learning:

- *Eco-Diversity*—More varied work settings inside and outside the "office."

- *Spatial Transparency*—More opportunities for employees to observe the behavior of each other and the work they are doing.

- *Neutral Zones*—More deliberate planning, design, and use of spaces not "owned" by any particular discipline or unit.

- *Human Scale*—Smaller scale work areas within floors; and less separation of related functional areas.

- *Functional Inconvenience*—Designing space to increase the opportunity for chance encounters.

from barber chairs and antique cabinets to Adirondack style stick furniture. Similarly jarring variety often exists between the research scientists and the human resource managers in technology companies. The difference goes beyond the furniture itself to include subtle differences in how space is used and the role it plays in how the organization functions.

Where responsibility lies within the corporation for knowledge management largely dictates the approaches taken to manage it. Information technology leaders tend to look for answers in places like the corporate intranet. Human resources leaders are more likely to emphasize training and incentive programs. Designers seek solutions in the physical design of the work environment. No single approach, by itself, can create the dynamic harmony needed to create a healthy and productive organizational ecology. Compounding the problem over the next decade, as the Baby Boomers start to retire en mass, the tacit knowledge or what Leonard and Swap call "deep smarts"[75] of the most experienced and talented employees will dissipate, leaving organizations more vulnerable to reduced opportunities for informal learning.[76] The need, as Davenport and Prusak point out, is to "bake in" the processes and mechanisms for informal learning, rather than relying on episodic knowledge management projects and formalized training programs.[77] Time pressures, in particular, almost guarantee that good intentions for formalized information sharing are likely to quickly dissipate.[78] Another approach is needed.

One way to think about formal versus informal communication and interaction is the difference between active and passive solar energy systems. Active solar energy systems, using photovoltaic cells, require not just the cost of the specialized and expensive cells themselves, but also the associated plumbing and wiring and transformers needed to generate useful electricity. Such systems not only cost a significant amount initially, but require ongoing maintenance to insure their performance. By contrast, passive solar energy systems, like thick stone walls, absorb heat during the day and disperse it at night. Once installed,

there is minimal additional cost or maintenance required. The system essentially becomes invisible.

Both approaches generate energy. However, the cost and effort to sustain the passive system over long periods of time is much lower. It also is more resistant to and robust in the face of rapidly changing technologies that characterize active solar systems. Organizational ecologies that use design to shape interaction and communication patterns have the potential to operate as a form of deliberate but passive knowledge management system. Once in place, relatively little active maintenance of the spatial elements of the system is needed. The physical design of the workplace can act as a catalyst for change. However, as is true of any system, no single factor will create a high-performance solution.[79] Building an organizational ecology in dynamic harmony requires not just the right space, but also the information technology systems, management philosophies and styles, and organizational culture to be aligned and mutually reinforcing.

Notes

1. T.H. Davenport and L. Prusak, *Working Knowledge: How Organizations Manage What They Know* (Cambridge, MA: Harvard Business School Press, 2000); N.M. Dixon, *Common Knowledge: How Companies Thrive by Sharing What They Know* (Cambridge, MA: Harvard Business School Press, 2000).
2. Davenport and Prusak, op. cit., p. 2.
3. Dixon, op. cit.
4. Davenport and Prusak, op. cit., p. 5.
5. Dixon, op. cit., p. 13.
6. C. Soo, T. Devinney, D. Midgley, and A. Deering, "Knowledge Management: Philosophy, Processes, and Pitfalls," *California Management Review*, 44/4 (Summer 2002): 129-150, at p. 130.
7. Ibid.
8. Dixon, op. cit.; R. Mascitelli, "From Experience: Harnessing Tacit Knowledge to Achieve Breakthrough Innovation," *Journal of Product Innovation Management*, 17/3 (May 2000): 179.
9. R. Cross and A. Parker, *The Hidden Power of Social Networks* (Cambridge, MA: Harvard Business School Press, 2004).
10. R. Kraut, R. Fish, R. Root, and B. Chalfonte, "Informal Communication in Organizations: Form, Function and Technology," in S. Oskamp and S. Spacapan, eds., *People's Reactions to Technology in Factories, Offices, and Aerospace* (Thousand Oaks, CA: Sage, 1990.); L. Prusak and D. Cohen, "How to Invest in Social Capital," *Harvard Business Review*, 79/6 (June 2001): 86-93.
11. Dixon, op. cit.
12. Davenport and Prusak, op. cit.
13. J. Pfeffer and R.I. Sutton, *The Knowing-Doing Gap: How Smart Companies Turn Knowledge Into Action* (Cambridge, MA: Harvard Business School Press, 1999).
14. T. Davenport, J. Harris, D. De Long, and A. Jacobson, "Data to Knowledge to Results: Building an Analytic Capability," *California Management Review*, 43/2 (Winter 2001): 117-138; Soo et al., op. cit., p. 130.
15. T.J. Baldwin and J.K. Ford, "Transfer of Training: A Review and Directions for Future Research," *Personnel Psychology*, 41/1 (Spring 1988): 63-105; D.L. Georgenson, "The Problem of Transfer Calls for Partnership," *Training and Development Journal*, 36/10 (October 1982): 75-78.
16. Georgenson, op. cit.
17. Davenport and Prusak, op. cit., p. ii.
18. A.B. Hargadon and R.I. and Sutton, "Technology Brokering and Innovation in a Product Development Firm," *Administrative Science Quarterly*, 42/4 (December 1997): 716-749.

19. A.B. Hargadon, "Group Cognition and Creativity in Organizations," *Research on Managing Groups and Teams*, 2 (1999): 137-155; A.B. Hargadon, "Brokering Knowledge: Linking Learning and Innovation," *Research in Organizational Behavior*, 24 (2002): 41-85.
20. Hargadon (1999), op. cit.
21. Hargadon (1999), op. cit., p. 151.
22. Dixon, op. cit., p. 4.
23. Dixon, op. cit.
24. Soo et al., op. cit.
25. R. McDermott, "Why Information Technology Inspired but Cannot Deliver Knowledge Management," *California Management Review*, 41/4 (Summer 1999): 103-117.
26. J.S. Brown and P. Duguid, "Organizational Learning and Communities of Practice: Toward a Unified View of Working, Learning, and Innovation," *Organizational Science*, 2/1 (February 1991): 40-58; P. Hildreth and C. Kimble. *Knowledge Networks: Innovation through Communities of Practice* (London: Idea Group Publishing, 2004); E. Wenger, *Communities of Practice: Learning, Meaning and Identity* (Cambridge: Cambridge University Press, 1998); H. Saint-Onge and D. Wallace, *Leveraging Communities of Practice for Strategic Advantage* (New York, NY: Butterworth Heinemann, 2003).
27. Cross and Parker, op. cit
28. J. Lave and E. Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991).
29. Brown and Duguid, op. cit.
30. T. Allen, *The Flow of Technology* (Cambridge, MA: MIT Press, 1976).
31. E. Lesser and L. Prusak, "Communities of Practice, Social Capital, and Organizational Knowledge," in E. Lesser, M.A. Fontaine, and J.A. Slusher, *Knowledge and Communities* (Boston, MA: Butterworth-Heinemann, 2000), pp. 123-131.
32. D. Bailey, J. Gainsburg, and L. Sept, "Apprentice in the Chute, Guru in the Web: How Workplace Learning Varies by Rate of Knowledge Change," unpublished manuscript, 2005.
33. F. Becker and F. Steele, *Workplace by Design: Creating and Managing the High Performance Workscape* (San Francisco, CA: Jossey-Bass, 1995); F. Becker, *Offices that Work: Workspace Strategies that Add Value and Improve Performance* (San Francisco, CA: Jossey-Bass, 2004).
34. Becker (2004), op. cit.
35. T. Kelley, *The Art of Innovation* (New York, NY: HarperCollins Business, 2001).
36. Hargadon (1999), op. cit.
37. Kelley, op. cit.
38. Hargadon and Sutton, op. cit.; Hargadon (1999), op. cit.
39. J. Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," in W.E. Bijker, T.P. Hughes, and T. Pinch, eds., *The Social Construction of Technological Systems*: (Cambridge, MA: MIT Press,1987), pp. 111-134; Hargadon and Sutton, op. cit.
40. Allen, op. cit.
41. Becker and Steele, op. cit.
42. Kelley, op. cit.; M. Fradette and S. Muchaud, *The Power of Corporate Kinetics* (New York, NY: Simon & Shuster, 1998).
43. Hargadon (1999), op. cit.
44. Fradette and Muchaud, op. cit.
45. J. Mardex, "The Ecology of Knowledge Networks: A Study of the Johnson Graduate School of Management's Sage Hall Facilities," master's thesis, Cornell University, Ithaca, NY, 2004.
46. Y.C. Chen, "The Effects of Space use and Communication Patterns on Research Performance in a University Environment," master's thesis, Cornell University, Ithaca, NY, 1992.
47. Ibid.
48. Allen, op. cit.
49. Becker and Steele, op. cit.
50. Lave and Wenger, op. cit.
51. Chen, op. cit.
52. F. Becker and W. Sims, "Offices that Work: Balancing Communication, Flexibility and Cost," Cornell University International Workplace Studies Program, Ithaca, NY, 2001.
53. Baldwin and Ford, op. cit.
54. Lave and Wenger, op. cit.
55. Hildreth and Kimble, op. cit.; Wenger, op. cit.
56. Becker and Sims, op. cit.
57. Bailey et al., op. cit.

58. Hargadon and Sutton, op. cit.
59. Becker (2004), op. cit., p. 15.
60. Becker and Sims, op. cit.
61. Becker and Sims, op. cit., pp. 15-16.
62. Becker and Sims, op. cit., p. 13.
63. Becker and Sims, op. cit., p. 15.
64. M. Apgar, "The Alternative Workplace: Changing Where and How People Work," *Harvard Business Review*, 76/3 (May/June 1998): 121-136; Becker (2004), op. cit.
65. Becker and Steele, op. cit.; F. Becker, B. Davis, and W. Sims, "Using the Performance Profile to Assess Shared Offices," *Facility Management Journal* (May/June 1991), pp. 14-29.
66. Becker and Steele, op. cit.
67. Allen, op. cit.
68. M. Gladwell, *The Tipping Point: How Little Things can make a Big Difference* (Boston, MA: Little, Brown, 2000).
69. J.D. Gilleard, and L.C. Tarcisius, "Improving the Delivery of Patient Services: Alternative Workplace Strategies in Action," *Facilities*, 21/1-2 (2003): 20-27.
70. Ibid.
71. Becker and Steele, op. cit.
72. Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, eds., Committee on Quality of Health Care in America, Institute of Medicine, *To Err Is Human: Building a Safer Health System* (Washington D.C.: National Academy Press, 2000); E. Coiera, "When Conversation Is Better than Computation," *Journal of the Medical Informatics Association*, 7 (2000): 277-286; *Patient Safety and Clinical Quality Program, Second Report on Incident Management in the NSW Public Health System, 2004-2005,* NSW Department of Health, North Sydney, Australia, 2005.
73. R. Iedema, D. Long, K. Carroll, M. Stenglin, and J. Braithwaite, "Corridor Work: How Liminal Space Becomes a Resource for Handling Complexities of Multi-Disciplinary Health Care," Proceedings of APROS 11: Asia-Pacific Researchers in Organization Studies 11th International Colloquium, Melbourne, Australia, December 4-7, 2005.
74. Ibid., p. 9.
75. D. Leonard and W. Swap, "Deep Smarts," *Harvard Business Review*, 82/9 (September 2004): 88-97.
76. Ibid.; D.W. DeLong, *Lost Knowledge: Confronting the Threat of an Aging Workforce* (New York, NY: Oxford University Press, 2004).
77. Davenport and Prusak, op. cit.
78. Soo et al., op. cit.
79. Becker and Steele, op. cit.; G. Turner and J. Myerson, *New Workspace, New Culture: Office Design as a Catalyst for Change* (Aldershot: Gower Publishing Ltd., 1998).