DECEMBER, 1999

COMING TO THE CROSSROADS OF KNOWLEDGE, LEARNING, AND TECHNOLOGY: INTEGRATING KNOWLEDGE MANAGEMENT AND WORKPLACE LEARNING

Bill Penuel
Center for Technology and Learning
SRI International

Third in a Paper Series:
DESIGNING LEARNING: PRINCIPLES AND TECHNOLOGIES

Series Editor
Andrew L. Cohen, Ph.D.
Lotus Research
alcohen@lotus.com

This paper series was conceived and edited by Andrew L. Cohen of Lotus Research, who envisioned a series of papers aimed at outlining research related to the design of technology-supported workplace learning environments based on the principles of cognitive science. SRI International is responsible for the contents of the papers.

Any questions about these papers should be directed to Lotus Research at **alcohen@lotus.com**.

EXECUTIVE SUMMARY

While companies have made great strides in recent years toward managing knowledge more effectively, few companies have been able to draw connections between knowledge management and workplace learning. In this paper, we present the learning challenges of both newcomers and experts to professional communities of practice, and we present examples of integrated knowledge management and learning solutions that have been adopted in companies to support these different kinds of learners.

Newcomers need to know where expertise is distributed across a company, and how they can access it. They need to know to whom to turn with questions about personnel, marketing, sales, and the like. The company's knowledge management strategy, therefore, needs to provide newcomers with access to experts, opportunities in training and informal settings to rub elbows with more experienced staff. Newcomers also need to learn how to do their jobs, which may also involve interaction with experts and require practice in solving the kinds of problems they will face on the job. As they begin to work, there are always "teachable moments" on the job, opportunities within ongoing practice to help newcomers reflect on their practice and gain a deeper understanding of their work and how it contributes to their company's success.

Examples of successful knowledge management and learning solutions aimed at supporting novices focus on knowledge mapping, storytelling, and the creation of opportunities within ongoing practice to support reflection on problems and solutions. The Microsoft SPUD project is described as a means to helping newcomers identify where expertise is located in a geographically dispersed company and how to access experts. The GuSS simulations designed by the Institute for Learning Sciences use stories embedded within simulations to help novices learn how to sell Yellow Pages advertisements. And the Answer

Garden is a database tool developed to help programmers access expertise while leaving a record of problems asked and solved for other newcomers to access.

Experts' learning needs are focused about the requirement to interact with other experts to update continually their expertise. Opportunities to share stories of successful practice (and dramatic failures) provide experts with ways to expand individual skill to form broader communities of practice. Similarly, knowledge networks can help leverage innovation and provide environments for experts to solve new and emerging problems faced by companies. And where experts come from different disciplines, domains, or companies, there are opportunities for experts to begin to escape the blinders imposed by their own specialization.

Organizations that have successfully supported expert learning have embraced knowledge management and learning strategies that provide experts with opportunities to encounter other experts who are in remote areas from them, or who share different perspectives from them, or who come from other enterprises altogether. The Center for Innovative Learning Technologies is an innovative collaborative that brings together industry and expert researchers in learning technologies, and its Knowledge Network is a means to helping these diverse groups join forces to build new and innovative tools for learning. Likewise, the Center for Army Lessons Learned relies on databases and listservs to aid its network of diverse experts in transforming bits of information from staff in the field of operations to useful knowledge to help save lives in the new world of peacekeeping Army operations.

From these examples, we can interpret three critical points of intersection between workplace learning and knowledge management strategies. First, workers learn and manage knowledge within communities of practice. A second common thread is that learning and knowledge management are most effective when centered about actual problems. A third important intersection is that

effective knowledge management involves leaving visible traces of the learning process.

INTRODUCTION

As the global economy continues to transform itself at a rapid pace , companies have come to focus more and more on the importance of creating and managing knowledge.[1] The rise of knowledge management in companies across industries not typically associated with the production of information comes at a time when businesses are recognizing the role knowledge plays in keeping companies competitive. Companies need both to manage effectively the knowledge they do have, distributed across people, technologies, and organizational practices, and to acquire new knowledge that will enable them to stay competitive in the marketplace.

While companies have made great strides in recent years toward managing knowledge more effectively, few companies have been able to draw connections between knowledge management and workplace learning, another emerging central interest of business today. Companies have begun to examine how concepts like the learning organization are related to knowledge management strategies[2], but they are rarely guided by clear definitions of what learning is and how best to support it in the workplace. In this paper, we aim to draw attention to examples of companies that have integrated an understanding of how people learn into their knowledge management strategies. We pay particular attention to the ways that collaborative technologies have supported companies in developing integrated learning and knowledge management solutions. We recognize that technology has played a critical role in both knowledge management[3] and in workplace learning, as we discussed in our second paper "New Workplace Learning Technologies: Activities and Exemplars."

---

[1] Prusak, L. (1997). Introduction to knowledge in organizations. In L. Prusak (Ed.), *Knowledge in organizations* (pp. ix-xv). Boston: Butterworth-Heinemann.
[2] Senge, P. (1990). *The fifth discipline.*
[3] Prusak, L. (1997).

DIFFERENT LEARNING PROCESSES FOR DIFFERENT SITUATIONS

Effective companies recognize that there are different kinds of learning for different situations. Likewise, there are different strategies that a company can adopt to manage knowledge in order to meet different learning needs and accomplish the central goal of managing the company's expertise. In this paper, we will consider two different kinds of learning in detail: the learning of newcomers or novices on the job, and the learning of experts. For each group, we identify key learning needs and corresponding knowledge management strategies that address those needs. We'll also present examples of companies who have used technology successfully to meet learning needs and accomplish knowledge management goals at the same time.

In our first paper, we outlined several learning principles that can be observed across different learning situations. A central assumption embedded in all the principles is that learning takes place within communities of practice. In other words, we are always learning in context, on the go, as we participate in activities with other people, institutions, texts, and technologies. Those contexts are often defined by a professional community of people who do things together or who share a common professional identity—computer programmers, lawyers, doctors, and so forth. By arguing that learning takes place in a community of practice, we are saying that those professional and institutional contexts are always with us as we learn, and they shape what we learn, why we learn, and how we learn at work.

For a newcomer, learning to become a part of the community of practice at a new job requires first and foremost an understanding of that broader community's resources (Table 1).

Table 1

Newcomer Learning Needs

Newcomer Learning Need	Learning Principle	Knowledge Management Process	Example
To learn how expertise is distributed across the company	Learning takes place in communities of practice.	distributing representations of expert knowledge	Microsoft SPUD Project
To learn the kinds of tasks they will be expected to perform on the job	Novices learn to become experts through practice in solving a variety of problems in a domain.	Simulating work practices Distributing expert stories	Yellow Pages Sales (ILS)
To take advantage of learning opportunities within ongoing practice	Learning is enhanced through collaborative reflection.	Designing forms of strategic assistance that makes problems and solutions visible to learners	Answer Garden

Newcomers need to know where expertise is distributed across a company, and how they can access it. They need to know to whom to turn with questions about personnel, marketing, sales, and the like. The company's knowledge management strategy, therefore, needs to provide newcomers with access to experts, opportunities in training and informal settings to rub elbows with more experienced staff. Newcomers also need to learn how to do their jobs, which may also involve interaction with experts and require practice in solving the kinds of problems they will face on the job. As they begin to work, there are always "teachable moments" on the job, opportunities within ongoing practice to help newcomers reflect on their practice and gain a deeper understanding of their work and how it contributes to their company's success.

However, supporting learning among experts in a company requires different strategies than supporting novices or newcomers becoming expert in their company's specific practices. Learning among experts, even in companies who are heavily dependent on the knowledge they produce, can be extremely

difficult.[4] Experts' learning needs are focused about the requirement to interact with other experts to update continually their expertise (Table 2).

Table 2

Expert Learning Needs

Expert Learning Need	Learning Principle	Knowledge Management Process	Example
To expand expertise beyond individual skill	Learning takes place in communities of practice.	Collection and sharing of stories among experts	Collection and sharing of stories among experts
To draw from domain expertise to solve new and emerging problems faced by the company	Becoming an expert means applying learning to new contexts.	Creating knowledge networks to leverage innovation	Creating knowledge networks to leverage innovation
To escape blinders imposed by professional specialization	Prior knowledge mediates (can enhance and inhibit) learning. Learning is enhanced through reflection.	Creating problem-solving environments where diverse experts can interact	Creating problem-solving environments where diverse experts can interact

Opportunities to share stories of successful practice (and dramatic failures) provide experts with ways to expand individual skill to form broader communities of practice. Similarly, knowledge networks can help leverage innovation and provide environments for experts to solve new and emerging problems faced by companies. And where experts come from different disciplines, domains, or companies, there are opportunities for experts to begin to escape the blinders imposed by their own specialization.[5]

We believe that these two different kinds of learning comprise the core of the kind of learning most companies need to consider in order to design knowledge management solutions that also support effective workplace

[4] Starbuck, W.H. (1992). Learning by knowledge-intensive firms. *Journal of Management Studies, 29*, 713-740.

[5] Armstrong, J.S. (1985). *Long-range forecasting: From crystal ball to computer.* (2nd edition). New York: Wiley.

learning. Creating effective workplace learning involves much more than devising a knowledge management strategy; it involves a careful implementation of tools and processes that allow for the transfer of knowledge from expert to novice and for the creation of new knowledge as experts interact with one another. Knowledge transfer and knowledge creation, we argued in the first paper, are thoroughly social processes, involving much more than transferring the contents of what's in an individual's head or in a particular database to another person's head via a book, lecture, or email. It involves both explicit knowledge that is easily codified and tacit, how-to knowledge that is harder to characterize.[6] Both processes involve workers as active constructors of their own learning and require considerable social, institutional, and technological support to succeed.

In the examples of knowledge management strategies and learning processes we present in this paper, we pay particularly close attention to the way that learners—both expert and novice—play an active role in monitoring their own learning. We also focus on the ways that technology supports this role and also builds organizational knowledge within a company. At the intersection of workplace learning and knowledge management can be seen key processes and technologies that on the one hand help manage the existing knowledge assets of a company while at the same time building up and expanding the existing expertise to meet emerging demands and open up new opportunities for organizations.

KNOWLEDGE MANAGEMENT PROCESSES THAT SUPPORT NEWCOMER LEARNING

[6] Nonaka, I. (1998). The knowledge-creating company. In *Harvard Business Review on knowledge management* (pp. 21-46). Boston, MA: Harvard Business Review Press.

One of the central ways that companies manage knowledge is by hiring, training, and dismissing personnel.[7] Companies can significantly alter the knowledge available to them by bringing in promising novices and new experts or by training their existing staff in new work processes designed to keep a company's competitive edge. Any time companies bring in new staff, however, they are faced with the challenge of helping newcomers learn about the company's culture and ways of doing business. They are also faced with the challenge of introducing newcomers to their specific jobs—what is expected of them and how they are to relate to other groups within the organization, for example. Third, much of what newcomers will be expected to learn will necessarily be learned on the job, as they are trying to solve problems they encounter as they work. A mixture of formal and informal training is typically needed to ensure that newcomers do not flounder but rather engage quickly in the task of contributing to their company's bottom line.

SPUD: Learning how Expertise is Distributed

For newcomer learning to be effective, the company's managers need to have some pretty clear ideas about the expertise that newcomers will need to acquire and build that awareness into a comprehensive workplace learning program. One knowledge management tool that may be helpful is a *knowledge map*, graphical representations of the distribution of knowledge in a company. Information mapping may describe location of information, who's responsible for it, what it's used for, and access privileges.[8] A knowledge map, among other

[7] Starbuck, W.H. (1992).
[8] Davenport, T.H., Eccles, R.G., & Prusak, L. (1992) Information politics. *Sloan Management Review*, 52-65.

things, is intended to illustrate shortages and redundancies—where there's too little or two much information.[9]

The SPUD ("Skills Planning 'and' Development") Project at Microsoft is an example of a knowledge map aimed at matching system developers to jobs and work teams.[10] The project involved several steps: developing a structure of knowledge competency types and levels; defining knowledge required for particular jobs; rating performance of people in current jobs; implementing knowledge competencies to on-line system; and linking to training system. The project identified workers with various kinds of skills labeled anywhere from "foundation" (having skills that most system developers are likely to have) to "universal" (being skilled in a broad range of highly-technical tasks) and identified both explicit and tacit kinds of expertise. SPUD allowed newcomers in Microsoft to get a better sense of "who's who" across domains, to identify who might be available to solve a problem in a new area or with a particular kind of software.

What new system developers at Microsoft and newcomers at companies elsewhere must do in order to gain expertise and competence is to develop into full members of the local community of practice at their workplace. To accomplish this aim, newcomers—like all apprentices to communities of practice—need to be able to identify who are experts in the company, where they are located, and how to approach them, something that the SPUD project began to do for newcomers at Microsoft. But they needed more than just a database to learn how to do their jobs.

Newcomers also need opportunities to participate in practice "on the periphery"[11] while they are learning how to do their work. Practice on the

---

[9] Davenport, T.H., & Prusak, L. (1997). *Information ecology: Mastering the information and knowledge environment.* New York: Oxford University Press.

[10] Davenport, T.H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know.* Boston, MA: Harvard University Business School Press.

[11] Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

periphery can involve interaction with experts via simulations and modeling tools, where the company's expertise is captured and distributed via training modules to newcomers. It can also involve on-line assistance to newcomers, where experts provide help in solving problems on the fly. When a record of this learning is kept in common, the problem-solution pairs are made available to other learners in the company (both newcomer and expert), and contribute to the company's management of expertise.

GuSS: Learning How to Do One's Job

One of the problems companies face when designing learning opportunities for newcomers is how to best use experts' time. Experts in companies are always in high-demand: using them to conduct regular training sessions with new employees is not always an option. And even if it is an option, the question remains: how best to use their time? Or, from a knowledge management perspective, what is the most efficient way to ensure that knowledge of experts is transferred to novices and distributed widely across the company? No matter what, the use of experts to support learning will be costly, but the cost of failing to give newcomers the foundation they may need to create the next generation of ideas and products for the company may be even greater.

The Institute for Learning Sciences (ILS) has developed a process for gathering what have been called "war stories"[12] from experts as a first step toward transferring knowledge from expert to novice in a company (see also our second paper). War stories are stories told by experts, often to one another, that capture the interesting and unusual problems faced by people on the job— the missed opportunity, the intractable customer service problem, and so forth. What is particularly useful about war stories as a knowledge management

[12] Orr, J. E. (1991). Sharing knowledge, celebrating identity: War stories and community memory among service technicians. In D. S. Middleton & D. Edwards (Eds.), *Collective remembering: Memory in society* (pp. 169-189). Newbury Park, CA: Sage.

strategy is what also makes them such a good learning tool—war stories provide insight about how experts handle real problems on the job. To be sure gathering stories is no easy task itself: it requires the kinds of skills anthropologists bring to the task of describing cultural practices. One needs to have a good idea of what different communities of practice are up to when they are working. The collector of war stories must "restore the work," making visible what is often invisible or tacit for even the practitioners themselves.[13] And most importantly, one must know when a particular story should be told and in what situations.

ILS has developed processes for companies that employ scenarios and simulations for use in formal training environments that incorporate the use of war stories of the kind described above.[14] The ILS approach calls for intensive data gathering on the part of trainers—acquiring some knowledge of the domain, interviews with experts, and the identification of both typical and atypical failures of workers on the job—at the beginning of the process. Interviewers ask specific questions about unusual problems workers have had to face, inventive solutions to problems, and try to identify how experts label and store the war stories they tell for their own use in practice. Based on this information, trainers construct a set of *scenarios*, or possible situations that provide opportunities for workers to gain skill in the target domain.

A set of software tools, GuSS (Guided Social Simulation) and SPIEL (Story Producer for InteractivE Learning) are available to trainers to help re-contextualize the war stories into the new scenarios that have been created. GuSS is a program designed to teach complex social skills such as coaching, supervision, and selling. GuSS presents learners the constructed scenario, possible sequences of action, and feedback on how they are performing as they respond to the evolving situation in the scenario.

---

[13] Star, S.L. (1995). The politics of formal representations: Wizards, gurus, and organizational complexity. In S.L. Star (Ed.), *Ecologies of knowledge: Work and politics in science and technology* (pp. 88-118). Albany, NY: SUNY Press.

[14] Ibid.

The war stories "pop up" in GuSS as users perform some action that is inconsistent with what an expert might do. For example, in one simulation created by trainers at Ameritech, account executives encounter a situation in which they were trying to sell ads in the Yellow Pages to a customer who had bought an ad in the past. The business has been experiencing difficulties in the past year, and getting the customer to buy again or even buy a bigger ad will be a tough sell. In the opening scene, the office manager and wife of the owner answers the door. If the user fails to use the opportunity to ask her about some of what's been going on in the business before her husband (to whom she defers when he is present), a headline pops up to warn the user that a critical opportunity to learn about the business has been lost. A tag line or "bridge" announces the relevance of a war story to follow: assuming that the owner's wife will not have a role in the business may not be wise. A video of an expert seller at Ameritech can then be viewed, in which the seller tells of a story involving a husband and wife team where the wife was responsible for all business decisions. While the seller had made the appointment with the husband, if she had ignored the wife in the conversation, the sale would have been lost.

Within the GuSS architecture, SPIEL functions as the tool that trainers use to specify what story to tell when. In this sense, SPIEL helps restore some of the context of the war stories that are lost when they are videotaped. They key to the success of simulations in GuSS is that the stories being told are *relevant* to the problem at hand; They may function, moreover, not just to warn against possible opportunities missed, but in many other ways as well. Stories are categorized in SPIEL as to whether they show alternatives, critique the learner's expectations, project possible results of learner actions, or explain the perspectives of other people to the learner—all functions that stories may have in

the workplace.[15] SPIEL requires designers to create only one index of what the story "means," and uses the strategy set to determine which stories to use when in a scenario. SPIEL then causes an appropriate story to "pop up" during the course of the simulation as appropriate.

Making war stories available to newcomers in organization through the GuSS and SPIEL tools enables newcomers to learn many aspects of their work practice that might be lost if they were simply given a training manual and taught a list of instructions on how to do their jobs. First, the war stories help to characterize *non-canonical practice,* that is, events that are anomalous, unusual, or surprising.[16] Describing the non-canonical helps workers understand what can't be written down in policy guidelines, procedures, or other kinds of "directive documentation." It gives them clues for what to pay attention to, for what kinds of tacit knowledge they will need to perform skillfully on the job.

The Answer Garden: Learning Opportunities within Ongoing Practice

There are a number of tools that have been designed to help workers locate the information and expertise they need "just in time." Databases are certainly one source of information that many workers consult, especially if they are actively maintained and there is a culture within the company that invites writing down expertise in a database and then using it. The success of any such database depends on this culture and on the way information and expertise are represented within it. It is possible to design learning environments that help newcomers and experts come together and that augment a traditional discussion or problem-solving database with some specific tools to help make learning problems and their solutions visible to newcomers.

---

[15] Burke, R.B. (1998). Representation, storage, and retrieval of tutorial stories in a social simulation. In R.C. Schank (Ed.), *Inside multi-media case based instruction* (pp. 175-284). Marwah, NJ: Erlbaum.

[16] Brown, J.S., & Duguid, P. (1991). *Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation*. Palo Alto, CA: Xerox PARC.

The Answer Garden is a tool designed to support the growth of organizational memory through the creation of databases of commonly-asked questions.[17] It is designed especially for organizations that provide telephone help lines to customers, since these companies need to answer recurring (and novel) questions quickly and accurately. To use the Answer Garden, users respond to a hierarchically-ordered set of multiple-choice questions. The order and questions are set by the experts, who use a tree-branching strategy to help users identify their problems and locate answers. Users can see the "tree" at anytime, so that they can see the expert's picture of the array of possible problems users might face. If they don't find an answer to their question, they can press a button with the label "I'm unhappy." Users can then send an expert an anonymous email with their question. New questions and answers are immediately fed into the database, which grows as users and experts interact. Experts can also redesign the tree-branching structure as new questions arise or to clarify parts of the knowledge structure that may be confusing to users. The database grows organically, producing useful knowledge just in time, as users need information to solve problems at hand in their work.[18] The expertise that is captured in the Answer Garden is different from training manuals and other directive documentation developed ahead of time by planners, because it is formed on-line, as problems are being solved. The advantages of Answer Garden is that it's available anytime and that the information is likely to be perceived as more reliable, since companies identify experts to answer the questions posed by users. The experts, in turn, don't have to answer many simple questions that recur, but can instead concentrate on more interesting problems.

---

[17] Ackerman, M.S., & Malone, T.W. (1990). Answer Garden: A tool for growing organizational memory. In *Proceedings of the ACM Conference on Office Information Systems* (pp. 31-39). Cambridge, MA.

[18] Ackerman, M.W. (1994). Augmenting the organizational memory: A field study of Answer Garden. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work* (pp. 243-252).

A field study of Answer Garden shows some of its promise and also some of the limitations of the current design. A group of software engineers at Harvard and MIT used Answer Garden for a semester to help solve problems they encountered using the X Window system and its toolkits. This field of work practice is an ideal testbed for an organizational memory tool like Answer Garden": there is no body of knowledge that all software engineers share, and the constant change in the field requires engineers to be developing expertise constantly, "just-in-time." Experts in using the system were also available to help by responding to emails sent by engineers who could not find the answer to their question in the Answer Garden.

Usage of the system was fairly consistent over the semester. Over half the software engineers used the system at some point during the time. Of these, half used the system intermittently or more than 10 times during the semester. These data and interviews from users suggest that the software engineers saw the usefulness of the system in principle: they were comfortable using the Answer Garden as an intermittent source of expertise in solving problems they had with the X Window system.

The Answer Garden is a potentially powerful tool for supporting newcomer learning, because it provides newcomers with access to experts in real time and to the ways they have helped other novices in the past. The email system allows newcomers to ask questions without feeling incompetent, and it allows everyone to see a visual representation of the problem spaces that other newcomers have inhabited as they progressed in learning the X Window system. Its record of problems and solutions contributes to an organization's memory of what problems have been solved and thus helps to manage the expertise in a particular domain in which the Answer Garden is employed. The Answer Garden, then, could be said to be a "just-in-time" learning solution where the learning is not lost but is maintained as part of the organization's history of learning opportunities.

KNOWLEDGE MANAGEMENT PROCESSES THAT SUPPORT EXPERT LEARNING

Supporting learning among experts requires a somewhat different set of processes than those required for newcomers. Experts in today's economy do not remain experts simply by holding onto what knowledge they have; they, too, must be involved in learning and the creation of new knowledge. What makes the experts 'experts' today may in fact be that they can learn quickly to solve new, never-before anticipated problems on the job. The expert is fundamentally an innovator, problem-creator as well as problem-solver, engaged in supporting their company's ongoing efforts to position itself as a leader within a particular field.

To function in this way, experts need to operate within larger learning communities or learning organizations. They need opportunities to encounter other experts who are in remote areas from them, or who share different perspectives from them, or who come from other enterprises altogether. Their learning depends on "gatherings of diverse experts," encounters with others that may force them to rethink their approaches to defining and solving problems they encounter on the job. By encountering diverse perspectives, experts become less likely to remain blinded by their own professional biases, and by encouraging a dialogue among experts from different domains, experts come to see new and challenging problems as opportunities to apply what they know to engage the company's emerging problems and opportunities.

Gatherings of diverse experts are occasions for *knowledge creation* within companies. They are fundamentally opportunities for companies to invent new work processes, create new products, and identify new markets. Knowledge management among experts is a problem of organizing learning resources and opportunities in such a way that experts have new venues for

talking with each other. That talk must take place within a culture of risk-taking and innovation that encourages them to develop projects and products that force them to pull together expertise from different disciplines or fields. In this way, learning and knowledge management come together to support both individual expert and organizational learning across the company.

Revisiting the Denver Project: Expanding Expertise Beyond Individual Skill

The process of gathering experts together to talk with one another is illustrated by the photocopier repair technicians we described in our first paper.

The Denver Project involved giving technicians portable radios to allow technicians to talk to one another to solve difficult problems they encountered at client work sites.[19] The project was successful (in the eyes of technicians) because technicians were able to share stories and problems with each other on the go. The radios reduced their reliance on face-to-face meetings at the beginning or end of the workday and made their sharing of expertise a regular part of their jobs.

The technicians were using their own "war stories" in ways that were different from how ILS used its war stories in designing simulations for newcomers. For the technicians, the war stories served to build an emerging community of practice among expert repair technicians: the stories told about

particular machine repairs, client relationships, and their own mistakes were a means of developing and demonstrating their competence as technicians and as a means of collective remembering. This collective remembering preserved knowledge of different repair situations, which could be applied to diagnose new, unanticipated problems. Technicians used the old knowledge—told through stories shared and reconstructed by technicians—when they recognized familiar patterns emerging in a new situation. Over time, experts

---

[19] Orr, J. E. (1993). Ethnography and organizational learning: In pursuit of learning at work. In S. Bagnara, C. Zucchermaglio, & S. Stucky (Eds.), *Organizational learning and technological change.* New York and Berlin: Springer Verlag.

became even better at diagnosing problems,[20] and through telling and listening to stories, the technicians came to construct interpretive communities that share ways of relating events, interpreting situations, and diagnosing and solving problems.[21] Ultimately, they developed a shared company database that captured their war stories and made them available to all technicians. Technicians' stories thus act as "repositories of accumulated wisdom"[22] within the company, helping to achieve the fundamental goal of the creation of knowledge about new and often as-yet-unsolved problems.

Today there are an increasingly sophisticated ways that technologies can support this kind of expert-expert learning that integrate people, processes, and technology into integrated knowledge management-expert learning solutions. These technologies distribute company expertise broadly at the site of problem solving and help create new knowledge among experts that can help identify new products and markets. The technologies draw on the power of the Internet and company intranets, a backbone that supports remote collaboration. These technologies also scaffold expert learning by providing specific ways for experts either to develop a broader understanding of the expertise available to them to solve a particular problem or to dialogue with one another in the course of solving a problem.

The CILT Knowledge Network: Solving New and Emerging Problems

Just as stories help accomplish goals of individual and team workplace learning and knowledge generation, so too do representations and models. Among other things, shared models can establish a common language for collaborating across and within communities of practice. Problems in communication are typical when, say, engineers, contractors, and architects

[20] Orr, J. (1991).
[21] Brown, J.S., & Duguid, P. (1991).
[22] Ibid.

collaborate to build an office building.[23] Shared representations provide experts with a means to see what experts are around them and available to solve them. Knowledge networks, like knowledge maps, are tools that allow workers to learn more about the expertise around them. Some knowledge networks, like the one we describe here, are specifically geared toward helping experts learn from one another and create new learning technologies at the edge of their own expertise.

The Center for Innovative Learning Technologies is an innovative collaborative that brings together industry and expert researchers in learning technologies. The CILT Knowledge Network is a continually-updated database of resources about the Learning Technology research community available to any CILT member. The database includes description of CILT members, projects, and papers. Within the database is a demonstration tool developed by AT&T called ReferralWeb for creating knowledge maps that help the user visualize the connections between people in CILT as shown by who co-authored publications with whom. ReferralWeb lets expert researchers begin to see the networks and connections among other experts as evidenced by prior collaboration, not just institutional affiliation. What makes the CILT Knowledge Network useful, however, is not just the mapping tools and database, but the processes that surround the Network and motivate collaboration. Members of CILT participate in an annual conference, at which they present the latest tools in one of four areas: visualization and modeling, community tools, ubiquitous tools, and assessment. Researchers from across organizations—including across industry and research organizations—can collaborate to develop mini-grants to explore the edges of learning technology. Funded mini-grants have included product development proposals that could lead to commercialization, and researchers

[23] See, for example, Engestrom, Y., Engestrom, R., & Karkkainen, M. (1995). Polycontextuality and boundary crossing in expert cognition: Learning and problem solving in complex work activities. *Learning and Instruction, 5,* 319-336.

Star, S.L., & Greisemer, J.R. (1989). Institutional ecology, "translations," and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939. *Social Studies of Science, 19,* 387-420.

involved have all testified to the success of CILT in promoting these kinds of cross-institutional collaborations to support innovation.

CALL: Making Problems and Solutions Visible

The aim of the Center for Army Lessons Learned (CALL) is to gather information about U.S. Army operations and convert it into knowledge that improves the effectiveness of troops in the field. CALL is unusual in that it sends teams of experts into the field to observe missions first hand and then works with line and staff organizations to distribute knowledge in the form of "lessons learned" both vertically and horizontally within the organization. In recent years, as the Army has performed functions that it has been ill-prepared to carry out, such as peacekeeping, the CALL's ability to provide best practices knowledge rapidly to field operations staff has become a critical component of Army operations.[24]

Conditions within Army operations certainly support organizational learning. Widespread information sharing is valued, because withholding information costs lives. Good ideas are implemented not because someone demands it, but because they are useful in saving peoples' lives. The Army consistently reviews its operations using the After Action Reviews Process. After missions and trainings, officers meet with each other to discuss what went wrong, what was successful, and are therefore used to collaborative reflection on their experiences as a means to enhance organizational learning..

CALL is particularly successful in supporting expert learning. CALL relies on communities of experts from different fields to structure a process for observing missions in action, to actually go on missions, and to synthesize information into lessons learned. Teams who go into the field are comprised of

8-12 “guest experts” from across the Army with different specialist roles. CALL selects one lead for the team from within its organization, and one of the guest experts serves as a co-lead for each team, ensuring that CALL itself is able to learn continuously from its observations.

The team members’ job is to identify systematic problems and also successful solutions or best practices. In the field, they act as vertical and horizontal information sources. When they are faced with new problems, they may offer to local units lessons they have culled from previous missions. They may also watch as leaders in charge of the mission come up with solutions to unanticipated problems, and document those for review. In this way, the CALL team members gain trust by contributing their expertise, and in exchange, they get inside information about how the operation is working from the viewpoints of participants in the operation.

CALL team members in the field submit their information daily to the CALL headquarters where they are entered into a database in the form of thick descriptions. They are also posted on bulletin boards and distribution lists in order to get feedback from a diverse group of experts across the country. The descriptions circulated by CALL keep communities of experts updated on new developments in their particular area of expertise and also serve as the basis for the creation of “lessons learned.” The ideas they generated are turned around to the ground team within five days and developed into simulations, training manuals, and videos for use by troops in the operation.

The interaction among diverse experts is critical in the transformation of thick field descriptions into lessons learned that can be used in the field. Through discussion among experts on bulletin boards and listservs, and through feedback with experts in the field, common interpretations are developed by hashing out divergent views and by attempting to identify bias in information-

---

[24] Henderson, J. C., Sussman, S. W., & Thomas, J. B. (1998). Creating and exploiting knowledge for fast-cycle organizational response: The Center for Army Lessons Learned. *Advances in Applied*

gathering. These cross-functional teams help to distribute best practices quickly, while at the same time supporting expert learning. The technology enables the rapid distribution of information to experts across the organization, enabling them to participate collaboratively to create useful knowledge to staff in the field. The experts who participate in CALL are constantly challenged to update their expertise, and their interaction with experts from outside their specialization to develop useful interpretations of events for operations staff enable individual expert and organizational learning to happen simultaneously.

CONCLUSION: THE LEARNER-WORKER ROLE REVISITED

In this paper, we have described several processes and technologies that can help companies work more effectively to leverage the knowledge they have to solve new problems while at the same time supporting workplace learning among individuals and teams working on those problems. In each of the examples, we can see exemplary practices in knowledge management, supported by tools that help meet the learning needs of workers, whether they be novices or experts.

There are three critical points of intersection between workplace learning and knowledge management that can be identified in the three examples (see Figure 2).

Figure 2 The Intersection of Knowledge Management and Workplace Learning

Point of Intersection	Example	Learning Principle	Knowledge Management Outcome
Workers learn and manage knowledge within communities of practice.	*Novice learning:* Microsoft SPUD Project *Expert learning*: Denver Project	Learning takes place within communities of practice.	Novices and experts alike know where and how to access expertise within the company
Learning and knowledge	*Novice learning:* Yellow Pages Sales	Novices learn to become experts	Expertise is effectively transferred from

Business Strategy, 5, 103-128.

management are most effective when centered around actual problems.	(ILS) *Expert learning:* CILT Knowledge Network	through practice in solving a variety of problems in a domain. Becoming an expert means applying learning to new contexts.	expert to novice; new expertise is generated through creative solutions to new problems
Effective knowledge management involves leaving visible traces of the learning process.	*Novice learning:* Answer Garden *Expert learning:* CALL	Prior knowledge mediates (can enhance and inhibit) learning. Learning is enhanced through reflection.	Individual learning is transformed into organizational memory, a resource for company-wide learning.

First, *workers learn and manage knowledge within communities of practice.* Both learning processes and knowledge management processes are embedded within communities of professionals, whether they are experts or novices. In the Microsoft SPUD project, novices learned about the distribution of expertise within the extended professional community of a large company distributed across a wide geographical area. Novices could also become participants in a trajectory of expertise-development that was aligned with the knowledge map created by the company. In the Denver Project, it was experts learning from each other through stories they shared about difficult problems they faced on the job. The result of both interventions was that novices and experts alike became more knowledgeable about where and how to access expertise within the company.

A second common thread is that *learning and knowledge management are most effective when centered about actual problems.* In the simulations designed by ILS, novices learned how to solve the kinds of problems they would face on the job, becoming expert through practicing a variety of problems in their target domain. Via the CILT Knowledge Network, researchers and business developers came together to apply what they already knew to innovate and address emerging problems, generating new expertise through creative solutions to new problems. Knowledge transfer and knowledge generation were key outcomes in both projects, as novices and experts both had occasion to become active in their own learning by engaging with core problems within their field or organization.

A third important intersection is that *effective knowledge management involves leaving visible traces of the learning process.* The Answer Garden leaves a "trace" of every problem faced by novice programmers and its solution provided by an expert. The CALL team leaves visible traces in the form of databases of thick descriptions and "lessons learned" that are used by operations staff in the field. In both cases, experts' and novices' prior knowledge is transformed. Learners use their prior knowledge, but they transform it in the process of taking advantage of learning opportunities embedded within ongoing practice. The result is that their expertise is expanded, and by the technology's leaving a trace of their learning, individual learning becomes organizational memory, a resource for company-wide learning.

A final word of caution: the examples that show the intersection of workplace learning and knowledge management should be viewed as unusual and distinctive. It is easy to conflate learning and knowledge management as concepts and strategies and tempting to believe that by designing an effective knowledge management strategy, one has solved the problems of workplace learning. The examples within the points of intersection, however, do point to the promise and potential of creating an integrated solution, the key to which is rooted in both principles of learning and the collaborative technologies that support the solution. Our future as learners and as designers of learning depends upon an understanding of the limits and possibilities of this intersection.