Technology Foundations of the Learning Organization

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The degree to which modern technology can enable the learning organization is bounded only by human imagination and creativity. Every day, new and exciting technologies are emerging or are becoming practical and affordable that can have a profound impact on how people capture knowledge, achieve understanding, and communicate with one another. These activities are fundamental building blocks of organizational learning.

Technologies that support these activities can be grouped into four major clusters: data management, multimedia, networks, and artificial intelligence. Technologies that efficiently and effectively manage huge stores of data (and particularly text) provide an important foundation for learning applications by expanding beyond traditional text and graphics displays to incorporate motion video, still photographs, sound, and speech. Multimedia technologies facilitate the person-machine interaction required for successful learning applications. Network technologies enable the electronic linkage of disparate databases and people on an as-needed, low-effort basis. And artificial intelligence drives the implementation of intelligent agents and expert systems that package and leverage know-how, specialized skills, and knowledge.

Until quite recently, technology has not been available to implement the powerful and widespread applications needed to support a learning organization. While learning applications such as computer-based training have existed for some time, their impact was modest until they were able to capitalize on more powerful PCs, laser disk storage, high resolution graphics, and the like. Similarly, many learning organization applications rely on the recent deployment of advanced technology infrastructure available to all employees organization-wide: highly interactive client/server systems, powerful desktop computers with high-resolution color graphics, high-speed local and wide-area communications networks, and large-capacity data management for text and multi-media applications.

In this article we review some of the applications of these and other technologies to learning. Some are prosaic, some exhilarating, but all are real and practical. Learning organization applications can be classified into five major categories:

- Training and education
- Collaborative work
- Knowledge sharing
- Decision support and visualization
- Expert systems

Training and Education

The use of videotapes for training and education has been commonplace for some time. However, videotapes provide a passive experience that is less than ideal for effective learning. As the ancient Chinese proverb teaches:

Tell me, I forget. Show me, I remember. Have me do, I understand.

Interactive multimedia systems immerse students in the experience, allowing them to experiment with options, make mistakes, and receive feedback. For example, Motorola’s highly automated pager assembly facility in Florida employs a few staff members who must be extremely well trained. Because of the prohibitive cost of using this expensive three-shift capital asset for training, Motorola developed a multimedia-based virtual reality training system. This interactive training system has proven itself by reducing both training time and the number of mistakes made by the newly trained operators. Motorola workers who had been trained with the standard method made six times as many errors as those trained with the virtual reality simulator.

Another example of the creative use of advanced training systems is provided by Interactive Video Concepts Incorporated. IVCI has developed videodisc-based systems for training hospital social workers to help people deal with the grief of a family member’s serious illness or death. The system starts in a conventional videotape format, presenting the students with the type of situation they will face on the job. However, at several points in the story the system pauses and requires the students to make a choice from a menu of possibilities. The students get immediate feedback about the consequence of a particular action, along with comments from the instructor about the wisdom of each choice.

The use of the computer to assist and augment classroom instruction has roots that go back to the early 1960s, when the computer-aided instruction (CAI) system called Plato was developed. The project, headed by Dr. Donald Bitzer at the University of Illinois, was funded in part by a grant from the National Science Foundation and used mainframe computer hardware provided by Control Data Corporation (CDC). Because the state-of-the-art computer technology of the time limited the deployment of Plato to special training sites set up by CDC, there was little widespread use of CAI despite impressive demonstrated benefits in terms of reduced learning time and higher test scores. It was not until 1983 that CDC's investment paid off with the first profits realized by Plato. Today Plato lives on under the auspices of TRO Learning, Inc., and provides annual revenues of $17 million, growing at 19 percent per year.

In the mid-1980s, the first low-cost computer systems were introduced into homes and schools. Firms such as Texas Instruments, with its TI-99/4A, and Apple Computer, with its Apple II computers, introduced a broad variety of software designed to supplement classroom teaching of mathematical and verbal skills. Apple in particular developed a successful niche by placing machines in public schools. Although there continue to be barriers to broader usage of CAI, computer instruction has demonstrated proven benefits. It allows each student to progress at his or her own rate of speed and keeps the student's attention level high. It also provides an environment in which the student feels free to experiment with the wrong answers without fear of criticism. The student receives immediate feedback on progress without waiting for test results. And students consistently rate CAI as more fun, allowing a longer period of instruction than is possible in a conventional classroom. Perhaps most importantly, CAI actually improves the quality of learning as measured in retention and test scores. Furthermore, CAI allows one skilled instructor to handle large groups of students, who don't have to be in the same place at the same time. No wonder that today computers have an accepted and honored place in the schools. Their use continues to increase as fast as institutional factors allow.

Home „entertainment“ software is a major category in retail computer stores, often accounting for some 25 percent of the shelf space. The titles are generally rich with multimedia and combine traditional programmed learning text with sounds, pictures, and games. As we are still in the early stages of developing creative material, we can expect to see continued innovation and growth in the CAI category.

Collaborative Work

Groupware is a generic term for a variety of computer- and communications-based facilities that enhance the efficiency and effectiveness of people engaged in collaborative work. Because organizational learning by definition involves multiple people learning and sharing knowledge in a team setting, any technology that enhances their collaboration and communication can be thought of as a learning enabler.

By far the most widely used technology in this category is electronic mail (e-mail), which has now achieved a very high level of penetration for use within corporations (e.g., *USA Today* recently reported that 83 percent of employees in the U.S. federal government and 62 percent of employees in the headquarters *of Fortune* 2000 companies use e-mail), and more recently between corporations (for example, via the Internet). While electronic mail is frequently used in a straightforward way (for example, person A sends a notification to person B, or one person distributes a notice to several people), it is also frequently used in a more iterative, collaborative manner that promotes learning and sharing of ideas. Here, person A might initiate a thought that is sent via e-mail to a number of other persons, who in turn respond to each other with their thoughts on the same topic. In this manner, ideas can be shared and collaboration achieved (e.g., a joint decision reached) asynchronously among people in widely differing time zones and at different management levels in the enterprise. (Interestingly, people seem willing to send e-mail messages to superiors when they would hesitate to send a normal memo or phone message.) MCI, Microsoft, and Apple, among others, have cultures that depend on a huge daily volumes of e-mail.

Despite the speed and efficiency of e-mail, by itself it adds little to the learning environment. More significant is the concept of the bulletin board. Most systems support bulletin boards that promote interchange among many people on a topic. Here messages are sent to the bulletin board rather than to a closed set of participants; anyone can then jump in and read from the bulletin board or gain access to earlier „correspondence.“ In this manner, a chronological record is created of the interchange among the participants, and others can go back to the beginning and recapture the thoughts and ideas as they were developed. Bulletin boards are now widely used in both corporate and public networks, such as America On-line or Prodigy.

A step beyond the bulletin board is a category of systems that are geared to support collaborative work, the most popular of which is Lotus Notes. Using Notes, many people can share information (e.g., memos, presentations) as well as reference materials. While bulletin boards constrain participants to a single subject (e.g., preparation of this year's budget), more powerful systems such as Notes provide broader and more precise access by cross-referencing subject matter among many different data sources. For example, Chase Manhattan Bank used Lotus Notes to link together various internal and external data sources that are easily accessible via the internal Notes network, to which most employees have access through their desktop or laptop computers. Users of this system can then add their own comments or data (e.g., conversations with customers) and make them immediately available to anyone with a PC. In this way, what is learned in one part of the organization can be easily captured, organized, and made available quickly to the rest of the enterprise.

Lotus, which was recently acquired by IBM, has captured the largest share of the collaborative work market. However, despite the many productive applications that have been built using Notes, there are also instances in which the product has fallen short of expectations. Real learning, using Notes or other technology, depends on the creation of a social environment in which people are motivated to contribute valuable information (e.g., lessons learned) to a common base and become accustomed to going to this base to find useful information and ideas.

Still another type of groupware is designed to facilitate a team of people in a meeting (either co-located or via videoconference). All attendees have access to PCs or specialized input devices on which they can register their confidential votes on a particular topic, and the results appear on the overhead screen. Because the system is computer based, users can easily perform real-time analyses, such as calculation of means, medians, and variances, and also correlations (e.g., correlating the answers with the respondent's age or number of years with the company). IBM has made effective use of meeting-support software from Ventanna Corporation to conduct idea brainstorming, classification, and voting. Users of these systems report that the time required for such meetings is reduced by up to 10 times. In addition to the productivity gain, there are many other benefits: Shy participants get equal access to the contribution process. The immediate feedback ensures that all comments are captured. And the meeting report can be distributed without delay.

Knowledge Sharing

Knowledge management and sharing systems capture relevant knowledge in a database system and then make it available to others in the organization as needed. Knowledge sharing and knowledge sharing systems differ from data sharing and conventional database technology in several important respects, as shown in Exhibit 1.

The knowledge shared on the system may be internal or external. Internal knowledge might include, for example, best practices or intelligence about customers or competitors. Toyota has created a database of responses from two customer surveys that it makes available to dealers, salesmen, market researches, and even service personnel. External knowledge might include R&D reports, economic and industry news, technology trends, etc.

The superficial challenges in sharing and managing knowledge involve collecting it and then making it available in easy-to-use form on the desktop. External information is easy to collect, as there are many commercial services that will supply information on a regular basis or allow you to connect into their network to search for some specific knowledge.

Decision Support and Visualization

A large variety of technology learning applications fall into the category of understanding and decision-support systems. Understanding is a key element in the learning process, and many types of systems can help individuals and groups reach a higher understanding of what is actually happening or likely to happen. Usually this heightened understanding serves to support a decision. Systems that increase understanding include, for example, statistical analysis systems, which make large and complex sets of data points and patterns in the data visible so that averages, deviations from averages, trends, and couplings between the data can be understood. Similarly, graphical analysis systems reduce large and complex data sets to a graph or picture so that viewers can gain insights into the meaning of the data.

Another example is the use of geographic overlays to help in understanding data that have spatial dimensions. For example, Levi Strauss, Bane One, Arby's, and Kaiser Permanente all use geographic data overlays to better understand their market dynamics. The application works in nearly the same way for each of these firms. The firms' vital revenue statistics by product category are divided into geographic regions (in some cases down below the zip code level into census tracks). By using colors to represent income level, education, and other demographics, the product sales and growth can be correlated with these demographics. Using the analysis, the product mix can be adjusted to balance and maximize the revenue for each census track and thereby for the firm as a whole.

So-called „data mining" systems capitalize on the evolving ability of information technology (and, recently, parallel processing database machines) to help discover meaning and make practical sense out of masses of transaction-based data. The most common application is the analysis of point-of-sale data, now captured as a by-product of supermarket optical scanners. The Chicago-based firm Information Resources, Inc. (IRI) has made the capture and analysis of information from supermarket optical scanners the centerpiece of its business. By going into midsize markets, IRI is able to get nearly 100 percent access to the data being captured by every supermarket in the community. It collects and analyzes this data for the market as a whole and tracks some specific households that show bar coded ID cards at checkout. As the product manufacturers experiment with different advertising and promotion mixes in the market, this monitoring gives them nearly instant feedback into the effectiveness and impact of each dollar expended on promotion. In some markets they have even employed technology to vary the advertising on a home-by-home basis and tracked the different impact of each ad.

Exhibit 1

Data Sharing vs. Knowledge Sharing

Information System	Data Sharing	Knowledge Sharing
Query Structure	Generally structured and difficult to use	Generally unstructured and easy to use
Access	Generally limited to a few with specific job needs	Generally widely available to many who both add and extract knowledge
Information Stored	• Numbers • Text	• Numbers • Text • Images • Sound • Rules • Advice & expertise • Procedures
Output	• Periodic reports • Ad hoc queries	• Ad hoc • Continuous and integrated

Another example is Citibank's Point of Sale (POS) Systems Operation. POS analyzes the purchase patterns of each of Citibank's Mastercard, Visa Card, and Diner's Club customers so that the company can develop a unique package of coupons designed to be of interest to each customer's household. Analysis of this huge volume of data can help companies learn about their customers' habits and preferences and assess the impact of various promotional campaigns.

Virtual reality technology also supplies some interesting applications in helping to understand data. For example, investment portfolio analysis frequently involves trying to comprehend relationships among many variables. In a personal investment situation, the variables include: risk versus income, investor goals and objectives for growth versus capital conservation, personal income and expected trend, personal obligations to children and other family members, need for liquidity, and costs of making transactions. Business investment variables mirror those of personal investment and add such variables as expected return on investments and need to ration capital across a variety of possible uses. Users of virtual reality technology can view this data as three-dimensional shapes, which they can actually manipulate by using a „data glove," thus acquiring a greater understanding of the relationships among the variables.

Another class of systems designed to improve understanding is the so-called „management flight simulator" (alternatively called a „microworld"). An outgrowth of industrial dynamics (now called systems dynamics), these simulations are built on an underlying „mental model" of the dynamic and frequently complex cause-and-effect and feedback relationships among actions that management can take in running a business, or that various parties can take in a multiparty environment. Using a microworld, a person can input certain actions (e.g., setting investment levels, hiring rates, prices, service levels, etc.) and the system will analyze the results, showing the person (or team) the cause and effect and the potential consequences of each action.

The idea isn't so much that the simulation gives the „right" answer, but that it gives a reasonable answer and forces the group to share assumptions and insights about why that result might be caused by the actions taken. For example, Innovation Associates, a leader in the learning field, helped a large power company build a dynamic model of its business. This model attempted to capture the relationships among electricity prices, competition, productivity, costs, regulations, revenues, and alternative fuel shifts, so that the company could better understand the potential impact of different marketing programs from a variety of perspectives.

While interest in microworld simulations is growing, fundamentally they are not new, although PC technology has enhanced their human/machine interaction and their ability to handle more complex underlying models. There is also widespread recognition that in order for real learning to take place, the team experience must be carefully structured. Otherwise, it turns into a haphazard trial-and-error „game" to beat the system (which is fun, but provides little actual learning). The key lies in what happens before the simulation (developing hypotheses about cause and effect) and after the simulation (interpreting and learning from the results).

Another way that technology contributes to understanding is in test environments and testing facilities. Testing and experimentation are basic to the learning cycle. Simulations can be thought of as a way to test a hypothesis in a simulated environment, while test environments provide real but limited test conditions. Demos, mockups, breadboards, pilots, and models all provide the ability to try something out, learn what might be workable or not, and change design parameters prior to investing huge sums in production versions. Generic facilities that support such testing can be thought of as learning tools. For example, The New *York* Stock Exchange has built a „Usability Testing Lab" to aid in the design of enhanced trading systems. A new feature is quickly mocked-up and demonstrated to trading teams made up of specialists and clerks; as a result, the designers and users can jointly learn what is feasible and beneficial in a short time.

Expert Systems

Highly customized and specific systems have been developed to support some aspects of learning. Expert systems build on artificial intelligence technology to capture the learning of „experts" and make it available to non-experts. For example, Long Island Lighting has developed an expert system to capture certain knowledge about the diagnosing of power plant problems by key personnel before they retire from the company. American Express has created an expert system that is highly successful at detecting and managing credit card fraud. This system detects patterns of card use that depart from norms for that cardholder and then brings into play the manual intervention of a customer service representative to validate the cardholder and the transaction. With the growth in electronic commerce and wireless communications, the use of this technology for fraud management is likely to increase.

Another specialized system is in use at GM to support Quality Function Deployment. The advanced engineering and manufacturing organizations, along with product program managers, use the inquiry system to reduce the discrepancy between market information and design specifications.

Successful expert systems encapsulate the right learning of experts into a structured set of rules, enabling this learning to be shared across the organization.

Conclusion

Firms that have effectively deployed the technology infrastructure outlined above are positioned to implement learning organization applications. These, in turn, can yield important benefits for competitive advantage: the ability to capture and organize large quantities of information from both inside and outside the enterprise and to enable the right people in the organization to make sense of it, and the ability to quickly and easily share knowledge acquired in one part of the organization with individuals and groups across the entire organization.

[1] Electrical World*, March 1992, „At Lilco, experts may retire, but they leave their brains behind."*

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